REPORT

TO THE GOVERNMENT OF CEYLON

ON THE

PEARL OYSTER FISHERIES

OF THE

GULF OF MANAAR,

BY

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WITH SUPPLEMENTARY REPORTS

UPON THE

MARINE BIOLOGY OF CEYLON,

BY OTHER NATURALISTS.

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CONTENTS OF PART I.

PEARL OYSTER REPORT.

SUPPLEMENTARY REPORTS.

PREFACE.

THE plan of this work is as follows :—

AN INTRODUCTION explaining briefly the past history of the Pearl Banks in the Gulf of Manaar and the circumstances which led to my Ceylon Expedition, and the subsequent work to which it gave rise, is followed by a section, entitled NARRATIVE, which deals with the course of the investigations undertaken by Mr. HORNELL and myself, given in chronological order. The observing stations where the fauna was investigated around the Coast of Ceylon are described in detail in the Narrative ; but those other investigations—such as the anatomy of the Pearl Oyster, a description of its parasitic worms, and an account of its pearl-formation—which will be dealt with separately in special articles later on, are not treated fully in this section. After the Narrative comes a Description of the physical condition of the pearl-oyster banks or "paars" of the Gulf of Manaar, followed by their classification from the fisheries point of view, and by a short discussion as to the causes of certain paars being unreliable, and of the serious mortality of the oysters. Then comes a section dealing with the Observations and Experiments made by Mr. HORNELL and myself on the life-history and habits of the pearl oyster, which form the basis of some of our recommendations as to the cultivation of the oyster banks.

This general part is then followed by the Supplementary or Special Reports, which various scientific friends have kindly undertaken to write upon their special groups or subjects. I feel that these articles by experts add very greatly to the completeness and value of this Report, which without them could only have given a very imperfect account of the fauna and flora of the Gulf of Manaar and of the other natural conditions of existence surrounding and influencing the pearl oyster on the various "paars."

Of these special Reports, seven are published in the present Part I. The first of these is on the Geology of the Sea-bottom, by Mr. JOSEPH LOMAS, F.G.S. ; it deals with the very fundamental question of what the "paar" is, how the hard, cemented material usually known (and marked on the charts) as "rock," which by its presence enables the pearl oysters to live there, comes to be formed.

The next is by Mrs. GEPP on the Algæ collected, and this contains an account of the previously unknown fructification of a species of *Halimeda*, one of the commonest and most characteristic forms of sea-weed on the pearl banks.

The remaining Reports are Zoological. Mr. A. E. SHIPLEY's on the Gephyrea, Mr. E. R. SYKES' on the Chitons, and Mr. J. PEARSON's on the Holothurians, all contain descriptions of interesting new forms. Mr. W. M. TATTERSALL's Report on the Cephalochorda adds no new species of Amphioxus, but performs the equally useful function of showing that some of those previously described are so closely linked by variations that they may safely be regarded as the same. It is interesting to find that out of the dozen well-established species of Amphioxus, no less than seven were found in two months work round the Coast of Ceylon.

The last Report in this present Part I.—that on the Copepoda, by Mr. ISAAC THOMPSON and Mr. ANDREW SCOTT—is by far the largest, and deals with a great number of species. It is certainly surprising that we should in such a short time, without being able to pay any special attention to the group, have come across no less than 283 species of Copepoda, of which 76 were new to science. Mr. THOMPSON has acknowledged handsomely the large share which his colleague, Mr. A. SCOTT, has taken in the more laborious parts of the preparation of the Report; but I also must draw attention to the combined industry and skill which Mr. SCOTT has exhibited in the beautiful drawings for the numerous accurate plates illustrating the new species of Copepoda.

The next Part will be ready early in 1904, and will contain Reports upon the Sponges, by Professor A. DENDY; the Hydroid Zoophytes, by Miss L. R. THORNELY; the Medusæ, by Mr. E. T. BROWNE; the Turbellaria, by Mr. F. F. LAIDLAW; the Polychæta, by Mr. HORNELL; the Cephalopoda, by Dr. W. E. HOYLE; the Cumacea, by Dr. W. T. CALMAN; the Fishes, by Mr. J. JOHNSTONE; and the Entozoa of the Pearl Oyster, by Mr. A. E. SHIPLEY and MR. HORNELL.

The remaining Parts, which it is hoped will be issued during the following year, will deal with the other groups of animals. The reports on the Amphipoda by Mr. A. O. WALKER, on the Caprellida by Dr. PAUL MAYER, on the Isopoda by the Rev. T. R. R. STEBBING, on the Ostracoda by Mr. ANDREW SCOTT, on Sarcophytum and its allies by Miss E. PRATT, on the Nudibranchiata by Mr. G. P. FARRAN, on the Nullipores by Mr. J. LOMAS, the Polyzoa by Miss L. R. THORNELY, the Crinoidea by Mr. H. C. CHADWICK, and the Alcyonaria by Professor J. ARTHUR THOMSON, are in progress, and some of them are far advanced. My wife is helping me with the identification of the remaining Echinodermata, and Professor JEFFREY BELL has kindly undertaken to examine and describe those that seem new. Mr. A. LEICESTER and Mr. W. J. HALLS are engaged in examining the Molluscan shells, and will draw up a list of all the species collected. A few other groups are still unexamined. The final Part will contain in addition the remainder of Mr. HORNELL's and my own observations and conclusions, including the results of our experiments now in progress, and our final recommendations as to the future management of the pearl oyster banks.

It is pleasant to be able gratefully to acknowledge much help, both administrative and scientific. To many in Ceylon—to their Excellencies the Governor Sir West Ridgeway and the Lieutenant-Governor Mr. E. F. im Thurn and to others—I am indebted for much kindness and consideration which smoothed away difficulties, expedited my work, and rendered duty a pleasure. I desire also to record my thanks to Captain J. Donnan, then Master Attendant at Colombo and Inspector of the Pearl Banks, and to his successor, Captain J. Legge, who, during the time which I spent with them on the inspection barque "Rangasameeporawee," spared no trouble in trying to let me examine as satisfactorily as possible the various banks and the other localities and conditions which I desired to investigate. I had also the advantage of spending some days on the pearl banks with Sir William Twynam, who has had a long extended experience of the fisheries as Superintendent from 1862 to 1896, and as Government Agent of the Northern Province.

Several men of science in Ceylon were kindly in their welcome and practical in their help. I would specially mention Dr. A. J. Chalmers, through whose good offices the Medical College at Colombo placed accommodation in one of their laboratories at the disposal of Mr. Hornell and myself; Mr. J. C. Willis, Director of the Botanic Gardens at Peradeniya, and the late Mr. Oliver Collett, of Roselle, who has himself written on the pearl-oyster fisheries. I was fortunate in accidentally meeting during my first few days in Ceylon Dr. Paul and Dr. Fritz Sarasin, who had made important biological investigations at Trincomalee; and also Professor Alexander Agassiz, then returning from his expedition to the Maldives, who very kindly allowed me to ship from his steamer to mine, as they lay together in Colombo Harbour, a reel containing 600 fathoms of steel-wire dredging rope.

I desire to record my entire satisfaction with the work done by Mr. James Hornell, both while I was with him and also since. I was fortunate in having such a capable and willing assistant, and such a helpful and pleasant companion. It would have been quite impossible for me to have got through the work that had to be done in the very limited time at my disposal had it not been for Mr. Hornell's skilled assistance.

I am much indebted to the Staff of the Colonial Office, and to Sir Michael Foster, K.C.B., of the Royal Society, for their interest in this investigation, for their advice from time to time, and for the trouble they have taken in facilitating the arrangements by which this Report will be published by the Royal Society for the Government of Ceylon. And I need hardly say how gratefully I acknowledge the appreciation of my labours shown by the Royal Society in assisting, in the first instance, towards my being requested to carry out the investigation and subsequently in undertaking the publication of the Report.

W. A. HERDMAN.

The University, Liverpool,
August, 1903.

REPORT ON THE PEARL OYSTER FISHERIES OF THE GULF OF MANAAR.

INTRODUCTION.

The celebrated "Pearl oysters" of Ceylon are found mainly on certain parts of the wide shallow plateau which occupies the upper end of the Gulf of Manaar, off the North-west Coast of the Island and South of Adam's Bridge. Pearl banks also exist on the opposite Coast of India, off Tuticorin. The animal (*Margaritifera vulgaris*, Schum., = *Avicula fucata*, Gould) is not a true oyster, but belongs to the family Aviculidæ, and is therefore more nearly related to the Mussels (*Mytilus*) than to the Oysters (*Ostrea*) of our British seas. One very notable character of great practical importance, in which it differs from *Ostrea*, is that the Pearl oyster, like our common Mussels, has a "byssus" or bundle of tough threads by which it can attach itself to rocks or other foreign objects.

The Pearl Fisheries of Ceylon, India, and the Persian Gulf, yielding the highly prized "Oriental" pearl, are of very great antiquity. They are probably the most ancient fisheries still in existence, and seem to be carried on at the present day under very much the same conditions as 2000 or perhaps even 3000 years ago. These fisheries are referred to by various classical writers, and Pliny, after saying how highly valued the pearls are at Rome, refers to Taprobane [Ceylon] as "the most productive of pearls of all parts of the world."* Pliny also describes the coral that abounds in the Gulf of Manaar, and mentions pearls and precious stones as the products of Ceylon. But the Singhalese records take us to still earlier times. According to the "Mahawanso," pearls figure in the list of native products sent as a present from King Vijáya of Ceylon to his Indian father-in-law in about 540–550 B.C.; and again when, in B.C. 306, King Devanampiyatissa sent an embassy to India the presents are said to include eight kinds of Ceylon pearls. The King's Hall in the Brazen Palace at Anuradhapura (B.C. 161) is said to have been decorated with native pearls. The mortar in the ruins of Polonaruwa shows the remains of the pearl-oyster shells which were used in its manufacture—no doubt the refuse of an

* 'Plin. Nat. Hist.,' Bk. IX., chap. 54, Lemaire's Edition. I am indebted to my colleague, Professor H. A. Strong, for kindly giving me these and other references. Athenæus and Ælian make similar statements. The anonymous "Periplus" of the Erythræan Sea describes a great pearl fishery at Colchi, near Comar, in Taprobane or Ceylon, which probably refers to some part of the Gulf of Manaar.

early fishery. Many other references could be given. In the eighth to eleventh centuries, trade in the East was in the hands of the Persians and Arabs, and we find Arab writers alluding to the pearls. We know also that they enriched the kings of Ceylon in the days of MARCO POLO (1291). One record, given by Friar JORDANUS, says that in 1330 about 8000 boats were engaged in the pearl fisheries of the Gulf of Manaar.

CÆSAR FREDERICK, a Venetian merchant (1563), crossed from India to Chilaw (about the middle of the West Coast of Ceylon) to be present at a pearl fishery, the methods of which were very much as they would be at the present day. We are told that the Tamil name "Salubham" (Sea-of-Gain) given to the Gulf of Manaar because of its pearl banks, was also applied to Chilaw, which in former times was the town nearest to the fishery. The centre of the pearl fishery is now much further north, but the oyster "paars" still exist off Chilaw, and were fished at least thrice during the nineteenth century, in 1803, 1815, and 1884. And so we continue to have glimpses,* through the centuries, of this ancient and highly prized industry being carried on with little or no change, first under the Singhalese kings of Kandy and the Tamil kings of Jaffna, and subsequently under the successive European rulers. At the time when RIBEYRO† wrote (1685), Aripu was, as it has been since, the centre of the northern fisheries, and from the description given, it is evident that the method of fishing in these Portuguese times was as we see it now, even to the manning of the divers' boats and the cessation of diving at noon. As would be expected, we have much more definite records of the details of the fisheries during the Dutch and British occupations than in previous times. We have a vivid description, by MARTIN, of a fishery which took place off Tuticorin in 1700. PERCIVAL (1803) and CORDINER (1807) both give excellent accounts of the early British fisheries. The last Dutch fishery took place in 1768, and the first under English control in 1796—and for this fishery the arrangements were made before the surrender of Colombo.

* Here is another glimpse of the early native fisheries which I have just (August 18th, 1903) received from Sir WILLIAM TWYNAM of Jaffna. He says: "It is an extract from the translation of an old Tamil work called the 'Kalveddu,' given to me some time ago by a Mr. TILLEANOBELAM, employed in the Jaffna Kachcheri"—"VIDANARAYANEN CHEDDI and the Puravu men who fished pearls by paying tribute to ALLIYARASANI, daughter of PANDIYA, king of Madura, who went on a voyage, experienced bad weather in the sea, and were driven to the shores of Lanka, where they founded Karainerkai (Karativo) and Kutiraimalai (Kodramallai). VIDANARAYANEN CHEDDI had the treasures of his ship stored there by the Puravus, and established pearl fisheries at Kadalihilapam (Chilavaturai) and Kallachihilapam (Chilaw), and introduced the trees which change iron into gold," &c., &c.

Sir W. TWYNAM adds: "The Puravu divers referred to were afterwards converted to Roman Catholicism by St. FRANCIS XAVIER, and their descendants are, I believe, the Roman Catholic Puravu divers who now come to our fisheries from Tuticorin and other ports in Southern India;" and "some large mounds of old oyster shells were pointed out to me in the neighbourhood of Marichchukaddi as having been the accumulations of Queen ALLIYARASANI's fisheries."

† My copy is LE GRAND's translation, "Histoire de l'Isle de Ceylan," Amsterdam, 1701; I believe it is doubtful whether the original Portuguese of Captain RIBEYRO was ever published.

A notable feature of these fisheries, under all administrations, has been their uncertainty and intermittent character. The Dutch records show that there were no fisheries between 1732 and 1746, and again between 1768 and 1796. During our own time the supply failed—to mention only the longer intervals—in 1820 to 1828, in 1837 to 1854, in 1864 to 1873, and finally after five very successful fisheries in 1887 and the succeeding years, culminating in the record fishery of 1891 (when the Government proceeds reached close upon a million of rupees), there has been no return for the last decade. In addition to the longer intervals given above, there were many unproductive single years or groups of two and three; in fact there were, in all, only 36 fisheries during the nineteenth century. It will be of interest to give here the complete list in the following table (p. 4), compiled by Mr. HORNELL at the Government Record Office in Colombo. Besides showing the marked intervals, and the general irregularity in results, it brings out the very considerable value of the fisheries, and is a useful indication of the relative productiveness of the principal paars.

The intermittent character of the fisheries has been recognised by various writers both before and since 1740, when Baron VON IMHOFF, then Governor, wrote in a memorandum for his successor:—"It is now several years since the pearl banks have fallen into a very bad state both at Manaar and Tuticorin; this is mere chance, and experience has shown that, on former occasions, the banks have been unproductive even for a longer period than has yet occurred at present." What was formerly put down to "chance" has in most lines of inquiry proved susceptible of scientific analysis and explanation, and it is reasonable to expect that, in the case of the pearl fisheries, investigation will lead to a better understanding of the phenomena, and a rational treatment based on such knowledge to a greater regularity in the results.

Writing in 1697, for the instruction of the Political Council of Jaffnapatam, the then Commandant of that town justly remarked that "the pearl fishery is an extraordinary source of revenue on which no reliance can be placed, as it depends on various contingencies which may ruin the banks or spoil the oysters." The above is quoted by both THURSTON and COLLETT in their recent papers. Mr. THURSTON's comment is: "And this remark holds good after the lapse of two centuries." The late Mr. OLIVER COLLETT adds: "This statement holds good after a lapse of more than two centuries—indeed, the periodical disappearance of oysters from certain of the banks, sometimes for many years at a time, may be said to form one of the peculiar characteristics of the Ceylon fishery. Nevertheless, since the British occupation of the island, a sum equal to more than one million sterling has been derived from the fishery; and the matter is therefore one of immense importance to the Government of the Colony."*

* "Pearl Oysters and Pearl Fisheries," by O. COLLETT, F.R.M.S., 'Journ. R. Asiat. Soc.,' Ceylon Branch, vol. XVI., No. 51, 1900.

PARTICULARS of the Pearl Fisheries held during the Nineteenth Century.

(Compiled from the Government Records.)

Year of fishery.	Total number of oysters fished.	Gross Government proceeds in rupees.	Name and region of bank fished. [*The notes within square brackets are added by Mr. Hornell.*]
1801	[Particulars not available as to number of oysters fished.]	150,227	Kondatchi Paar.
1803		163,154	Chilaw Paar.
1804		770,202	Aripu [Cheval and Modragam paars (*fide* VANE'S "Report" to Governor, Sir H. WARD, February, 1863).]
1806		412,842	,,
1808		842,577	,,
1809		272,463	,,
1814		1,051,876	,,
1815		5,842	Chilaw Paar.
1816		9,266	Aripu [Cheval and Modragam paars (*fide* VANE).]
1820		30,410	,,
1828		305,234	South-East Modragam Paar.
1829		382,737	North-West Cheval Paar.*
1830		222,564	South-East ,, ,,
1831		293,366	North-West ,, ,,
1832		45,810	Off Karativu (near the Isle of Cardieu).
1833		320,896	Periya Paar Kerrai.
1835	16,058,880	403,460	,, ,, ,,
1836	6,181,537	58,624	Modragam Paar.
	737,105	10,524	Cheval Paar [Central].
	2,974,236	40,158	Periya Paar Kerrai.
	6,117,750	145,629	Koddai Paar [South Cheval].
1837	2,538,307	106,312	North Cheval Paar.*
1855	6,743,762	109,220	South-West Cheval Paar.
1857	32,453,053	203,633	North-West ,, ,,
1858	16,484,861	241,200	,, ,, ,,
1859	3,143,402	194,481	,, ,, ,,
	6,391,549	287,678	North Modragam Paar.
1860	791,226	87,269	,, ,, ,,
	2,813,271	279,547	South-East Modragam.
1863	11,695,794	510,178	South-East Cheval Paar.
1874	1,699,669	101,199	North-West Cheval Paar.
1877	6,685,001	184,591	South-East and East Cheval Paar.
	164,719	4,420	North Modragam Paar.
1879	7,645,901	95,694	Kottapakku Paar (3 miles West of Cheval Paar) [Periya Paar].
1880	35,238,972	200,152	North-West Cheval Paar.
1881	27,338,596	599,533	,, ,, ,,
1884	636,000	17,153	Off Chilaw.
1887	8,834,330	103,664	North Modragam Paar.
	22,513,575	292,430	North-East Cheval Paar.
1888	22,052,769	804,247	Cheval Paar (whole) and both Modragams (North and South).
1889	38,995,447	498,377	Muttuvaratu Paar. [Included in these figures are the proceeds of 1 day's fishing each year on Karativu Paar (200,243 oysters in 1891).]
1890	33,677,892	313,177	
1891	44,311,441	963,748	

* [We cannot attach much importance to the topography of the Cheval Paar in these early records. The nomenclature of the regions has varied much in the past. For example, DONNAN'S North-East Cheval is not that of STEUART.]

Many reasons, some fanciful, others with more or less basis of truth, have been given from time to time for the recurring failures of the fishery; and several investigations, such as that of Dr. KELAART (who unfortunately died before his work was completed) in 1857 to 1859, and that of Mr. HOLDSWORTH in 1865 to 1869, have been undertaken without much practical result so far.

In September, 1900, after a continued failure of the fishery for ten years, I was asked by the Colonial Office (acting on the advice of the Council of the Royal Society and of Professor RAY LANKESTER) to examine the records and report upon the matter, and in the following spring I was invited by the Government to go to Ceylon at the end of the year, with a scientific assistant, and undertake such investigation into the condition of the pearl banks as might appear necessary. I arrived at Colombo in January, 1902, and, as soon as a steamer could be obtained, proceeded to the Gulf of Manaar.

In April it was necessary to return to my University duties in Liverpool, but I was fortunate in having taken out with me as my assistant Mr. JAMES HORNELL, who, it was arranged, would remain in Ceylon for at least a year longer in order to continue the observations and experiments we had started and complete our work. This programme has been carried out, and Mr. HORNELL has kept me supplied with almost weekly reports, and with specimens requiring detailed examination.

The s.s. "Lady Havelock" was placed by the Ceylon Government at my disposal for the work of examining into the biological conditions surrounding the pearl-oyster banks; and this enabled me on two successive cruises of three or four weeks each to examine all the principal banks, and run lines of dredging and trawling and other observations across, around, and between them, in order to ascertain the conditions that determine an oyster "paar." Towards the end of my stay I took part in the annual inspection of the pearl banks, by means of divers, along with the retiring Inspector, Captain J. DONNAN, C.M.G., and his successor, Captain LEGGE. During that period we lived and worked on the native barque "Rangasameeporawee," and had daily opportunity of studying the methods of the native divers and the results they obtained.

It is evident that there are two distinct questions that may be raised—the first as to the abundance of the adult "oysters," and the second as to the number of pearls in the oysters, and it was the first of these rather than the frequency of the pearls that seemed to call for investigation, since the complaint has not been as to the number of pearls per adult oyster, but as to the complete disappearance of the shell-fish.

Most of the pearl-oyster banks or "paars" (meaning rock or any form of hard bottom, in distinction to "manul," which indicates loose or soft sand) are in depths of from 5 to 10 fathoms, and occupy the wide shallow area of nearly 50 miles in length, and extending opposite Aripu to 20 miles in breadth, which lies to the south of Adam's Bridge. On the western edge of this area there is a steep declivity, the sea deepening within a few miles from under 10 to over 100 fathoms; while out in the centre of the southern part of the Gulf of Manaar, to the west of the Chilaw pearl banks, depths of between 1000 and 2000 fathoms are reached. On our two cruises in the "Lady Havelock" we made a careful examination of the ground in several places outside the banks, to the westward, on the chance of finding beds of adult oysters from which possibly the spat deposited on the inshore banks might be derived. No such beds, outside the known "paars," were found; nor are they likely to exist. The bottom deposits in the ocean abysses to the west of Ceylon are "globigerina ooze" and "green mud," which are entirely different in nature and origin from the coarse terrigenous sand, often cemented into masses, and the various calcareous neritic deposits, such as Corals and Nullipores, found in the shallow water on the banks. The steepest part of the slope, from 10 or 20 fathoms down to about 100 fathoms or more all along the western coast, seems in most places to have a hard bottom covered with Alcyonaria, Sponges, deep-sea Corals, and other large encrusting and dendritic organisms. Neither on this slope, nor in the deep water beyond the cliff, did we find any ground suitable for the pearl oyster to live upon.

It soon became clear to us that different paars were placed under very different physical and biological conditions, and that the sudden disappearance, or the continued absence, of pearl oysters in different localities and at different times might be and probably was due to very different causes. The Periya Paar, about 20 miles from land and close to the top of the steep slope (see p. 78), is very differently situated from the East Cheval or the Modragam paars relatively near the shore, protected to some extent from the ocean and with shallow water all around. The pearl oyster is the same animal all over the district, and facts of anatomy and physiology once ascertained will hold good; but the paars are different, each presents its own problems, and all must be studied. In reading the reports of former superintendents and inspectors of the pearl banks, it is possible, after acquiring some knowledge of the physical and biological conditions of the various paars, to account for some of the apparently mysterious disappearances of oysters and catastrophic changes in the fauna. It is unnecessary to go over all the cases that have been recorded, but the recent history of the Periya Paar, and the more noteworthy disasters on the Cheval and other important paars, will be found discussed below. For a knowledge of the past history of the pearl banks we are indebted mainly to the official reports of the Ceylon Government. I would mention especially as amongst the most important contributions to our knowledge of the subject: the reports of Dr. E. F. KELAART in 1857 to 1859; the "Account of the Pearl Fisheries of Ceylon," by Captain JAMES STEUART, Ceylon, 1843; H. SULLIVAN THOMAS' "Report on the Pearl Banks and Fisheries of Tuticorin"; "The Pearl and Chank Fisheries of the Gulf of Manaar," by E. THURSTON (Bulletin of the Madras Museum, No. 1, 1894); Mr. E. W. H. HOLDSWORTH'S "Report on the Pearl Oyster Banks," 1867; Captain J. DONNAN'S successive Reports on Inspections and Fisheries; and finally the comprehensive and most interesting "Report on the Ceylon Pearl Fisheries," drawn up in 1899 by Sir WILLIAM C. TWYNAM, K.C.M.G. (Colombo, 1900).

There is much that we agree with in all of these previous reports. There are some points in each on which we differ from the author. We account for the occurrence in another way, or draw a different conclusion from the observed facts. Several of these writers, although not strictly speaking scientific men, were accurate observers and acute investigators who have left valuable records. Others better equipped in scientific training have been prevented from doing more by unfavourable circumstances. Dr. KELAART's short reports show that he was tackling the problems in a scientific manner, and his researches were incomplete at the time of his sudden death.* Mr. HOLDSWORTH's visit to Ceylon (1865–69) was apparently made at an unfortunate time. Mr. OLIVER COLLETT states ('Journ. R. Asiat. Soc.,' Ceylon, Br., 1900) that Mr. HOLDSWORTH never had an opportunity of seeing a fishery, and according to Sir W. TWYNAM, he "did not witness an inspection of a bank with a bed of oysters on it, young or old." Mr. HORNELL and I were more fortunate, as during our cruises in the Gulf of Manaar we found pearl oysters in all stages of growth, from the microscopic free-swimming larvæ and newly-deposited "spat" to the pearl-bearing adults, and we have also two consecutive inspections of banks well covered with oysters, and the successful fishery of 1903, from which to draw conclusions. Mr. THURSTON, of Madras, has also had experience of fisheries and inspections with Captain DONNAN, and has written a most interesting and valuable record containing a great deal of incidental information as to the fauna of the Gulf of Manaar, but had apparently not the opportunity and the implements for a more detailed survey, nor the time for a more thorough investigation of the oyster problems.

To all our predecessors, however, we are indebted for information and for suggestions which have been of value to us in our work. That work has led us into various different lines of inquiry. Outside the larger influences, cosmic in origin, uncontrollable, and wide-spread in effect, such as oceanic currents, monsoon storms, depth of water, configuration of bottom, and shifting sands which may devastate a bank and cause the sudden disappearance of many millions of oysters, there are, in addition, various minor causes of failure of the fisheries, some of which we were able to investigate. The pearl oyster has many enemies, such as Star-fishes, boring Sponges which destroy the shell, boring Molluscs which suck out the animal, internal Protozoan and Vermean parasites, and carnivorous Fishes, all of which cause some destruction, and may on occasions conspire to ruin a bed and change the prospects of a fishery. But, in connection with such animate foes, it is necessary to bear in mind that, from the fisheries' point of view, their influence is not wholly evil, as some of them are closely associated with pearl production in the oyster. One enemy (a Plectognathid fish), which doubtless devours many of the oysters, at the same time

* Soon after the fishery of 1859, during which Dr. KELAART worked with the Swiss Naturalist, HUMBERT, at Chilavaturai, he was sent to England in medical charge of General LOCKYER, who was very ill and died in the Red Sea. Dr. KELAART, who was in constant attendance on the General, died suddenly a day or two later.

receives and passes on the parasite which leads to the production of pearls in others. The loss of some individuals is in that case a toll that we very willingly pay, and no one would advocate the extermination of that particular enemy.

In fact, while wholly at the mercy of its inanimate surroundings, such as storms and sand, the pearl oyster can probably cope under most circumstances with its animate environment on the paars, if not too recklessly decimated at the fisheries, and if not exposed to some exceptional combination of adverse influences. Man has thus afforded to him the opportunity of intervening. Although he cannot control the monsoon or build a sea-wall around the "paar," yet without any violent attempt to disturb the balance of Nature, or remove wholly the influence of any particular enemy, he can compensate to some extent for the damage he himself does, and he can help the oyster population to withstand the attacks of normal enemies and prevent complete destruction under abnormal combinations. This he can do by giving some attention to the breeding stock, by having a more intimate knowledge of the exact distribution of the oysters at all ages on the ground, by attending to the dissemination and location of "spat," by thinning out in parts where there is overcrowding, or where young are mixed with old, and by transplanting, when required, the growing young from unsuitable ground, where from experience it is known they cannot arrive at maturity, to more sheltered and reliable "paars."

It is clear that, in considering the conditions of existence of the oyster and the vicissitudes of the pearl banks, we have to deal with great natural influences which cannot be wholly removed, though they may to some extent be avoided and compensated for; and that, consequently, it is necessary to introduce large measures of regulation and cultivation in order to increase the adult population on the ground, have the more reliable "paars" provided more fully with successive broods of young oysters by transplantation, and so give greater constancy to the supply and remove the disappointing fluctuations in the fishery.

We have shown conclusively in our work the ease with which young pearl oysters can be dredged up in quantity and transported to considerable distances, and we can also demonstrate by our figures the advantages derived by transplantation from overcrowded and unhealthy localities to better conditions. The young are present in abundance, and they are probably sacrificed in millions every year. When we examined the Periya Paar in March, 1902, we estimated the number of young pearl oysters on the ground at not less than a hundred thousand millions; when Mr. Hornell returned in November they were all gone. With such numbers the inshore paars could be kept continuously supplied with young oysters transplanted from their precarious position on the more exposed grounds out at sea.

There is no reason for any despondency in regard to the future of the pearl fisheries, if they are treated scientifically. The adult oysters are plentiful on some of the paars and seem for the most part healthy and vigorous; while young oysters in their first year, and masses of minute spat just deposited, are very abundant in many places. The material exists, ready for man's operations.

To the biologist two dangers are, however, evident, and, paradoxical as it may seem, these are *overcrowding* and *overfishing*. But the superabundance and the risk of depletion are at the opposite ends of the life-cycle, and therefore both are possible at once on the same ground—and either is sufficient to cause locally and temporarily a failure of the pearl-oyster fishery. What is required to obviate these two dangers ahead and ensure more constancy in the fisheries is careful supervision of the banks by someone who has had sufficient biological training to understand the life-problems of the animal, and who will therefore know when to carry out simple measures of farming, such as thinning and transplanting, and when to advise as to the regulation of the fisheries.

In connection with cultivation and transplantation there are various points as to structure, reproduction, life-history, growth and habits of the oyster which we had to deal with, some of which we were able to determine on the banks, while others have been the subject of Mr. Hornell's work since, in the little marine laboratory we established at Galle, in the south of Ceylon.

Although Galle is at the opposite end of the island from the pearl banks of Manaar, it is clearly the best locality in Ceylon for a marine laboratory—both for general zoology and also for working at pearl-oyster problems. Little can be done on the sandy exposed shores of Manaar Island or the bight of Kondatchi—the coasts opposite the pearl banks. The fisheries take place far out at sea, from 10 to 20 miles off shore, and it is clear that any Natural History work on the pearl banks must be done not from the shore, but, as we did, at sea from a ship during the inspections, and cannot be done at all during the monsoons because of the heavy sea and useless exposed shore. At such times, the necessary laboratory work supplementing the previous observations at sea can be carried out much more satisfactorily at Galle than anywhere in the Gulf of Manaar.

Turning now from the health of the oyster population on the "paars" to the subject of pearl-formation, which is evidently an unhealthy and abnormal process, we find that in the Ceylon oyster there are several distinct causes that lead to the production of pearls. Some pearls or pearly excrescences on the interior of the shell are due to the irritation caused by boring sponges and burrowing worms. Minute grains of sand and other foreign particles gaining access to the body inside the shell, which are popularly supposed to form the nuclei of pearls, only do so, in our experience, under exceptional circumstances. Out of the many pearls I have decalcified, only one contained in its centre what was undoubtedly a grain of sand; and from Mr. Hornell's notes taken since I left Ceylon, I quote the following passage showing that he has had a similar experience:—"February 16th, 1903. '*Ear-pearls*,' of two decalcified, one from the anterior ear (No. 148) proved to have a minute quartz grain (micro-preparation 25) as nucleus." Since then he has found one more.

It seems probable that it is only when the shell is injured, as, for example, by the breaking off or crushing of the projecting "ears," thereby enabling some fine sand to gain access to the interior, that such inorganic particles supply the irritation which gives rise to pearl formation.

Pearls of another class are found in the muscular tissue of the animal, usually in the levators of the foot, and in the palpar region, but also frequently in the pallial insertions, rarely at the insertions of the retractor and adductor muscles. These muscle-pearls have no organic nuclei. They seem to start as minute calcareous concretions ("calcospherules") in the tissue, and the centre is sometimes crystalline. They may be extraordinarily abundant. At the insertion of one levator muscle, 23 small pearls were counted with the eye, while under the microscope 170 additional tiny spherules were found to be present.

The best pearls, however, the "cyst" or "orient" pearls, lie in the thin muscular margin of the mantle, or in the thick white lateral part over the stomach and liver, or even, secondarily, free in a cavity of the body.

Consequently, as we shall show in the section of the Report dealing with pearl-formation, we can classify these pearls from the biological point of view into three sets:—(*a.*) "Ampullar-pearls" which are not formed within closed epithelial sacs like the others, but lie in pockets or ampullæ of the epidermis. The nuclei may be sand-grains or any other foreign particles introduced through breaking or perforation of the shell. (*b.*) "Muscle-pearls" formed around calcospherules at or near the insertions of the muscles. (*c.*) "Cyst-pearls" where concentric layers of nacre are deposited on cysts containing parasitic worms in the connective-tissue of the mantle.

The majority of the fine pearls found in the soft tissues of the body of the Ceylon oyster contain, in our experience, the more or less easily recognisable remains of Platyhelminthian parasites (especially the young larva of the Cestode *Tetrarhynchus*), so that the stimulation which causes eventually the formation of an "orient" pearl is, as has been suggested by various writers in the past, due to infection by a minute worm, which becomes encased and dies, thus justifying, in a sense, DUBOIS' statement that:—"La plus belle perle n'est donc, en définitive, que le brillant sarcophage d'un ver" (Comptes Rendus Acad. Sci. Paris, 14th Oct., 1901).

To Dr. KELAART (1857–59) belongs the honour of having first connected the formation of pearls in the Ceylon oyster with the presence of vermean parasites. It is true that FILIPPI, seven years before, in 1852, showed that the Trematode *Distomum duplicatum* was the cause of pearl formation in the fresh-water Mussel *Anodonta*, and KÜCHENMEISTER (1856), MÖBIUS (1857), and others extended the discovery to other pearl-producing oysters, and to other parasites; but it is possible that KELAART knew nothing of these papers, and that he made his discovery in regard to the Ceylon oyster quite independently. He (and the Swiss Zoologist, HUMBERT, who was with him at a pearl fishery) found "in addition to the Filaria and Circaria, three other parasitical worms infesting the viscera and other parts of the pearl oyster. We both agree that these worms play an important part in the formation of pearls; and it may yet be found possible to infect oysters in other beds with these worms, and thus increase the quantity of these gems." Thus we have KELAART, in 1859, definitely stating the possibility, in the case of the Ceylon pearl oyster, of infecting other beds with the larvæ of the pearl-producing Platyhelminthian parasites in order to increase the quantity of pearls.

THURSTON, in 1894, confirmed KELAART'S observation, finding in the tissues and also in the alimentary canal of the Ceylon oyster, "larvæ of some platyhelminthian (flat worm)." He figures ('Madras Mus. Bull.,' I., Plate II., fig. 1) a section showing two of the parasites encysted between the alimentary canal and generative tubes. Here the matter rested so far as the Ceylon pearl oyster was concerned.

Long before, however, GARNER, in 1871, had associated the production of pearls in our common English Mussel (*Mytilus edulis*) with the presence of Distomid parasites; GIARD (1897) and other French writers have made similar observations in the case of *Donax* and other Lamellibranchs; and DUBOIS (1901) has more recently ascribed the production of pearls in Mussels on the French coast to the presence of the larva of *Distomum margaritarum*. H. L. JAMESON (1902), then followed with a more detailed account of the relations between the pearls in *Mytilus* and the Distomid larvæ, which he identifies as belonging to *Distomum* (*Brachycælium*) *somateriæ* (LEVINSEN). JAMESON'S observations were made on Mussels obtained partly at Billiers (Morbihan), a locality at which DUBOIS had also worked, and partly at the Lancashire Sea-Fisheries Marine Laboratory at Piel, in the Barrow Channel. Finally, DUBOIS has just published a further note (Comptes Rendus Acad. Sci. Paris, 19th Jan., 1903) in which, referring to the causation of pearls in *Mytilus*, he says (p. 178):—"En somme ce que ce dernier [GARNER] avait vu en Angleterre en 1871, je l'ai retrouvé en Bretagne en 1901. Quelques jours après mon départ de Billiers, M. LYSTER JAMESON, de Londres, est venu dans la même localité et a confirmé le fait observé par GARNER et par moi." But JAMESON has done rather more than that. He has shown that it is probable (his own words are "there is hardly any doubt") that the parasite causing the pearl-formation in our common Mussel (not in the Ceylon pearl oyster) is the larva of *Distomum somateriæ*, from the eider duck and the scoter. He also believes that the larva inhabits *Tapes* or the cockle as a first host before getting into the mussel.

We have found, as KELAART did, that in the Ceylon pearl oyster there are several different kinds of worms commonly occurring as parasites, and we shall, I think, be able to show in a later section of this report that Cestodes, Trematodes, and Nematodes may all be concerned in pearl-formation. Unlike the case of the European mussels, however, we find that in Ceylon the most important cause is a larval Cestode of the Tetrarhynchus form. We first found this larva in pearl-like cysts outside the liver of pearl oysters on the Cheval Paar during the second cruise of the "Lady Havelock" in February and March, 1902. Since then Mr. HORNELL has traced a considerable part of the life-history of this parasite, from an early free-swimming stage to a late larval condition in the File-fishes (*Balistes mitis* and *B. stellatus*) which frequent the pearl banks and prey upon the oysters. We have not yet succeeded in finding the adult worm, but it will probably prove to infest the Rays or other large Elasmobranchs which may devour *Balistes*.

We have also found the pearl-provoking Cestode larva in *Pinna*—where pearls are sometimes found—but we have no reason to suppose that *Pinna* finds a place in the same life-cycle with the pearl oyster. Nor do we think that any other Mollusc or Invertebrate is implicated. The stages in the life-cycle, as regards environment, are probably as follows:—

1. Free embryos in the sea;
2. Encapsuled in the pearl oyster;
3. Later larval stage in the File-fishes;
4. Adult in large Elasmobranchs.

We suppose, then, that the adult Worm from the body of the Shark or Ray sets free its numerous young embryos into the sea; and there we pick up the history, for amongst our Vermean embryos in the tow-net we have some caught on the Muttuvaratu Paar, in November, 1902, which we consider to be the younger stage of our *Tetrarhynchus* larva. Such free-swimming embryos on an oyster bank will readily gain access to the body of the oysters. They will be carried in with the current of water, and may either pass into the alimentary canal with the microscopic food particles or get lodged in the gills. We have found these in the gills, and have also found very young stages in the mantle; while later stages of larger size are common in the liver and in the connective-tissue of the body-wall generally. In some samples of oysters examined scarcely any individuals are free from the encysted parasites, and in one 45 cysts were counted. In the case of oysters so infested which are eaten by the File-fishes—and from the frequency with which we, and others, have found the broken-up shells in the stomach there can be no doubt that these fishes do eat the oysters—the Cestode larvæ are transferred to the body of the new host; and Mr. Hornell has found them in quantity in the alimentary canal and peritoneum of specimens belonging to the two common species *Balistes mitis* and *B. stellatus*, from several localities. The Cestodes are now in a later stage, and are clearly recognisable as *Tetrarhynchus*; but are not yet adult and have no reproductive organs. Whether they become mature in time in the body of the File-fish or, as we think more probable, in a larger animal which feeds upon that fish, such as one of the large Elasmobranchs common in these seas, we cannot yet say; but possibly that point may be settled before the Report is finished.

In those oysters, on the other hand, which do not become the prey of the File-fish the larval Cestodes have no opportunity of fulfilling their destiny as parasites, but die and become encapsuled in the layers of pearly nacre deposited by the living tissues of the oyster upon the source of irritation. What proportion of the parasites become the nuclei of pearls we are not able to say, but many, we feel sure, neither complete their life-history nor yet remain long enough encapsuled in the bodies of adult oysters to become pearls of value. There are many potential and incipient pearls in young oysters which, even if transferred to the body of a fish, contain only dead larvæ, and so are lost from the parasite population; while the death of their host prevents them from causing pearl-formation. It is not sufficient for the oyster to be infected by the *Tetrarhynchus*, it must also live, retaining its parasite, until such time as it can produce sufficient deposit of the calcareous secretion to form a true pearl. In the case of the Ceylon pearl oyster very little increase in size of the shell by additions to the ventral margin takes place after an age of three and a half or at most four years has been reached. But the shell after this period thickens greatly by the deposit of nacreous material in its interior and especially in the neighbourhood of the hinge at the dorsal edge. This is the time of rapid pearl-formation. The oyster's tissues are then in the condition which leads to the secretion and deposition of limy material either externally by additions to the thickness of the shell, or internally as successive coats deposited upon any particle—such as a dead parasite or, it may be, a sand-grain, a Diatom frustule, a fragment of nacre, ova, or excreta—which has given rise to the necessary stimulation.

There is general agreement amongst those who have seen most of the Ceylon oyster on its native banks that the animal does not, as a rule, live beyond six or seven years. Captain DONNAN's opinion is that "the oysters may be profitably fished at the age of four years, and that they are in their prime at five years, and may be kept till that age if circumstances will permit of it; but if they are kept till the sixth year they are almost certain to be found dead." From the figures he gives in his reports it seems that the age of the oysters at fisheries where we have reliable data has been nearly always under five years. The pearl oyster should be fished when it measures $3\frac{1}{2}$ inches in diameter at right angles to the hinge line, has no soft growing edge to the shell, and shows a deep V-shaped groove between the valves at the hinge.

Although it is not correct to say that there are no pearls in young oysters, for we have found some of moderate size in quite small oysters, still there is no doubt that rapid and widespread pearl-formation begins only when the animal is about three and a half years old and has ceased to grow a thin spreading ventral margin to the shell. During the year or eighteen months following this is the time when it is most profitable to fish the oysters up and open them for the sake of their pearls. Although some oysters contain more pearls than others, and some paars have on occasions been characterized by richness in pearl-production, the Cestode parasites are apparently very widely spread and generally distributed. All oyster communities of the proper age contain pearls, and it would probably be impossible to transplant young oysters to any ground in the Gulf of Manaar where they would not become to some extent infected by the pearl Cestode. The frequent thinning out of young oysters, and the transporting as required from one ground to another, which we shall recommend at the conclusion of this Report, will, however, have the effect of causing a more even distribution of the parasites, since some oysters will be taken from more highly infected ground to less, carrying with them the larvæ, either free or encapsuled, and others, again, which may have escaped infection will go to areas where they run a greater chance of encountering the parasite. It is important to note also, in view of experiments in other parts of the Colony, that the *Tetrarhynchus* parasites are not only widely distributed over the banks in the Gulf of Manaar, but also at other places on the coast of Ceylon.

Mr. Hornell* has found *Balistes* with its Cestode parasite both at Trincomalee and at Galle, and the sharks and rays also occur all round the island; so that, in short, there can be no doubt as to the probable infection of pearl oysters grown at these or any other suitable localities.

The details and illustrations of the parasitic life-history outlined above, and the figures upon which our statements in regard to the oysters are based, will be given in the special articles further on in this Report. But even when we have figured all our specimens, have described all that we have seen, and have shown what conclusions may safely be drawn, we feel sure that gaps will be left, and possibly doubts remain, which can only be filled up and finally settled by patient work extending over years, carried on by a competent observer resident in Ceylon, and having at his disposal a laboratory and experimental tanks. A marine biologist working at the Galle Biological Station can scarcely fail to add further details affecting the life-history of the oyster and the prosperity of the pearl fisheries.

During the two cruises of the "Lady Havelock," in our work on the parasites, commensals, enemies, food, and other organisms associated with the pearl oyster, we were brought in contact with many forms requiring identification, and some apparently new to science. It was clearly our duty to collect all such and have them worked up with the view of elucidating the fauna of the Gulf of Manaar and also of making any necessary comparisons with other parts of the coast. Consequently, I am now able to supplement this Report by a series of papers, written by specialists upon the various groups of animals, which not only adds to the completeness of the pearl-oyster work, but will also, I hope, be recognised as a welcome contribution to the marine biology of Ceylon.

The land fauna of Ceylon is very much better known than the marine. Dr. E. F. Kelaart published in 1852 his important work, the 'Prodromus Faunæ Zeylanicæ,' dealing with the mammalia, birds and reptiles. Mr. E. L. Layard has worked at the ornithology and conchology, and we have his papers in the 'Annals and Magazine of Natural History.' Harvey visited Ceylon in 1852 to collect the Cœlenterates and Crustacea. Schmarda, a few years later, wrote on the worms. In Emerson

* It is only due to my excellent assistant, Mr. James Hornell, to state that our observations on pearl-formation are mainly due to him. During the comparatively limited time (under three months) that I had on the banks, I was mainly occupied with what seemed the more important question of the life-conditions of the oyster, in view of the frequent depletion of particular grounds.

TENNENT'S 'Ceylon' (1859) there is a good summary of the fauna as known up to that time, with lists which were supplied, or supplemented, or revised by HUXLEY, GRAY, HANLEY, KELAART, and others. Further papers on new animals in various groups (many of them collected by Dr. W. C. ONDAATJE) have been published from time to time by BOWERBANK, ALLMAN, RIDLEY, DENDY, BELL, CARTER, NEVILL, and the SARASINS. But the most notable contribution to our knowledge of the marine fauna is THURSTON'S 'Notes on the Pearl and Chank Fisheries and Marine Fauna of the Gulf of Manaar,' published from the Government Central Museum, Madras, in 1890. In this interesting little work Mr. E. THURSTON, with the help of Professor DENDY, Professor JEFFREY BELL, Professor HENDERSON, and Mr. E. A. SMITH, gives considerable lists of the Porifera, Cœlenterata, Echinodermata, Crustacea, Mollusca and Pisces which he had collected during visits to Tuticorin, Rameswaram, and some parts of the Ceylon pearl banks.

Taking a somewhat wider area—the northern part of the Indian Ocean—there are three recent series of faunistic explorations which have some bearing on our work, viz., the reports upon Dr. ANDERSON'S collections made in the Mergui Archipelago ('Journal Linnean Soc., Zool.,' vols. XXI. and XXII.), the great series of Memoirs, Reports, and 'Illustrations' issued by Major ALCOCK, of the Calcutta Museum, as a result of the explorations of the surveying vessel "Investigator," and lastly, Mr. STANLEY GARDINER'S series dealing with 'The Fauna and Geography of the Maldive and Laccadive Archipelagoes' (Cambridge Press). The Ceylon marine fauna resembles that of Mergui in some respects, but differs in detail; Dr. ALCOCK'S "Investigator" work has been mainly—though not wholly—in the abyssal waters of the Indian seas; while the Maldives are an Oceanic group, in contrast to Ceylon which is faunistically as well as geologically a part of India. Our dredgings were nearly all within the 100-fathom line, and were mainly in the zone of 5 to 20 fathoms. This account of a shallow-water Continental coast fauna may fill a gap and be of use for comparison with these other recent investigations in the Indian Ocean.

The faunistic reports which will appear along with this INTRODUCTION in Part I. will tell their own story, but it may be well to give briefly what information I can in regard to a few of the other groups, the reports upon which may not be ready for some months.

Professor DENDY has sent me a preliminary report upon the Sponges as follows:—

"This collection of sponges appears to be by far the most extensive that has ever been made in Ceylon waters, and contains many species of great interest. Amongst the siliceous sponges, the Tetractinellida are represented by at least a dozen species, including a new *Stelletta*, a new *Plakinastrella*, and a form which will be described as the type of a new genus under the name *Dercitopsis cingalensis*. There are also a massive Lithistid, a *Placospongia*, and a curious Suberites-like species which is anchored by silky tufts of spicules in soft mud. Amongst the Monaxonids, the Chalinidæ, Ectyoninæ, and Axinellidæ are the most conspicuous groups; while of special interest from the point of view of the pearl fishery is a Clionid which burrows in the shells of the pearl oyster. Many of the Monaxonids are characterised by a strong development of horny fibre, and from these we pass by a natural transition to the true horny sponges, represented by the genera *Euspongia*, *Phyllospongia*, *Hircinia*, *Dysidea*, *Spongionella* and *Aplysina*. The *Euspongia* is a fairly good, compact, resilient bath sponge . . . . . and the possibility of establishing a sponge fishery is worth consideration." Professor DENDY then gives a list of his identifications, amounting to about 60 species.

Mr. HORNELL, who is reporting upon the Polychæte worms, has sent in a preliminary list of over 60 species, at least four of which are new to science and will (Mr. HORNELL states) be described under the names—"*Hermione ridgewayi*, *Thalenassa imthurni*, *Phyllodoce foliosopapillata* and *Spiochætopterus herdmani*."

Mr. ISAAC THOMPSON and Mr. ANDREW SCOTT, who are working up the Copepoda, state that "The collection of Copepoda is the richest and most varied series of this group that has ever been brought from tropical seas by any expedition. The group is represented by over 200 known species and nearly 80 new species, now being described. Of these new species only a small number are true pelagic forms, the remainder being littoral and semi-parasitic species, mostly associated with the pearl oysters on the paars. Some of the pearl-oyster washings were extremely rich in minute Crustaceans, mainly Amphipods and Copepods. The washings from the Muttuvaratu oysters yielded 43 species belonging to the Harpacticidæ alone, besides several species of Lichomolgidæ and Ascomyzontidæ, many of which are new to science."

Mr. A. O. WALKER, who is reporting upon the Amphipoda, writes to me that it is "The most important collection of Amphipods which has yet been made known from the tropics . . . . . It contains over 70 species, and the report will describe a large number of new species, some of which will require new genera . . . . . Many of the forms are closely allied to British and Mediterranean species, while others again have been described from the Australasian seas . . . . . The size of the individuals is small; compared with those from the Arctic and Antarctic areas they are pygmies."

Mr. JAMES JOHNSTONE, who is writing on the fishes, reports:—"The collection consists of 116 species belonging to 73 genera. It is very representative and contains species belonging to 37 families. About 6 forms are still undetermined, and most of these are probably new to science. A number of the species obtained are apparently new to the fauna of India and Ceylon."

In other groups also, Hydroids, Polyzoa, Turbellaria, Alcyonaria, Cumacea and Cephalopoda novelties are turning up, but the examination of these is not yet far enough advanced to warrant more detailed announcement. In the concluding article of the Report I hope to submit such discussion as may seem necessary of the general characteristics and affinities of the marine fauna of Ceylon.

NARRATIVE,

WITH

AN OUTLINE OF THE INVESTIGATION,

AND

DETAILS OF THE STATIONS WHERE OBSERVATIONS WERE MADE.

THE greater part of our observations at sea (as distinguished from the laboratory work which came later), both on the Pearl Oysters and on the animals that are associated with them and the conditions that surround them on the banks in the Gulf of Manaar, can be given most conveniently in the form of a narrative of our cruises in the s.s. "Lady Havelock" and with Captain DONNAN in the inspection boats. This narrative is written out with as little change as possible from the diary and other note-books in which each day's work was recorded at the time. Consequently the names in the lists of species* although, with the help of my friends who are kindly working up the groups, they have been corrected up to the time of writing, will naturally in some few cases require alteration, and therefore it will be understood that, in the event of any difference in nomenclature, the "Supplementary Reports" that follow must supersede the lists in this "Narrative." On the other hand, this section contains the authoritative statement as to the dates, localities, depths, and other particulars of the observing stations, and therefore forms a necessary introduction to the Special Reports. A station, in the later sections of the work, may be referred to briefly by its roman numeral, and the details, both as to the locality and conditions and also as to the other organisms obtained, may be found here.

I may add, in conclusion, that my view in regard to these present lists is that although by no means *complete*, they are substantially *correct* as far as they go, and will serve a useful purpose in giving a general impression of the most abundant and conspicuous, or in other ways noteworthy, organisms at each observing station. They will also enable conclusions to be drawn as to the fauna of the "paars," and as to the enemies and other competing organisms which may affect the life and prosperity of the pearl oyster.

* As all these species will be treated more fully in the Special or Supplementary Reports, I have not considered it necessary to give in these provisional lists the authorities and references. To have done so would have added greatly to the length of the lists, with little or no compensating advantage.

Mr. Hornell and I arrived in Ceylon on January 20th, 1902, so as to leave some weeks free before the end of February, when we proposed to join Captain Donnan in his annual inspection of the pearl banks. This interval I had thought essential in order that we might perfect and test our apparatus, find out the necessary methods of investigation, and make ourselves acquainted with the biological conditions in the Gulf of Manaar, and with any special features in which that region differs from the other seas around Ceylon. For the purpose of this preliminary biological survey the Government of Ceylon placed the s.s. "Lady Havelock"* at my disposal, in the first instance for a period not to exceed three weeks. This first cruise lasted for twenty days (January 30th to February 19th), and was followed, for reasons given below, by a second cruise of about four weeks in the same vessel. After that we joined Captain Donnan on his inspection barque.

In the first cruise of the "Lady Havelock" my objects were :—

(1.) To investigate the general biology of the seas around Ceylon, and especially of those places where pearl oysters were said to exist.

(2.) To examine more carefully any localities that seemed to be likely spots for uncharted pearl oyster banks.

(3.) To investigate the fauna, the bottom deposits, and the characters of the water in the Gulf of Manaar for comparison with the conditions at Trincomalee, Galle, and other parts of the coast.

(4.) To make experimental hauls of the fish- and the shrimp-trawls round the coast, so as to obtain information as to the prospects of fish-trawling as an industry in Ceylon waters.

(5.) To look into any other departments of marine biology which might be prosecuted as useful industries.

We joined the s.s. "Lady Havelock" on the evening of Thursday, January 30th, 1902; and started from Colombo harbour early the following morning. The course during this cruise is shown by the strong dotted line on the map (p. 19), and the observing stations are marked by a cross within a circle (see also more detailed map on p. 82). After steaming northwards for some hours the dredge was put overboard for the first haul about 11 A.M., at 5 miles S.W. of Negombo in $12\frac{1}{2}$ fathoms of water. The rest of the day was occupied in dredging and trawling along an area about 5 miles in length extending opposite Negombo Lake from Pamunogan at the south to Negombo, keeping from $4\frac{1}{2}$ to $5\frac{1}{2}$ miles off shore, in from 12 to 20 fathoms. A little further out the sea deepens very rapidly, 50 fathoms being reached 10 miles from land, 70 fathoms a mile further out, over 700 fathoms at about 18 miles west of Colombo and 1000 fathoms at about 20 miles from land. My object in working along

* I ought to state that on the whole the "Lady Havelock" proved a very suitable vessel for the purpose, and I desire to record also my sincere thanks to Captain Campbell and the officers and others on board for the pains they took to carry out my wishes. The steamer is shown on p. 54.

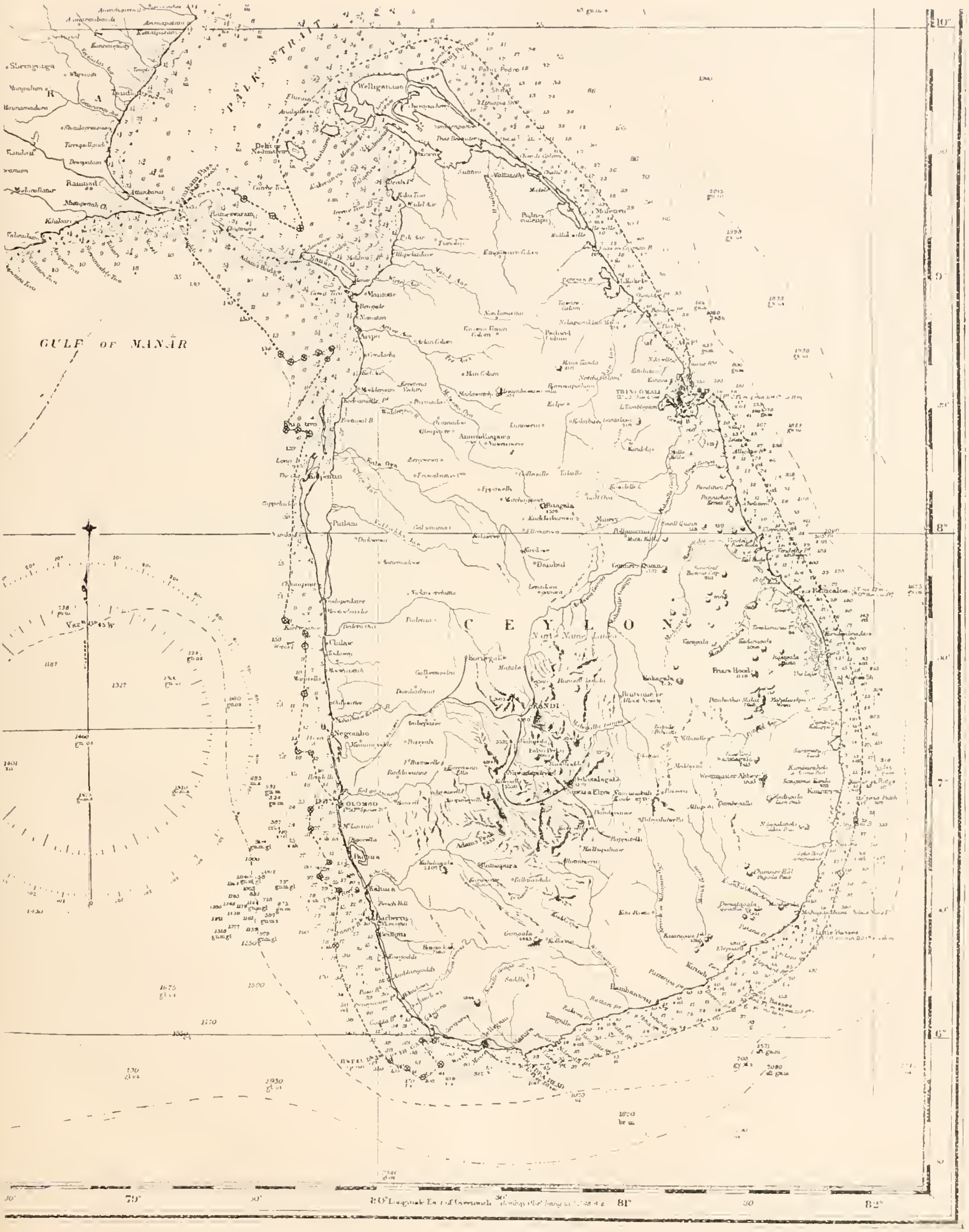


Fig. 1. Sketch-plan of route in first cruise of "Lady Havelock," January–February, 1902.

the shelf within the 20-fathom line off Negombo was (1) to get a fair sample of the conditions and the fauna for comparison with the pearl bank region off Aripu further north and (2) to explore the ground and the water, as we did wherever possible, for any stages young or old of the pearl oyster.

There is a record of an old pearl oyster bed, the "Muttu-Parawuttu Paar" lying about 4 miles W. of Negombo in 9 fathoms. No oysters have, however, been found there I believe for many years. We did not find any trace of this paar, but may have been just outside it; next day however we came upon large quantities of young pearl oysters about 7 miles further to the north. Half-a-dozen hauls of the dredge, two hauls of the 25-foot beam-trawl, with a 7-inch fish-net, and four surface gatherings with the silk tow-net were taken on this first day, off Negombo; and these, although recorded separately at the time, may now be united as one locality:—

STATION I.—Five miles west and south-west of Negombo; 12 to 20 fathoms; bottom coarse yellow sand with a few dead shells; temperature of sea, 77·5° F.; dredged and trawled. Amongst the animals were:—

Various sponges;

Diphasia mutulata, *Lytocarpus* (? n. sp.), *Campanularia juncea*, and some Plumularian Zoophytes, *Caryophyllia* sp. and *Heteropsammia michelini* (with commensal Gephyrea), Gorgonacea (*Spongodes*, &c.);

Leptoplana sp. and another Turbellarian, and *Aspidosiphon corallicola*, *Filograna* sp., *Hyalinœcia* sp., *Terebella* sp., *Acholoe* sp. (commensal with *Astropecten*), *Hesione* sp., *Ophelia* sp. and other Annelids;

Crisia sp. and other Polyzoa;

Echinus and Temnopleurids (sev. spp.), *Salmacis bicolor* and *S. sulcata*, *Lovenia elongata*, *Clypeaster humilis*, *Echinodiscus auritus*;

Thyone sacellus, *Holothuria atra*, *H. tenuissima* and allied species of "trepang" (up to 16 inches long), *Pectinura intermedia* and other Ophiuroids, *Astropecten hemprichii*, *Luidia maculata*, *Antedon* sp.;

Lepas sp., *Hippolyte* sp. (with Bopyrid) and other Macrura, *Neptunus* sp., *Calappa* sp., *Ebalia* sp., and other Brachyura;

Acanthochites penicillatus, *Styliola acicula*, *Teredo* sp. (in wood), *Arca* (sev. spp.), *Venus lamarcki*, *Cardium rugosum*, *Pinna bicolor*, *Pectunculus* sp., *Dentalium octagonum*, *Murex tenuispina* and *M. haustellum*, *Oliva candida*, *Turbo margaritaceus*, *Conus marmoratus*, *Natica* sp., *Harpa conoidalis*, *Umbrella* sp., *Pleurophyllidia* sp., *Melibe fimbriata* and *Sepia* sp.

Molgula sp., and some colonies of a snowy white *Leptoclinum* which grows over the coarse quartz sand and cements the grains together.

The Tow-net gatherings contained:—

Trichodesmium erythræum (in quantity), Diatoms, *Ceratium tripos* and some Foraminifera; *Sagitta* sp., *Salpa democratica-mucronata*, and *Oikopleura* sp.;

Copepoda—many, including a conspicuous blue form *Centropages violaceus*, and also *Oithona similis*, *Euterpe gracilis*, *Ectinosoma atlanticum*, *Temora discaudata* and *T. stylifera*, *Eucalanus subtenuis*, *Calanus vulgaris*, *Calanopia elliptica*, *Corycæus speciosus* and *C. venustus*.

[NOTE.—In coming across the Indian Ocean to Ceylon we used silk tow-nets day and night to strain the organisms from the sea-water running from the tap in one of the bath rooms. In two of these gatherings I obtained the pelagic Amphioxus (*Branchiostoma pelagicum*, Günther). One specimen was taken in a coarse net on January 16th, to the south-east of Sokotra, about halfway between Perim and the Maldives; and five others were found in a finer net on January 20th, after passing Minikoi Atoll, and therefore between the Maldives (where this species was found by Stanley Gardiner) and Ceylon.

Amongst other interesting or novel forms found on the way to Ceylon were:—a new species of *Centropages* (rather widely distributed), *Miracia minor* (taken near Sokotra, previously known from Gulf of Guinea), *Mecynocera clausi* (common), *Scolecithrix chelifer* (Red Sea, the only known locality), *Pseudodiaptomus salinus* (Suez Canal and Red Sea, males found for the first time), *Anymone spherica* (in Suez Canal), *Acartia dubia* (Suez Canal, only known previously from Gulf of Guinea), *Pseudocyclops obtusatus* and *Canuella perplexa* (both European forms, now found in Suez Canal). These will be discussed fully by Mr. Isaac Thompson and Mr. Andrew Scott in their Report on the Copepoda—see below, p. 227.]

On Saturday, February 1st, we dredged and trawled at various localities between Negombo and Chilaw, covering an extent of about 23 miles. The distance was generally from 4 to 5 miles off land, and the depth varied from 8 to 14 fathoms.

This day's hauls can be grouped into two localities; the first (Station II.) from opposite Ooluwitti to off Mararilla, half-way from Negombo to Chilaw, and the second (Station III.) off Chilaw; we dredged and trawled at both, as follows:—

STATION II.—From 7 to 14 miles north of Negombo, 5 miles off shore; 8 to 9 fathoms; bottom coarse yellow sand, shells, stones, and small coral; temperature of sea, 77·5° F., specific gravity, 1·023. Two hauls of fish-trawl and several of dredge.

Pachychalina sp., *Acanthella carteri*, *Hircinia* sp., and *Siphonochalina* sp. (pale lilac, with large oscula occupied by small colourless *Alpheus*);

Masses of living corals (up to 20 × 14 × 6 inches), many solitary corals, mainly *Stephanoseris rousseaui* and *Heteropsammia michelini*, small scarlet Actinians;

Lineus sp., *Aspidosiphon corallicola* (in the solitary corals), Lumbrinereids, *Hesione* sp., *Axiothea* tubes (in masses), *Serpula actinoceros*, *S. quadricornis*, *Sabellaria bicornis*, and many Polyzoa;

Antedon variipinna and another species (many), *Luidea maculata*, *Clypeaster humilis*, *Laganum depressum* and *Echinodiscus auritus*, *Salmacis dussumieri*, scarlet Ophiuroids, and *Phyllophorus cebuensis*;

Leucothoe spiniearpa and other small Amphipods and Isopods not yet determined, some Macrura, *Galathea* sp. (black and white), and *Pilumnus vespertilio*;

Young pearl oysters (in quantity), *Avicula vexillum*, *Conus marmoreus* and a few other common shells, *Philine* sp., *Aplysia* sp.;

Pseudorhombus arsius, and some sea-snakes (see p. 65).

On the second haul, which was 5 miles off Ooluwitti, at a depth of $8\frac{1}{2}$ fathoms, the trawl came up with the beam broken, but contained some large masses of coral and great quantities of young pearl oysters, measuring from $\frac{1}{4}$ to $1\frac{1}{2}$ (mostly 1) inch across. There is evidently at this point some hard bottom with coral growing on it, and with many broken lumps of coral and rounded masses of nullipore, from the size of a walnut to that of an orange—constituting in fact a "paar" upon which young pearl oysters are living. The oysters we got are in their first season, and probably ranged from one to three months in age. On the sand outside this hard patch we brought up quantities of the filamentous green weed (*Hypnea*, *Cladophora*, and *Gracilaria* spp.), which we found afterwards on the south part of the Cheval Paar, covered with the newly deposited "spat" of the pearl oyster.

STATION III.—Off Chilaw, $2\frac{1}{2}$ to 4 miles off shore; 9 to 14 fathoms; bottom coarse sand and small corals; temperature of sea, 77·75° F.; specific gravity, 1·023; one haul of fish-trawl and several of dredge.

Large numbers of *Heteropsammia michelini* (with Gephyreans).
Antedon sp., *Pentaceros lincki* and *P. nodosus*, *Echinanthus rosaceus*;
Aspidosiphon corallicola, Pagurids and other crabs, *Neptunus pelagicus*;
Mitra militaris, *Turbinella rapa* (the sacred chank), *Philine* sp.;
Leptoclinum (2 species).

We were now in the region of the Chilaw Paars, which consist of (1) one large bank running north and south for about 9 miles, at a distance of from 7 to 8 miles from shore, with a depth of 8 to 10 fathoms; (2) a group of two small paars lying north-east of the large Chilaw Paar, at from 5 to 6 miles off-shore; and (3) four small paars nearer the shore opposite Karkopani, about 4 miles north of Chilaw. These small paars are little hard patches, so-called "rock," on the general sandy expanse. The rough bottom varies greatly in depth, the extremes on these inner paars off Karkopani being 6 to 16 fathoms. Outside the outer large Chilaw Paar the depth increases rapidly, and at one place, in less than a mile, we pass from 10 to over 100 fathoms, at about 10 miles off shore.

On February 2nd we first had several hauls of the dredge (the trawl could not be used because of the very irregular hard bottom) amongst the inner paars off Karkopani, then trawled in the more even sandy ground (9 to 11 fathoms) between the inner and the outer paars, and finally had a couple of hauls of the dredge along the outer edge of the outer paar at depths of from 10 fathoms outwards to about 30 (the dredge dropped off the bottom finally on the steep slope about the 100-fathom line). I have placed the dredging off Karkopani as Station IV., and have united the trawling and dredging further out as Station V.; but Stations III., IV., and V., explored on the two days spent off Chilaw, do not differ much and may be regarded as one region. (Also Station LXIX., see chart of route and stations on p. 82.)

STATION IV.—Opposite Karkopani, from 1 to 3 miles off-shore; depth 6 to 9 fathoms; bottom coarse yellow sand with dead shells, nullipores and corals; temperature of sea (7 A.M.), 77·8° F.; specific gravity, 1·023. Several hauls of dredge.

Orbitolites complanata and *Heterostegina depressa* (forming a good deal of the sand);

Axinella donnani, *Acanthella carteri*, and a black leathery sponge;

Solenocaulon sp., *Sarcophytum ehrenbergi*, *Goniastræa* sp. (green), *Turbinaria cinerascens*, *Heteropsammia michelini* (with Gephyreans);

Luidea maculata, *Asterina cepheus*, *Astropecten hemprichii*, *Echinus* sp. (small, flat), *Echinolampas oviformis*, *Maretia planulata*, *Clypeaster humilis*, *Lovenia elongata*, *Thyone fusus*, var. *papuensis* (two), *Holothuria atra;*

Gephyreans (yellowish, burrowing in pearl oyster shell), Cirratulids (deep red), *Sabellaria bicornis*, Serpulids (on pearl oysters), *Trophonia* sp. (?), and Polyzoa;

Caprellids, Pagurids, Portunids, *Calappa* sp. and other crabs;

Acanthochites penicillatus, and, in addition to pearl oysters, molluscs belonging to the following genera:—*Avicula*, *Solen*, *Pecten*, *Mactra*, *Cardium*, *Arca*, *Pectunculus*, *Strombus* (*S. succinctus*), *Cypræa*, *Conus*, *Terebra;*

Branchiostoma belcheri, *Asymmetron cingalense*, and a Solenette (*Cynoglossus* sp. ?).

STATION V.—On both edges of upper end of Chilaw Paar, from 5 to 10 miles off shore; depth, 9 to 11 fathoms and upwards; bottom coarse yellow sand, with many *Orbitolites* and *Heterostegina* inside the paar, outside broken coral, *Halimeda* and Nullipores; temperature of sea (2 P.M.), 79° F.; specific gravity 1·023. One haul of trawl and several of dredge.

Tetractinellid sponges, *Siphonochalina* sp., *Acanthella carteri*, *Dictyocylindrus* (scarlet, massive), *Pachychalina multiformis* var. *manaarensis*, *Madrepora* (two species), *Pocillopora* sp., *Turbinaria cinerascens*, *Plexaura indica;*

Pentaceros lincki and a white Spatangoid;

Pectinaria sp., *Euphrosyne* sp., *Polynoe* (spiny); Polyzoa (various);

Melita obtusata, *Elasmopus subcarinatus*, *Leucothoe spinicarpa* and another (? n. sp.), some interesting new Caprellids, *Galathea elegans* and some other Decapods;

Pectunculus sp., *Pinna bicolor*, and many young pearl oysters; *Leptoclinum* sp.

The Tow-net gatherings during the day (February 2) contained *Sagitta*, *Appendicularia*, Nauplei, Plutei, Larval Polychætes, the veliger stage of Mollusca, eighteen species of Copepoda and the conspicuous blue *Centropages violaceus*.

Having now obtained what we considered fair samples of the bottom, and of the animals associated with the pearl oysters, on the paars off Chilaw, and of the ground between the paars, we steamed for some distance north along the shores of Kalpentyn Island, and anchored for the night about 1 mile off "St. Anna's Church," near the Etaly ferry across Putlam Lake (one of the succession of great inland seas, "gobbs" or lagoons, that extend up this coast of Ceylon) to Putlam Fort. The tow-net was left out all night, and on being hauled at 5 A.M. was found to contain many large Stomatopod larvæ in various Erichthus stages, and some Lucifers, various other larvæ as on the previous day and a few Copepods (*Labidocera acuta*, *L. kroyeri*, and *Calanus vulgaris*). Another haul taken at the same spot from 8 to 9.30 A.M. contained a mass of minute plant-life, *Navicula* and other diatoms, *Pediastrum*, and many small larvæ of worms and Copepod nauplei; also small adult Copepods (*Ectinosoma rosea* and *E. atlanticum* and *Oithona similis*).

A third haul at 11.30 A.M. had swarms of crab zoea and some Foraminifera (*Planorbulina*), also the blue Copepoda (*Centropages violaceus*), *Pontella securifer*, several species of *Labidocera*, including a large new species, also a greenish-blue larval Squilla. This last haul was taken further north, over Muttuvaratu Paar, but the difference in these successive gatherings is probably due to some extent to the time of day and to tidal currents carrying streams of plankton past the ship.

My intention was now to examine the neighbourhood of the celebrated Muttuvaratu Paar lying off the middle of Karativo Island, and perhaps one of the most important of the pearl oyster grounds after the Cheval and Modragam paars. It afforded profitable fisheries in 1889, 1890, and 1891.

We commenced dredging at 11.30 A.M. and spent the rest of the day in making a traverse from east to west across the paar and into the deep water lying outside it. The first five hauls were all in the neighbourhood of the paar and may be considered as one locality (Station VI.), and several hauls were then taken at two spots (Stations VII. and VIII.) further out, the first at 45 to 50 fathoms and the second at 90 to 100 fathoms. This was one of the localities where we examined the ground outside the known paars, down to the 100-fathom line, with the view of ascertaining whether there was any evidence in support of the statement which had sometimes been made in the past, that there were probably unknown beds of pearl oysters further out and in deeper water from which spat was produced for the supply of the inshore paars. No evidence was found.

STATION VI.—Across Muttuvaratu Paar, 4 to 6 miles west of the centre of Karativo Island; depth 6 to 9 fathoms; bottom sand with hard patches of "rock" at intervals; temperature of sea at noon 78° F., at 4 P.M. 79° F.; specific gravity 1·023. Five hauls of dredge.

Spongionella nigra, *Phyllospongia holdsworthi*, *Axinella donnani*;

Zoanthus sp. and lilac Actinians, *Madrepora cytharea*, *Montipora* sp., *Porites* sp., Astræids (two species), *Turbinaria cinerascens*, *Sarcophytum ehrenbergi*, *Plexaura indica* (with Cirripede galls), and other Alcyonaria;

Sabellaria bicornis and *Serpula* sp.;

Echinaster purpureus, *Ophiocnemis marmorata*, *Cucumaria turbinata*;

Pearl oysters, *Modiolaria* sp., *Modiola* sp., *Doris* sp.;

Botryllus sp. and *Leptoclinum* sp.;

Small olive-green Wrasse with white tail (*Pomacentrus bankanensis*).

STATION VII.—Further out, from 6 to 7 miles off shore; depth 45–50 fathoms; dredged.

Large masses of coral overgrown with *Chama foliata*; *Chromodoris* sp.;

Squilla (small—many—in cavities of the coral);

Sabella sp., *Eunice* sp., *Lepidonotus acantholepis* and *Harmothoe imbricata*, all evidently associated with the coral.

STATION VIII.—Still further out, $7\frac{1}{2}$ to $8\frac{1}{2}$ miles off shore; depth 90–100 fathoms; dredged.

Gorgonia miniacea, *Juncella juncea*, *Antipathes* sp. (black, fan-shaped), *Cyathohelia* (?) and another allied form;

Galathea sp. (scarlet), *Lambrus* sp., *Arcania* sp. and other crabs;

Some species of *Nassa* and *Murex* and some small Octopods.

We now steamed further north to the region of the great Cheval paars, lying off the bight of Kondatchy, and started dredging at 8 A.M. on Tuesday, February 4th, along the southern edge of the West Cheval Paar. My object was, after seeing the condition of the ground on the Cheval Paar, to make a line of dredgings across the Cheval and the region outside it to the Periya Paar.

STATION IX.—On south-west corner of West Cheval Paar, about 12 miles from land; depth 7 fathoms; bottom fine quartz gravel, nullipore concretions, and many dead young pearl oyster shells; temperature of sea, 78° F., specific gravity, 1·023; dredged.

Axinella tubulata, *Clathria indica* (on oyster shells);

Sertularia distans and other Hydroids;

Actinometra parvicirra and another species, *Pentaceros lincki*, *Clypeaster humilis*, *Holothuria tenuissima*;

Physcosoma scolops (in *Axinella tubulata*, with commensal tubicolous Oligochætes), *Serpula actinoceros*, *Armandia* sp.;

Pearl oysters, along with "Suran" and "Oorie";

Branchiostoma belcheri (several).

In this haul young pearl oysters about $\frac{1}{2}$ inch to 1 inch in size were obtained in quantity, but the majority were dead; of 200 picked up at random only 20 were living. A large number of small boring Gastropods (belonging to the genera *Purpura*, *Nassa*, *Sistrum*, &c., and known collectively to the natives as "Oorie") were present. They ranged from $\frac{5}{8}$ inch to $\frac{7}{8}$ inch long and were very active, and no doubt contribute to the mortality of the oysters. There were also present considerable numbers of the small mussel, *Modiola barbata*, known to the natives as

"Suran," which form irregular nodular masses of gravel and oysters bound together by a network of byssal threads spun by the mussel. A number of the shells of the Suran as well as of the pearl oysters were perforated by the boring Gastropods.

The next eight hauls (Stations X. to XVII., some of them really representing more than one descent of the dredge) form a series taken from east to west from inside the Cheval to outside the Periya Paar.

STATION X.—One mile to east of East Cheval Paar; depth $5\frac{3}{4}$ fathoms; bottom quartz sand and dead shells; no oysters; dredged.

Sclerophytum polydactylum, *Suberogorgia suberosa*, and other Alcyonaria;
Luidea maculata, *Astropecten hemprichii*, *Pectinura gorgonia;*
Cirratulus sp., *Acholoe* sp. (on *Astropecten*), Lumbrinereids;
Caprellids (many), *Hyastenus* sp. (covered with Hydroids);
Eburna sp., *Turritella* sp., *Philine* sp.;
Styela sp. (with red apertures), *Molgula* (many), *Leptoclinum* sp.;
Dragonet (*Platycephalus punctatus*).

STATION XI.—On East Cheval Paar; depth 6 fathoms; bottom, sand; dredged.

Hircinia clathrata (with *Acasta spongitis*);
Campanularia juncea, *Plumularia setacea* (? n. sp.), *Idia pristina* and *Monostachys dichotoma;*
Centrosiphon herdmani, n. gen. and sp. (Shipley), *Physcosoma asser;*
Clypeaster humilis and *Echinodiscus auritus*, *Lovenia elongata* and *Echinolampas oviformis*, *Synapta* sp. (?);
Lepidonotus carinulatus, *Harmothoe imbricata*, *Filograna* sp., *Retepora* sp.
Species of *Conus*, *Cypræa*, and *Oliva;*
Branchiostoma californiense, *Asymmetron* (*Heteropleuron*) *cultellum*.

STATION XII.—Between East and West Chevals; 6 fathoms; bottom fine sand and much green Algæ (*Hypnea*, *Cladophora*, *Gracilaria* spp.), no oysters; dredged.

Laganum depressum, *Clypeaster humilis*, and *Echinodiscus auritus;*
Sphæroma sp., *Mæra rubromaculata*, *Elasmopus subcarinatus*, Caprellids and other Amphipods; *Philine* sp.

STATION XIII.—On West Cheval Paar; depth 6 fathoms; bottom old worn coral fragments and dead shells.

The haul contained nothing conspicuous except a number of large pearl oysters and a few small ones. The larger ones measured $2\frac{3}{4}$ to $3\frac{1}{4}$ inches across. There were also a few dead oysters, four of which had the valves honeycombed by the boring sponge *Clione;* and some of the coral fragments contained the Gephyrean *Aspidosiphon steenstrupia*. The corals were mainly *Porites* and Astræids.

STATION XIV.—About 2 miles west of West Cheval Paar; depth 8 fathoms: bottom sand with many young and a few old pearl oysters; dredged.

Astropecten hemprichii, *Linckia lævigata*, *Echinaster purpureus*, *Clypeaster humilis*; *Chlœia ceylonica*, *Serpula actinoceros*, *S. quadricornis*, *Ophelia* sp.; *Margaritifera vulgaris* (in quantity) and *Natica* sp.

Leptoclinum sp. (green).

In this haul three dozen large and about 15,000 healthy young pearl oysters were taken. The young were placed in batches in our deck tanks and kept under observation.

STATION XV.—On Periya Paar, 18 miles off shore; depth 9 fathoms; bottom sand; many young oysters; dredged.

Petrosia testudinaria and other large sponges, *Reniera* sp. (green, with oysters attached), *Axinella tubulata* (with commensal worm) and *A. donnani*, *Phyllospongia holdsworthi*;

Favia sp. (large, green), *Adamsia* sp. (small, grey, proliferating);

Echinostrephus molare, *Ophiomaza cacaotica*, *Pectinura intermedia*;

Eunice cirrobranchiata (?), *Armandia* sp., *Sabella phæotænia*, *Serpula quadricornis*, *Leucodora* sp., Pagurids (brilliant orange);

Pearl oysters, "Suran," "Oorie," *Murex anguliferus* (the elephant chank), and species of *Conus*.

The small oysters of this haul were many of them dead. They measured from $\frac{1}{2}$ to over $\frac{5}{8}$ inch in size, and quite a number of the dead valves were perforated by boring Gastropods. Out of a small handful taken at random, 17 oysters were living and 45 were dead, 7 of which were perforated, and along with them were 3 "Suran" and 2 "Oorie" ($\frac{5}{8}$ inch long).

STATION XVI.—On Periya Paar, about a mile further north; depth 9 fathoms; bottom sand, with nullipores, dead coral and shells, with great quantities of young living pearl oysters; dredged.

Orbitolites (very large), *Heterostegina depressa*, *Amphistegina lessonii*;

Isodictya sp. (green);

Paraplanocera aurora;

Pearl oysters and *Solarium* sp., *Turbo* sp., and young Octopods (a new species with branched processes on the body);

Antennarius nummifer.

The numerous pearl oysters in this haul were nearly all young ones, from $\frac{5}{8}$ inch to $\frac{15}{16}$ inch in size, and apparently in a healthy condition.

STATION XVII.—Outside western edge of Periya Paar; 11 fathoms; bottom same as last haul; small pearl oysters very abundant; dredged.

Ciocalypta sp., and other sponges;

Holothuria atra, *Ophiocnemis marmorata*;

Phyllodoce foliosopapillata n. sp. (Hornell), *Lepidonotus trissochætus*, *L. carinulatus*, *Panthalis melanonotus* (in sandy gelatinous tubes);

"Suran," *Avicula* sp.;

Asymmetron (*Heteropleuron*) *cingalense* (12 specimens).

Of the numerous small pearl oysters in this haul rather more than half (on the average 11 to 9) were dead, many of them entangled with "Suran."

Several hauls of the tow-net were made during the day (February 4), and amongst the most abundant organisms noticed were:—

Diatoms (vast quantities), Ceratium, Peridinium, and spherical gelatinous Algæ.

Mitraria, Nauplei, and other larvæ;

Copepods (29 species), *Oithona similis*, *Calanus minor*, *Pseudodiaptomus aurivillii*, *Pontellopsis strenua* and *P. perspicax*, *Calanopia elliptica*, *Labidocera acuta*, *Tortanus forcipatus*, *Centropages* sp. (new to science);

Salpa democratica-mucronata.

The blue Copepods and Salpa were mainly in the later more westerly hauls (18 miles from shore), and the Diatoms and Algæ in the earlier hauls on the Cheval paars. A gathering taken during the night gave some large *Sagitta*, a few small Medusæ, some Amphipods and *Nebalia*.

Having now made a preliminary examination of the pearl-bank regions in the Gulf of Manaar and obtained some samples, I decided to visit various other localities round the island to which attention has been directed either by the literature of the subject or by information obtained since landing in Ceylon. We therefore made our way next through the Pamban Pass, between Rameswaram Island and the mainland of India, into Palk Bay, which lies north of Adam's Bridge (see map of route, p. 19).

On February 5th, while lying at the southern end of the passage, waiting for the pilot, the sea-temperature at 10.30 A.M. was 77·5° F., and the specific gravity was 1·0205. A tow-net gathering taken here contained a new species of *Centropages*, with a remarkable dorsal spine, and a new species of *Labidocera*.

On February 6th, at the north end of the pass, opposite the village of Pamban, at 7 A.M., the sea-temperature was 76° F. and the specific gravity only 1·019; at 7 P.M. in the middle of Palk Bay the sea-temperature was 78° F. and the specific gravity 1·021. This day was spent trawling and dredging in Palk Bay, a wide shallow area lying between Adam's Bridge and the northern end of Ceylon, and partly enclosed by the chain of islands extending southwards from Jaffna, with, for the most part, a muddy bottom at a depth of from 6 to 8 fathoms. Parts of it near the islands are much blocked, as we found later, by luxuriant coral growths, but the centre presents a large open expanse with a uniform soft bottom suitable for trawling. Pearl oysters are said to be found in a few feet of water in some places round the shore, but there are no fisheries, and our object here was not to look for "paars" but for *fish*, as I had undertaken to report upon any grounds suitable for the use of the European fish- or shrimp-trawls if occasion presented itself.

We first took a haul of the dredge to ascertain the bottom and, finding it soft and muddy, put over the large fish-trawl about 7 miles north-east of Rameswaram, at a depth of 7 fathoms, and towed for 6 or 7 miles in a south-easterly direction parallel with the length of the island. A second haul of the trawl was made from the point reached onwards in the same direction to a point due north of about the centre of Adam's Bridge and distant about 9 miles. The third haul was from that point onwards in a more easterly direction towards the Island of Manaar. The beam of the trawl came up damaged on this occasion and had to be shortened by about a foot. The fourth and last haul of the day was taken rather further out than the last and further east, off the western end of Manaar Island, and about 9 miles off shore. Here the beam again broke and required to be repaired, but the contents of the net were saved. The hauls varied from 4 to 7 miles in length and the trawl was generally down nearly two hours. The bottom remained the same and the depth was very uniform. In the middle of the stretch it deepened to 8 fathoms, but towards the end we ran into 7 again. As these hauls were practically continuous, and as the conditions and the results were so much alike in all cases, I think it best to consider the whole day's work as one locality (Station XVIII.), lying to the north of Adam's Bridge and contrasting markedly with the much more irregular bottoms and hard ground lying to the south in the Gulf of Manaar.

STATION XVIII.—South-west part of Palk Bay, off Rameswaram Island and Adam's Bridge, from 7 to 9 miles off shore; depth 7 to 8 fathoms; bottom fine soft bluish-grey mud containing casts of various Molluscan shells; four hauls of fish-trawl and one haul of dredge :—

Holothurian (white and minutely spinous, apparently a new species of *Synapta*), *Salmacis bicolor ;*

Nemertine (large red, like *Valencia splendida*, and also two slender white ones), (?) Terebella tubes, (?) Sabella tubes, *Chlœia ceylonica*, *Gastrolepidia clavigera*, other Polychætes ;

Anilocra sp., *Squilla* sp., Macrurids (sev.), Portunids and other crabs ;

Eburna sp., *Turbinella rapa*, *Fusus turricula*, *Nassaria acuminata*, *Mitra pyramidalis*, *Cerithium citrinum*, *Murex tenuispina* (many), *Natica* (with egg-coil), *Mya* sp., *Pinna fumata*, *Lithodomus* sp., *Dentalium* (up to 3½ inches long), Cephalopod eggs ;

Balanoglossus (probably *Glandiceps haekii*).

The Fish* caught on this occasion were :—

"Cat-fish" (*Arius venosus*, Cuv. and Val.) ;

"John Dory" (*Gazza equalaformis*, Rüpp., and *Equala splendens*, Cuv.). Up to

* I give the English rough equivalent as entered at the time in the diary, followed by the scientific name as determined since by Mr. J. Johnstone, who will report upon the fishes in detail.

6 inches long. Even those of 3 inches long showed the ovaries mature. Intestine dark green in colour and contents consisted entirely of a large Navicula-like Diatom;

"Arnoglossus" (*Psettodus erumei*, Bl.);

"Sand-eels" (several small *Tæniolabrus* sp. and another);

"Bass" (*Sciæna maculata*, Bl. Schn.);

"Soles" (*Cynoglossus* spp.);

"Pomfret" or "Pamplette" (*Stromateus sinensis*, Euphr.);

"Plaice" (*Pseudorhombus arsius*);

"Mackerel" (*Caranx hippos*, Linn., probably = *Scomber heberi*, Bennett).

During the day (February 6) several tow-net gatherings were taken. In the morning (8 a.m.) there was a large amount of material, chiefly Alima and other Crustacean larvæ, also some large *Sagitta*, a few Mysids and large Copepoda (*Labidocera acuta* and *Pontella tenuiremis*). In the afternoon there were fewer animals, but an enormous amount of *Trichodesmium erythræum*, which in places formed a dirty reddish scum on the surface.

This same locality (Station XVIII.) was also visited later on (March 14th) and trawled over again with much the same results. [Station XIX. is in the northern part of Palk Bay, and was worked on March 16th—see below, p. 83, and map, p. 82.]

Palk Bay measures about 34 miles from north to south (roughly from off Jaffna to the middle of Manaar Island) and 40 miles from east to west along the south (say from Manaar to Rameswaram), and is 20 miles across further up between Delft Island and Devil's Point. It is about 100 miles round the coast from Rameswaram to Punkudutiva, and another 30 across the entrance; and must contain over 900 square miles. Of this area probably two-thirds is trawlable ground, with an even muddy bottom at a depth of 7 fathoms nearly all over, while outside is the still wider area of similar character known as Palk Strait, between Ceylon and the Tanjore Coast. Our hauls in both the north and the south parts of Palk Bay showed that there are plenty of fish, and apparently this shallow area serves as a very valuable "nursery" for young fishes.

A great part of the Ceylon coast would certainly be very difficult to fish according to European methods, and in some cases it is practically impossible to trawl because of the coral reefs and other obstacles; but Palk Bay is one of a few areas where there is a considerable extent of ground suitable for trawling, and containing an abundant fish fauna.

The "Lady Havelock" now steamed round the north end of the island from Palk Bay to Trincomalee. After the Gulf of Manaar I regarded Trincomalee as the most important place I had to visit and report upon—in the first place, because of Dr. Kelaart's experiments and observations in regard to pearl oyster cultivation there some fifty years ago, and secondly, because pearl oysters are known still to live in some parts of the inner bay, where they are collected and eaten by the natives and where pearls are occasionally found. About the time we arrived in Ceylon some letters appeared in the Colombo newspapers on the matter, and a Mr. J. B. Colomb, resident in Trincomalee, sent to me one or more specimens of oysters from which pearls had been obtained.

On February 7th, at 7 A.M., we were off Muletivo Shoals, on the north-east coast, and the sea-temperature was 77° F. and the specific gravity 1·021; at 7.30 P.M. that night in Trincomalee inner bay the temperature of the sea was 78·3° F. and the specific gravity 1·022. About 2 P.M. we reached Back Bay (fig. 2), outside Trincomalee, and took a haul of the dredge (Station XX.) in order to see whether the

Fig. 2. Sketch-plan of the bays round Trincomalee, showing Stations XX. to XXXI.

ground was suitable for pearl oysters. The bottom was hard and bore a mixed fauna, but no oysters were found. The tow-net contained a number of Copepoda, including *Oithona minuta* and a new *Labidocera*, close to *L. kroyeri*.

STATION XX.—North part of Back Bay, Trincomalee; depth 11–13 fathoms; bottom hard; dredged. Amongst the animals obtained were:—

Anemones attached to *Fusus tuberculatus*, *Heterocyathus aequicostatus*, and *Heteropsammia michelini* (with Gephyreans);

Stellaster sp. (many), *Astropecten hemprichii* and *A. euryacanthus*, *Ophiocnemis marmorata* and other Ophiuroids, *Cucumaria imbricata* (several);

Aspidosiphon corallicola, &c.;

Cardium rugosum, *Fusus tuberculatus*, *Cerithium citrinum*, *Tudicla spirillus*, *Philine* sp.

We divided up the days devoted to work in the neighbourhood of Trincomalee so as to examine as much as possible of the fauna of this extensive and complicated region (see fig. 2). About twelve bays were explored either with the steamer or the small boats, and we also managed to do some collecting along the shore. The general arrangement was:—

On February 7th, Back Bay;
,, ,, 8th, Back Bay, Dutch Bay, and off Foul Point;
,, ,, 9th, at anchor, shore-collecting, and investigating the pearl oysters;
,, ,, 10th, dredging from the boats in the creeks of the inner bay;
,, ,, 11th, Tamblegam Bay.

On February 8th, at 7 A.M., the sea-temperature in the inner bay was 77·5° F., and at 8 A.M., in Back Bay, was 78° F., the specific gravity at both localities being 1·021. We started dredging at 8 A.M., in the southern part of Back Bay (Station XXI.), one of the localities where Dr. KELAART is said to have deposited pearl oysters in 1857, and where we were told the native fishermen occasionally found them.

STATION XXI.—In Back Bay, North of Fort Frederick; depth 8–12 fathoms; bottom firm sand, in places some mud; several hauls of dredge, but no traces of pearl oysters. Amongst the animals obtained were:—

Adamsia? (on Chank shell), *Virgularia juncea*, *Pteroeides esperi*;

Laganum depressum, *Thyone fusca*, n. sp. (PEARSON), *Cucumaria imbricata*, various Ophiuroids and small Asterids (mainly young *Stellasters*):

Carinella sp., *Terebella* and other worm tubes;

Portunids (small), *Ebalia* sp. and other crabs;

Turbinella rapa, *Strombus succinctus*, and species of *Conus*, *Cerithium*, *Dentalium*, and *Cardium*;

Psammaplidium sp. and *Leptoclinum* (sev. spp.).

We then tried Dutch Bay (Station XXII.), to the South of Fort Frederick, with similar results, a hard bottom with an abundant general fauna, but no pearl oysters.

STATION XXII.—Across mouth of Dutch Bay from Fort Frederick to Dutch Point; depth 13 fathoms; bottom dead coral, shells, and Nullipores; dredged.

Fungia sp., *Dendrophyllia* sp., *Heteropsammia michelini* (with Gephyrea), *Sarcophytum* sp., and other Alcyonaria;

Linckia diplax, *Astropecten zebra* (?), and various Ophiuroids;
Halsydna sp., *Serpula actinoceros;*
Pontonia sp., *Lambrus* sp., and other Decapods;
Molgula sp., and a few common Molluscs.

As we had heard that pearl oysters had been found "off the Suami Rock," Fort Frederick, between Dutch Bay and Back Bay, I considered it necessary to examine the ground further in close to the rocks where the steamer could not be taken. So we engaged a pilot's large boat with a native Tindal and crew and took with us Mr. J. B. Colomb, from Trincomalee, who professed to know where specimens had been obtained by native fishermen. We took haul after haul of the dredge close in along the northern edge of the Suami Rock (Station XXIII.), beginning abreast of the detached rock off the point of Fort Frederick peninsula and working along parallel with the shore past the old Dutch boat-jetty. We were all the time on the ground indicated by Mr. Colomb and the native pilot, and obtained good hauls, but nowhere was there any trace of pearl oysters—not even fragments of dead shells.

STATION XXIII.—Close to Suami Rock, Back Bay; depth $4\frac{1}{2}$ to 8 fathoms, mostly between 5 and 6 fathoms; bottom sand, shells, and in places stones and corals. Half-a-dozen hauls of the dredge.

Caryophyllia sp. and other small corals, *Rhipidogorgia* sp. and other Alcyonaria;
Spatangoid, *Antedon* sp., Ophiuroids, *Holothuria atra*, *Linckia multiforis;*
Melita obtusata, *Ebalia*, and other small crabs;
Malleus vulgaris, *Octopus* sp.

We then steamed across the mouth of "Great Bay," in order to try a haul of the trawl in the open off Foul Point. Unfortunately the bottom proved unsuitable, the trawl eventually caught fast, and, before the strain could be relieved, the bridle parted and the wire rope came in, bringing with it the ring of the bridle (in which was entangled a beautiful dendritic Antipatharian colony) and leaving the trawl at the bottom. We then dredged over the same ground in the hope of entangling the dredge in some part of the trawl, but in vain. We may unite these hauls as:—

STATION XXIV.—Two and a-half to three miles north of Foul Point; depth ranging from 46 to 24 fathoms; bottom hard and rough—probably rock.

Sponges (many), various corals;
Various Gorgonacea, including *Juncella juncea* and *Solenocaulon tortuosum; Antipathes* sp., and *Cirrhipathes spiralis;*
Antedon reynaudi (on Gorgonids), various Ophiurids (on Gorgonids);
Bonellia punicea (in Coral);
Melita obtusata and other Amphipods;
Ischnochiton ferreus, n. sp. (Sykes).

We landed with a party of our Maldivian lascars at Shell Bay, near Foul Point, to examine and collect on the beach. Many "calling-crabs" (*Gelasimus*) were seen, and a large quantity of molluscan shells was obtained—a species of *Bulla* was especially common. Only one specimen of pearl oyster (dead, but having the valves still attached) was found, and a closely allied species of *Avicula* with a longer wing was also taken. Amongst the other shells obtained here, and at other places round Trincomalee, were such typical Indian forms as :—

Pecten plica, *Pinna bicolor*, *P. fumata*, *P. chemnitzii*, and *P. zebuensis*, *Modiola tulipa*, *Psammobia amethystus*, *Cardium asiaticum*, *Ostrea hyotis*, *Vulsella rugosa*, *Avicula vexillum*, *Arca decussata*, *Chama foliata*, *Malleus vulgaris*, *Placuna placenta*, *Ricinula arachnoides*, *Rotella vestiaria*, *Trochus niloticus*, *Margarita acuminata*, *Phasianella lineolata*, *Fasciolaria trapezium*, *Pyrula ficus*, *Fusus tuberculatus*, *Murex haustellum*, *M. tenuispina*, *Eburna zeylanica*, *Triton lotorium*, *T. pilearis*, *T. gallinago*, *T. tripus*, *Xenophora calculifera*, *Solarium perspectivum*, *Strombus succinctus*, *S. sibbaldii* and *S. canarium*, *Cassis glauca*, *C. canaliculata*, *Dolium maculatum*, *D. olearium*, *Conus tessellatus*, *C. terminus*, *C. miles*, *C. betulinus*, *C. striatus*, *Oliva maura*, *O. gibbosa*, *O. ispidula*, *O. elegans*, *O. torsans*, *O. candida*, *Cypræa arabica*, *C. lynx*, *C. moneta*, *C. ocellata*, *C. errones*, *C. caput-serpentis*, *C. coffea*, *C. tigris*, *C. mauritiana*, *C. asellus*, *Natica mammillata*, *Pterocera scorpius*, *Harpa conoidalis*, *H. ventricosa*, *Eburna ceylonica*, *Pyrazus palustris*, *Turritella duplicata*, *T. attenuata*, *Telescopium fuscum*, *Terebra tigrina*, *Turbinella spirillus*, *Bulla ampulla* and *Spirula peronii*.

Two hauls of the dredge were now taken nearer Foul Point (Station XXV.) in much shallower water and on smoother but less interesting ground.

STATION XXV.—Three-quarters of a mile to a mile west-north-west of Foul Point; depth 8 fathoms; bottom firm, Orbitolites sand and Nullipores; dredged.

Orbitolites complanata, *Heterostegina depressa* and other Foraminifera;

Fungia dentata; *Antedon* sp.;

Hyalinœcia sp. (numerous), *Sigalion* sp.; various crabs; *Molgula* sp.;

*Amphioxus** (two, young), *Saurida nebulosa*, *Leptocephalus* and a small Sole.

Several TOW-NET gatherings had been taken during the day (February 8th), but they contained comparatively little except *Trichodesmium erythræum*, which was present in great abundance, some *Euchæta* sp., *Labidocera kroyeri*, *Euterpe acutifrons*, and many young Copepods.

The following day (Sunday) we lay at anchor in Trincomalee harbour, and employed the time in very necessary examination, preservation, and packing of specimens, and unpacking of stores, and writing up of notes. We also did some shore-collecting and obtained local evidence in regard to the occurrence of the pearl oysters at Trincomalee. Mr. COLOMB had brought on board, for our inspection, a number of the empty shells of oysters which had been picked up by the natives in shallow water between Powder

* Specimens apparently not kept, so species not certain.

Island and Victoria Wharf. They had been gathered alive in January and used for food. We measured 240 valves, which ranged in size from 2·2 to 5 centims. in diameter. The average size was 4 centims. So these, as well as all we collected ourselves, were of small size.

Trincomalee is an admirable collecting ground for molluscan shells; some of the numerous beaches in the neighbourhood have fine specimens cast up—for which natives are constantly on the look out—and there are Moormen in the town who are expert dealers, and have large stocks. I examined several of these collections, with the object of looking for large specimens of the pearl oyster; but although nearly every little box or basket of shells, made up for sale to passengers on the steamers, contains a couple of valves of pearl oysters, these are all of small size, and none were seen comparable with those from the Gulf of Manaar.

Some detached valves, about $1\frac{1}{4}$ inches long, were found on the shore close to the Cutch Company's bungalow. Near the same spot were some heaps of a large *Mytilus*, having masses of quartz gravel entangled in the byssus, and also quantities of *Pinna*—evidently all used for food. Many small rock oysters were seen adherent to boulders and masonry at various points round the bay (see fig. 3).

The sea-temperature this day (February 9th) in the harbour was 78·2° F. at 8 A.M., and 78° F. at 7 P.M. The specific gravity at both times was 1·021.

Next day (February 10th) at the same place, at 7 A.M., the temperature was 78° F., and at 7 P.M. was 78·8° F. At both times the specific gravity was 1·020. There had been some rain in the night. The temperature in our various tanks in the ship, in which we kept animals under observation, now began to vary considerably. In the ship's baths the water was 80° F., while some of our wooden tanks were only at 75·5° F. February 10th was devoted to dredging in the various smaller bays or coves which open off the so-called "harbour" (fig. 2) or inner bay of Trincomalee. We may regard each bay as one station, although several hauls of the dredge may have been taken in it.

STATION XXVI.—Outer part of Yard Cove, between Plantain Point and Middle Point and inwards to the "narrows"; depth 2 to 8 fathoms; bottom coarse sand and gravel with thin layer of mud on surface. Several hauls of dredge.

Much black branched and pale lilac Renierid sponges;
Astropecten sp.; *Synapta striata* (lilac and white, in branches of sponge masses);
Sipunculids, Lumbrinereids;
Various Ebalid, Portunid and Eurynomid crabs;
Strombus succinctus (many), *Neritina* sp. (common); *Molgula* sp.

STATION XXVII.—Entrance and middle of Cod Bay; depth 4 to $6\frac{1}{2}$ fathoms; bottom muddy sand; several hauls of dredge.

Gelliodes carnosa, *Halichondria* sp., *Clathria* sp.;
Thyone calcarea, n. sp., *Holothuria tenuissima*, *H. atra*, and *H. marmorata*;

Polynoe sp., *Glycera decipiens*;
Strombus sp. and other common Molluscs;
Amphioxus (apparently undetermined).

STATION XXVIII.—Middle of China Bay; depth 7 to 14 fathoms; bottom black sandy mud; several hauls of dredge.

Holothuria gallensis, n. sp. (PEARSON), *Astropecten hemprichii*, *A. polyacanthus*;
Glycera (small pink), and some long calcareous worm tubes, &c.

STATION XXIX.—French Pass; depth 4 to 7 fathoms; bottom mud with a few stones; several hauls of dredge.

Holothuria marmorata (the large yellow, spotted brown trepang);
Some Molluscs, Annelids and Polyzoa (including *Adeona* sp.).

STATION XXX.—Nicholson's Cove; depth $4\frac{1}{2}$–10 fathoms; bottom muddy sand; dredged.

Euspongia officinalis; and a Cubomedusa;
Holothuria atra (the large black and pink trepang);
Hyalinœcia sp.;
Strombus succinctus, *S. sibbaldii*, and a few other common Molluscs.

The shoal at the inner end of Nicholson's Cove has a hard bottom with occasional boulders, which are covered with small rock oysters up to $3\frac{1}{2}$ inches long (average size 2 inches). It is one of the few spots at Trincomalee which would probably do well for the pearl oyster.

Mr. HORNELL and I managed to land also during this day at various points to examine the shore and the shallow-water fauna—which was very important here because of the remarkable fact that the pearl oyster is found living naturally between tide-marks.

At the far end of Nicholson's Cove we found one or two dead specimens of the commercial sponge, and we also dredged a piece which proved to be *Euspongia officinalis*. This showed that it evidently grows in the neighbourhood, and we have since found it in quantity. In the mangrove swamps which fringe the ends of this and some other coves there are great numbers of small land crabs (*Ocypoda macrocera*) and also of the semi-terrestrial fish *Periophthalmus*, some of which we caught, with some difficulty. We tried to keep the *Periophthalmus* alive in our tanks on the ship, but the little fish persisted in coming out of the water and getting on deck. They scrambled up the vertical wooden sides by taking advantage of the angles at the corners of the tanks.

We waded over all the shallower parts of the harbour where Dr. KELAART had investigated the pearl oysters in 1857, and where Mr. COLOMB reported that oysters are now found by the natives. The chief place is between Powder Island and the shore near the wharf (fig. 2). Here the bottom is hard gravel with some rock *in situ* and large boulders. Rock oysters and a species of *Arca* are abundant on the rock and boulders (fig. 3) and on pieces of wreck, also quantities of

Fig. 3. Rock oysters (*Ostrea* sp.) in Trincomalee harbour at low tide.

Mytilus of good size were living on and in the gravel anchored by the byssus. Attached to these and to other objects were many pearl oysters of smallish size. Samples of these were taken alive to our laboratory on board ship. In the sand around the island *Pinna bicolor* lives in abundance, of large size, almost wholly buried, the tips of the valves just projecting beyond the level of the sand, and the byssus deep below, generally having some larger objects such as small stones and dead shells attached to it. On the shores of Powder Island we also found *Periophthalmus kohlreuteri* and thick-bodied land-crabs, and also a shore-crab with a long crenated front margin between the eyes; a *Neritina* and a *Littorina* were common, and we found a large rough Nudibranch, yellow and grey speckled, under a stone.

I obtained a native dug-out canoe and went across the bay towards Orr's Hill to see some natives diving for trepang in a few fathoms of water. The species were *Holothuria marmorata* (spotted yellow and brown forms) and *H. atra* (black, with a lighter pinkish under-surface). The divers were said to obtain 75 cents (one shilling) per 100 for these.

We next examined a reef of rock and coral lying off the Cutch Co.'s bungalow. Here by wading, or by using the water-glass in the deeper parts, we saw living coral in quantity (chiefly *Porites* and Astræids), much sponge, and many fair-sized pearl oysters attached either to mussels as before or to the rock by their byssus. They appear to extend sporadically across the sand from Powder Island to Orr's Hill. *Pinna bicolor* and *P. fumata* were present in the sand and gravel around, and an *Ostrea* on the rocks. We caught a small yellow *Ostracion* amongst the pearl oysters. Undoubtedly this spot, and the ground round Powder Island and the shoal at end of Nicholson's Cove are the best spots in Trincomalee for the cultivation of the pearl oyster. The bottom is suitable, and apparently the animals live naturally and grow fairly well there. Most of the other bays and creeks we examined are useless because of the large amount of mud present. We deposited in the harbour a number of living pearl oysters brought round from the Gulf of Manaar. They were enclosed in a wire cage anchored and buoyed at a spot duly recorded outside Little Powder Island. Mr. HORNELL will examine these on his next visit to Trincomalee.

Of the pearl oysters collected at Powder Island and on the reef off the Cutch Co.'s bungalow, 33 were at once examined as to the sexual condition—18 were males, 11 females, and 4 quite immature. The males ranged in size from $1\frac{7}{16}$ inch to $2\frac{1}{4}$ inches, and the females from $1\frac{5}{16}$ inch to $2\frac{1}{2}$ inches. Some of these were ripe, and we fertilised some ova with the spermatozoa.

On the following afternoon we examined the shore in the other direction (south), between the wharf and York Island, by means of small boat and wading. Here we came again upon rock oysters, small land crabs and a large *Ligia*, also living corals and *Pinna*. The bottom round York Island and towards the rocks near the Admiral's house is hard and seems suitable for pearl oyster cultivation ; we found several dead pearl oyster valves on the shores of the island.

On the whole Trincomalee presents several distinct advantages as a locality in which experiments in pearl oyster cultivation might be carried on ; but on the other hand it has several disadvantageous characters. As to the first, the pearl oyster already lives there in a healthy state, and sometimes, at least, produces pearls. Secondly, the locality is protected from the monsoons and sheltered in all weathers, so that work and observations could be carried on at all times of the year. Thirdly, there are several places in the bay where the bottom is hard and seems suitable for the attachment of pearl oysters. The greater part of the area is, however, very muddy ; it is said that large quantities of clay are washed down by the rains, the specific gravity of the water is rather lower than that usually found in the Gulf of Manaar, and, so far as our observations show, the plankton or microscopic life floating in the water is relatively small in amount and that will probably mean poor feeding for the larger animals. The pearl oysters we found at Trincomalee struck us as looking rather dwarfed or poorly nourished, and they were found to be sexually mature at a much smaller size than was the case with those of the Gulf of Manaar. Hence while experiments might be carried out at Trincomalee when impossible elsewhere because of weather, the conditions of water and food are probably not so favourable as in the Gulf of Manaar and would probably not lead to such active growth and shell (including pearl) formation.

The greater part of our last day (February 11th) at Trincomalee was devoted to the examination of Lake Tamblegam, an enormous shallow sea-water area opening by a narrow entrance from Great Bay. The sea-temperature at 7.20 A.M. in Great Bay, off the entrance to Tamblegam, was 78° F. and the specific gravity 1·0166 ; at 9 A.M. in Lake Tamblegam the temperature was 80° F. and the specific gravity 1·0145 ; at

7 P.M. in Trincomalee harbour the temperature was 78° F. and the specific gravity 1·0202. The entrance to Tamblegam is obstructed by a long curved sand-spit on the south and a number of scattered rocks and reefs on the north, so the steamer was unable to get within a mile or more of the channel. From there we sailed in the ship's gig with a strong easterly wind which carried us into the lake in fine style, but gave considerable trouble when we tried to return in the afternoon. The passage was found to be too narrow and too much obstructed to beat out against the wind, and when we lowered the sails and started to row out through the breakers now coming in from Great Bay, first one and then a second of the six oars broke, followed by the snapping off of one of the brass rowlocks at a critical moment. The boat then made way very slowly, dodging where possible behind the rocks at Noddi Tevu, and so eventually got through the worst of the sea and out of the narrow channels into the open bay.

Lake Tamblegam has long been known as the scene of a fishery of the flat thin "window-shell" oyster, *Placuna placenta*, a remarkable form (see fig. 4) in which

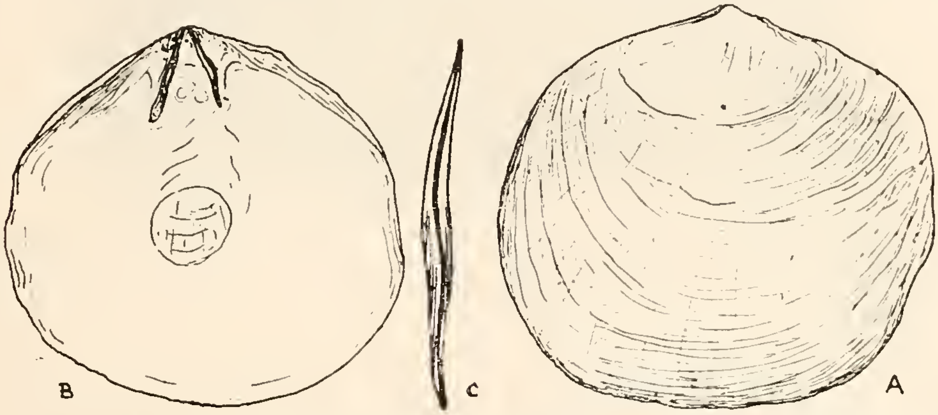


Fig. 4. *Placuna placenta*, from Lake Tamblegam; half natural size. A, outside of shell; B, inside; C, edge view.

an exceedingly thin body is contained—or compressed—between two almost flat discoidal valves of considerable size (up to 6 inches across) which can easily by scraping off the outside be rendered at least translucent to light, and are said to be used as window-panes in Chinese huts and at Goa. Pearls are not unfrequently found in these window-shell oysters and profitable fisheries have been held in the past at Tamblegam. The pearls are mostly small and these are said to be exported to India to be calcined to make chunam for betel-chewing. We did not on this visit see any living specimens of *Placuna*, although Mr. Hornell has seen them since; but the great gleaming piles of dead shells seen at various points along the shore (fig. 5) were evidence of the enormous numbers that had been taken in the former fisheries, and especially at the last fishery fifteen years ago, when the stock in the lake seems to have been nearly cleared out. There were also in places heaps of piled up rock-oysters (*Ostrea* sp.), some of very large size. These, as well as a large species of *Venus* and a mauve *Psammobia*, are used as food by the natives. The whole lake, measuring more than 20 miles round, is very shallow, most of it being under a fathom in depth. On the southern coast we found there was not enough water to row round near the shore in the ship's boat, so we crossed to near Corrinjahvat in the north

Fig. 5. Heaps of window-shell oysters (*Placuna placenta*) on the shores of Lake Tamblegam, from the last fishery.

where great piles of *Placuna* valves line the shore. We took a few hauls of the dredge here in about 1 fathom of water, and also dredged across the mouth of the inlet known as Narche Coudar (fig. 2, p. 31). In both spots (the whole of Lake Tamblegam may be regarded as Station XXXI.) the bottom was mud with a little sand, and there were few animals:—some worm tubes, a few small Medusæ, a flat Clypeastroid and some Pagurids in Gastropod shells.

The bad weather, and a knowledge that the difficulty we should have in getting out would be increased with delay, prevented our spending longer time in Tamblegam Lake, and unfortunately fully as many days as could be spared had now been given to the Trincomalee district. But I arranged with Mr. Hornell that after my departure from Ceylon he should take an early opportunity of visiting Trincomalee and Tamblegam by land, and by making use of native fishermen and divers from the shore, satisfy himself as to any of the matters which we had left undecided.

The main points on which I wished him to get further evidence were:—

(1.) Whether the water of the harbour differed much in muddiness and salinity at other seasons;

(2.) Whether the commercial sponge which we had found lived in any easily accessible spot in sufficient quantity to constitute a fishery;

(3.) Whether the window-shell oyster was still present in abundance in any part of Lake Tamblegam.

Mr. HORNELL carried out these instructions in October, 1902, when he spent a week at Trincomalee and made a thorough examination of Tamblegam Lake. He was successful in settling, I think, all the points referred to him. He found that the specific gravity of the water varied about 1·019, at a temperature of 84° F. to 90° F. But he was told this had been an unusually dry season at Trincomalee.

With the help of native divers he found the bath sponge living in quantity, of good size and suitable form, in a few feet of water along the shores of Plantain Point and in Yard Cove. I have examined the specimens he sent to Liverpool and have shown them to Professor ARTHUR DENDY, our leading specialist on the subject. Professor DENDY determines them as *Euspongia officinalis*, the common bath sponge, and describes the samples we had before us as being a fairly good, compact, resilient bath sponge, but containing a certain amount of grit in the form of broken foreign spicules in the primary fibres. He adds: "The possibility of establishing a sponge-fishery is worth consideration."

Mr. HORNELL examined a number of pearl oysters from round Powder Island and elsewhere in the harbour. They had increased in size since our visit in February but were not so numerous.

In his visit to Tamblegam (Station XXXI.) he found the temperature of the water varied from 87° F. to 90° F. and the specific gravity from 1·016 to 1·019. Amongst the animals he obtained were:—

Tetractinellid sponge (a curious Suberitid species which lives anchored in the soft mud by silky tufts of spicules, and the presence of which is regarded by the divers as an indication of *Placuna*);

Sagartia sp. (on *Cassis*) and a (?) Cerianthid (in tube);

Various crabs, including a burrowing form with scarlet antennæ;

Venus sp. (collected as food by natives near mouth of Kinnia River), *Psammobia* sp. (mauve, eaten by natives), *Placuna placenta*, Trochoid shell (abundant). *Ostrea* sp. (rock oyster).

We left Trincomalee on the night of February 11th, for Galle, and the following morning at 10 A.M., when 30 miles south of Batticalloa, found the sea-temperature to be 78° F. and the specific gravity 1·0215. We took a haul of the dredge (Station XXXII.) some distance further on, off the south-east of the island.

STATION XXXII.—Five miles East of Arugam Bay; depth 17 fathoms; bottom fine sand.

Solenocaulon tortuosum and other Alcyonaria;

Astropecten (two species);

Serpula actinoceros:

Ampelisca macrocephala, Pagurids;

Cassis glauca and a few other Molluscan shells.

A TOW-NET gathering taken at the same time yielded 26 species of Copepoda along with *Trichodesmium erythræum*.

Another haul of the dredge was taken further on at—

STATION XXXIII.—Halfway from Arugam to Little Basses, about 4 miles from land; depth 18 fathoms; bottom dead shells and Nullipore.

Axinellid sponge (large, orange, branching, gorgonid-like form, which is probably a new genus);

Solitary corals, *Plexaura indica* and some other Gorgonacea;

Rhinobrissus pyramidalis (?), various Ophiuroids;

Ampelisca macrocephala, and other Amphipoda.

We reached Welligam (or Belligama) Bay, near to Dondra Head, the most southerly point of the island, in the early morning of February 13th. One of the points I had to determine during this preliminary survey of the marine biology of the Ceylon coast was the most suitable spot for a small marine laboratory in which Mr. HORNELL could continue our work at the pearl oysters during the monsoon after I left. All naturalists know of Professor HAECKEL's visit to Ceylon in the winter of 1881–2, and of how he carried on shore and pelagic work for some months at the southern end of the island, and especially at Welligam (the "Bella-Gemma" of the enthusiastic German professor), where he found congenial quarters, ideal natives and an interesting fauna. His happiness in his general surroundings is reflected in his glowing description of the bay as a zoological paradise. Hearing that I was going to Ceylon, HAECKEL kindly wrote pressing "Bella-Gemma" upon my attention as an ideal spot for a biological station. He also very fairly mentioned Trincomalee as a place where his friends Dr. PAUL and Dr. FRITZ SARASIN had worked but which he did not himself know. Welligam looked charming on land, but seemed to us to have a poor bottom fauna compared with either Galle or Trincomalee. HAECKEL however worked mainly, if not wholly, on the surface animals collected with the tow-net; and these no doubt, so far as the oceanic forms are concerned, are much the same as at Galle.

While the "Lady Havelock" lay at anchor in Welligam, we went off in the boat and had seven hauls of the dredge scattered fairly over the bay so as to adequately sample the ground. As all parts seemed alike in character and fauna I propose to unite them as—

STATION XXXIV.—Welligam Bay, various parts; depths 2 to 7 fathoms; bottom shell-sand and a little mud; sea-temperature at 7 A.M. 77·8° F., specific gravity 1·0225; dredged.

Orbitolites complanata, *Polytrema miniaceum*, and small sponges;

Hydractinia sp., small Gorgonids;
Echinodiscus auritus, *Lovenia elongata*, *Antedon* sp.;
Glycera lancadivæ, *Serpula* sp., and some other small worms, Lepralid Polyzoa;
Ampelisca brevicornis, some Pagurids and small crabs;
Turritella duplicata, *Philine* sp. and many dead molluscan shells;
Molgula sp. (small), *Amaroucium* sp. and Amphioxus* (2).

We landed at the south-eastern corner of the bay, near the fishing village of Mirissa, which seemed the most promising part—zoologically—as it may possibly be a little sheltered from the south-west monsoon, and examined a good deal of the beach and of the shallow water near from the boat. There are red cliffs of coarse gneiss at the extremities of the bay, which no doubt give it its chart name "Red Bay." Pagurids of several species, some inhabiting the shells of Helix and other land Molluscs, were very common on the upper part of the beach and in the cocoa-nut plantations beyond. A crowd of several dozen were found congregated upon a small heap of dung evidently feeding. Others were sheltering in numbers about the roots of the trees. A *Pterocera* shell (*Pt. lambis*) was found on the beach, small Limpets were abundant on the red rocks at the point, and many long-spined purple Echinids (*Stomopneustes variolaris*) were in hollows in the rock pools, and also under the sea in cavities and crevices of the rock. Living Corals were seen from the boat in the shallow water just inside the point.

On the whole this was a disappointing bay. There is no place where experiments in the cultivation of the pearl oyster could be carried on. There is no ground where we could expect to find the animal, or where it would probably be able to live. The bay is open to the full force of the south-west monsoon, and this would introduce difficulties in collecting and other biological work during a great part of the year. It is unsuitable both for the general work of a biological station and also for the special purposes of the pearl oyster investigation.

We went on the same night to Galle—the last of the localities round the coast which I had noted for comparison with the Gulf of Manaar.

Altogether five days were spent on this occasion investigating Galle and its surroundings, and another visit of several days was paid later on, in March.

February 14th was spent in dredging in the bay, and shore-collecting;
February 15th in dredging near Watering Point, and shore-work;
February 16th in examining the Coral reef and the lagoon (see fig. 6);
February 17th in dredging off entrance to Galle Bay and neighbourhood;
February 18th in dredging and trawling in deeper water outside Galle and onwards.

On February 14th we had several hauls of the dredge in the entrance to the bay, between the points, which may be united as—

* Probably *Branchiostoma lanceolatum*, but the specimens have apparently not been preserved.

STATION XXXV.—Entrance to Galle Harbour, near the black buoys and Mata-Mada Rocks; depth $4\frac{1}{2}$ to 7 fathoms; bottom coarse sand; sea-temperature, at 6.30 A.M. 78·5° F., at 9.30 A.M. 79° F.; specific gravity 1·023; dredged.

Calcareous sponge (*Clathrina* sp.), *Hymeniacidon* sp.;

Diphasia mutulata;

Glycera sp., *Leanira* sp.;

Ampelisca brevicornis, Hippa asiatica, and several Brachyura;

Pteropods, and some shells of the genera *Cucullæa, Ostrea, Anomia, Turritella:*

Branchiostoma lanceolatum.

Fig. 6. Sketch chart of Galle Bay, showing Stations XXXV. to XLI., the Coral reef, Lagoon, position of the Biological Station (B.S.), &c.

Four hauls of the dredge taken in the afternoon and evening near Gibbet Island and the Kata Rocks may be united as—

STATION XXXVI.—Galle Harbour, off Gibbet Island and Glosenburg from Kata Rocks inwards; depth 2 to $4\frac{3}{4}$ fathoms; bottom fine sand and mud; dredged.

Some sponges, and *Hydractinia* sp.;

Nereis foliosa, *Glycera* sp., *Serpula quadricornis*;
Ebalia sp. and other small crabs;
Shells of *Dentalium octagonum*, *Eburna canaliculata*, and other Molluscs;
Leptoclinum sp., and *Branchiostoma* (*Dolichorhynchus*) *indicus*.

Halobates was seen on the surface in quantities during the afternoon, and a townet gathering taken in the evening, after dark (about 9 P.M.), contained *Corycæus obtusus*, *Labidocera pavo* and *L. kroyeri*, *Pseudodiaptomus serricaudatus*, and a new species of *Centropages*. On the following evening, after dark, we again got very much the same series of Copepoda.*

In the little bay between Gibbet Island and Glosenburg (fig. 7) the bottom is fine sand, ripple-marked, and with occasional boulders. The entrance is bounded by a chain of submerged rocks covered with Algæ and Corals. The bottom and sides are not unsuitable as a locality for biological experiments when in the condition in which we saw them, but the situation is exposed, and there is probably a heavy surf rolling into the little bay during the south-west monsoon. We examined this bay and also the creek behind Gibbet Island with some care, as the locality had occurred to us as a possible position for the biological laboratory, and moreover HAECKEL in his book on Ceylon had strongly recommended it for the purpose (see below, pp. 46, 47).

On February 15th we examined the south-eastern corner of the bay inside Watering Point, both by dredging and on shore. The hauls are united as—

STATION XXXVII.—North-west to north-east of Watering Point, about 200 yards off shore; depth 7 fathoms; bottom fine dark sand with some broken coral in places. Nearer the shore, inside Watering Point, are small coral reefs.

Various Alcyonaria and living Corals, chiefly Madrepores;
Synapta sp. (?) and *Holothuria atra*;
Filograna sp. and *Leucodore* sp.;
Calappa sp. and some Ebalid Crabs, *Hippa asiatica*, and some Pagurids;
Margaritifera vulgaris (dead shells).

We then landed at Watering Point to examine the shore, and were struck by the filthy and insanitary condition of the water which was then being pumped into water-boats to supply ships, from the old Portuguese tank. We explored the beach in both directions, and also the cliffs above, and, from the boat, the shallow water lying off the beach, with a view to reporting on this corner of the bay as a possible site for our marine laboratory. The advantages are the shelter and protection from the monsoon afforded by the headland, purity of the sea-water, and the presence of hard patches at the bottom in places where there is a fringe of living coral, and where we had found evidence of a few pearl oysters living naturally. The disadvantages are however very serious, viz., the complete isolation and the comparative inaccessibility.

* Mr. HORNELL, tow-netting at Galle since, has obtained these same Copepoda with the addition of *Calanopia elliptica*, *Acartia centrura*, *Labidocera detruncata* and a new species of *Lichomolgus*.

During the monsoon it might often be difficult to reach this spot by boat across the bay, and the distance round from the town of Galle by land is considerable (see fig. 6), and the latter part of it steep and with no proper road.

The possible sites at Galle had seemed to be :—

(1.) In the Fort, where the Government offices and European quarters are situated (fig. 6).

(2.) On Gibbet Island or Glosenburg, in or about Bayley's Villa or the neighbouring native village (fig. 7).

(3.) At Watering Point (fig. 6).

We now ruled out the last; and made a further examination of Gibbet Island. This is much nearer the town, and has a good road leading to it. Some of the

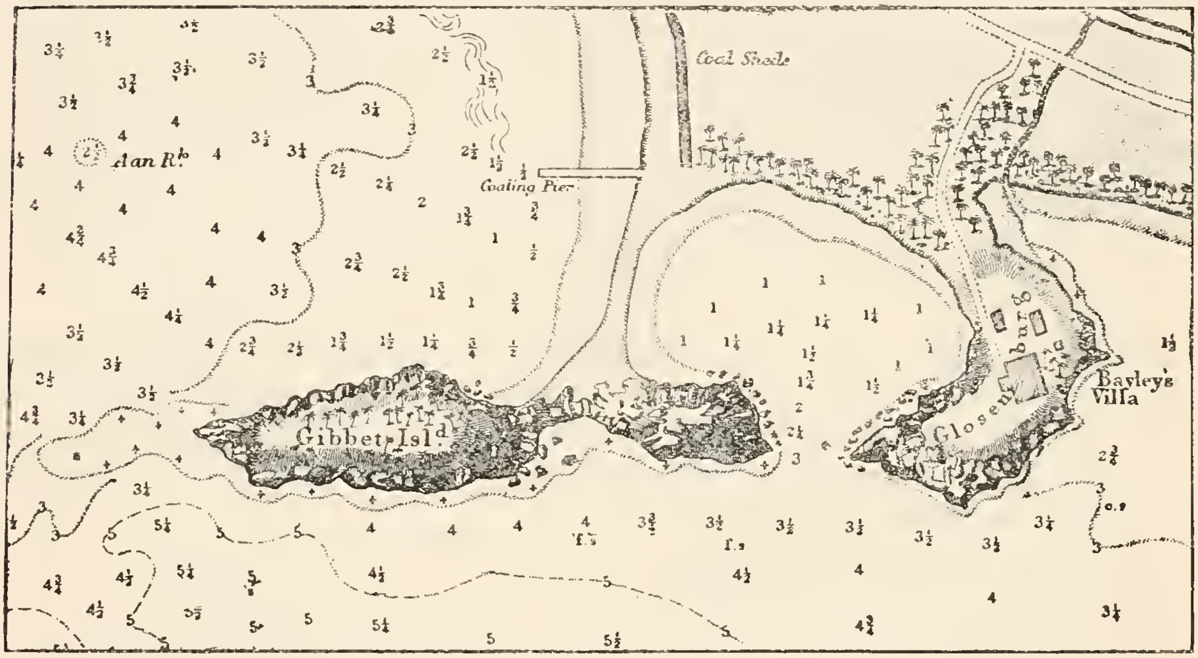


Fig. 7. Gibbet Island, Glosenburg and neighbouring creeks, in Galle Bay, showing the position of Bayley's Villa, recommended by Professor E. Haeckel, in 1881, as the site of a Biological Station.

old P. and O. Co.'s quays and walls would no doubt lend themselves well for adaptation as tanks; but, as I have shown above, it is quite a question whether work would be possible in either of the adjoining creeks during the height of the monsoon, and whether therefore this locality presents any advantage over the Fort, which would be more convenient and satisfactory in many ways for European workers.

Professor Haeckel writing, in 1881, his opinion of Galle as the site for a Marine Biological Station says*: "But more attractive to me . . . were the magnificent corals,

* English translation—'A Visit to Ceylon,' Kegan Paul, &c., London, 1883, p. 181.

which grew in extraordinary abundance on the surrounding rocks; even the little inlet used by Captain Bayley as a dock for his boat, and the stone mole where we disembarked, were closely gemmed with them, and in a few hours I had added considerably to my collection of corals. A very large proportion of the multifarious forms of animal life, which are distributed over the coral reefs near Galle, were to be seen crowded together in this narrow space—huge black sea-urchins and red starfish, numbers of crustaceans and fishes, brightly coloured mollusca, strange worms of various classes, and all the rest of the gaudy population that swarms on coral reefs and lurks between the branches. For this reason, Captain Bayley's bungalow . . . is particularly well-fitted to be a zoological station, and is only half an hour's distance from the conveniences of the town."

However, after full consideration, we differed from our German friend and decided to recommend a site in the Fort as the best position at Galle (see below, p. 92).

On two of these days we landed with a party of our Maldivians carrying ship's buckets, and, crossing the town, descended the ramparts of the Fort between "Triton" and "Neptune" Bastions (see fig. 6), in order to collect on the coral reef which fringes the shore along this side of the town, and in order to examine the possibilities of the lagoon inside the reef for purposes of pearl oyster work. The reef there runs at an average distance of about 500 feet from the shore, and the lagoon varies in depth at low tide from 1 to 6 feet. It is possible to wade over the greater part of it at a depth of 18 inches or 2 feet. The collecting is very rich, and the colouring gorgeous. Many common genera of Corals, such as *Madrepora*, *Montipora*, *Pocilopora*, and *Galaxea*, greenish-brown *Meandrina*, vivid grass-green *Astræa* or *Favia*, and others abound, but even more conspicuous in many parts of the lagoon are huge colonies of the massive leathery or slimy Alcyonaria belonging to the genus *Sarcophytum* and its allies *Sclerophytum*, *Lobophytum*, *Sinularia* and *Alcyonium*. We obtained about twelve species of the fleshy Alcyonaria in the lagoon, including *Sarcophytum ehrenbergi*, *Sclerophytum polydactylum*, *Scl. durum*, *Scl. densum*, *Lobophytum hedleyi*, *L. pauciflorum*, *L. densum*, *Alcyonium pachycladis*, and about four other species some of which are probably new to science. Amongst the other fixed forms Nullipores and incrusting Polyzoa are much in evidence forming smooth layers, filling up crevices and cementing together the separate coral colonies, branches and broken masses. STANLEY GARDINER has shown the importance of Nullipores in the formation of reefs. I am inclined to think from what I saw at Galle and also on the coral formations in the Gulf of Manaar that incrusting calcareous Polyzoa play at least as important a part in covering and consolidating the fragile, broken, or decaying coral colonies. The more abundant and characteristic Algæ (other than Nullipores) growing over the dead corals on this reef are: A small *Corallina*, three species of *Caulerpa* (probably *C. racemosa*, *C. plumaris*, and *C. sedoides*), *Halimeda tuna*, *Padina commerssonii*, *Peysonnelia rubra*, and the lace-like *Vanvoorstia spectabilis*. Bright green Zoanthids, one a long cylindrical form with two rows of tentacles, and compact masses of *Palythoa caribbæa* are also conspicuous. Even the compound Ascidians (Botryllids and Leptoclinids) are of a brilliant green colour. The Tunicate fauna of Galle includes a common *Ascidia* allied to *A. depressa* of European seas, a small red *Cynthia*, a dark brown *Ascidia* like *A. fumigata* of the Mediterranean, a dull-grey Polyclinid (? *Amaroucium*), and about half-a-dozen species of Leptoclinids, one of a lilac colour, one of a rich green, one of a very dark brown, several white and grey forms, and a large handsome new species with pinnacled upgrowths mottled black and white, which I propose to describe under the name of *Leptoclinum im-thurni*. Turning to non-colonial and more or less wandering animals, a feature of the lagoon is the huge black, brown and mottled Holothurians, which lie about on the coral sand and the commoner forms of which (*Holothuria atra*, *H. marmorata*, *H. vagabunda* and *H. tenuissima*) are fished as "trepang." Some others (*Actinopyga mauritiana*) have a flattened under-side and are coloured conspicuously black and white; and we were fortunate in finding three species which have been described as new by Mr. Pearson, viz., *Thyone hornelli*, *Actinopyga serratidens* and *Holothuria gallensis*. Long-spined purple Echinids, large Ophiuroids, star-fishes, and other Echinoderms are found. There are Turbellaria, including a beautiful white species with black mottling which, Mr. Laidlaw tells me, will require a new genus near to *Discocelis*. The Polychæte worms include spinous Polynoids, a large olive-green *Loimia*, *Eurythoe latissima*, *Onuphis maculata*, *Notocirrus trigonocephalus*, *Cirratulus* sp., a small speckled *Polymnia*, a huge *Sabellaria* (*S. bicornis*), *Spiochætopterus herdmani*, n. sp., Hornell (under stones), species of *Amphinome*, *Nereis*, *Syllis* (with buds), *Sabella fusca*, *Lepidonotus crispatus*, *Ophryotrocha*, *Amphitrite*, *Pista*, and others. We got an orange-red Nemertine, and a white species with red lines; also a pale yellow *Balanoglossus* in the calcareous sand under stones. There were many Pagurids—one a brilliant species with scarlet facings, and having the chelæ and other limbs barred with light blue and black alternately. The Amphipods we collected in the lagoon include, Mr. Walker reports, *Hyperia galba*, *Hyperoche cryptodactylus*, *Leptophoxus uncirostratus*, *Stenothoe monoculoides*, *Erichthonius abditus*, *Platophium* sp., *Mæra rubromaculata*, and a new species of *Ampelisca*. Amongst the numerous Molluscs are *Cypræa moneta*, *C. mauritiana*, a *Pleurobranchus*, an orange *Doris*. an *Aplysia*, an *Octopus*, *Harpa conoidalis*, *Pleurotoma nodifera*, *Nerita* sp., *Terebra* sp., several other Cowries and Cones, *Callochiton platessa*, and a new species of Chiton which Mr. Sykes has described as *Ischnochiton herdmani*. There were numerous brilliantly coloured fishes, including the curious little *Antennarius marmoratus*, Less.

This, of course, does not attempt to be a complete list, but merely to give some idea of the variety and abundance of the shore fauna at the spot which we eventually selected as the best in Ceylon for a Marine Biological Station.

On February 16th, at 8 A.M., in Galle harbour, the sea-temperature was 79° F., and the specific gravity 1·023. On February 17th, at 7 A.M., off Watering Point, the sea-temperature was 78·8° F., and at 6 P.M., at the same place, it was 80° F. At both times the specific gravity was 1·023. On this latter day we dredged and trawled outside Galle Bay, beginning at the south-east off Watering and Unawatti Points and working westward to the Gallehogalle Bank. The first three hauls of the dredge may be considered as Station XXXVIII., on the eastern side of the entrance to the bay, while the remaining three hauls along with three hauls of the trawl form Station XXXIX., to the westward, up to Gallehogalle Bank.

STATION XXXVIII.—Outside Watering Point and Unawatti Point, from ½ a mile to 1½ miles off land; depth 9 to 22 fathoms; bottom sand and mud with many shell fragments; dredged.

Halicornaria saccaria, *Gorgonia* sp., *Spongodes* sp.;

Spatangoid, *Clypeaster humilis*, and *Echinodiscus auritus*, *Astropecten polyacanthus* (?), *Ophidiaster cylindricus;*

Thalenessa im-thurni, n. sp., *Glycera* sp., *Hyalinœcia* sp., and Worm-tubes;

Portunids and other Crabs, some Macrura;

Strombus sibbaldii, *Eburna canaliculata*, *Oliva gibbosa*, *Philine* sp., and *Arca compacta;*

Molgula (small species);

Branchiostoma lanceolatum (at 9 fathoms, several), *B.* (*Dolichorhynchus*) *indicus* (at 9 fathoms).

STATION XXXIX.—From 2 miles south of Point de Galle westwards to Gallehogalle Bank; depths 16 to 30 fathoms; bottom fine sand; stones and Nullipore on the bank; dredged and trawled.

Polytrema miniaceum and other Foraminifera;

Stephanoseris rousseaui, *Spongodes*, *Eunephthya* and Gorgonids (sev. spp.);

Astropecten hemprichii, *Stellaster* sp., *Salmacis bicolor*, *Lovenia elongata*, *Echinodiscus auritus*, *Clypeaster* sp., and *Antedon* sp.;

Serpula actinoceras, Polyzoa (many);

Squilla, *Gonodactylus*, *Alpheus*, Amphipods and Isopods, *Pontonia*, various Pagurids and Crabs (one infested by *Sacculina*);

Philine sp., *Strombus sibbaldii*, *Sepia* sp., *Sepiola* sp.;

About 1350 Fish—of which 500 were small flat fish belonging to about 5 species and ranging from ½ inch to 4 inches in length, most being from 2 to 3 inches:—

Cynoglossus sp., *Rhomboidichthys* (2 spp.), *Arnoglossus* (?), Pleuronectidæ (very many), Gobiidæ (768, from 2 to 5 inches long), *Callionymus candicaudatus* (30, from 2 to 3½ inches long), and *C. sagitta* (50, from 1¾ to 3 inches long).

This sandy area lying to the east of Gallehogalle Bank and giving a uniform stretch for some miles at a depth of 25 to 30 fathoms is evidently a fish "nursery," or region where young fishes, both flat and round, belonging to 8 or 9 species and including such valuable forms as "Soles," "Turbot" and "Plaice," congregate in great numbers. In one haul of short duration we obtained about 1350 young fish, including 5 kinds of flat fish.

The Tow-nettings this day (February 17th) were very rich and included :—

Trichodesmium erythræum, *Ceratium*, Radiolaria ;

Various Siphonophora and Ctenophora ;

Sagitta (large), Larval Annelides, and some Syllids ;

Copepoda—Many beautiful species, including *Calocalanus pavo*, *Metacalanus aurivillii*, *Labidocera pavo* and *L. acutum*, *Centropages gracilis*, *Candacia catula*, and *C. truncata*, *Oithona plumifera* (colourless with little plumes of scarlet, and having pale lilac egg masses), and a new species of *Euchæta*—36 species of Copepoda in all ;

Also many larvæ—Nauplei, Zoea, Phyllosoma (many), Erichthus and Alima, larval molluscs and worms ;

Appendicularia, *Doliolum* and *Salpa democratica-mucronata* (large).

On February 18th we left Galle, and spent the day in dredging in the deep water further out than on the previous day, and onwards up the west coast on our way to Colombo. A considerable part of the time was spent on and off the 100-fathom line south of Galle.

At 6.30 A.M. at about 3 miles south of Point de Galle the sea-temperature was 79·5° F., and at 6.30 P.M. when we anchored for the night at $3\frac{1}{2}$ miles south of Barberyn Lighthouse it was 80° F. ; at both times the specific gravity was 1·023.

The day's dredging may be divided into 3 stations—

STATION XL.—About 10 miles off Watering Point, direction south by west ; depth 34 fathoms ; bottom coarse sand, shells, coral fragments, Nullipores and *Halimeda* ; dredged.

Polytrema miniaceum, *Alveolina boscii*, *Orbitolites complanata*, *Heterostegina depressa*, and *Amphistegina lessonii* ;

Tethya sp., some Tetractinellids, *Rhizochalina fistulosa*, and Horny sponges ;

Chironephthya variabilis, *Plexaura indica*, *Briareum* sp., *Solenocaulon* sp., Gorgonids (many), *Cavernularia obesa*, *Lituaria phalloides* and several species of Pennatulids, *Flabellum* sp., *Caryophyllia* sp., *Stephanoseris rousseaui* ;

Hydroids—*Sertularia distans*, *S.* (? n. sp.), *Antennella allmani*, *Zygophylax tizardensis*, *Idia pristina*, *Lytocarpus* (? n. sp.) ;

Clypeaster scutiformis (?) ; *Lovenia elongata*, *Phyllacanthus baculosa* and *Cidaris metularia*, *Echinothrix calamaria* ;

Species of *Protula*, *Glycera*, and *Hyalinœcia* ;

Polyzoa—a large number of species, of which Miss Thornely has already identified the following, *Cellepora cidaris*, *C. boryi*, *C. tritubereulata*, *Flustra spoliata*, *Chorizopora brongniartii*, *Cribrilina radiata*, *Micropora coriacea*, *Smittipora abyssicola*, *Membranipora cornigera*, and also species of the genera *Lepralia*, *Stomatopora*, *Idmonea*, *Cellaria*, *Schizoporella*, *Membranipora*, *Steganoporella*. *Smittia* and *Adeona*;

Galathea sp., *Dromia* sp., and several other small Crabs;

Tonicia pectinoides n. sp. (SYKES), *Turritella* sp., *Ceratosoma*, and other Molluscs;

A red species of *Cynthia* and *Ascidia* sp. (probably both new).

STATION XLI.—South of Galle, about 12 miles off land; depth, along the 100-fathom line; bottom composed of masses of calcareous branched and ramifying Foraminiferal tubes (*Ramulina* sp.); dredged.

Tetractinellid sponges;

Dendrophyllia sp., *Caryophyllia* sp., *Cirrhipathes spiralis*, *Antipathes* sp., Gorgonacea (many— half a dozen species);

Actinocucumis donnani, n. sp. (PEARSON), *Phyllacanthus baculosa*, various Ophiuroids, *Asterina cepheus*, *Stellaster* sp., *Actinometra* sp., *Echinanthus rosaceus*;

Pagurids and small Crabs;

Avicula radiata (living on Gorgonids), *Pleurotoma nodifera*, *Conus* sp., and a few other shells.

STATION XLII.—Off the Coast, about 4 miles south of Barberyn; depth 40 fathoms; bottom muddy; dredged.

Stephanoseris rousseaui (many, with Gephyrea), *Caryophyllia* sp., *Paracyathus* sp. (?);

Echinids (small), *Pentaceros nodosus*, *Astropecten hemprichii*, *Pteraster* sp.;

Aspidosiphon sp., *Pectinaria* sp., and some muddy worm tubes;

Dentalium sp.

On February 19th, at 6.30 A.M., 6 miles west of Kaltura, the sea-temperature was 79·3° F. and the specific gravity 1·023. At 1 P.M. this afternoon we lowered a white enamelled dish measuring 9 inches by 12 inches on the sounding line and found that it was distinctly visible to a depth of at least 17 fathoms—the sky being cloudy and the sea calm.

A good deal of ground was covered during the day (the last of our present cruise), and nine hauls of the dredge were taken between Kaltura and Colombo, at depths of from 20 to 30 fathoms. These may be divided into four stations:—

STATION XLIII.—Six miles due west of Kaltura (or Kalutara); depth 22 fathoms; bottom hard sand with Nullipores; dredged.

Axinella donnani;

Juncella juncea and *Scirpearella* sp., *Epizoanthus* sp. (on *Murex*), *Stephanoseris rousseaui*, and *Heteropsammia michelini* (with Gephyrea), *Flabellum* sp., *Caryophyllia* sp., and other small solitary Corals;

Cucumaria imbricata, *Clypeaster scutiformis*, *Lovenia elongata*;

Aspidosiphon corallicola, *Hyalinœcia* sp., *Pectinaria* sp.;

Melita obtusata, *Mæra rubromaculata*, and other Amphipods, some Pagurids, and some Peneids;

Murex tenuispina, *Terebra* sp., and some Lamellibranchs.

STATION XLIV.—Five miles north-west of last station; depth 30 fathoms; bottom fine sand and worn fragments of Coral; dredged.

Hydroids—*Halicornaria setosa*, and *H. saccaria*, *Lytocarpus* (? n. sp.), *Monostachys dichotoma*, *Idia pristina*, *Sertularia distans*, *Sertularella* sp., *Halecium* sp., and others;

Stellaster sp., *Linckia diplax*, small Temnopleurids, *Clypeaster humilis*;

Clœosiphon aspergillum, *Pectinaria* sp., *Sabellaria bicornis*, and some worm tubes;

Caprellids, *Calappa* sp., Portunids and other Crabs;

Philine sp., *Murex tenuispina* and many other Gastropods;

Molgula sp.

STATION XLV.—Four miles West of Pantura (or Panadure); depth 25 fathoms; bottom sand, shells and dead Corals; dredged.

Various Corals; *Gorgonia*, and *Melitodes*;

Astropecten sp., *Ophiothrix aspidota* and other Ophiuroids;

Hyalinœcia sp. (many), *Thalenessa im-thurni*, n. sp. (Hornell), *Iphione muricata*, *Lepidasthenia fulvovittata*, *Eunice* sp., *Stylarioides iris*, *Cirratulus* sp., *Serpula actinoceros*, and some worm-tubes;

Various Crabs (not yet determined);

Strombus succinctus, *Malleus vulgaris*, and a few other Molluscs;

Molgula sp.

STATION XLVI.—From off Mount Lavinia northwards to off Colombo, from 7 to 12 miles off shore; depth 25 to 30 fathoms; bottom Nullipore balls (*Lithothamnion fruticulosum*), Coral fragments, and some Orbitolites sand; five hauls of the dredge.

Orbitolites complanata, *Alveolina boscii*;

Rhizochalina fistulosa, *Tethya* sp., and other sponges;

Hydroids—*Sertularia distans*, *Sertularella* sp., *Halecium* sp., *Monostachys dichotoma*, *Idia pristina*, *Halicornaria setosa*, *Lytocarpus* (? n. sp.);

Chondractinia sp., and some sand-encrusted Anemones, *Chironephthya variabilis* (splendid arborescent colony having the axis and main branches white, and the twigs crimson lake), *Solenocaulon tortuosum*, *Juncella juncea*, *Scirpearella* sp., and other Gorgonacea (many), small species of *Fungia*, and other solitary Corals;

Actinometra sp. (dark coloured, on the dark twigs of *Chironephthya*), *Actinometra* sp. (large, orange coloured), Antedon sp. (small), *Phyllacanthus baculosa* (many large), various Ophiuroids, *Laganum depressum*, *Clypeaster humilis*;

Nemertine (red), *Trophonia* sp., Polynoids, *Serpula actinoceros*, *Eunice* sp.;

Polyzoa—(many, including *Retepora* sp., *Cellepora*, *Schizoporella*, *Adeona*, *Gemelli-*

pora, and *Cribrilina*). Most of the Polyzoa are strongly calcareous and brightly coloured (scarlet) forms;

Crabs (porcelain white, two species (?) on the white branches of *Chironephthya*), and other small Crabs;

A new species of *Chiton* (*Tonicia pectinoides*, SYKES), *Harpa conoidalis*, *Strombus succinctus*, *Murex tenuispinus*, *Murex haustellum*, *Conus betulinus*, *Natica mammilla*, *Malleus vulgaris*, *Philine aperta* (?);

Leptoclinum sp., *Rhodosoma* sp., *Styela* sp., *Molgula* sp., *Cynthia* (? n. sp.);

A small banded Sole (*Synaptura cornuta*).

TOW-NET gatherings taken during the day were notable for the abundance of Radiolaria, colonial as well as solitary—*Collozoum* and others, also *Trichodesmium erythræum*, some pelagic planarians, Syllids, Halobates, Tornaria, and the Copepoda—*Centropages furcatus*, *C. gracilis* and *C. tenuiremis*, n. sp., *Calocalanus plumosus*, *Mecynocera clausi*, *Oithona plumifera*, and about 20 others.

Although the depths were greater than that of the paars further north, it is important to note that the bottoms at several of these localities off Mount Lavinia and elsewhere south of Colombo were hard, clean, and apparently very suitable for the attachment of pearl oysters, being largely formed of the same balls of Nullipore (*Lithothamnion fruticulosum*) which characterise the paars in the Gulf of Manaar. It is very probable that this bottom extends into shallower water, and that suitable spots may be found nearer shore upon which the pearl oyster might be cultivated. It is said that a pearl oyster bank once existed off Mount Lavinia.

On the evening of February 19th we arrived at Colombo. In this first cruise in the s.s. "Lady Havelock," in addition to making a preliminary survey of the more important pearl oyster banks, we had sampled the bottom conditions and the fauna at various points round the island, and had made a special examination of the several localities (Palk Bay, Trincomalee and Galle) to which our attention had become directed. We had also considered these last and other localities very carefully with the view of choosing the best site for a small marine laboratory in which to carry on investigations and experiments with the pearl oyster. Our conclusion at the end of the cruise was that of all the places seen in coasting round the island only two would be at all suitable for this purpose, viz., Trincomalee and Galle.

Of these, Trincomalee has the distinct advantages of (1) complete shelter from the monsoons, and (2) natural beds of pearl oysters living in the harbour; but on the other hand the following may be noted as more or less serious objections:—

(1.) The specific gravity of the water is low, between 1·019 and 1·021 as compared with 1·023, the usual reading in the Gulf of Manaar;

(2.) The plankton at the time of our observations seemed sparse compared with that at Galle and in the Gulf of Manaar;

(3.) The distance, and therefore the time necessary in taking live oysters round, from the Gulf of Manaar is much greater. In the case of Trincomalee a steamer such as the "Lady Havelock" would take about 30 hours from the Cheval Paar, while Galle could be reached in about 18 hours;

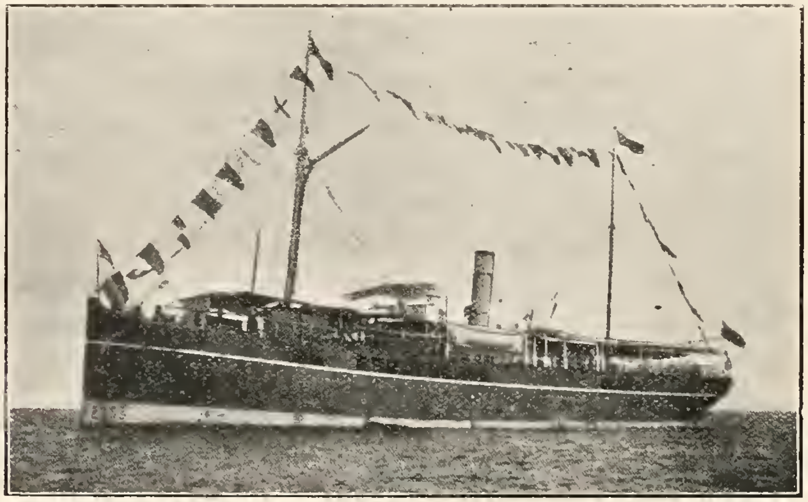
(4.) The bottom is muddy and is, in most parts, unsuitable for oyster culture, and the water is not comparable in purity with that in the Gulf of Manaar. Consequently it is probable that although some oysters may live at Trincomalee, they will not grow so rapidly and healthily as on the pearl banks;

(5.) The difficulty of access from Colombo and the distance from the scientific libraries and museum would be a real disadvantage to naturalists working continuously at Trincomalee;

(6.) Finally, for a Marine Station where ordinary biological investigations would be conducted, Galle presents a richer general fauna than Trincomalee, and has the additional special advantage of a coral reef and lagoon where collecting and observation can be easily carried on.

Galle as a locality no doubt also presents some disadvantages, the worst of which is that the bay lies open to the south-west monsoon; still there is the lagoon, parts of which could no doubt be made use of. The other advantages, the purity of the water, the richness of the plankton, the shortness of the journey from the Gulf of Manaar and the convenience of proximity to Colombo, render Galle, in my opinion, much the best site in Ceylon for a Marine Biological Station, and these eventually caused us to fix there our temporary laboratory, in which Mr. HORNELL was to carry on his work after I left the island.

I was asked, however, before deciding finally, to consider various spots in the Gulf of Manaar, such as Aripu, Chilavaturai, Kodramallai and Manaar, all on the shores of the pearl oyster region, and these I visited during our second cruise in the "Lady Havelock."



The s.s. "Lady Havelock," employed by the Ceylon Government for the pearl oyster investigation, February and March, 1902.

SECOND CRUISE.

On returning to Colombo, from this first cruise, for the purpose of joining Captain Donnan, the Master Attendant of Colombo, in his inspection of the pearl oyster banks, I saw for the first time the native barque "Rangasameeporawee" and the steam-launch "Serendib," and on examining them critically it was obvious, both to myself and to the ship's officers who were with me, that neither vessel would be able, without considerable changes, which could not be effected in time, to carry on the work which I still had to do. On pointing this out to Captain Donnan, he agreed with me, and when we waited upon the Lieutenant-Governor and represented the matter to him, he promptly authorized us to arrange for the engagement of the "Lady Havelock" for a further period of three or four weeks, as might be necessary, from 24th February. Thus it resulted that the "Lady Havelock" accompanied the two native barques "Rangasameeporawee" and "Sultan Iskander" and the s.s. "Serendib" to the Gulf of Manaar, where, in addition to carrying on my special work, she was on occasions of service in towing Captain Donnan's barque and so saving some valuable time.

This second cruise of the "Lady Havelock" lasted from 24th February to 20th March, inclusive, three weeks and four days. During the greater part of that time our steamer kept near to Captain Donnan's barque, and we accompanied him in his inspection of the banks. Not only had we thus the full advantage of the various vessels and their crews by means of which to obtain specimens and information, but Mr. Hornell and I were also able to talk over the work daily with Captain Donnan and his successor, Captain Legge. Later on we were joined by Sir William Twynam from Jaffna. That gave a unique opportunity of hearing from these two veteran inspectors and investigators about former conditions of the various banks and details of the past history of the pearl fisheries.

During this cruise the early morning and forenoon were usually occupied in following the operations of the divers, and in examining and recording the material brought up from different parts of the various "paars." About midday, when the divers ceased work, we started off in the "Lady Havelock" to dredge the neighbouring grounds between the oyster banks, or on parts of the paar in regard to which we wanted further information. In this way, beginning in the north of the district of Aripu, we examined the large and important East and West Cheval banks and the Periya Paar and several smaller banks lying some to the north and some to the south. We also, when in that neighbourhood, landed at various parts of the coast in the endeavour to find a suitable spot for a small Marine Laboratory, from which oyster culture and experiments could be conducted close to the banks. We tried Manaar, Aripu, Chilavaturai, Kodramallai, and later on the shores of Portugal and Dutch Bays, but without success. We could find no spot on the shores of the Gulf of Manaar that seemed suitable for the purpose, and none certainly with the natural advantages of Galle. On several occasions we, in the "Lady Havelock," left Captain DONNAN and the barques for a couple of days in order to run lines of dredgings across some of the deeper or more remote parts of the region, especially to the north and west.

Our journal of this cruise is as follows:—

We left Colombo on the afternoon of February 24th, having the barque "Rangasameeporawee" in tow. At 7 P.M., when off Negombo, the sea-temperature was 79·8° F. and the specific gravity 1·0235. The following morning, at 7 A.M., off Kalpentyn Island, the temperature was 79° F. and specific gravity 1·023; while at 7 P.M., when we anchored at 2¾ miles south-south-west of Chilavaturai, the temperature was 80·8° F. and the specific gravity 1·022—these temperatures being about 2° F. higher than we had found in the same sea three weeks before.

A tow-net gathering was taken at 5 miles north-north-west of Kodramallai Point. It contained a great quantity of the zoeas of Crabs, some new green Copepods (*Pontella danæ*, n. var., *Labidocera*, n. sp., and *Pontellopsis*, n. sp.), Sagitta, Lucifer, larvæ of Gastropods and Lamellibranchs. There were also many green filamentous Algæ, about 20 other Copepoda (*Eucalanus subcrassus*, *Rhincalanus cornutus*, *Ilyopsyllus affinis*, and *Centropages*, n. sp.) and many diatoms. One large bluish-green Copepod (the new *Pontellopsis*) had a plate-like radially marked mass of spermatophores on its hinder end (genital segment) which was so conspicuous as to be visible to the naked eye as a yellowish patch.

We went ashore at Chilavaturai, running in as far as we could in the "Serendib" and then in the ship's boat. Where the "Serendib" stopped, in 13 feet of water, the screw stirred up quantities of delicate red Algæ (*Hypnea musciformis* and *Polysiphonia* sp.) and very fine filamentous green stuff (*Cladophora* sp.) such as we also found growing in some parts of the Cheval Paar, and to which the minute oyster spat commonly becomes attached. These Algæ apparently grow on a coarse sandy bottom in various parts of the district.

Chilavaturai is famous in the annals of the Ceylon pearl fisheries as having always been the site of the fisheries camp during British times, except in the case of the small fishery of 1832 and the three fisheries of the Muttuvaratu Paar in 1889, 1890 and 1891. Sir W. TWYNAM and Captain DONNAN have shown however that there are reasons why Marichchukaddi, about 10 miles further down the coast, would be, in some respects, a better site for the camp in future fisheries of these northern paars.

Chilavaturai was one of the spots to which attention had been directed as a possible locality for the marine laboratory, and we consequently examined some empty rooms which adjoin the Rest-house; but found them inconvenient and in poor repair. They might no doubt be adapted to the purposes of a scientific workshop if the locality were suitable in other respects; but the shore is an impossible one.

We then steamed along the coast to Aripu, about 4 miles further north, where I had been asked to examine an empty government bungalow. This had four large, lofty rooms, a fine broad verandah and a large walled compound. Beside it were still to be seen fragments of the ruins of the old Dutch fort, to which our countryman Robert Knox made his way in 1679, when he escaped from Anuradhapura, after 20 years' captivity in the hands of the King of Kandy. This bungalow, so far as the house goes, could be made a perfectly suitable residence and workshop for the marine biologist were the locality suitable in other respects—but it is not.

At Aripu we visited the ruins of the "Doric," a classic structure often referred to in the reports of the pearl fisheries, and which we had been using as a landmark. It was built by Lord Guildford a century ago, as the official residence of the Governor when he attended a fishery, but being unused it later on fell into ruins. It has always served however as a useful and conspicuous object from which to take

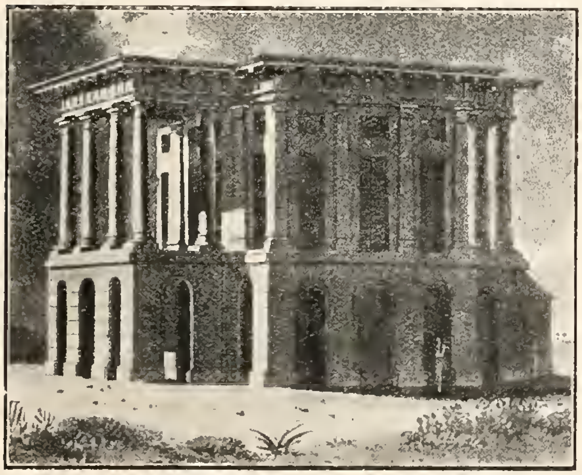


Fig. 8. The "Doric" as it was at the beginning of last century—from Cordiner's plate.

Fig. 9. The "Doric" as it now is—from a photograph taken in February, 1902.

bearings on the pearl banks. The figures given here show (fig. 8) its original appearance, from the plate in Cordiner's "Ceylon," 1807, and (fig. 9) its present condition from a photograph I took in February, 1902, with Captain J. Donnan, C.M.G., late Inspector of the Pearl Banks, in the foreground.

In the evening (February 25) we put two tow-nets out, one near the bottom and the other at the surface. The deeper net contained a large amount of the filamentous red Algæ (*Hypnea musciformis*, *Polysiphonia*, &c.), along with Molluscan and Annelid larvæ, Coscinodiscus, &c.

The surface net had Coscinodiscus and 14 species of Copepods, including *Calanopia aurivillii*, *Metacalanus aurivillii*, *Ilyopsyllus affinis*, and a new species of *Peltidium*.

On February 26th, at 7 A.M., $2\frac{3}{4}$ miles south-south-west of Chilavaturai, the sea-temperature was 78·1° F., and at 7 P.M., on the south central part of the Cheval Paar, the temperature was 79·5° F. At both times the specific gravity was 1·023.

A bottom tow-net which had been down all night was found on the morning of February 26th to contain great quantities of small Copepoda with very long caudal setæ (*Ectinosoma roseum* and *E. atlanticum*), also *Euterpe acutifrons* and a dozen other species, along with some Medusoids and Ctenophores.

About mid-day, when going under easy steam, we put out a tow-net which we had contrived with a canvas funnel in front of the mouth and having the narrow end forwards, so as to reduce the volume of water entering and so the pressure on the net. It worked well and gave us good hauls containing chiefly Nauplei, Zoeæ, 41 species of Copepoda, including the large blue *Pontella securifer* and the small long-tailed *Ectinosoma atlanticum*, *Centropages violaceus*, *Metacalanus aurivillii* (common), *Pseudodiaptomus aurivillii* (male previously unknown), and also *Ceratium* (two species), *Peridinium*, some Trochospheres, Radiolaria, many Diatoms, especially *Coscinodiscus* and long rod-like forms, *Sagitta*, *Salpa*, Appendicularians, Pteropods, and some Lamellibranch fry. It was evident from this and many other hauls that the microscopic plankton of the sea, both at surface and bottom, was very abundant in the Gulf of Manaar, and this must be of very great importance in feeding the pearl oysters.

We boarded the barque "Rangasameeporawee" later in the morning, and found that she was anchored on the position of the "shoal-buoy," a mark that Captain DONNAN has been in the habit of bringing with him on each inspection in order to indicate the north end of the long shoal which runs northwards from Karativo Island to the southern part of the Cheval Paar. The buoy (a large structure of casks and planks bearing a mast) is anchored over a sunken tank, and serves as a useful mark to take bearings from during the inspection of the banks.

We now set the divers to work to bring us up samples of the bottom, a rather coarse white quartz sand upon which great masses of fine green and red filamentous Algæ grow. These contained *Hypnea musciformis*, and undetermined species of the genera *Cladophora*, *Ceramium*, and *Chætomorpha*.

The divers brought up quantities of this weed, upon which, when put in our small glass aquaria, we soon found great numbers of very young pearl oysters—the spat being densely crowded in some places on the filaments of Algæ. The smallest size, of which there were very many, was about 0·5 millim. in diameter, but other samples measured up to 4 millims. This spat was evidently very young and the smallest had probably just become attached during the last few days. A quantity was kept alive under observation, some in wooden tanks on the barque and some in our glass aquaria on the "Lady Havelock." It was found to be restless and active, and to leave its attachment and crawl freely about on the Algæ or on the glass sides of the aquaria. For example, one specimen (*a*) crawled 5 inches up the glass within 18 minutes, the last $2\frac{3}{4}$ inches in 12 minutes; another (*b*) crawled 3 inches in

12 minutes; while a third (*c*) did $1\frac{1}{8}$ inch in the same time. Both *a* and *b* travelled at a greater rate at the beginning than towards the end of the time.

In the green weed were also large numbers of a white Leucothoid Amphipod (which Mr. WALKER considers to be a new genus), some interesting new Caprellids, and a good many Rissoa-like Gastropods about 7·5 millims. in length. Some specimens of a small white *Synapta* were also brought up in the sand.

In the afternoon we dredged and trawled from the "Lady Havelock" in the area lying south-west of the Cheval Paar. All these hauls may be united as—

STATION XLVII.—About 4 miles south of the West Cheval Paar; depth $8\frac{1}{2}$ to 9 fathoms; bottom sand overgrown with green Algæ; dredged.

Phyllospongia holdsworthi, Axinella donnani;
Astropecten hemprichii, Amphiura sp.;
Sabella phæotænia, Serpula sp.; various Crabs;
Pearl oysters (a few large and many very small), *Aplysia pulmonica* (?);
Molgula sp.;
Fish—both round and flat—including *Pegasus draconis, Upeneoides tragula, Gobius biocellatus, G. masoni, Teuthis oramin, Percis pulchella.*

On February 27th we joined Captain DONNAN in the morning on board the barque in order to see the work of the divers. During this and some following days two sets of diving operations were carried on simultaneously. Four large whale boats, each containing 10 or 12 natives under the charge of a tindal or boatswain, were engaged in making a survey by means of concentric equidistant circles—the boats circling first within a distance of $\frac{1}{4}$ mile, then between $\frac{1}{4}$ and $\frac{1}{2}$ mile, and finally between $\frac{1}{2}$ and $\frac{3}{4}$ mile from the barque, which was anchored in the centre—and keeping their distances approximately by means of radially placed buoys bearing flags. From these boats the divers went down at frequent intervals, and the result of each dive was recorded by the tindal on a plan. At the same time we had a set of two or three divers in the "Serendib" (fig. 10), and with these we took samples from between the paars or in any other localities where we wanted further information to supplement the results of the inspection boats.

The ground we worked over this morning was mostly formed of dead coral and Nullipore with some *Sargassum* and other Algæ, the depth being 6 to $6\frac{1}{2}$ fathoms. Pearl oysters of two ages were found; the larger being estimated at 3 years old and the smaller size at 6 months (see fig. 11). The oysters were accompanied by great quantities of small boring Gastropods (the "Oorie" of the divers) belonging to the genera *Purpura, Nassa, Sistrum, Pinaxia, Natica, Murex* and *Turbinella* (mostly *Sistrum spectrum* and *Pinaxia coronata*), and in places were entangled in the byssus nests of masses of "Suran" (*Modiola barbata*). A deep purple spreading sponge (? *Pachychalina multiformis*), upon which were opisthobranchs of the same colour (*Aplysia* sp.) was common.

Around such hard patches the bottom is all sand, in some parts coarse, in others finer, and varying in constitution from almost pure quartz to a neritic deposit formed mainly of the shells of Foraminifera (*Orbitolites*, *Heterostegina*, *Alveolina*, &c.). On the sand fewer oysters are found, but they cannot be said to be absent, especially in the neighbourhood of a "paar" (or hard patch). When present they are generally

Fig. 10. Our two divers on the "Serendib."

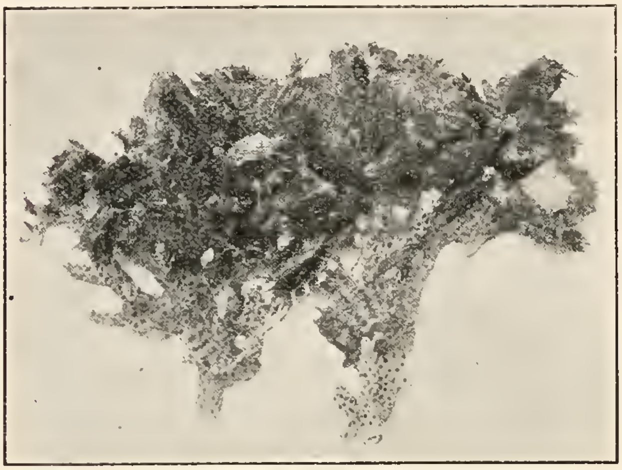


Fig. 11. Young pearl oysters, about six months old, attached to a dead Madrepore Coral.

united in clumps of several fastened together by their byssus threads or attached by some hard object such as a Nullipore nodule, a dead shell or a fragment of coral. In some cases two or three large oysters (about 3 years old) will form a centre upon which a great many young ones (about 6 months old) are fastened (fig. 12). In some places there is undoubtedly overcrowding, the larger oysters being completely surrounded with masses of young piled so closely as to smother some and probably interfere with the growth of all. This is a precisely similar case to that of the overcrowding found in European mussel beds, where the advantage of thinning out and transplanting is well known.

We got the divers to construct for us, after several dives to verify the details, a model on the deck of the "Serendib" showing the distribution of oysters on the rock and sand at the bottom. Fig. 12 is from a diagrammatic drawing (in bird's-eye-view) showing what they produced.*

Although oysters lying on the sand may manage to survive for a time, especially if

* These and our other conclusions in regard to the configuration and constitution of the paars and the distribution of the pearl oysters were verified later on by Mr. HORNELL when, at the fishery in the spring of 1903, a European diving costume being available, he was enabled to make a personal inspection of the bottom.

united in clumps, it is evident that they are in a dangerous position and are liable to be overwhelmed and smothered at any time by a shifting of the loose bottom.

There is apparently plenty of available hard ground with a dead coral, or consolidated sand, or Nullipore bottom round about the known paars to which young oysters from unsuitable sandy grounds or from overcrowded spots could be easily

Fig. 12. Diagram showing the arrangement of pearl oysters (large and small) in clumps on the sand and singly attached to flat ledges of rock.

moved. We accumulated many observations bearing on this question during the next few weeks and also during Mr. HORNELL's inspection visit to the banks in November, 1902, and during the fishery of March and April, 1903. It will be further discussed in our Recommendations at the end of this report.

In order to trace the extension of the pearl oysters beyond the limits of the recognised paars, we took a number of hauls of the dredge, in the afternoon, from south to north in the middle between the East and West Cheval paars on, in the main, a sandy bottom. These may be joined as—

STATION XLVIII.—Between East and West Cheval paars; depth $6\frac{1}{2}$ to $7\frac{1}{2}$ fathoms; bottom sand, fragments of dead Coral, shells and Nullipore; dredged.

Some solitary Corals, *Halicornaria saccaria;*

Salmacis sulcata and *S. dussumieri*, *Laganum depressum*, *Lovenia elongata*, many *Clypeaster humilis*, *Echinolampas oviformis;*

Polyzoa—13 species, amongst which are *Lepralia dorsiporosa*, *Micropora coriacea*, *Scrupocellaria scrupea*, *Schizoporella lineata*, *Cellepora avicularia*, *Idmonea serpens*, *Smittia reticulata* and *Brettia* sp.;

Stenothoe marina (variety) and other Amphipods; pearl oysters (very many, mostly young), *Turbinella rapa* and a few common Molluscs;

Asymmetron (*Heteropleuron*) *cingalense.* A new species of *Emmelichthys* was also obtained here at a later date.

A single haul (the second) in the middle of the area in question gave us nearly 2 cwt. of pearl oysters, large (3 years old) and small (6 months). Most of them were attached to fragments of worn coral or to one another.

Two hauls of the dredge upon the northern end of the Cheval region, depth $6\frac{1}{2}$ fathoms, gave much the same bottom and result, but with fewer living pearl oysters. The sea-temperature this day was, at 7 A.M., 78·3° F., and at 9 P.M., 79·5° F., and the specific gravity on both occasions 1·023, at anchor on the South Cheval. The following day (28th) the temperature, at 7 A.M., was 78° F., and at 6 P.M. it was 79·3° F. on the South-east Cheval. The specific gravity was still 1·023.

We now had various sets of pearl oysters under close observation in our wooden tanks, glass aquaria, and sea-water baths, on both the barque and the "Lady Havelock," in order to test powers of detaching and travelling and re-attaching, regeneration of the byssus when cut and when torn out, and similar matters; but the results of these experiments will be given separately further on in the report.

On the morning of February 28th we (in the "Serendib") traversed from south to north the inspection circle ($1\frac{1}{2}$ miles in diameter) which covered the southern end of the East Cheval, 18 dives being taken at about equidistant points with the following results. This will serve as an example of the many lines of dives we traversed during the next few weeks.

Dives.	Bottom.	Pearl oysters.	Any other animals.
1	Sand	Few, large and small	*Malleus vulgaris.*
2	Rock	Large oysters	*Modiola*-"suran."
3	Sand	Few large, many small	
4	Rock	Many large, few small	
5	Sand	Many small, some large	"Oorie."
6	Rock	Large and small	
7	,,	,, ,,	
8	,,	,, ,,	
9	Sand	Few clumps, large and small	
10	Rock	Clumps of large	Green corals (*Favia*), dark green *Antedon*, and *Alphæus* of same colour.
11	Sand	Few clumps, mostly small	*Pinna bicolor.*
12	Rock	Clumps of large and small	*Campanularia juncea* ("Heather").
13	Sand	None	
14	Rock	,,	,, ,,
15	,,	Small, few	,, ,, and sponges.
16	Sand	None	
17	Rock	One large	,, ,,
18	,,	None	

The large Hydroid Zoophyte *Campanularia juncea*, which grows in tufts a foot in height and looks somewhat like old withered masses of heather, is very characteristic of this East Cheval paar. The beautiful large pinnate *Halicornaria insignis* is also found here, and usually bears the protectively-striped *Avicula zebra* which is almost invisible on the Zoophyte. We also found *Meleagrina margaritifera*, the large mother-of-pearl oyster on the south part of East Cheval Paar.

In the afternoon we dredged over the ground lying between the shoal buoy and the south end of the Periya Paar.

STATION XLIX.—South-west of Cheval to off south end of Periya Paar; depth 8½ to 13 fathoms; bottom sand, Nullipores, and dead shells; 6 hauls of dredge.

Lovenia elongata, *Echinolampas oviformis*, *Maretia planulata*, *Clypeaster humilis*, *Echinodiscus auritus*, and *Echinanthus rosaceus*, *Holothuria atra*;

Worm-tubes (*Sabellaria*, *Serpula*, *Filograna*);

Tritæta tenuipes, *Leucothoe spinicarpa* and other Amphipods, *Calappa* sp., and some other Crabs, and Peneids;

Mollusca (*Turritella maculata*, *Cassis glauca*, *Strombus succinctus*, *Pinaxia coronata*, &c.), also pearl oysters, *Dolabella* sp., and a few small Octopods;

Cynthia sp.;

Branchiostoma lanceolatum, var. *belcheri* (14 specimens), *Asymmetron* (*Heteropleuron*) *cingalense* (2 specimens).

When in one of the hauls we touched the south end of the Periya Paar we obtained a great number of young pearl oysters, just as we had found before, and were to find again in our later examination of this bank.

On March 1st we moved our centre southwards on to the Modragam paars. At 7 A.M., on the south end of East Cheval, the sea-temperature was 78·7° F., and at 7 P.M., on the North Modragam, it was 79·7° F.; in both cases the specific gravity was 1·023. In the morning we made a diving traverse from south to north through the Modragams to the Cheval. The pearl oysters were not very numerous, but were exceptionally large, although probably not older than those on the Cheval Paar. Captain DONNAN, from his close observation of the oysters on these paars extending over many years, feels confident that the shells grow more rapidly, and to a larger size, on the Modragam than on the Cheval paars, and on the East Cheval than on the West. Our own measurements made later on bear this out. It is very possible that these differences may be due to feeding, and that the explanation is that the conditions become less favourable further from the shore and towards the north-west. The Modragams are also sheltered by the shoal running up from Karativo Island to the Cheval.

The details of these dives need not be given. On the whole they show much the same distribution as those given above. Between the North Modragam and the South Cheval, in 6½ fathoms, along with abundance of young pearl oysters a few months old, we found quantities of red Algæ (*Polysiphonia*, &c.) covered with minute "spat" evidently quite recently deposited.

In the afternoon we dredged again over Station XLIX., from the south-west corner of the West Cheval to the south of Periya Paar; the depths found varied from

8 to $13\frac{1}{2}$ fathoms and the bottoms and animals were much the same as before (including two species of Amphioxus). We found quantities of young oysters in our last haul, about 5 miles south of Periya Paar, 12 to $13\frac{1}{2}$ fathoms, on a firm bottom of Nullipores and Orbitolites sand, showing that there are outlying patches beyond the limits of the known paars where oysters may be found. This particular spot would, however, even if the oysters attained maturity, be too deep for most of the native divers to work. Their usual limit is about 9 fathoms. We had them a few weeks later making a few descents for us in 11 fathoms on the Periya Paar, but they had just time to get a sample of the oysters or whatever lay before them on arriving at the bottom. Captain Donnan has had exceptional divers who have made descents for him in 15 fathoms, but they had barely time to secure a single handful of the bottom before having to come up in an exhausted condition. I timed many dives and none reached two minutes, very few were over a minute and a half.

Samples from all the pearl oysters we obtained on the different paars from the divers or by dredging were examined as to their food, their reproductive condition, their general condition of body and parasites and as to any stages in pearl-formation. All these matters will however be dealt with separately further on in the report.

On March 2nd, being now in the neighbourhood of Kodramallai Point and Marichchukaddi, which was the site of the Camp during the three last pearl fisheries (1889 to 1891), and also during the recent fishery of 1903, we took the opportunity to go ashore and inspect, as Captain Donnan thought that possibly we might find a sheltered corner of the bay suitable for the marine laboratory.

We landed at Kodramallai Point, and examined the coast (fig. 13) for a little way

Fig. 13. Part of the pearl-divers' fleet at Marichchukaddi—from a photograph by J Hornell.

northwards towards the Modragam River, but found it quite hopeless for our purpose. The rock at the point forms a moderate headland and runs out seawards as a little reef. It is apparently all sandstone; there is no coral, and it gives practically no protection from the south-west monsoon. The shore of the bay is muddy and the water shallow for a long way off. There is much *Zostera*, but every living thing seems covered with a fine deposit of mud.

In the afternoon we sailed for Manaar, which I had been asked to examine and report upon. The sea-temperature at 7 A.M. on North Modragam was 79° F. and at 7 P.M. on the south bar at Manaar it was 81° F., the specific gravity as usual was 1·023 at both times.

We had caught a number of Sea-snakes (Hydrophidæ) during the last few days, and the stomachs of all these were examined to see whether any foundation in fact existed for the belief that they feed upon the pearl oysters. We found no evidence of that. Without exception the stomach contents in the snakes we caught were the more or less digested but still recognisable remains of various kinds of fish. Such examinations, and the recording of our pearl-oyster experiments and statistics, went on during the time spent in getting from one spot to another, and when lying at anchor. Dr. W. HANNA, of Liverpool, has kindly examined the Hydrophidæ I brought back and finds that three species are represented, viz., *Enhydris curtus*, *Hydrus platurus* and *Hydrophis fasciatus*.

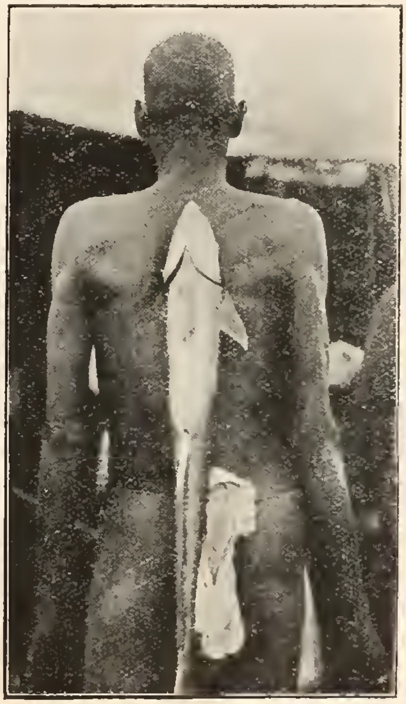


Fig. 14. Remora attached to the back of a diver.

On arriving off the south bar at Manaar we took a tow-net gathering which contained, amongst other Copepoda, *Oithona rigida*, *Euterpe acutifrons* and *Labidocera acuta*. We also caught a large Remora (*Echeneis naucrates*) measuring fully 24 inches in length and having a sucker 6 inches long. It was slate-blue dorsally and of a lighter colour ventrally. On laying it with the sucker against the upright bare back of a diver, in the air, it at once adhered so firmly that one could grasp it by the tail and pull with some force without detaching the fish (fig. 14).

March 3rd was occupied in enquiring into the marine biological possibilities of Manaar. The sea-temperature at 7 A.M. was 79°·3 F. and at 7 P.M. on the north end of the East Cheval was 80° F., the specific gravity being 1·023.

We crossed the south bar in the ship's boat with some difficulty, and went aground several times in the long shallow muddy passage leading up to the town of Manaar. The Assistant Government Agent sent for Mr. V. VRASPILLAI, the respected and experienced Adigar of Musali, who took us round to the various bays and creeks, showed us the different kinds of shore, and gave us full information as to the fishing and the shell-fish found locally, and the influence of the tides and winds. The Adigar entirely confirmed our own opinion, formed from what we saw, that there is no spot in the neighbourhood of Manaar suitable for pearl-oyster work. The North channel we found is as unsatisfactory as the South, and the great creek immediately to the north-east of the Fort is quite shallow and muddy. Not even cockle-like shell-fish can be got to live there, and in fact dead shells have to be imported from Aripu for calcining to make the "chunam" for betel-chewing. *Pyrazus palustris* is most abundant in these muddy shallows. Turtle are also plentiful round Manaar and are caught by the harpoon, which is a short four-sided iron spike sharpened at one end and having a ring on one side to which a long cord is attached. The spike is loosely fastened to the end of a pole, from which it readily becomes detached when implanted in the plates of a turtle's back, leaving the animal anchored by the long cord. Dugong are also taken here, they feed upon the Zostera which is plentiful all around.

On March 4th we were back again with Captain DONNAN and his inspection boats on the north end of the East Cheval, where at 7 A.M. the sea-temperature was 79° F. and specific gravity 1·023. The forenoon was spent examining with the divers, in the "Serendib," the middle part of the East Cheval and the area to the west of it, on which we found more oysters both large and small than within the usually recognised limits of the paar itself. In three dives on this western part the oysters came up attached to coral blocks, in the fourth they were in clumps lying on sand; they averaged 15 oysters to a dive.

In the afternoon we dredged from the "Lady Havelock" in the same region and northwards to the Periya Paar Kerrai and Vankali Paar; and obtained striking proof, as on many other occasions, of the superiority of dredging over diving as a method of obtaining the pearl oysters. The first haul, during which the dredge was only off the deck 10 minutes, brought up 65 large oysters along with other organisms. The first few hauls were practically upon Station XLVIII., dredged on February 27th, and the more abundant animals obtained* were the same as before (see p. 61); while the remaining hauls further north may be divided into two sets, those about Periya Paar Kerrai (Station L.) and those of Vankali Paar (Station LI.).

STATION L.—On Periya Paar Kerrai and to the north; depth $7\frac{1}{2}$ fathoms; bottom sand and dead shells; dredged.

Various common Corals;
Serpula actinoceros;
Mæra rubromaculata and other Amphipods;
Pearl oysters, mainly small, *Oscanius* sp.;
Branchiostoma lanceolatum and variety *belcheri* (large and plentiful).

* It will of course be recognised by naturalists that many other minute or obscure forms (Amphipods, Hydroids, Polyzoa, &c.) were obtained at nearly all these hauls; and these will be treated of in the special reports that follow.

STATION LI.—West of the last Station, on Vankali Paar and southwards; depth $7\frac{1}{2}$ to 8 fathoms; bottom sand, dead shells and Coral fragments; dredged.

Some common Corals (*Madrepora* and *Turbinaria*), and *Heterocyathus æquicostatus* (with Gephyreans), several Gorgonids (large colonies);

Clypeaster humilis and *Echinodiscus auritus;*

Aspidosiphon sp.;

Lilljeborgia pallida (a British species!);

Pearl oysters, plentiful—both large and small (60 large in a haul).

The Tow-Nets on March 4th gave us:—Medusæ, *Sagitta, Alciopa,* Appendicularians and about 35 species of Copepoda—some of them in great abundance—amongst which may be mentioned *Metacalanus aurivillii, Centropages,* n. sp., and *Calanopia minor.*

Fig. 15. Two of the divers on the "Rangasameeporawee" with the wire-net and coir cages in which our experimental pearl oysters were suspended over the ship's side for two months.

Some experiments were made during this and succeeding days in towing pearl oysters of different sizes, under various conditions, and at different rates up to 8 knots an hour, which showed us that it would be easier to transport young than old oysters in bags, nets or crates hung over the ship's side (see fig. 15), and also that old oysters are apparently less able to withstand the action of a strong current than younger forms. From the cages and baskets (generally made of the coir fibre of the cocoanut) used on these and subsequent occasions when pearl oysters were hung out over the side of the ship we obtained various small animals, especially Hydroids, amongst which were a *Clava*, two species of *Sertularia*, a scarlet *Eudendrium*, a *Bougainvillea*, and several Plumularians.

On March 5th the sea-temperature was slightly over 79° F. both morning and evening, on the north end of the Cheval, with a specific gravity of 1·023. In the morning as usual we were with the divers (who work from 6 a.m. till noon) working over the northern end of the East Cheval and outside the paar to the north and east. Practically no oysters were found. Some fine colonies of the hydroid Zoophyte *Halicornaria insignis*, with *Avicula zebra* attached, were found here (off north end of Cheval, 6 fathoms). On moving south-east along the edge of the paar to its middle portion we came upon quantities of a fine brown fucoid Alga smothered in young oyster "spat." The Alga was growing on what the divers call "flat rock"—a calcrete formed by the cementing together of the sand and shell fragments *in situ*. We also obtained at the same spot a fine tuberculated dark green Holothurian (*Stichopus chloronotus*).

In the afternoon we dredged to the north of the East Cheval Paar, running a line of hauls to the Vankali reef lying about 6 miles to the north and then north-west along the outer face of the reef and so back. Six hauls were taken which may be united as—

STATION LII.—Between north of Cheval Paar and Vankali reef; depth 3 to 6 fathoms; bottom sand; no pearl oysters; dredged.

Halicornaria setosa and *H. saccaria*, *Lytocarpus* (? n. sp.) and *Sertularia tenuis*, *Cavernularia obesa* (many), *Virgularia juncea*;

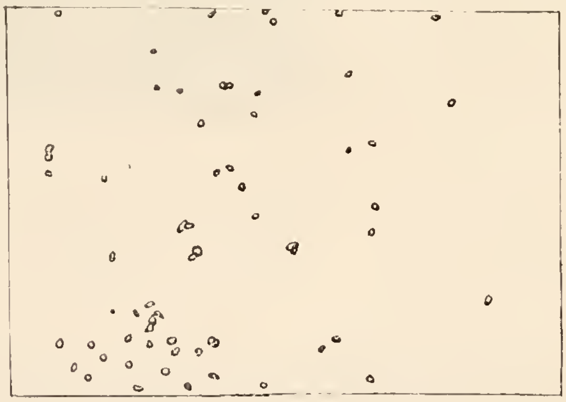
Hermadion sp., *Panthalis melanonotus*, *Psammolyce* sp., *Onuphis* sp.;

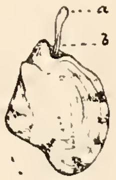
Ostracod (very large, possibly *Cypridina formosa*, or a new form); *Modiola* sp. (in gelatinous nests), and other Lamellibranchs, *Turbinella pyrum*, *Strombus succinctus*, *Pinaxia coronata*, *Pyrazus palustris*, *Persona ridens* and *Buccinum melanostoma*;

Asymmetron (*Heteropleuron*) *cultellum*.

The Tow-Nets at this locality gave us about 28 species of Copepoda, representing 12 genera. These like the other tow-net results will be given in detail in the report on the Copepoda, but Messrs. Thompson and Scott give the following as noteworthy from this haul:—*Mecynocera clausi*, *Paracalanus parvus*, *Acrocalanus longicornis*, *Centropages furcatus* and a new species, *Pseudodiaptomus aurivillii*, *Labidocera pavo*, *L. kroyeri* and a new species.

During parts of this day we had living pearl-oyster spat under observation in flat wooden tanks and in our narrow vertical "window" aquaria. In the latter, numbers





B.

Fig. 16. Arrangement of spat on glass of aquarium 7 minutes after all started from bottom. B, one individual enlarged, showing the extended foot.

of individuals placed at the bottom started at once to climb up the glass sides and travelled on the average at the rate of about an inch per minute. At the end of the first minute 65 individuals were crawling up the glass. At the end of seven minutes six had reached the surface of the water, a distance of $3\frac{1}{4}$ inches. Most of the rest had attached themselves at various points lower down. The actual disposition on the glass side of the small aquarium at the end of seven minutes, and an enlarged figure of an individual when climbing, to show the expanded foot, are given in fig. 16. The object of this record is to emphasize the great activity and the locomotory powers of the spat at this stage, when it is usually regarded as a sedentary and in fact a fixed animal. In climbing, attachment is made by the base *b* of the foot, the distal portion being elongated. Then the tip *a* fixes and *b* at the same time is freed and the animal is drawn upwards by the contraction and shortening of the muscular foot. Then *b* fixes once more, *a* is extended to a new position and the process is repeated.

Fig. 17. Sketch of young pearl-oyster spat attached to *Sargassum*.

We frequently observed that spat collected on weed (such as *Sargassum*, fig. 17, and *Hypnea* or *Cladophora*) very readily detached itself and wandered on to other objects or became transferred to the walls of the vessel, or even adhered together in balls of from 4 to 10 individuals.

We now moved to the north end of the West Cheval Paar, where on March 6th, at 7 A.M., the sea-temperature was 79·3° and at 7 P.M. 79·5° F.; the specific gravity as usual being 1·023. In the morning we ran 2 lines of dives, from the "Serendib" north-eastwards from the northern end of the West to the northern end of the East Cheval, getting a small number of large oysters (with some dead shells) and considerable quantities of young. We also brought up a very fine specimen of *Toxopneustes pileolus* with very beautiful and conspicuous pedicellariæ, in which the 3 valves are united by a discoid reddish membrane bordered by a conspicuous white line.

The rest of the day was spent in dredging at a point about 10 miles north of the morning position. Here 5 hauls were taken which may be regarded as—

STATION LIII.—Ten to twelve miles north of Cheval Paar and about 12 miles west of Vankali (or Bangalli) Church; depth $7\frac{1}{2}$ to 9 fathoms; bottom muddy sand with some dead shells; no large pearl oysters, only a few small; dredged.

Halimeda and some Nullipores, green Algæ and *Halophila ovata*;

Axinella donnani, and other sponges;

Lytocarpus spectabilis, *Campanularia juncea*, and species (which may be new) of *Halecium*, *Obelia*, *and Campanularia*; Pennatulids and various living Corals;

Clypeaster humilis, *Laganum depressum*, *Antedon* sp. (sev.), and *Actinometra* sp.;
Psammolyce sp. and other worms;
Polyzoa belonging to the genera *Lepralia*, *Adeona*, *Crisia*, and *Scrupocellaria*;
Melita obtusata, *Erichthonius* sp., *Siphonœcetes* sp. and other Amphipods, *Elsia indica* and *Lysianassa* (? n. sp.), *Lambrus*, *Pleurophyllidia* sp., and *Kalinga ornata*;
Branchiostoma lanceolatum, and variety *belcheri*.

The bottom Tow-net at 7 P.M. contained, amongst other Copepoda, *Pontella securifer*, *Ectinosoma atlanticum* and *E. roseum*, *Metacalanus aurivillii* and *Pseudodiaptomus aurivillii*—22 species in all.

At the end of the day's work we anchored about 15 miles to the north of our morning position on the Cheval with the view of spending the following two days in working this northern end of the Gulf of Manaar, above the recognised paars.

In the intervals of dredging and when moving from place to place, we were now continuously engaged in examining the parasites of the pearl oysters and their influence upon pearl-formation. We also decalcified such small pearls as were found. This work was continued as time permitted during the next few weeks, and also by Mr. Hornell after I left. We found various parasites, in the liver especially, some of which were Platyhelminthian and others Sporozoan in their nature, and some of which were enclosed in calcareous capsules. Mr. Hornell afterwards determined that these were Tetrarhynchus larvæ of Cestodes, and we have no doubt that they are in many cases the nucleus of the pearl, and the irritating cause of its formation.

On March 7th, at 7 A.M., the sea-temperature was 79·5° F. and at 6 P.M. it was 80° F., about 10 miles south of Adam's Bridge. This day and the following one were spent in continuous dredging in the northern end of the Gulf of Manaar, south of Adam's Bridge, from south of Thanni-Kodi on Rameswaram Island to south of Talamanaar on Manaar Island. Eight hauls were taken on the first day and 13 on the second, but although a wide extent of ground, about 18 miles from west to east, was worked over no natural limits present themselves, and I consider it best to unite the 21 hauls as a single locality (Station LIV.). We started at about 15 miles south of Thanni-Kodi and worked westwards into shallower water for two hauls and then southwards into much deeper water (30 fathoms), the dredge eventually falling "out of soundings." The 5th haul was in 40 fathoms at about 16 miles south of Thanni-Kodi. Here we obtained *Panthalis melanonotus*, in a muddy mucous tube very like the condition in which we find the same genus in water of the same depth in the Irish Sea. We then ran north into 15 fathoms (6th haul) and dredged eastward for the two remaining hauls in depths of 10 to 8½ fathoms, at about 10 miles south of Adam's Bridge. We anchored for the night with Thanni-Kodi bearing north, 18° W., and distant 10 miles.

The following morning we began dredging at the same spot and worked eastwards and then south-east through depths averaging 8 or 9 fathoms. In the 8th haul, south of Talamanaar, we came upon a rough bottom of living coral at 4 to 5 fathoms.

The 11th haul was upon the Anaivelundan Paar where some of the elephant's-ear coral (*Turbinaria cinerascens* and *T. crater*) from which the paar gets its name was brought up. The two final hauls were a little south of this on sand and dead shells, and then we ran for the south end of the Cheval Paar where the barques were then at anchor.

STATION LIV.—In northern part of Gulf of Manaar, south of Adam's Bridge; depths from 4 to 40 fathoms; bottom varied, from sand to living Coral—over 20 hauls of the dredge during two days.

Nullipores, *Halimeda*, *Corallina* and other Algæ;

Orbitolites complanatus, *Heterostegina depressa*, *Amphistegina lessonii* and other Foraminifera;

Petrosia testudinaria, *Halisarca* sp. (black), and other Sponges;

Pennatulids, various dendritic Alcyonaria, *Sclerophytum gardineri*, and *Lobophytum hedleyi* (?), *Sphenopus marsupialis*, *Fungia crassitentaculata*, *Goniopora* sp., *Pachyseris* sp., *Pocillopora grandis*, *Turbinaria cinerascens* and *T. crater*, *Porites arenosa*, *Cœloria sinensis*, and other Corals;

Hydroids—*Plumularia setacea*, *Monostachys dichotoma*, *Pasithea hexodon*, *Sertularia* (? n. sp.);

Phyllacanthus baculosa, *Linckia biforis*, *Astropecten hemprichii*, *Pentaceros lincki* and *P. nodosus*, *Actinometra parvicirra*, and *Antedon palmata*, *Holothuria atra*, *H. kurti*, *H. monacaria*, *Colochirus doliolum*, *Col. quadrangularis* and the new variety *mollis*, *Havelockia herdmani*, n. gen. et sp. (PEARSON) and many Ophiuroids;

Worm tubes (*Serpula*, *Sabella*, &c.), *Physcosoma asser*, *Panthalis melanonotus*, *Thelepus* sp., *Terebella* sp., *Nothria* sp., *Lingula*;

Polyzoa—many, belonging to the genera *Crisia*, *Buskia*, *Amathia*, *Ætea*, *Alcyonidium*, *Cellepora*, *Cellaria*, and *Porella*;

Lambrus sp., *Dromia* sp., *Pinnotheres* sp., *Leucosia urania*, and other Crabs;

Pearl oysters (very few—scattered), and *Modiola* (in gelatinous nests), Nudibranchs, *Ranella albivaricosa*, *Triton* sp., *Pleurotoma crispa*, *Turritella maculata*, *T. candida* and another sp., *Nassa rufula*, *N. micans* and *Dolabella* sp.;

Leptoclinum (several spp.); *Asymmetron cingalense*; Syngnathid with dendritic filaments.

TOW-NET gatherings taken both on the surface and at 12 fathoms, on March 7th, showed vast quantities of diatoms—chiefly *Biddulphia* with some *Ceratium tripos* and some small Radiolaria; also *Trichodesmium erythræum*, *Sagitta* and over 20 species of Copepoda, including:—

Paracalanus crassirostris, *Centropages furcatus*, *Calanopia elliptica*, *Labidocera minuta*, *Ectinosoma atlanticum* and *E. roseum*, *Oithona similis*, *O. plumifera* and *O. rigida*, *Corycæus obtusus* and *Euterpe gracilis*.

On March 8th we obtained, in addition to most of the above:—

Calanus vulgaris, *Centropages orsini* and *C. kroyeri*, *Labidocera acuta*, *Pseudodiaptomus serricaudata*, *Acartia erythraea*, *Calanopia elliptica* and *C. minor*.

On March 9th the sea-temperature at 7 A.M. was 79·8° F. and at 5 P.M. was 80·1° F., and the specific gravity was a shade under 1·023.

In the morning we worked with the divers over the south part of the region between the East and West Chevals. The oysters found here were mostly small (6 months old), growing in clumps or attached to the large valves of *Pinna bicolor*, which is very abundant here partly imbedded in the sand (fig. 18) - there are probably about 3 or 4 to the square yard. A shoal extends from this point (about the shoal buoy or south centre of Cheval Paar) southwards to the northern end of Karativo Island some 10 miles away. There is a tradition among the divers

Fig. 18. Large specimen of *Pinna* covered in its upper part with young pearl oysters and in the lower part with tags of byssus, indicating where oysters had been attached.

Fig. 19. Sketch-chart showing the shoal extending northwards from Karativo Island to the Cheval Paar.

that in former days Queen ALLIYARASANI, an Amazonian princess who ruled the Tamils in the northern part of Ceylon and personally superintended her pearl fisheries, used to sit on the north end of the long island of Karativo and watch the divers at work on the Cheval Paar. Karativo is now out of sight of the Cheval and there is no reason to think that the paar ever extended further south; but the soundings along the shoal (see fig. 19), taken along with the evidences of coast erosion that we found at Kodramallai Point and along the shores of the Bight of Kondatchi (see fig. 20, showing an old cannon near the Doric, at Aripu, nearly toppled over through the

Fig. 20. Captain J. DONNAN, late Inspector, and Captain J. LEGGE, present Inspector of the Pearl Banks, on an old cannon near the ruins of the Doric: to show the erosion of the coast in the bight of Kondatchi—from a photograph taken February, 1902.

washing away of the land by the sea), render it highly probable that Karativo in former times extended northwards along the line of the shoal; and so, possibly, the tradition of Queen ALLIYARASANI is a record of the time when Karativo reached the Cheval Paar.

On March 9th we dredged about the southern part of the Periya Paar. The first haul was taken across the paar, and immense quantities of small oysters (about 6 months old) and a bucketful of large ones (3 years old) were obtained.

The remaining three hauls (Station LV.) were outside the paar, and to the south, and extended westwards to "out of soundings."

STATION LV.—To the west and south-west of southern end of Periya Paar; depth 11 to 24 fathoms; bottom sand, Nullipores and dead Corals; dredged.

Codium bursarium, *Bryopsis*;

Orbitolites complanatus, *Heterostegina depressa*, &c.;

Axinella tubulata, *Suberites inconstans*, var. *digitata*;

Some Corals, Antipatharia, *Juncella juncea*;

Nemertine, *Physcosoma agassizii*, *Clœia ceylonica*;

Toxopneustes pileolus, *Cidaris metularia*, *Echinolampas oviformis*, *Lovenia elongata*, *Maretia planulata*, *Schizaster* sp.; *Stichopus variegatus*;

Balanus sp., various Macrura, *Lambrus* sp., and other Crabs;

Pearl oysters (both large and small), *Modiola* sp. (in gelatinous nests), *Murex tenuispina*, *Melibe* sp., *Doridium* sp., *Hexabranchus* sp., and small Octopods.

On March 10th we had a long day of dredging (17 successful hauls) on and outside Dutch Modragam, Karativo, and Col. Hamilton's Alentura paars, all lying outside the northern part of Karativo Island.

The hauls may be grouped into three stations (LVI. to LVIII.).

STATION LVI.—West of Kodramallai Point, about 10 miles off shore, on and around Dutch Modragam Paar; depth 8 to 9 fathoms; bottom coarse quartz sand, with red weed (*Hypnea musciformis*, &c.) in places on which were immense quantities of pearl-oyster spat; 4 hauls of dredge.

Virgularia sp. (several);

Laganum depressum, *Echinodiscus auritus*;

Sipunculus sp., *Hermione ridgewayi*, n. sp., *Lepidonotus carinulatus*, *Chlœia ceylonica*, *Sabella phæotænia*, *Sigalion mathildæ*;

Leucosia sp., and other small Crabs;

Pearl oysters (young, 6 months old), *Aplysia* sp.; *Asymmetron cingalense*.

STATION LVII.—To the west of last station, outside Dutch Modragam Paar; $11\frac{1}{2}$ to 36 fathoms; bottom Orbitolites sand, Nullipores and dead Corals; 5 hauls of dredge.

Orbitolites complanatus, *Heterostegina depressa*;

Petrosia testudinaria and other sponges;

Stephanoseris rousseaui (with Gephyreans), Pennatulids, Gorgonids, and Reef Corals;

Phyllacanthus imperialis, *Laganum depressum*, *Clypeaster humilis*, *Fibularia volva*, *Actinometra parvicirra*, *Antedon bella* and *A. milberti*;

Nemertines, *Aspidosiphon* sp., *Sigalion mathildæ* (in Coral), *Elasmopus subcarinatus*, and other Amphipods; *Isocardia* sp. and *Doriopsis* sp.

STATION LVIII.—Further south than last Station, on and outside Karativo Paar and the adjacent Colonel Hamilton's Alentura Paar; depths mainly 9 to 26 fathoms, but once or twice the dredge may have slipped into deeper water—we were close to "out of soundings"; bottom Orbitolites sand, and some Nullipore and Coral fragments; 8 hauls of the dredge.

Orbitolites complanatus, *Heterostegina depressa*, *Rotalia calcar*, *Alveolina boscii*;

Various sponges;

Gorgonia sp., *Juncella juncea*, *Sphenopus marsupialis*, Corals (from living reef);

Antedon sp., *Holothuria atra*, *Stichopus chloronotus*, var. *fuscus*;

Hyalinœcia sp., *Distomum* sp. (on gills of pearl oyster), *Stylochus* sp.;

Lysianassa (? n. sp.), *Leptophoxus uncirostratus*, *Elasmopus subcarinatus*, and a new species of *Lambos*;

Pearl oysters (a few old and young), and *Avicula vexillum;*

Ascidia-like Clavelinid, *Branchiostoma lanceolatum*, var. *belcheri* (several).

A tow-netting taken below the surface, at 6 to 10 fathoms, gave amongst other things a large new Ostracod, a new species of *Centropages, Mecynocera clausi, Metaealanus aurivillii, Oithona plumifera, Clausocalanus furcatus*, and *Pseudodiaptomus serricaudatus*—over 20 species of Copepoda.

On March 10th, at 7 A.M., south of Cheval, the sea-temperature was 79·8° F.; on the 11th, at 6.30 A.M., off north end of Karativo Island, it was 80° F., and at 6 P.M., on Periya Paar, it was 81·1° F., the specific gravity as usual being about 1·023.

On March 11th, we continued dredging amongst the smaller paars to the south of the Cheval district and lying outside Karativo Island. The 9 hauls may be grouped in two sets, as follows:—

STATION LIX.—On and around DONNAN'S Muttuvaratu Paar; in shallow water, $6\frac{1}{2}$ to 9 fathoms; bottom Nullipore and dead Coral fragments; 5 hauls of dredge.

Tetractinellids, and other sponges;

Madrepora (spp.) and other living Corals, *Sarcophytum* sp. and *Selerophytum densum;*

Clypeaster (young), *Culcita schmideliana;*

Palmyra aurifera, Stylarioides parmatus, Lepidonotus carinulatus, Eunice teretiuscula, Ammochares sp., *Sabella phæotænia, Elsia indica;*

An Ascomyzontid Copepod which will require a new genus;

Pearl oysters, *Doris* sp., *Casella* sp., and a number of small Octopods.

STATION LX.—Outside DONNAN'S Paar; in deeper water, 20 to 30 fathoms; bottom Orbitolites sand, a little Nullipore and dead Coral; 4 hauls of dredge.

Orbitolites complanatus, and other Foraminifera;

Raspailia thurstoni, and other sponges;

Pennatulids, *Umbellula* and other Alcyonaria, *Sphenopus marsupialis*, and some living Corals, Antipatharia;

Phyllacanthus baculosa, Astropecten polyacanthus, Culcita schmideliana, Nardoa tuberculata, Ophiocoma scolopendrina, Cucumaria tricolor;

Various Molluscan shells (undetermined) and some Nudibranchs (*Doriopsis*).

A TOW-NETTING taken at the same time gave:—Amongst 28 species of Copepoda, *Pontella securifer, Calocalanus pavo, Oithona plumifera* and *Candaeia ethiopica.*

We now returned, northwards, to the Periya Paar in order to investigate its condition more thoroughly, as it was evidently the deepest and furthest seawards of the paars where oysters in any quantity were to be found. It was also by far the most extensive area covered with young oysters, and yet its past history has shown that it cannot be relied upon to yield fisheries. Again and again it has been reported as covered with young oysters, again and again they have all disappeared.

Captain DONNAN in his forty years' experience has only had one fishery on the Periya Paar—the only one to his knowledge (he told us) that had ever occurred. It has frequently, at an inspection, been found to have abundance of newly deposited small oysters, while at the next inspection these oysters have gone and a fresh deposit of younger ones may be in their place. Occasionally a few may have remained for a second year, but they have always disappeared before becoming large enough to fish, except in the one case of the fishery in 1879—and even that was of limited extent and only involved a small part of the bank.

The shallow-water plateau round the coast in the northern part of the Gulf of Manaar, upon which the pearl-oyster paars are placed, can usually be distinguished very clearly by the navigator on account of the difference in the tint of water. Even 20 miles from shore, in fine weather, the yellow sandy bottom shows up through the clear water, and the slope is so steep that there is an abrupt change from the dark blue of the deep ocean "out of soundings" to the lighter tint of the plateau. I am told that captains who know the district, making for the Pamban Pass, know it is useless to take soundings for the banks until the lighter coloured water is reached; and the line of junction is usually sharply marked.

Now the Periya Paar is close to the edge of the plateau, about 18 miles from land and at a depth of 8 to 10 fathoms (fig. 21). It runs for about 11 nautical miles north and south, and varies from 1 to 2 miles in breadth, and this—for a paar—large extent of ground has been called by the natives the "mother-paar" under the impression that the young oysters, that come and go in fabulous numbers, arise there and migrate or are carried inwards to supply the inshore paars with their populations. During a careful investigation of the Periya Paar and its surroundings we satisfied ourselves that there is no basis of fact for this belief, and it became clear to us that the successive broods on the Periya Paar, amounting probably within the last quarter century alone to many millions of millions of pearl oysters, which if they had been saved would have constituted enormous fisheries, have all been overwhelmed by natural causes, due mainly to the configuration of the ground and its exposure to the south-west monsoon.

The following table shows in brief the history of the Periya Paar for the last twenty-four years :—

February, 1880. .	Abundance of young oysters.
March, 1882. . .	No oysters on the bank.
March, 1883. . .	Abundance of young oysters, 6 to 9 months old.
March, 1884. . .	Oysters still on bank, mixed with others 3 months old.

March, 1885. . .	Older oysters gone and very few of the younger remaining.
March, 1886. . .	No oysters on bank.
November, 1887 .	Abundance of young oysters, 2 to 3 months old.
November, 1888 .	Oysters of last year gone and new lot come, 3 to 6 months old.
November, 1889 .	Oysters of last year gone; a few patches present of 3 months old.
March, 1892. . .	No oysters on the bank.
March, 1893. . .	Abundance of oysters of 6 months old.
March, 1894. . .	No oysters on the bank.
March, 1895. . .	No oysters on the bank.
March, 1896. . .	Abundance of young oysters, 3 to 6 months old.
March, 1897. . .	No oysters present.
March, 1898. . .	No oysters present.
March, 1899. . .	Abundance of oysters, 3 to 6 months old.
March, 1900. . .	Abundance of oysters, 3 to 6 months old; none of last year's remaining.
March, 1901. . .	Oysters present of 12 to 18 months of age, but not so numerous as in preceding year.
March, 1902. . .	Young oysters abundant, 2 to 3 months old. Only a few small patches of older oysters (2 to 2½ years) remaining.
November, 1902 .	All the oysters gone.

It is shown by the above that since 1880 the bank has been naturally re-stocked with young oysters at least 11 times without yielding a fishery.

The 10-fathom line skirts the western edge of the paar and the 100-fathom line is not far outside it (fig. 21). An examination of the great slope beyond is sufficient to show that the south-west monsoon running up towards the Bay of Bengal for 6 months in the year must produce a current which will beat with full force on the

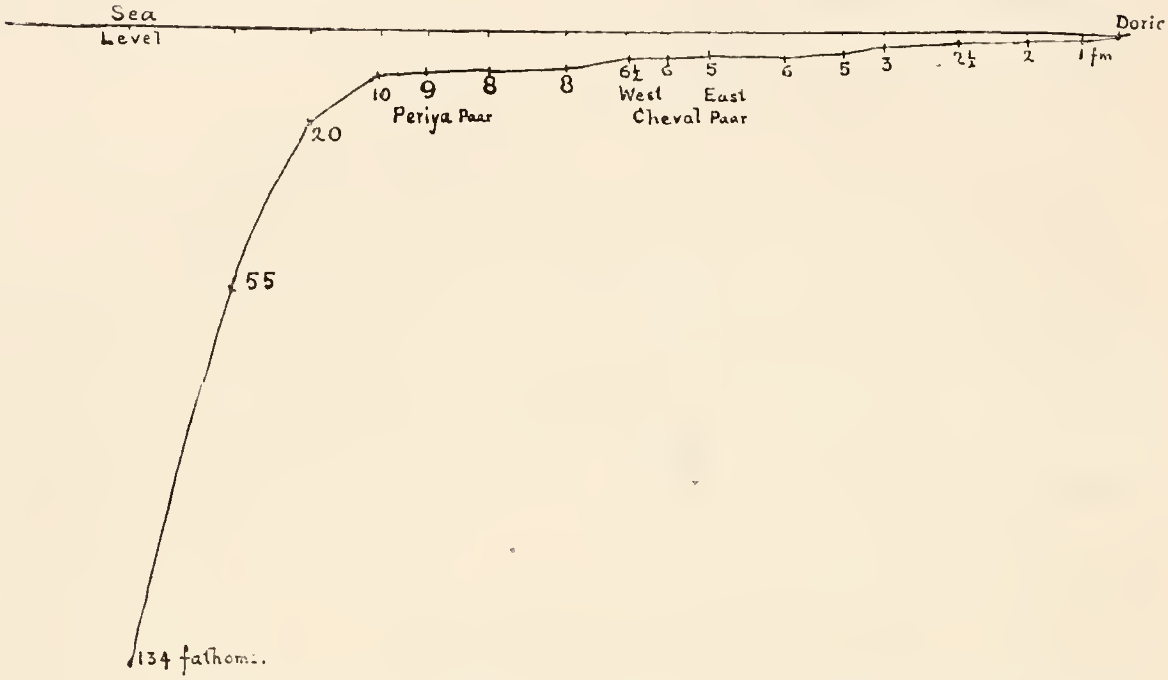


Fig. 21. Section across the sea from the Doric at Aripu westwards through the Cheval and Periya paars into deep water. Horizontal scale, ¼ inch = 1 mile; vertical scale, ¼ inch = 10 fathoms.

exposed seaward edge of the bank and cause great disturbance of the bottom. Figure 21 shows diagrammatically the sudden change in slope outside the paar.

In our previous hauls on the Periya Paar we had found very large numbers of young oysters, and wishing to ascertain how extensive the bed was, on March 12th we steamed in the "Serendib" to the northern extremity of the paar and then south for over 6 miles along its length, diving at intervals. We have the details of 18 dives recorded, and all of them except two give "small pearl oysters in abundance." We were convinced both from this day's work and our previous experiences when dredging that the Periya Paar was covered in March 1902 over the greater part of its extent with enormous quantities of young oysters. Now the area of the paar we take to be, from Captain Donnan's charts and our own observations, about 16 square miles, and we estimated at the time that the oysters were so closely placed that the bank must have held not less than about a hundred thousand millions. In the preliminary Report to the Colonial Government, written in July, 1902, I gave this rough estimate and stated my belief that these young oysters were doomed to destruction and ought to be removed at the earliest opportunity to a safer locality further inshore. Mr. Hornell was authorised by the Government of Ceylon to carry out this recommendation, and went to the Periya Paar early in November with boats and appliances suitable for the work, but found that he had arrived too late. The south-west monsoon had intervened, the bed had apparently been swept clean, and the enormous population of young oysters which we had seen in March, and which might have been used to stock many of the smaller inshore paars, was now in all probability either buried in sand or carried down the steep declivity into the deep water outside. This experience, taken along with what we know of the past history of the bank as revealed by the Inspectors' reports, shows that whenever young oysters are found on the Periya Paar, they ought without delay to be dredged up in bulk and transplanted to suitable ground in the Cheval district—the region where the most reliable paars are placed.

From this example of the Periya Paar it is clear that in considering the vicissitudes of the pearl-oyster banks we have to deal with great natural influences which cannot be removed, but which may to some extent be avoided, and that consequently it is necessary to introduce large measures of cultivation and regulation in order to increase the adult population on the grounds, give greater constancy to the supply, and remove the disappointing fluctuations in the fishery. The depth of water at the spots where our divers went down on the Periya Paar varied from 9 to 12 fathoms, the bottom is hard, so-called "rock," in most parts; in some places the flat "rock" is covered by a thin layer of coarse quartz sand. A certain amount of dead shells, bored by Gastropods, occurred, and a good many "Oorie" were brought up. Some coral fragments were found in places, and a few other animals, Terebellids in sandy tubes, and small fish (*Gymnapistus niger*), &c., were obtained.

The sea-temperature on the Periya Paar at 7 A.M. was 80·3° F., and in the evening (6 P.M.) on the Periya Paar Kerrai, much further inshore and north of the Cheval, it was 82° F., the specific gravity on both being 1·023.

We then, on March 12th, had 4 hauls of the dredge off the northern end of the Periya Paar to the west and south-west. These may be united as—

STATION LXI.—To the west and south-west of northern end of Periya Paar; 12 to 14 fathoms; bottom sand, Nullipore and Coral, with Sargasso weed.

Axinella tubulata and *A. donnani*, *Petrosia testudinaria;*

Heterocyathus aequicostatus (with Gephyrea) and other Corals;

Physcosoma scolops (in *Axinella tubulata*), *Nicomache* sp., *Gastrolepidia clavigera;*

Phyllidiella sp.; *Asymmetron* (*Heteropleuron*) *cingalense.*

The TOW-NET at the same time gave some Copepoda, including *Pontellopsis strenua* and *Corycaus gracilicaudatus.*

On March 13th the day was spent in dredging from Periya Paar Kerrai westwards, across Periya Paar and outwards to the west and south into deep water. Thirteen hauls were taken, which may be grouped as two Stations—

STATION LXII.—Between Periya Paar Kerrai and Periya Paar, working westward; depth 7 to 13 fathoms; bottom coarse quartz sand, some Orbitolites sand and Nullipores. Three hauls of dredge.

Orbitolites complanatus, and other large Foraminifera;

Chætopterus appendiculatus, *Sabellaria bicornis*, *Filograna* sp., a tube-building Amphipod (*Cerapus* sp.);

Echinostrephus molare, *Echinodiscus auritus*, *Stichopus chloronotus;*

Craspedochiton laqueatus (several), Pearl Oysters (small very abundant), "Suran," *Ostrea* sp., *Venus* sp., *Murex* sp., *Ficus ficoides;*

Molgulids, flat Polystyelid colony (on oyster shell);

Branchiostoma belcheri (11 specimens), "Sand-eels" (*Trichonotus* sp.).

STATION LXIII.—To the west of Periya Paar, going south; depths 17 to 55 fathoms (we sounded in 80 fathoms when the dredge was put over for one haul, but it is doubtful whether the dredge touched the bottom before we drifted in to about 40 fathoms); bottom Orbitolites sand, some dead Coral, shells and pieces of Nullipore. Amongst the animals were:—

Orbitolites complanatus, *Heterostegina depressa;*

Ciocalypta tyleri, var. *manaarensis*, *Spirastrella* sp., and other sponges;

Heteropsammia michelini (orange), with Gephyreans, *Flabellum rubrum*,* *Dendrophyllia* sp., *Juncella* (? n. sp.), *Pteroeides* sp.;

Actinometra parvicirra, and another species, *Salmacis dussumieri*, *Clypeaster scutiformis*, *Lovenia elongata*, *Echinolampas oviformis*, *Fibularia volva*, *Echinoneus cyclostomus*, *Pectinura gorgonia*, *Ophiopteron elegans*, *Astropecten polyacanthus;*

Chlœia sp., *Serpula* sp.; *Hippa*, *Thia*, and other Crabs;

Polyzoa—*Lepralia edax*, and *L. robusta*, and species of the genera *Scrupocellaria*, *Adeona*, *Gemellipora*, *Schizoporella*, *Membranipora*, *Microporella*, *Bowerbankia* and *Ascopodaria;*

Mollusca—including, *Mitra crebulirata*, *M. militaris*, *Cerithium armatum*, *C. citrinum*, *Strombus pulchellus*, *Natica albumen*, *Pleurotoma tigrina*, *Nassa* sp., and *Dentalium* sp.; Molgulids.

The sea-temperature at 7 A.M. on the west of the Periya Paar Kerrai was 81° F., and at 6 P.M. on the Vankali Paar was 82°·1 F., the specific gravity as usual being 1·023.

We tow-netted during the day, and obtained on the surface numerous deep blue Copepoda (*Labidocera acuta*) a deep blue Porpita and colonies of Compound Radiolaria (*Collozoum* sp.) with black pigmented individuals, also Erichthus and other larval

* Mr. STANLEY GARDINER informs me that this belongs to the "facies" or variety which has the form known formerly under the name *F. stokesi* (ED. and H.). See GARDINER 'Mar. Invests. in S. Africa,' p. 117, 1902.

Crustacea and much *Trichodesmium erythræum*. Twenty-four species of Copepoda have already been identified by Mr. ANDREW SCOTT from this haul.

The deep TOW-NET brought up *Sagitta*, a violet Appendicularian, filamentous Algæ forming balls, a large new Ostracod, and 15 species of Copepoda including *Clausocalanus furcatus* and *Ectinosoma atlanticum*.

In the evening, at 9 P.M., the sea was dotted with bright phosphorescent lights of considerable size singly placed at some distance apart. These for over an hour continued to glow with a pulsating appearance *in harmony*—all shining brightly at the same moment, and then all flickering out together, to re-appear simultaneously a few seconds later. We went out at once with a net and obtained a sample of the plankton, but could not be sure that we had caught any of the pulsating forms. The gathering contained *Sagitta* (very many), *Appendicularia*, Copepoda—half-a-dozen common species and *Sapphirhina sinuicauda*, *Pontella fera*, *Calocalanus pavo* and some smaller forms, along with half a-dozen one-inch-long Heteronereids of a reddish-brown colour. We suspected the light to be due to the last-named, and if that is so, possibly the periodicity was a result of the epitocous condition and was accompanied by a simultaneous discharge of genital products.

On March 14th, at 7 A.M., at the southern end of Pamban Pass, the sea-temperature was 82°·5 F. (5 degrees higher than it was at the same spot on February 5th) and the specific gravity was 1·022. At 6 P.M. in Palk Bay, the sea-temperature was again 82°·5 F. ($4\frac{1}{2}$ degrees higher than on February 6th) and the specific gravity was 1·021. We anchored for a couple of hours one mile off the village of Rameswaram and landed in the boat, examining the beach, the coral shoals on the way in, and the raised coral platform along the shore alluded to by THURSTON ('Notes on the Pearl and Chank Fisheries, &c.,' Madras Museum, 1890).

Two long hauls of the large shrimp-trawl were now taken in Palk Bay on the way across to Jaffna. The first was over the same region trawled on February 6th (Station XVIII.), but at right angles to our former course (see fig. 22). Starting due east of Rameswaram, about $4\frac{1}{2}$ miles off shore at a depth of 5 fathoms, we towed for about 10 miles to the north-east, towards the island of Catchetivo, the water deepening gradually to 7 fathoms. The bottom was soft grey-blue mud, containing small concretionary nodules and many casts of the interior of Gastropod shells. The animals obtained were mostly the same fish and invertebrates as on February 6th, a few small Crabs, Molluscs and Echinids; also a species of *Arcania* with large lateral projections of a deep violet colour on the carapace. Several pearl oysters were obtained in this haul, and a sea-snake.

The second haul was taken to the south-east of Catchetivo Island, in a depth of 7 fathoms. The trawl was worked rather more rapidly with the result that it did not hug the bottom so closely, and brought up no mud and very few invertebrates, but a large haul of small Scopelid fishes which filled half-a-dozen ship's buckets and numbered over 2500 specimens. They apparently belonged to only 3 or 4 species

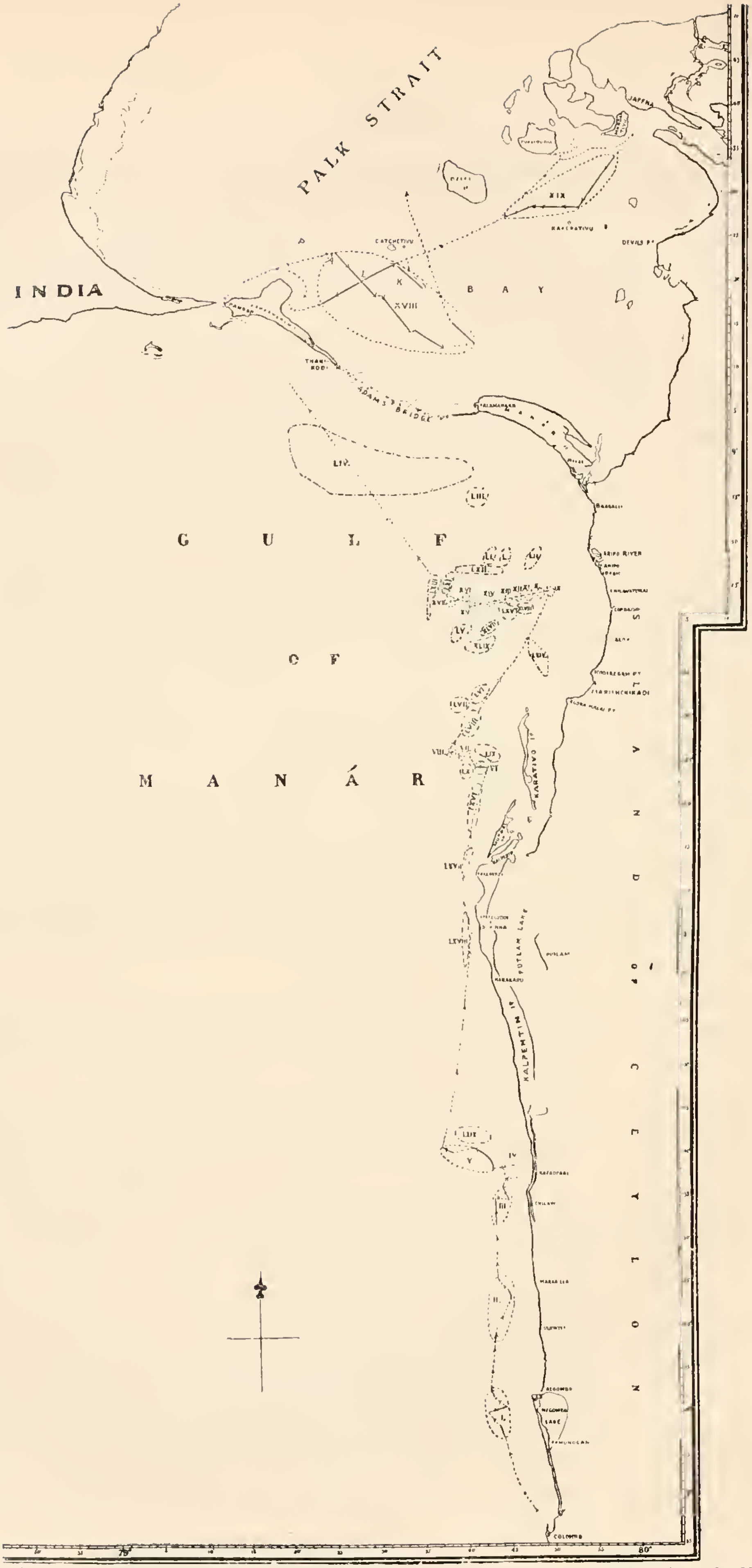


Fig. 22. Sketch-map of Gulf of Manaar and Palk Bay, showing Stations I. to XIX. and XLVII. to LXIX. The course of the first cruise is shown by the dotted lines with arrows. The stations of the second cruise are surrounded by dot-and-dash lines.

(*Saurus indicus*, *S. myops* and *Saurida tumbil*), all of silvery aspect. The trawl also contained 6 sea-snakes, 2 small Octopods (*Polypus granulatus* and another species), and 6 or 7 very fine prawns (*Penæus* sp.).

On March 15th we lay at anchor off Jaffna, taking in supplies and arranging for Sir WILLIAM TWYNAM to join our party. At 8 A.M. the sea-temperature was 82°·8 F. and the specific gravity 1·021; at 8 P.M. both readings were the same.

On March 16th we trawled in the northern part of Palk Bay, down the broad passage between the islands from Mandativo to Delft Island at depths increasing gradually from 4½ fathoms outwards to 8. About 12 miles were covered in 3 hauls, the first southwards from off Mandativo towards Kakerativo; the second from east to west about 2 miles north of Kakerativo, depth 7 fathoms; and the third half-way between Kakerativo and Delft Island, depth 8 fathoms. The last haul was on the mud with concretions, as at Station XVIII. (March 14th), but the two previous ones were on sand and shells with some living Coral. I consider all this day's work as being one locality (see fig. 22).

STATION XIX.—In north part of Palk Bay, east of Delft Island; depth 4½ to 8 fathoms; bottom sand and shells to mud; sea-temperature, 7 A.M. off Mandativo Island 82·8° F., 5 P.M. off Jaffna 84° F., specific gravity in both localities 1·020; 3 hauls of the large shrimp-trawl.

Various sponges;

Medusæ (*Nausithoë*, &c.), *Turbinaria cinerascens* and other Corals;

Some Amphipods, Erichthus, Phyllosoma, Prawns and Crabs;

Arca tortuosa, *A. compacta*, *A. tetragona* (?), *A. virescens* (?), *Mytilus barbatus*, *Cerithium citrinum*, *Mitra pyramidalis* (?) and other shells, and Octopods (*Polypus*);

A number of Polyzoa belonging to the genera, *Bugula*, *Cellepora*, *Lepralia*, *Schizoporella*, *Smittia* and *Crisia*;

Leptoclinum (2 species), *Rhabdocynthia* sp., *Rhodosoma* sp., *Polycarpa* sp., and *Salpa runcinata-fusiformis* (large, many);

Small Sole (*Solea oculus*).

On the way back to Jaffna to pick up Sir WILLIAM TWYNAM, we anchored for a couple of hours on the edge of the large shoal lying south and east of the Island of Punkudutivo (marked on the chart "Pearl beds") and went off in the boat to examine the coral reef and see if any trace could be found of the pearl-oysters said to have formerly existed there. We expected from the chart to have to row for at least a mile before coming to the reef, but in a couple of hundred yards progress was stopped by coral growing to within a foot or so of the surface, and on trying several other passages inwards to the land all were found blocked by luxuriant coral growth. We had then to leave the boat and wade over the coral plateau on the tops of enormous branched Madrepores and other flattened expanded colonies (the largest I saw anywhere round Ceylon) which crushed and snapped under one's weight and occasionally gave way altogether, letting one down into a hole with much laceration of skin on legs and arms. No traces of pearl oysters were seen, but possibly we were not able to get far enough inshore. On returning to the ship we found she had shifted her position, as on swinging round to her anchor in what according to the chart was 3 fathoms of water, she hit the rudder against the edge of a mass of growing coral reaching to within a couple of feet of the surface. The officers, from the deck, had fished up several large pieces of colonies for me with boat-hooks. It is evident that the coral reef is extending rapidly at this spot. It must not be supposed that a coral reef once it is surveyed remains stationary. Under some conditions it may become reduced in size, and under others it may show rapid growth both horizontally and vertically. The most abundant forms we obtained were:—*Madrepora cervicornis* and several other allied species, *Pocillopora grandis* and *P. cæspitosa*, *Porites palmata*, several species of *Montipora*, and various Astræids.

On March 17th in Pamban Pass at 7 A.M., the sea-temperature was 82° F., and the specific gravity 1·0206; at 6 P.M., on Kallatidel Paar, the temperature was 82·7° F., and the specific gravity 1·023. After rejoining Captain DONNAN and the inspection boats in the South Cheval district, we took 4 hauls of the dredge between the South Modragam Paar and Kodramallai Point. These may be united as:—

STATION LXIV.—From between South Modragam and Jaggerboom paars along a line south-east towards Kodramallai Point; depth $4\frac{1}{2}$ to $5\frac{1}{2}$ fathoms; bottom coarse sand, with much fine green-weed and small pearl oysters.

Some Renierid sponges;

Lytocarpus (? n. sp.), *Campanularia juncea*, *Fungia dentata* (many), large solitary Corals, and some Pennatulids;

Echinaster purpureus, *Pentaceros lincki* and *P. nodosus*, and many Ophiuroids;

Chlæia sp., *Harmothoë imbricata*;

Many Amphipoda including a new species of *Lambos*, *Lysianassa* (? n. sp.) and a remarkable new species of *Leptochelia* with immense chelæ considerably longer than the body;

Craspedochiton laqueatus, *Margaritifera vulgaris* (many small), *Turbinella rapa* (large), *Pleurotoma crenulata*, *Nassa reticosa*, *Pterocerus* sp., *Vertagus uluco*, *Vermetus* sp., *Lamellaria* sp., *Dolabella* sp., *Aplustrum thalassiarchi*.

The fine green-weed from the bottom had very young spat of pearl oysters on it. The small oysters dredged were about 8 or 9 months old, and were in quantity at about $3\frac{1}{2}$ miles off Kodramallai Point. A tow-netting on March 17th gave us a new species of *Centropages* with a prominent dorsal spine.

On March 18th the sea-temperature on Kallatidel Paar, at 7 A.M., was 82·2° F., and on Cheval Paar, at 6 P.M., was 82·7° F.

In the morning I visited Aripu Coral Reef in one of the boats, and waded over parts of it. It was very rich zoologically, the coral growth being exceedingly luxuriant. The most prevalent forms were :—several species of *Madrepora*, *Montipora*, *Turbinaria*, *Goniastræa*, *Favia* and *Porites*. Large *Cypræa tigris*, large *Ascidia* sp., a pinkish *Rhabdocynthia*, *Cynthia* sp., *Eurythoe latissima*, *E. longicirra*, *Notocirrus trigonocephalus*, and some Holothurians (including *Holothuria monacaria*) were amongst the other conspicuous forms collected.

In the afternoon we dredged round the shoal buoy at the south end of the Cheval Paar, and in a north-westerly direction.

STATION LXV.—From shoal buoy up West Cheval Paar; depth $7\frac{1}{2}$ to 8 fathoms; bottom white quartz sand; 4 hauls of dredge.

Campanularia juncea; *Pseudoboletia* sp.;

Hyale nilssoni (variety), *Pisa* sp. (many) and other Crabs;

A few adult and very many young Pearl Oysters, *Doris* sp., *Aplysia* (green coloured);

Branchiostoma lanceolata, var. *belcheri* (9 specimens), and the long worm-like fish *Opichthys timorensis*.

On March 19th, at 6.30 A.M., on the south-east of Cheval the sea-temperature was 82·5° F., and at 7 P.M. it was 83·5° F. The day was spent in dredging down the coast from DONNAN'S Muttuvaratu Paar (Station LXVI.) through Mudalaikuli Paar and Talaivillu Paar (Station LXVII.) to Coppeluddi and Navakaddu Paar (Station LXVIII.). Eight hauls were taken, grouped in three stations.

STATION LXVI.—From south of DONNAN'S Muttuvaratu Paar along the west of the northern part of Mutwal Island as far as off Mudalaikuli Paar; depths 10 to 35 fathoms; bottom Nullipore and Orbitolites sand, some red Algæ and dead Coral; three hauls of dredge.

Orbitolites complanata, *Alveolina boscii*;

Tetilla poculifera, n. sp. (DENDY), *Stelletta* sp., a Calcisponge and others.

Halicornaria setosa, *Sarcophytum*, Pennatulids and other Alcyonaria, *Flabellum* sp., *Heterocyathus æquicostatus* (with Gephyreans), and living Madrepores;

Phyllodoce foliosopapillata and *Mystides* sp. (afterwards found in our pearl-oyster cages at Galle, and may have come from this paar), *Aspidosiphon corallicola*;

Antedon palmata (?), *Holothuria atra* and *H. kurti*, *Cucumaria imbricata*;

Mæra rubromaculata;

Terebra sp., *Pteroceras* sp., *Phyllidia nigra* and small Octopods (*Polypus* sp.);

Cynthia dura (?), *C.* sp., *Polycarpa* sp., *Leptoclinum* sp.

STATION LXVII.—On and off Talaivillu Paar, off south end of Mutwal Island; depth 10 to 14 fathoms; bottom dead Coral and Nullipore; 2 hauls of dredge; *Halimeda tuna*, *Padina commersonii*. No Pearl Oysters.

Various sponges, chiefly Tetractinellids; *Stephanoseris rousseaui* and *Hetero-*

psammia michelini (with Gephyreans), *Caryophyllia* sp., *Lobophytum pauciflorum*, *Sclerophytum* (? n. sp.), and *Alcyonium pachycladis*;

Hermione sp. and other Annelids; *Asterina cepheus* and *Echinanthus* sp.;

Dexamine sp. and other Amphipods;

Vertagos pharos, and various undetermined Molluscs;

Branchiostoma lanceolatum, var. *belcheri* (several) and *Rhodosoma* (? *papillosum*).

STATION LXVIII.—From off Coppeluddi southwards to Navakaddu Paar; depth 8 to $18\frac{1}{2}$ fathoms; bottom Nullipores (*Lithothamnion fruticulosum*), Coral and muddy Orbitolites sand; three hauls of dredge.

Orbitolites complanatus and other Foraminifera;

Auletta aurantiaca, *Axinella tubulata*;

Various living Corals—*Cœloria* sp., *Madrepora* (sev. spp.), *Fungia crassitentaculata*, *Flabellum* sp.;

Colochirus sp. (?);

Pagurids and various small Crabs;

Molluscan shells (undetermined), *Doris* sp. (with black branchiæ).

A Tow-net gathering yielded many Copepoda of a bluish colour, including *Pontellopsis armatus*, *Pontellina plumata*, *Labidocera kroyeri* and *L. acuta*.

On March 20th Mr. Hornell and I were on our way back to Colombo, on the "Lady Havelock," with a cargo of oysters for Galle. We dredged at two points, (1) on the north end of Chilaw Paar, just north of Station V., and (2) off Negombo. At the latter spot we were again on the bed of oysters we had found on January 31st (Station I.) and obtained some young (about 6 months) on a bottom of coarse yellow sand containing *Caulerpa plumaris* and *Halophila ovata*. At the Chilaw Paar locality we had three hauls which are united as—

STATION LXIX.—On and to the east of the north end of Chilaw Paar; depth 8 to 11 fathoms; bottom yellow quartz sand, with some Coral fragments. Yellow Algæ with Oyster-spat; dredged.

Heterocyathus æquicostatus (with Gephyreans);

Echinodiscus auritus, *Clypeaster humilis*, *Actinometra* sp. (deep olive-brown with yellow tips to pinnæ, harbouring an olive-brown *Alpheus* striped with grey);

Aspidosiphon corallicola, Lumbriconereids and other Worms;

Balanus sp., Amphipods and some Decapoda;

Large and small Pearl Oysters and some other common Lamellibranchs, gelatinous Nudibranchs (*Melibe fimbriata*);

Large colony of a reddish Polystyelid, many Leptoclinids (white and drab), *Branchiostoma lanceolatum*, var. *belcheri* (numerous).

A Tow-netting at the same locality gave us, amongst other Copepoda, the large blue *Pontella princeps* and *P. securifer*, *Pontellopsis armatus* and *Labidocera kroyeri*.

We reached Colombo at 4.30 P.M., and this brought to an end the second cruise of the "Lady Havelock," which had lasted for three weeks and four days. We had left Captain DONNAN before the end of his inspection of the banks, because now that I had seen all possible spots on the coast which might serve for a biological laboratory and had selected Galle as being unquestionably the best, it seemed desirable—as the result of correspondence with the Lieutenant-Governor—that I should see for myself the several quarters at Galle that had been proposed and plan out with Mr. HORNELL the necessary alterations and fittings. We took with us various samples of living oysters, both large (3 years old) and small (about 6 months) which were conveyed safely from the pearl banks to Colombo in our steamer tanks and from Colombo to Galle by train in large earthenware "chatties" of sea-water. The journey occupied, with our necessary stoppages, four complete days at a very hot time of year. We were, however, able at the end of it to deposit most of these oysters in a living condition in the sea at Galle on the evening of March 22nd. They soon recovered activity, and were found next morning to be climbing up the chatties and on the netting in which we had enclosed them. The next three days were spent at Galle in examining, along with Mr. H. W. F. C. BRODHURST, the Government Agent, and Mr. T. TWYNAM, the Master Attendant, certain offices and bungalows in the Fort, in the native Bazaar and near Bayley's Villa on Glosenburg (see fig. 7, p. 46). Notwithstanding Professor HAECKEL's favourable opinion of the last named as a site, given 20 years ago, we found it necessary to reject that end of the bay in favour of the Fort; and in the end for several reasons, which I reported to the Lieutenant-Governor, a portion of the former Military Hospital conveniently situated on the ramparts at Akersloot or Sailors' Bastion, close to a good supply of clean sea-water, was selected as being the locality best fitted for adaptation as a marine laboratory (fig. 25). This report was acted on soon after I left Ceylon, with the result that Mr. HORNELL, upon his return from the pearl-banks in April with a further supply of oysters, was very soon established in a simple but efficient laboratory at Galle—carrying on the work I had left in his hands. Since then Mr. HORNELL has, by fortnightly letters, and frequent longer reports, drawings and specimens, kept me in close touch with all the details of his work; and I have sent him what information and instructions were necessary from time to time. The results of these observations at the Galle Laboratory will be given in the later parts of this report.

After having settled matters at Galle so far as was then possible, and having deposited our pearl oysters in bags and baskets suspended from buoys and spars anchored out in the bay (fig. 23), Mr. HORNELL and I returned to Colombo late on March 25th. The following day was occupied in seeing the Lieutenant-Governor in regard to the laboratory at Galle, and other business, and in packing and despatching some of the collections. Early in the morning of the 27th we started by coach to Chilaw, whence we went on by small boat next day to join the "Serendib," which was sent down the coast by Captain DONNAN to meet us. I had now only about ten days left in Ceylon and was anxious to spend most of that time on board the inspection barque seeing

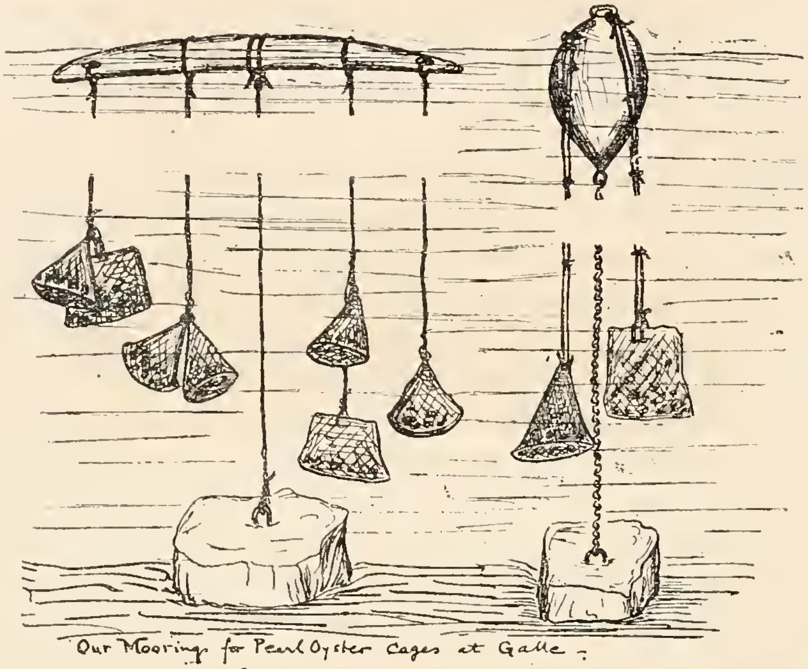


Fig. 23. Experimental oyster cages moored in Galle Bay.

the divers at work and following their results day by day. We reached the "Rangasameeporawee" on the Muttuvaratu Paar in the evening of the 28th, and rejoined Captains DONNAN and LEGGE and Sir W. TWYNAM. On the 29th March we were working on DONNAN'S Muttuvaratu Paar all day. There were plenty of oysters, and the divers brought us up samples and other specimens enough to keep all hands busy. Amongst other interesting forms found here was a new species of Chitonidæ, *Ischnochiton ravanæ*, n. sp. We had now re-started all the tanks and tubs and had many experiments under observation. The paar was estimated to have about 277,000,000 of oysters between $1\frac{1}{2}$ and $2\frac{1}{2}$ years old, but quite a number of them, in the samples we examined, were found to have a dwarfed or ill-grown appearance, accompanied by a yellow discoloration of the mantle and other tissues. We carefully examined this yellow and stunted condition of these oysters both at the time and since, and shall discuss it later on in the report. A good deal of our time was now occupied in examining the food in the stomachs and the sexual condition of the oysters (fig. 24 shows our work place on the barque). We also took tow-net gatherings and obtained samples of the bottom and the bottom fauna by means of the divers, but we had no further dredging or trawling.

The TOW-NET on March 29th, over DONNAN'S Paar, yielded *Trichodesmium*, *Sagitta*.

Pteropods, and 35 species of Copepoda including—*Corycaeus venustus* and *C. speciosus*, *Clytemnestra scutellata*, *Ectinosoma roseum*, *Acartia erythraea*, *Oncaea mediterranea*.

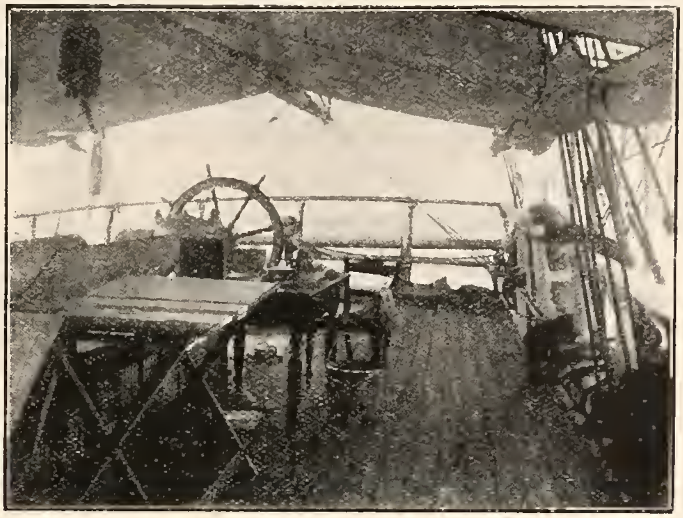


Fig. 24. The deck laboratory on the "Rangasameeporawee," from a photograph by J. HORNELL.

Rhincalanus cornutus, *Euchaeta marina*, *Eucalanus subtenuis*, *Setella gracilis*, *Tortanus forcipatus*, *Calocalanus pavo* and *C. plumosus*. We also obtained from this paar a remarkable Copepod, described below (see p. 245) as the type of a new genus *Ridgewayia*, in honour of His Excellency Sir J. WEST RIDGEWAY, Governor of Ceylon at the time of these investigations.

The sea-temperature on March 29th at 5.30 P.M. was 84° F., and specific gravity was 1·023. The temperature in our wooden tanks on board at the same time was 83° F., and we generally managed, by covering the tanks with moist canvas, to keep the temperature of their contents a degree or two below that of the sea.

The weather was now very hot. On March 30th, the sea-temperature at 7 A.M. was 84° F., and at 5 P.M. was 85° F. We now moved to the southern part of the paar, and in the afternoon rowed to the coral reef lying off Dutch Bay, where Captain LEGGE and I waded over the reef and collected various samples of the fauna.

On March 31st the weather was still warmer. The sea-temperature was 85° F. in the morning and 88° F. in the afternoon, but we managed to keep that in our tanks on board down to 83°·5 F. to 84° F., and the oysters remained very healthy. We moved this morning to the Mudalaikuli Paar, which we found to be practically a living coral reef with no oysters. Fine coral colonies (*Cœloria sinensis*, *Prionastraea* sp., *Pachyseris* sp., *Goniopora* sp., *Hydnophora microcona*, *Galaxea* sp., and *Fungia patella*) and sponges (*Axinella carteri*, *Phyllospongia holdsworthi*, *Spongionella nigra*) were brought up by the divers, but not a single oyster. In the afternoon we took boat and landed at Kattanattu Point, where a long sandy spit runs out to the north-west with a coral reef continuing onward in the same direction and others parallel outside it, so as to give some shelter to a little bay inside the point. We found however that the locality was quite unsuitable for oyster cultivation. In the south-west monsoon the surf evidently breaks over the spit and without doubt churns up the water and the bottom of the bay. This opinion was entirely corroborated by what we heard from the natives on shore.

The Tow-netting on March 30th over the Mudalaikuli Paar gave very much the same results as on the previous day. As additional forms obtained may be noted—

Calanopia elliptica, *Centropages orsini* and a new species of *Centropages*, *Pseudodiaptomus serricaudatus*, and *Eucalanus monachus.*

On April 1st we moved the barque to Talaivillu Paar, where again we found no oysters, the bottom being practically a living coral reef. At 8 A.M. the sea-temperature was 86° F., and at 5.30 P.M. 87° F., and the water in our tanks 84° F. The specific gravity was 1·0229. On Talaivillu Paar we obtained, on a brown (largely calcareous) sand with much *Halimeda* (*H. gracilis* and *H. tuna*)—

Axinella donnani, various incrusting and some Tetractinellid sponges;

Cœloria sinensis, *Porites arenosa*, *Fungia crassitentaculata*, *F. patella*, Madrepora (sev. spp.), *Montipora* sp., *Favia* and other Astræids, *Flabellum* sp., *Sarcophytum roseum*, and other Alcyonaria;

Clæosiphon aspergillum, *Sabellaria bicornis;*

Dexamine sp. and other Amphipods;

Phyllidia varicosa and *P. ceratosoma; Leptoclinum* sp.

The Tow-nets gave 22 species of Copepoda, amongst which may be mentioned:—

Setella gracilis, *Oncæa mediterranea*, *Corycæus longistylis*, *Acartia erythræa*, *Pseudodiaptomus aurivillii*, *P. serricaudatus*, and *Tortanus forcipatus.*

On April 2nd, at 6.40 A.M., the sea-temperature was 85° F. and at 6 P.M. it was 86·5° F., the specific gravity being 1·0228. We had moved to the Navakaddu Paar, where the usual diving operations were continued all forenoon. The bottom here consists largely of great blocks of dead Coral much encrusted with Polyzoa, Nullipores, compound Ascidians, &c., together with a certain amount of living Coral, such as Astræids and *Porites.*

Amongst other organisms brought up on Navakaddu were:—*Halimeda gracilis* and various red Algæ (*Hypnea musciformis*, *Polysiphonia*, &c.).

Asterina cepheus and *Antedon* sp. (? *A. palmata*);

Chætopterus appendiculatus, *Trophonia* sp.

Amphipods, Compound Ascidians, and a new species of Chitonidæ, *Callochiton sublævis*, n. sp. (Sykes). There were no pearl oysters.

The Tow-nets this day, in addition to *Trichodesmium* (very abundant) and *Ceratium*, contained a number of Copepoda, including *Setella gracilis*, *Corycæus venustus*, *Calanus minor*, *Ectinosoma atlanticum* and *Oithona plumifera.*

In the afternoon, still continuing south, we moved down upon the Udupankarai Paar. We found that there were no oysters on the ground, and not likely to be, as this paar, like several of the smaller ones in this neighbourhood, is now practically a living and growing coral reef; but from the older records it seems probable that in Dutch or Portuguese times these ranked amongst the productive oyster banks.

On April 3rd we moved down south to the Jokkenpiddi Paar, the last I was able to examine personally. The sea-temperature at 7 A.M. was 85·5° F. We anchored the barque on the north end, and in the "Serendib" ran south for about 7 miles and then steamed slowly back, sending the divers down every $\frac{1}{4}$ mile. Most of the dives gave a "rock" bottom with dead, and occasionally living, coral, and in several places young oysters (3 to 6 months) in quantity; depth $8\frac{1}{2}$ to 10 fathoms. Amongst the animals brought up were:—

Axinella donnani, an abundant lilac *Chalina* and other sponges;

Various Gorgonoids and common living corals;

Echinostrephus molare (in deep burrows in coral blocks), *Antedon* sp. (with commensal *Alpheus comatulorum*);

Sabellaria bicornis and other Worms; Dromiad and other small Crabs;

Chama foliata, and some coral-boring Lamellibranchs, Pearl Oysters, "Suran" (*Modiola*) and "Oorie" (*Sistrum*); *Leptoclinum* sp.

At 10 P.M., on April 3rd, I had to leave the barque "Rangasameeporawee," and was conveyed by the "Serendib" down to Colombo—as I was booked to leave Ceylon on April 7th, and had still to discuss various matters with the Lieutenant-Governor, transact business at the Master-Attendant's and other Government Offices in Colombo and see to the preservation and packing of many specimens. Mr. HORNELL remained with Captain DONNAN for a few days longer to complete the inspection of the southern paars, and obtain a supply of pearl oysters of various ages to take with him to the marine laboratory at Galle. He examined the Jokkenpiddi, Karkapanni, Chilaw, Oolawitti and Negombo paars, and brought a quantity of young oysters from these banks to Colombo, where they were suspended in coir baskets from the stern of the barque lying in the harbour. He then took the "Serendib" north to the Muttuvaratu Paar, obtained a supply of large oysters (3 years old), returned to Colombo, picked up the young oysters and conveyed the whole cargo round to Galle, where they arrived in splendid condition, not one oyster having died on the way. This shows the practicability of conveying the pearl oysters, both old and young, from place to place in a healthy condition by the means we adopted. Great care is, however, necessary if the temperature be high (the sea averaged about 85° F. during our operations) and if the run be more than 36 hours without

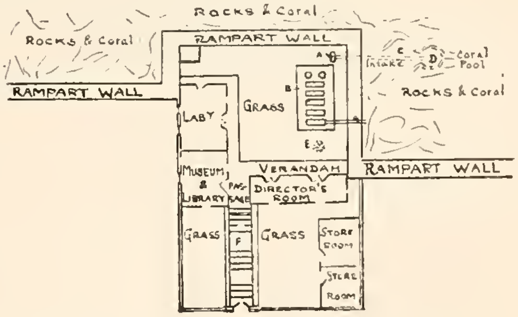


Fig. 25. Galle Marine Biological Station, at former Military Hospital on Akersloot or Sailors' Bastion.

A, semi-rotary hand pump; B, aquarium shed; C, inlet pipe from—D, coral pool; E, suriya tree; F, entrance steps from Dutch gateway dated 1759; G, overflow pipe.

a stop. On that account the November inspection would probably be a better time for transporting, as the temperature is lower then than in March and April.

For some time after this Mr. HORNELL was fully occupied in looking after his oysters sunk or suspended in bags and baskets and "chatties" from boats, and buoys and booms in various parts of Galle Bay; and in superintending the fitting up of the marine laboratory at Akersloot Bastion. In addition to the large rooms (fig. 25) obtained from the old Military Hospital, on the ramparts of the Dutch Fort, which had to be sub-divided and furnished with work-tables, shelving and cupboards, an outside shed formed of "cadjan" (the large leaves of the talipot palm) was erected as a tank-house (fig. 26) to accommodate the wooden tanks and glass aquaria containing

Fig. 26. Aquarium shed with wooden tanks at the Galle Marine Biological Station.

the oysters under experiment and observation. Care was taken in the site and construction of this tank-shed to make it as cool as possible, and the sides were closed in with "tat"-blinds (split bamboos tied together), as being airier and lighter than cadjan flaps. The tanks were connected with the sea by a semi-rotary pump and water pipes which were carried about 20 feet outwards from the base of the rampart in order that the intake might be placed in a deep clear pool lined with living coral. The reservoir into which the pump discharges and from which the sea-water runs through the tanks is formed of two large iron tanks such as are used for citronella oil, with their upper ends cut out, and joined by a pipe at the base. The various observational tanks and aquaria (which had been brought out from Liverpool) were joined up by means of glass and rubber tubing, and were provided with arrangements devised by Mr. HORNELL for distributing air in finely sub-divided bubbles throughout the water. This marine laboratory has proved in every way satisfactory and suitable for our work during the last year. Mr. HORNELL—as the later parts of this report will show—has been able to investigate there the greater part of the matters I left in his hands; but there is still much useful work connected both with the Pearl Fisheries and with other marine industries that he could continue to carry on in this scientific workshop. Moreover, with a little extension of accommodation and permanent equipment it would be an eminently desirable and well-fitted establishment for general marine biological investigation, and would add to the scientific resources and attractions of the Colony. As examples of this it may be mentioned that during the past year (1) Mr. HORNELL has been able to supply specimens of marine algæ to workers at the Peradeniya Botanical Gardens, and types of marine animals to the Medical College at Colombo; (2) a Swedish Botanist, Dr. NILS SVEDELIUS, from Upsala University, has already made use of the laboratory as a place of research, and has expressed the opinion that it is very favourably situated for a tropical Marine Biological Station; and (3) it would naturally afford accommodation and material to the other scientific men of Ceylon. It is conveniently and centrally situated in the Fort, easy of access from the railway station and near the boat jetty, close to pure sea-water, opposite the Vellikoko Reef, adjoining good collecting grounds and with a living coral reef fringing the base of its walls—it seems in short an ideal spot for the purpose. Dr. ARTHUR WILLEY, F.R.S., Director of the Museum at Colombo, writes to me in regard to this Galle Marine Station (May 8th, 1903)—"I shall certainly hope to see the Laboratory which you established at Galle made a permanent institution after the publication of your report. . . . I have been twice to Galle and have seen HORNELL there hard at work, and he has shown me the admirable though simple appliances which render so much service."

Mr. HORNELL's work at the Galle Laboratory since April, 1902, has been chiefly on the following points—all of importance in connection with our understanding of the mode of life, the prosperity and the reproduction of the pearl oyster:—

1. Byssus formation, attachment, detachment, casting off the byssus and re-attachment.

2. Locomotion, both in old and young, crawling by means of the foot, and movement of the shells.

3. Effect of being partially or completely buried in sand. A healthy oyster can free itself from a thin layer of sand, and usually does so; but it cannot get out of 3 inches of sand and soon dies when buried.

4. The sexual condition of the oyster, the production of eggs and spermatozoa, their emission, the fertilisation and the early stages of development.

5. The "spat"—its characters and stages, and comparison with small species of *Avicula*.

6. Food and feeding, and the respiratory and nutritive currents of water. Varying "condition" of different oysters.
7. Growth, increase of the shell and repair of injury.
8. Parasites—Sporozoa, Cestodes, Trematodes, Nematodes, &c., and Commensals: their effect upon the oyster.
9. Other diseased and abnormal conditions of the oyster.
10. Pearl-production, both artificial and natural.

Some of these inquiries were merely the continuation of observations and experiments we had made during our work in the "Lady Havelock," others were undertaken with the object of settling definitely doubts that had been expressed or difficulties that had been raised in the Inspectors' reports and other previous writings, such as Sir W. C. TWYNAM's "Report on the Ceylon Pearl Fisheries," Colombo, 1900—a most useful summary of many previous documents, illuminated by a personal experience of nearly half a century. Our results, although no doubt they could be added to by further work, are I believe conclusive so far as they go; and consequently must be recorded even when, as in some cases, they merely corroborate or extend what was observed by KELAART, THOMAS, HOLDSWORTH, THURSTON or others.

The powers of locomotion we found to be unexpectedly great, especially in the case of young oysters (see some instances we gave on p. 58); and the capability of detachment and re-attachment, and of renewed byssus-formation, is considerable. These are clearly points of great practical importance in connection with our recommendations as to the thinning out and transplanting of young pearl oysters. Such transplantation could only be successfully undertaken in the case of oysters able to find suitable stations in their new environment and to re-attach themselves securely. The effect of burying in sand throws light upon some of the catastrophes that have affected promising beds of oysters in the past, and the knowledge will be useful in leading us to remove the stock in dangerous positions from such risks in the future. The sexes are separate, and, as our experiments show, remain the same from season to season: each individual is permanently either male or female. The natural emission of both ova and spermatozoa has taken place in our tanks at the Galle Laboratory, and we have reared the young pearl-oyster from the egg to a shelled larval stage similar to one obtained in the tow-nets. On all the other points we have I believe made some additions to knowledge which will be discussed below in the special articles.

In October, 1902, Mr. HORNELL carried out my suggestion of a further examination of Trincomalee Harbour and Tamblegam Lake. He gave ten days to the work and got satisfactory results which I have already noted (see p. 41).

Early in November he joined Captain LEGGE in the inspection of the pearl banks for the purpose of obtaining a sample of oysters to be valued by the pearl experts at Colombo in view of the proposed fishery. The following paars were inspected :— South, East and West Cheval, and Periya Paar Kerrai in considerable detail, and from these samples were lifted (fig. 27); while the following were less fully examined :— Kondatchi Paar, Dutch Modragam Paar, Muttuvaratu Paar, Chilaw Paar, and the ground off Negombo. Mr. HORNELL examined large numbers of oysters from the

Fig. 27. Valuation sample of pearl oysters from the Cheval Paar, being brought on board the "Rangasameeporawee" from the inspection boats—from a photograph by J. HORNELL.

various paars as regards their sexual condition, parasites and the occurrence of pearls. He also investigated the plankton as fully as possible, and found, on Muttuvaratu Paar, the youngest stages of the larval Cestode which we regard as the chief cause of pearl-formation free-swimming in the water.

Mr. HORNELL also took a considerable number of living oysters round with him from Muttuvaratu and Chilaw paars to Galle, where he placed them at various chosen spots in the lagoon for observation and experiment.

The official samples of pearl oysters taken from the Cheval Paars and Periya Paar Kerrai in November were valued in Negombo by five expert native merchants and Captain LEGGE, the Inspector of Pearl Banks, with the following results :—

12,000	oysters	from the	South-East part of the Cheval Paar,	at Rs. 10 25 c.	per 1000
1,000	,,	,,	East Cheval Paar,	at Rs. 18 17¼ c.	,,
2,000	,,	,,	North-East part of the Cheval Paar,	at Rs. 23 12½ c.	,,
2,000	,,	,,	Periya Paar Kerrai	at Rs. 13 25 c.	,,

As a result of this valuation it was decided to hold a pearl-fishery in the spring of 1903; and it was announced in the Ceylon Government Gazette Extraordinary No. 5896, of December 22, 1902, that the fishery would take place at Marichchukaddi, which is about 8 miles south of Chilavaturai, on or about 22nd February, 1903.

The paars announced for fishing were :—

South-East Cheval Paar,	with 49	million	oysters	sufficient	for 120	boats	for 40	days
East Cheval Paar,	,, 11	,,	,,	,,	28	,,	40	,,
North-East Cheval Paar,	,, 13	,,	,,	,,	32	,,	40	,,
Periya Paar Kerrai,	,, 8	,,	,,	,,	20	,,	40	,,

Making in all . . . . . 81 millions of pearl oysters estimated as fishable.

Mr. Hornell left Galle on January 27th and arrived off Marichchukaddi, the head-quarters of the fishery, on January 31st, and in this neighbourhood he remained for the next three months, leaving on April 23rd and arriving back at the Galle Laboratory on 4th of May.

The fishery did not commence until March 3rd and it ended on April 15th, having lasted for 38 days and resulted in a revenue of Rs. 830,151 93 c. Thirty-nine millions of oysters are estimated to have been obtained from the eastern Cheval paars, and an inspection made by Captain Legge at the conclusion resulted in the estimate that 22 millions of adult oysters were still left on these paars alone. This demonstrates one of the obvious imperfections of the method of fishing by means of native divers. When the divers have made enough money, or are wearied of the work, or find that the scattered condition of the oysters makes it more difficult to fill their baskets, they can declare that the bank is exhausted and so cause a premature stoppage of the fishery. Under such circumstances most of the oysters left at the bottom might still be recovered by dredging.

In addition to the paars fished, a number of the neighbouring smaller paars were inspected, and Mr. Hornell was able, by means of the European diving suit which was now available, to make a personal examination of the bottom and acquire a fuller knowledge of the conditions than had before been possible. He made about 40 descents in all—upon the Cheval, North and South Modragam, Periya Paar Kerrai, Kondatchy, Aripu, Periya, Dutch Modragam, Naddakudda, Vankali, Anaivel-unden, Karativo, Alentura and Muttuvaratu paars. On the larger paars several descents were made, eleven upon the Cheval as the one deserving most attention. One important result of this personal inspection of the bottom was to establish—if that was necessary—the correctness of the conclusion we had arrived at during our work on the "Lady Havelock," that the greater part of the bottom on the pearl-banks is suitable for dredging, and that the oysters could be obtained from the paars during a fishery much more effectively and speedily by dredging from one or more small steamers than by diving. On the Muttuvaratu Paar Mr. Hornell reports that three dives showed a dredgable bottom, while the fourth dive was on a spot where the dredge could not be worked as the "rock rose from the bottom in great plateau-like ledges." A similar condition was found at one spot on the Dutch Modragam Paar, but otherwise the bottom all over the productive paars is perfectly suitable for dredging. The Cheval paars and the North and South Modragams present ideal bottoms for dredging, or even for working a small trawl upon, being level and consisting mainly of a thin layer of sand covering a firmer substratum of the cemented material known as "rock." I shall return to this matter of dredging for the pearl oysters, in place of diving, in my Recommendations at the end of the Report.

During this period Mr. HORNELL also examined large numbers of pearl oysters of various ages and from different paars and so was able to confirm and extend our previous observations. He was especially successful in obtaining stages in the formation of pearls, and in the life-history of the pearl-causing parasites. The details obtained during this three months' work on the pearl-banks have been incorporated with our other investigations (1) on the condition of the ground (see p. 99); and (2) on the parasites and pearl-formation, in the parts that follow.

For some weeks after this Mr. HORNELL was engaged at Galle in completing his notes and records of observations and in packing off to me the specimens which had to be examined in Liverpool, and so finished his work as my Assistant in this investigation. If he is enabled to continue his observations as a Marine Biologist at the Galle Laboratory, judging from the industry, energy and ability he displayed during the time we were associated in work, I can confidently predict that he will render signal service to the pearl, sponge, trepang and other marine fisheries of the colony.

The inspection barque "Rangasameeporawee."

Fig. 28. Chart of the Northern Paars.

DESCRIPTION OF THE PEARL-OYSTER BANKS OF THE GULF OF MANAAR.

The following account of the physical and biological characteristics of the various "paars" on the Ceylon side of the Gulf of Manaar is drawn up partly from the information obtained by dredging over the ground from the ss. "Lady Havelock," partly from our lines of dives from the "Serendib" during the inspection of March, 1902, and partly from the additional information which Mr. Hornell obtained during the fishery of 1903. On this last occasion a European diving dress was available for use—which we had not had in 1902—and consequently Mr. Hornell was enabled to descend himself, and so corroborate, correct, and supplement the information derived from the natives* by many further details. The lists of animals found on the "paars" given here are not intended to be exhaustive, or even full. The object is merely to mention a few of the more characteristic organisms in each case.

The paars may be arranged in two groups, the Northern from Adam's Bridge down to Kodramallai, and the Southern from that point onwards; we give a chart (fig. 28 and fig. 37) of each group. The Northern is by far the more important; it contains more paars, they are of larger extent, and have produced most of the recorded fisheries. The pearl-bank plateau, bounded for the most part by the 10 or 12-fathom line, widens greatly in the northern part of the Gulf of Manaar as it approaches Adam's Bridge (see fig. 1, p. 19); for whereas off Negombo and Chilaw it is only 3 to 6 miles from shore, off Aripu and Kondatchi it is from 16 to 20 miles.

This widening of the plateau north of Kodramallai allows the northern paars to form several series, one outside another, and roughly parallel with the coast, the inner series being about 4 and the outer 18 miles from land. Outside the paars the ground shelves away rapidly to 20 or 30 fathoms, which marks the top of the steep slope down to the mud-floored abyss forming the central portion of the Gulf. Along the line of this slope soundings in some places jump in very short distances from 20 fathoms to anything between 100 and 1000, with, of course, interesting differences in the fauna. Within the 10 or 12-fathom line, on the other hand, the ground is for the most part very level, especially on the wider northern part of the plateau. At the Cheval Paar a distance of 12 miles is run from shore before a depth of 7 fathoms is reached—a gradient of 1 in 1700. The surface of this plateau is for the most part

* Mr. Hornell, writing to me of the results of his inspection, says that he finds the diagrams compiled from the divers' reports erroneous, and adds, "On the other hand, the results obtained by dredging—which sometimes clashed with the divers' reports—were proved to be reliable, and indeed wholly accurate. The conclusions based upon this source of information require no emendation—merely amplification."

sand, diversified here and there by outcrops of so-called "rock," generally in the form of flat or slightly-inclined ledges, sometimes stepped to form low terraces, sometimes level with the surface, and sometimes even a few inches under it, the rock being then covered by a thin layer of sand, which shifts from time to time with the currents.

Some of the paars, such as the Muttuvaratu, Karativo, Dutch Modragam, and parts of the Western Cheval, are formed almost entirely of rock, and the small amount of sand found in crevices and sprinkled over parts is mostly of organic origin—*Heterostegina*, *Alveolina*, *Orbitolites*, and other large Foraminifera and fragments of shells. On other paars, such as the East and South Cheval, angular quartz sand predominates, sometimes underlaid by flat rock which crops out at intervals. Mr. J. Lomas, F.G.S., who has examined the samples of "rock" we obtained from the paars, is of opinion that they are all of recent origin, and are in fact merely a consolidation or cementing of the sand *in situ*. Further details of the nature of these modern calcareous rocks or "Calcretes," and of their mode of formation on the paars, will be given in Mr. Lomas' report which follows.

The calcretes naturally vary considerably from place to place, being in some cases mainly composed of terrigenons materials and in others being mainly neritic or formed of organic remains. The rock may be a grit stone formed of the yellow-tinted quartz sand, which is so abundant, cemented by carbonate of lime, or it may be largely dead worn and altered coral, or it may be a shelly mass, an agglomerate of the dead valves of pearl-oysters, cockles, and Pectunculids with Nullipores (*Lithothamnion*) and Polyzoa (Lepralids) intermingled.

In addition to the paars described below, there are a few others, marked on the chart as "Old" or "Old Dutch" (see figs. 28 and 37), which are either erroneous positions of other paars now more accurately determined or are patches which formerly bore oysters and have since changed their character.

We must not, however, try to be too precise in regard to the positions, sizes, and outlines of the paars. Our work in the "Lady Havelock" showed us that some spots around and between them are more or less hard-bottomed, and even in some cases bore oysters and are capable of becoming paars. On the other hand, it is known from the inspections that many parts of the known paars are temporarily, and possibly some parts even permanently, unsuitable for the attachment or rearing of oysters. We may consider, then, the whole plateau as potentially "paar" ground—some parts of it better suited for one purpose and some for another, some parts more constantly covered by the shifting sands, others more regularly bare and hard. This renders possible the farming operations, such as "culching" and transplanting, which we discuss in our "Recommendations."

Cheval Paar.

This is the most important and the largest of the paars, and is the central member of the northern set, most of the other paars being grouped around it (see fig. 28).

It lies from 9 to 13 miles off the coast, opposite the bight of Kondatchi, the northern point being due west of Aripu and the southern of Kallar tower. The paar extends for about $6\frac{1}{2}$ miles from north to south, and $4\frac{1}{2}$ miles from east to west, but is not all occupied by pearl oysters. The depths vary from 5 to $8\frac{1}{2}$ fathoms. The paar is usually divided into an eastern, a western, and a connecting southern portion, and in most of the fishery charts since the time of Steuart (1843), these have been combined to form a conventional horse-shoe shape, which, however, does not now correspond at all accurately with the area covered, or likely to be covered, by pearl oysters.

The parts of the paar differ considerably in character, the east and south being more or less sandy, and the west, and especially north-west, more rocky; and the effect of this difference can be traced in the condition and history of the pearl oysters from these parts.

The Cheval Paar has yielded many important fisheries. During the nineteenth century we find that the whole or parts of it were fished in 1804, 1806, 1808, 1809, 1814 (the largest fishery recorded), 1816, 1820, 1829, 1830, 1831, 1836, 1837, 1855, 1857, 1858, 1859, 1863, 1874, 1877, 1880, 1881, 1887, and 1888. In the earliest records the Cheval and Modragam paars are united as the Aripu banks.

West Cheval.—Here the bottom, especially towards the north, is very rocky, with little sand. The depth is mostly about 7 to 8 fathoms. The rock is a compact shelly limestone with some quartz sand cemented to it by carbonate of lime. It is much overgrown by Algæ and Sponges, and the *Sargassum* weed is especially abundant. Bare parts of the rock are of a reddish-yellow colour from ferruginous staining, and it is all much tunnelled by *Clione* and boring Molluscs. Between the long level stretches of rock are smaller sandy tracts, especially towards the south, where the sand is irregular, rising up into little hillocks, amongst which are scattered Nullipore balls and hemispherical Astræid corals. This large extent of rock, some hundreds of acres of continuous hard bottom, offers favourable conditions for the attachment of spat, and the area is notably prolific. During our inspection in March, 1902, Captain Donnan estimated that there were, on the West Cheval, 123 millions of oysters as against 74 millions on the eastern side of the paar. This abundance carries with it, however, the attendant danger of overcrowding as the oysters grow older, and appears to result in a stunted condition and, it may be, disease and wide-spread mortality. The dwarfed state of the oysters on both the North-west Cheval and the Muttuvaratu Paar has been recognised by the divers, and by the Inspectors in their reports, as the "Koddaipakku" variety (see, for example, Sir W. Twynam's "Report"). Captain Donnan remarks, under date 18th March, 1901, "I have noticed on previous occasions that young oysters on the East Cheval grow much larger and quicker than oysters on the West side of the Cheval." We found the average size of a fair sample of oysters from the North-west Cheval to be (March 27th, 1903): $61·50 \times 58·33 \times 26·84$ millims., while the average size from North-east Cheval was $76·05 \times 71·45 \times 31·45$ millims., and the average from Muttuvaratu was

57·54 × 54·00 × 24·42 millims., all being of the same season, from $3\frac{1}{4}$ to $3\frac{3}{4}$ years old. The stunting, although less marked than in the case of the Muttuvaratu Paar, is apparently a permanent characteristic of the North-west Cheval, and is due, we consider, to the conditions which favour an abundant deposit of spat leading afterwards to overcrowding and insufficient food.

The characteristic organisms on the bottom are:—

Sargassum and other Algæ (*Padina* and small Florideæ) in profusion;

Spongionella nigra, and a few Corals such as *Turbinaria cinerascens* and some Astræids; the large red starfish *Pentaceros lincki*, a fine species of *Cidaris* and *Antedon*. Quantities of *Aplysia* were seen, also *Lamellaria*, *Chromodoris*, *Scyllæa* and *Eolids; Pinna* lay flat on the rock in place of being partially buried in sand. The large pinkish Ascidian *Rhabdocynthia rosea* was also present.

East Cheval.—The bottom here consists of fragments of rock embedded in or covered with a few inches of sand. One piece brought up by the divers from the North-East Cheval ($6\frac{1}{2}$ fathoms) was a tabular calcareous mass, 4 feet by 2 feet by 4 or 5 inches thick, upon which about a dozen pearl oysters were attached, distributed as follows:- One end of the block projected above the sand and bore most of the oysters and some small Algæ, &c.; the other end was covered with a thin layer of sand, but had 5 oysters attached, the byssus passing through the sand to join the rock below—several other byssus tufts were also present; finally the middle, lowest, part was more deeply buried in sand and showed no trace of oysters. This case was typical of many "rocks" examined. The block was composed mainly of dead coral, upon which old worn shells and quartz grains had become cemented; partly by deposition of carbonate of lime and partly by incrusting calcareous Algæ, Polyzoa, and Serpulid tubes. The deeper parts showed ferruginous staining, and the cavernous condition of the interior in this and other blocks was due partly to the irregular disposition of the original components now cemented, and partly to boring by *Clione* and Molluscs. While at the north end of the paar the rock seems to be mainly dead coral, a little further south it becomes a grey-green compact grit stone cemented by carbonate of lime and incrusted with Nullipores and Polyzoa.

Over much of the East Cheval sand predominates on the surface, underlaid by rock, at a depth of 6 inches to 2 feet, from which in places corals and other colonies project above the sand. The pearl oysters, in our experience, were fairly evenly distributed, and in quality they proved to be the best of all those examined or fished. They were well-grown and vigorous (fig. 29), and richer in good pearls than any others.

In the sandy parts the pearl oysters are attached through the sand to buried fragments of rock, coral, or any firm substance. Sometimes one oyster is attached to a piece the size of a walnut, and two or three others are fixed to the shell of the first.

On this part of the paar large Algæ are scarce, but there were plenty of small Florideæ, *Padina*, *Laurencia* (boiled into jelly and eaten by the natives), *Poly-*

siphonia, *Corallina*; and a *Caulerpa* straggles through the sand. Amongst the commoner animals were hemispherical Astræid Corals, a small *Fungia* (*F. dentata*,

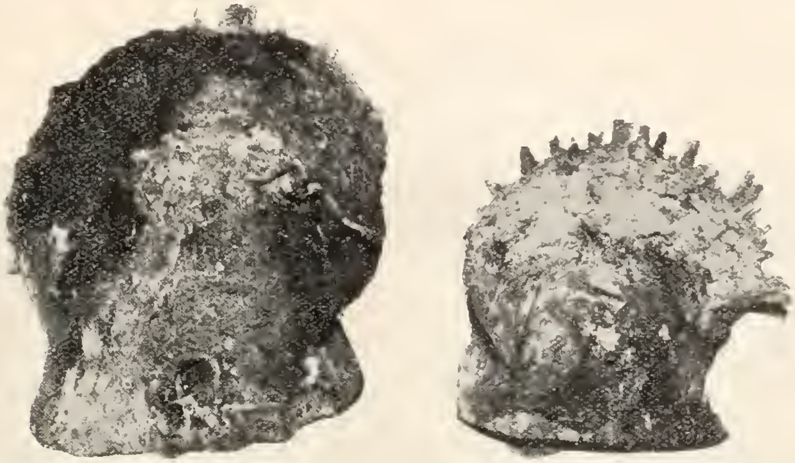


Fig. 29. Pearl-oysters from East Cheval Paar showing growing edges.

young, see fig. 30), a few Holothurians (*H. atra*), and the red *Pentaceros* and very many young *Aplysia*. But the most characteristic animal of this part of the Cheval Paar is the large Hydroid Zoophyte *Campanularia juncea*, which comes up in great bunches not unlike cut "heather," the name by which it has been sometimes indicated in the Inspectors' reports. The sand is largely composed of shell fragments, Nullipores

Fig. 30. *Fungia dentata*, living and expanded specimens from the East Cheval Paar, natural size.—From a photograph by J. HORNELL.

and Foraminifera. Other animals found here were *Spongionella nigra*, *Linckia* sp., orange Gorgonids, and species of *Haliotis*, *Arca*, *Cardium*, and *Turbinella*.

At the south-east corner of the Cheval we found that out of 307 dives 11 brought up adult oysters (7 from rock and 4 from sand), 216 brought up young oysters, 64 were on bare sand and 16 on rock without oysters.

About the middle of the East Cheval there are rocky patches of quartzose gritstone, which are too rugged to be fished by dredging, and yet are crowded with oysters. The few such areas on the pearl-banks might be cleared by divers, or if left unfished would no doubt form valuable breeding reserves.

South Cheval.—Unlike the eastern and western regions to the north, a remarkable uniformity characterises the whole of the southern part. The bottom is very level and is composed of sand and shell gravel, the latter chiefly the broken and worn fragments of pearl-oysters, Pectunculids, and Cockles. Scattered about in great profusion lie also fragments of dead coral, calcareous rock, shell-conglomerate, balls of *Lithothamnion* (fig. 31), from the size of a hazel nut to that of a cricket ball, and dead

Fig. 31. Nullipore ball (*Lithothamnion fruticulosum*) with tags of byssus where pearl-oysters have been attached (to the right), and similar ball still covered with young pearl-oysters (to the left); natural size.

shells. These fragments rarely exceed 6 inches in diameter, but some larger blocks of rock lie buried under the sand. Very rarely, however, is there any sign of extensive rock, such as is seen in the more northern parts of the paar, and none rises above the surface. This, like so much of the ground on the pearl-banks, is excellently suited for dredging over.

The pearl oysters lie for the most part loose on the sand in bunches, each bunch having in its centre one of the fragments of coral, rock, or nullipore. Often one oyster has three or four small stones and shell fragments entangled together in its byssus, while other individuals, usually younger, cling to its valves. There may be any number from 3 or 4 up to 15 or 16 oysters in a bunch. Some of the bunches (fig. 32) are formed of young and old individuals, ranging from 1 month up to nearly 4 years of age, joined together.

Non-calcareous Algæ are scarce here, *Pentaceros* and Holothurians are fairly common, and the Hydroid Zoophyte *Campanularia juncea* is characteristic of the eastern end and extends north along the East Cheval. *Spongionella nigra*, *Fungia dentata*, and Astræid Corals are also common, and a large mass of the delicate Annelid tubes, *Filograna*, was obtained near the shoal buoy. Dead oyster shells are very abundant at the eastern end, and it is here that we find the occasional lumps of shell-conglomerate formed of pearl oyster valves up to 4 years old, shells and casts of

Pectunculids, *Cardium*, *Macra*, *Venus*, &c., cemented together by mere films of carbonate of lime, supplemented in places by patches of *Lithothamnion* and Lepralid Polyzoa. This shell-conglomerate may be ferruginous like the Red Crag Deposits.

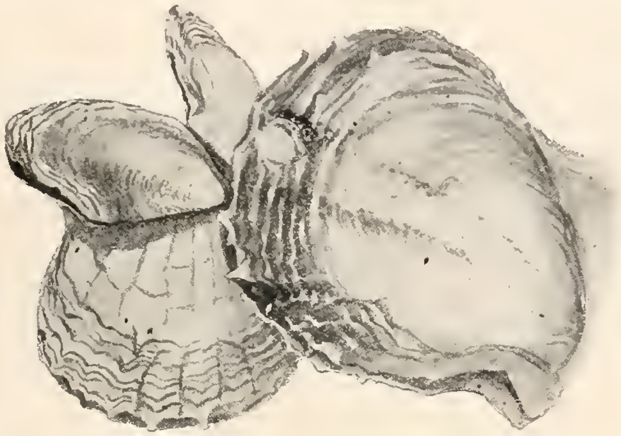


Fig. 32. Four generations of pearl-oysters from the Cheval Paar. The largest is $3\frac{3}{4}$ years old, the next is 18 months, two (above) are 8 months, and one (on the large shell) is about a month old. —From a photograph, March, 1903.

The cup-shaped horny sponge *Phyllospongia holdsworthi* is abundant at the western end, and, though not confined to this region, as has been supposed, is so characteristic that the native divers have named the western part of the bank the Koddai (or "Umbrella") Paar.

A comparison of these different parts of the Cheval Paar shows the great importance of scattered "culch" such as dead coral fragments, Nullipores, and old shells as a basis of attachment for the pearl oysters. The large embayment (fig. 32A) between the East and West Cheval has a bottom of sand, much of which could be made available for oyster cultivation by a system of "culching" with material brought from the beach or from any of the coral patches (Aripu, Kodramallai, &c.) in the neighbourhood. The limits of the paar might also, by the same process, be extended at least half-a-mile further to the east.

Fig. 32A. Proposed culture areas recommended for the Cheval Paar and Periya Paar Kerrai.

Modragam Paar, North.

This paar lies south-east of the central part of the Cheval Paar, at from $\frac{1}{2}$ mile to 1 mile distant, and is nearly 1 mile in diameter. It is about $8\frac{1}{2}$ miles west of Kallar tower. The depth is from $5\frac{3}{4}$ to $6\frac{3}{4}$ fathoms.

The bottom is sandy, ridged and furrowed ; no rock is to be found.

The pearl-oysters are in bunches lying on the sand, chiefly in furrows, each bunch having in its centre some fragment of dead coral, nullipore, calcrete, or other hard substance, to which most of the oysters are attached. In the first four bunches examined the numbers were 10, 8, 21 and 11 respectively. A characteristic feature is the number of barnacles and small rock oysters incrusting the valves.

Caulerpa (? *C. scalpelliformis*) is common here, growing in the sand along with the Phanerogam, *Halophila ovata*, of similar habit.

Amongst the animals noticed were :—*Clypeaster humilis*, *Salmacis bicolor*, *Luidea maculata* and *Pentaceros lincki*.

Captain DONNAN reported that the pearl oysters on this paar were "in great abundance in large clusters" in 1856 and again in 1857. These were fished in 1859 and in 1860. The paar yielded a small fishery in 1877 and a larger one in 1887, and again in 1888, when both Modragams were fished along with the whole of the Cheval Paar. The oysters on this paar are well grown, but seem limited in number for want of a hard bottom for attachment. The benefit of "culching" such a locality as this must be obvious.

MODRAGAM PAAR, SOUTH.

This lies 1 mile south-south-east of the North Modragam, and is about $\frac{1}{2}$ to $\frac{3}{4}$ mile in diameter. It is about 7 miles north-north-west of Kodramallai Point, and has a depth of $5\frac{1}{2}$ to 6 fathoms. The bottom is rocky but very level, and appears to be covered in its entire extent with a thin layer of sand, in which there are many broken shell fragments, especially pearl oysters, *Cardium* and *Pectunculus*. There are some Algæ, but when we examined the paar, very few pearl oysters.

Amongst the characteristic animals are :—the sponges *Axinella donnani* and *Spongionella nigra*, and many Astræid corals—small hemispherical colonies projecting through the sand and apparently attached to underlying rock.

This paar, along with the North Modragam, has usually been fished at the same time as the Cheval, but it apparently yielded important fisheries alone in 1828 and in 1860.

KONDATCHI PAAR.

This lies closer in-shore than the Cheval Paar, and about 1 mile due east of its southern end. It is about 1 mile in diameter, 7 miles off-shore, and has depths of 4 to 5 fathoms.

The greater part of the area is sand. Out of 171 dives 14 only were on rock, 157 on sand. There are occasional little patches of partly buried rock projecting from the smooth sandy surface. This paar is recorded to have only once yielded a fishery—that of 1801. There are now only a few pearl oysters, of mixed sizes, along with *Pinna bicolor*, *Luidea maculata*, and several kinds of *Pentaceros*—one very common species (?) is nearly black in colour, with red tops to the rounded tubercles, another form is grey, and another shows orange blotches and tubercles. Pennatulids, spinous and purple coloured, which had obviously been embedded in the sand, were also brought up. The shells of the pearl oysters were incrusted with small rock oysters (*Ostræa* sp.).

When we saw this bank in March, 1902, it had a crop of pearl oysters estimated at $5\frac{3}{4}$ millions. These had nearly all gone by March, 1903, and it is probable that their disappearance may be accounted for by the very large numbers of starfishes present, especially *Pentaceros lincki* (fig. 33).

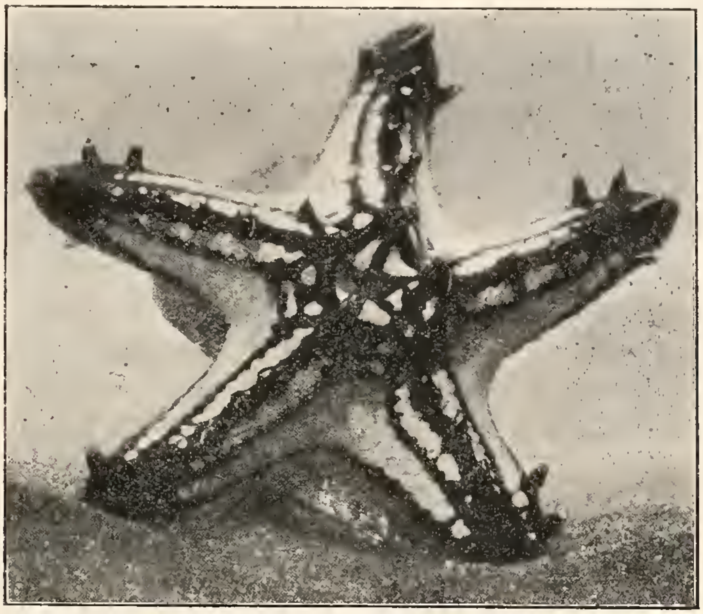


Fig. 33. *Pentaceros lincki*, DE BL., lying on a large pearl-oyster, half natural size.—From a photograph by J. HORNELL.

JAGERBOOM PAAR.

This lies 2 miles south of Kondatchi Paar and about $6\frac{1}{2}$ miles off-shore, opposite Kallar. It is about $1\frac{1}{2}$ miles across and has depths of 4 to $5\frac{1}{2}$ fathoms. The divers brought up pieces of the "rock" bottom, which consisted of rough quartz sand cemented by carbonate of lime, together with fragments of shell.

There are many starfishes (*Pentaceros lincki*) on this paar, as on Kondatchi Paar, and these probably contribute to the mortality of oysters.

An old Dutch "Jagerboom" bank is also marked on the charts about 2 miles south of the West Cheval and outside the Modragams—it is now covered with sand.

KALLATIDEL PAAR.

This little paar lies $1\frac{1}{2}$ miles to the east of the Cheval Paar and is about 7 miles off Aripu. It is nearly 1 mile in diameter and the depth is $5\frac{1}{4}$ fathoms. It is, in its present condition, unimportant.

ARIPU PAAR.

This lies 6 miles due west of Aripu, and 4 miles north-east of the north of the Cheval Paar. It is 1 mile in diameter, and the depth is 4 to 5 fathoms. Some old Dutch paars, marked on the charts as "Aripu," lie close to and outside. They are now covered with sand and are unimportant. About 1 mile further inshore lies Aripu

Coral Reef, round which is a hard patch of nearly 1 mile across, with depths of $2\frac{1}{2}$ to $4\frac{1}{2}$ fathoms. This, although itself unsuitable for oysters, is of value in supplying dead coral fragments, &c., as "culch" to neighbouring grounds. The bottom is level, consisting of sand and shingle lying on a foundation of flat rock. The sand varies from a mere sprinkling to a good depth. There are also some Nullipore balls, coral and shell fragments, and masses of cemented sand. Living corals are more abundant than on any part of East Cheval, no doubt owing to the proximity of the reef.

Amongst the more abundant organisms were :—

Various Algæ (including a *Galaxaura*, a fleshy *Laurencia* and *Halimeda tuna*), *Spongionella nigra*, *Axinella donnani*, *Phyllospongia holdsworthi*, *Turbinaria cinerascens* and *T. crater*, *Sarcophytum* sp., *Pentaceros* sp., *Linckia* sp., and other starfishes, *Holothuria atra* and other species, Ophiuroids and *Palinurus* sp.

The records of important fisheries early in the Nineteenth Century (between 1804 and 1820) on Aripu Paar do not refer to this little patch alone but to the great banks lying "off Aripu," viz., the Cheval and Modragam paars.

When we examined this paar there were comparatively few pearl oysters, but they were of various ages.

Challai Paar.

This little paar lies 5 miles to the east of the Cheval Paar, and about 4 miles south-west of Aripu. It is the nearest paar to land in this region, is about 1 mile in diameter, and $2\frac{1}{2}$ to $4\frac{1}{4}$ fathoms in depth. It does not now support any oysters, and is unimportant.

Periya Paar Kerrai.

This lies about 1 mile north-west of the most northerly point of the East Cheval Paar, and is about 12 miles west of Aripu. It varies from $\frac{1}{2}$ mile to $1\frac{1}{2}$ miles across.

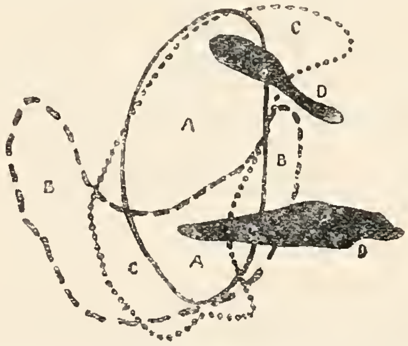


Fig. 34. Plan of the Periya Paar Kerrai. The whole line surrounding A shows the area as inspected in 1882, the dashed line round B shows the paar in 1884, the dotted line round C shows the condition in 1886, while the two black patches indicate the parts fished in 1835 and 1836.

and has depths of from 7 to 9 fathoms. The diagram (fig. 34) shows how the hard area forming the paar has varied in extent and shape from time to time.

The bottom is flat, being a continuous stretch of "rock" overlaid by a thin layer of sand. The samples we obtained were calcretes, largely encrusted with Polyzoa and Nullipores, and some shell conglomerates (fig. 35) formed of casts of the valves of pearl oysters, *Cardium*, *Pectunculus*, *Murex*, and *Cerithium*. Here and there the surface of the rock is exposed and coated by Nullipores and other encrusting organisms, and there pearl oysters (fig. 36, *o.*), or the marks of their byssus (*b.*), are found in quantity. Many crushed valves and broken fragments were also seen, showing that many more pearl oysters had been present lately. We attribute the destruction in this case to the carnivorous fish *Trygon uarnak* browsing over the bottom.

Fig. 35. Shell conglomerate from Periya Paar Kerrai.

Very little coral is present here—a few Astræids only were found. There is some *Sargassum* and a few other Algæ (*Acetabularia*, *Laurencia*, and *Lithothamnion* balls),

Fig. 36. Diagram illustrating the distribution of pearl-oysters and old byssus on "rock" and sand.

some black sponge (*Spongionella nigra*), a few trepang (*Holothuria atra*), and some starfishes (*Pentaceros lincki*). This paar yielded important fisheries in 1833, 1835, 1836, and then was not fished until 1903.

Outer or True Vankali Paar.

This lies 2 miles north-west of Periya Paar Kerrai, and about 14 miles due west of Aripu. It is $1\frac{1}{2}$ miles in diameter and the depth is $6\frac{1}{2}$ to $8\frac{1}{2}$ fathoms.

The bottom is flat "rock" covered with very many dead shells of pearl oysters, and other Mollusca, with comparatively little sand.

Amongst the other animals noticed were:—

Spongionella nigra, Astræids (small colonies), *Juncella juncea*, *Antedon*—black and grey on the Gorgonids, *Psolus* sp., *Balanus* sp. (large), *Galathea comatulorum* (this and a similarly coloured *Myzostomum* were attached to the *Antedon*), *Turbinella rapa*, *Murex regius* and some fishes (Labridæ and species of Balistes).

Inner Vankali Paar.

This lies 6 miles further east and is about 7 miles west of Aripu. It is about $1\frac{1}{2}$ miles in diameter, and the depth varies from 3 to 6 fathoms. This is a patch of rocky bottom, but close outside it are several old paars, named Vankali on the charts, which are now covered with sand.

Young oysters have been found on various occasions on the Vankali paars, but there has never been a fishery. In April, 1862, Mr. Vane reported a large bed of young oysters in this region, covering an extent of 3 miles, but they did not remain.

Anaivelundan Paar.

This is the most northerly paar, and lies $4\frac{1}{2}$ to 5 miles south of Adam's Bridge and nearly 8 miles south-south-west of Talamanaar. It is about $1\frac{1}{2}$ miles in diameter and has depths of 4 to 6 fathoms.

The bottom is composed of level "rock" overlaid with a thin sprinkling of sand. Attached to the rock is found much broad-jointed *Halimeda* (*H. tuna* var. *platydisca*), and also other Algæ, including *Chrysymenia uvaria*, *Udotea flabellata*, *Dictyurus purpurascens*, *Kallymenia perforata* and species of *Laurencia*, *Polysiphonia*, *Corallina*, *Acetabularia*, and quantities of *Sargassum*.

The most characteristic animals of this paar are the corals *Turbinaria cinerascens* and *T. crater*, the so-called elephant's-ear corals, from which the paar takes its native name.

Naddakadda Paar.

This lies $2\frac{1}{2}$ miles east of Anaivelundan Paar and 7 miles south of Talamanaar in Adam's Bridge. It is $1\frac{1}{2}$ miles in diameter, and the depth is $4\frac{1}{2}$ to $5\frac{1}{2}$ fathoms.

The bottom is formed of ridged sand, the underlying rock only showing in a few places. There are some Algæ (*Kallymenia perforata*, &c.) on the bottom, and some *Axinella donnani*, but no coral was found, and no pearl oysters.

The pearl oysters which have sometimes been found on this paar, and are sometimes washed up on the south of Manaar Island, are said to be of a flat shape and to have very few pearls.

To the south of this, and near the north end of the Periya Paar, two old Dutch paars are marked on the charts, which may be either erroneous positions of the Anaivelundan and Naddakadda or may be former paars now covered with sand.

Periya Paar.

This is a very long bank running north-north-west and south-south-east about 16 to 18 miles from land. It is about 11 miles in length and averages $1\frac{1}{2}$ miles in width. It is the paar that lies furthest from the shore, and has only been fished once, and then only the south-eastern part, in 1879. The depth varies over the different parts of the area from $7\frac{1}{2}$ to 13 fathoms, but the greater part of it is about $9\frac{1}{2}$ to 10 fathoms.

The bottom is a few inches of coarse quartz sand covering flat rock. The sand has ridges about 2 feet apart, and has plenty of small "culch," chiefly shells, lying in the hollows. In other parts the rock is exposed and covered with abundance of *Padina* and other Algæ, also Nullipore balls (*Lithothamnion fruticulosum*). The rock is, in the northern part, a fine grained calcareous sandstone much incrusted with Polyzoa, while further south it is a looser, more porous calcrete of a whiter colour.

Amongst the common animals found were :—

Axinella donnani, *Spongionella nigra*, *Petrosia testudinaria*, pink and white mottled Pennatulids, *Heteropsammia*, Astræids and *Turbinaria*, Eunicid worms, *Linckia* sp., *Cassis*, *Pectunculus*, *Arca*, *Chama*, *Venus* and other shells, *Labrus*, *Balistes*, Gobies and other fishes.

Even where the rock is exposed on this paar it would be suitable for dredging over —a matter of great importance, as this is the ground from which the largest supplies of young oysters can be obtained for transplanting to more reliable paars. Some further particulars in regard to this paar will be found in the "Narrative" (p. 76).

The SOUTHERN PAARS form for the most part a single series running north and south parallel with the coast from Negombo to Kodramallai. Off Chilaw, however, they become more extensive and allow of division into an outer paar and several inside it. At the northern end, also, off Karativo Island, the plateau widens, and is occupied by the large and important Muttuvaratu and several smaller paars. The chart of the Southern group (fig. 37) shows the paars from Kodramallai Point down to Navakaddua. The few banks remaining to the south of this (Jokkenpiddi, Oolawitti, and those off Chilaw and Negombo) are too distant to be included in the same figure, and scarcely require separate illustration. Their general position can be seen from fig. 1 and fig. 22, in the "Narrative."

These more southerly paars resemble closely in character the Periya Paar on the outside of the northern group. They are stretches of sea-bottom where the underlying calcrete or modern rock comes to the surface at intervals, or where loose fragments—lumps of calcrete, Nullipore balls, and dead shells—lie upon the surface, forming natural "culch" to which oyster spat can become attached. The exact conditions vary at different points along the coast, and, as might be expected, there are local differences noticeable in the fauna of the paars, which is affected by such factors as differences in depth, degree of exposure, and proximity to inlets of fresh water.

DUTCH MODRAGAM PAAR.

This lies 10 miles due west of Kodramallai Point and about 10 miles south-west of the North and South Modragams, and due north from Karativo Paar. It is $1\frac{1}{2}$ miles in diameter, and varies in depth from 8 to 14 fathoms.

Fig. 37 Chart showing most of the Southern Paars.

The bottom is rocky—a very coarse quartz grit cemented by lime, and with dead coral imbedded in places (*Madrepora*, *Montipora*, &c.). Foraminiferal sand (*Heterostegina*, *Orbitolites*, &c.) is present between the harder parts.

Out of 260 dives, 144 brought up adult pearl oysters, in 7 cases on sand and in 137 on "rock." The remaining dives were 83 on sand and 33 on rock not occupied by oysters. The pearl oysters are not very abundant and look rather stunted, and are overgrown with Leptoclinids, Sponges, small Algæ, and Serpulids; they are very similar to those on the Muttuvaratu Paar. Living *Fungia*, *Manicina*, and a few other corals are found, also *Culcita schmideliana*, *Linckia lævigata*, *Margaritifera margaritifera* (the "black-lip" pearl shell), many fishes, such as *Balistes mitis*, *B. stellatus*, and some Gobies.

This is one of the few paars on which it would be difficult to fish the pearl oyster by means of dredging. The bottom is so uneven and so rough with corals that the nets would be torn to pieces and the frames be broken, unless great care and skill were employed.

This paar is placed a couple of miles further to the north-east in an old Dutch chart. That may either be an erroneous position or may indicate a former patch of hard bottom.

Karativo Paar.

This lies 5 miles due west of the northern end of Karativo Island and 1 mile south of the Dutch Modragam. It is about 1 mile in diameter, and has depths of 8 to 10 fathoms. The bottom is very rocky and uneven, and it is one of the few spots that would be impossible for dredging. The rock is in the form of ledges, steps, or escarpments, with sometimes fully two feet of rise.

Scarcely any pearl oysters were seen, but amongt the few there was a living "black-lip" pearl oyster (*Margaritifera margaritifera*, Linn.). We also noted:—Madrepores, abundant, *Tridacna* sp., *Psolus* sp., *Asterias* sp., and shoals of Plectognathid fishes.

This paar was fished in 1832, and then again in 1890 and 1891, one day in each during the fishing of the Muttuvaratu Paar.

Alantura Paar (Hamilton's).

The paar lies about 1 mile to the south of Karativo Paar and $4\frac{1}{2}$ to 5 miles off Karativo Island. It is nearly 1 mile in average diameter, and the depth is 8 to 11 fathoms.

The bottom is very even—strewn with quantities of Nullipore fragments and other pieces of "culch," under which is *Heterostegina* and *Orbitolites* sand covering the flat

" rock." There are few attached coral colonies, but very many of a thin brown species of *Flabellum* lying on the sand.

This paar presents an excellent bottom both for the deposit of spat and also for dredging.

Muttuvaratu Paar (Donnan's).

This lies 5 miles west of Karativo Island and 3 to 4 miles south of Hamilton's Alantura Paar. It is $2\frac{1}{2}$ miles long (north to south) and $1\frac{1}{2}$ miles wide (east to west). The depth is 5 to 10, mostly 7 to 8 fathoms. On the whole it has a level hard bottom, and any little sand present is Foraminiferal. Of 289 dives, all were upon " rock," and 238 yielded adult oysters. Only the dives to the west part, in deeper water (fig. 39, A), were unproductive. This paar was covered, when we examined it, with plenty of pearl oysters, which are small for their presumed age, but thick, and with little or no signs of rapid or recent growth on the margins.

Oysters on this paar are rather characteristically associated with corals of the genera *Madrepora*, *Porites*, *Pocillopora*, *Montipora*, *Favia* and *Goniastrea*, growing upon the left valves which always lie uppermost in the usual position of the oyster (fig. 38). Some specimens are much overgrown with Polyzoa, sponges, &c. The

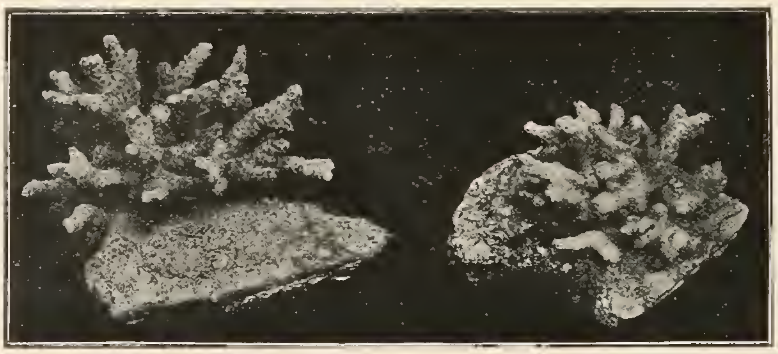


Fig. 38. Old pearl-oysters from the Muttuvaratu Paar, with large Madrepore Corals growing on the shell—half natural size.

oysters are also notably stunted in appearance, and their small size, compared with oysters of the same age from Cheval Paar, is well known, and has been recognised by various writers.

We found the specific gravity of the sea to be unusually low in this neighbourhood (1·0208, at a temperature of 85° F.). This may be due to proximity to the mouth of Putlam Lake, which probably discharges a considerable amount of fresh water derived from the Kala Oya and the Mi Oya Rivers. The bottom on this paar is flat " rock " with many small colonies of *Astræa*, *Cœloria*, and allied low-growing corals, with occasional bushes of large branched Madrepores, such as *M. cervicornis* and *M. cytherea*, rising to 18 inches or 2 feet in height. The pearl oysters on this paar in March, 1903, were "incredibly numerous, thousands in sight, crowding and even hiding the rock to which they anchor. One had to trample on them as one walked—no vacant spots to put the feet." Mr. HORNELL estimated them at about 125 adult oysters to the square yard. Captain DONNAN'S estimate in March, 1902, was 277 millions for the whole paar. This number has probably been greatly reduced since by disease. Fig. 39 gives some idea of the number and distribution of oysters in November, 1902.

Balistes stellatus, the file fish, seemed, during the inspection, to be very abundant on this paar, much more so than in the Cheval district. Many were seen in the water, and the boat's crew caught six in a quarter of an hour. It is interesting to note, in

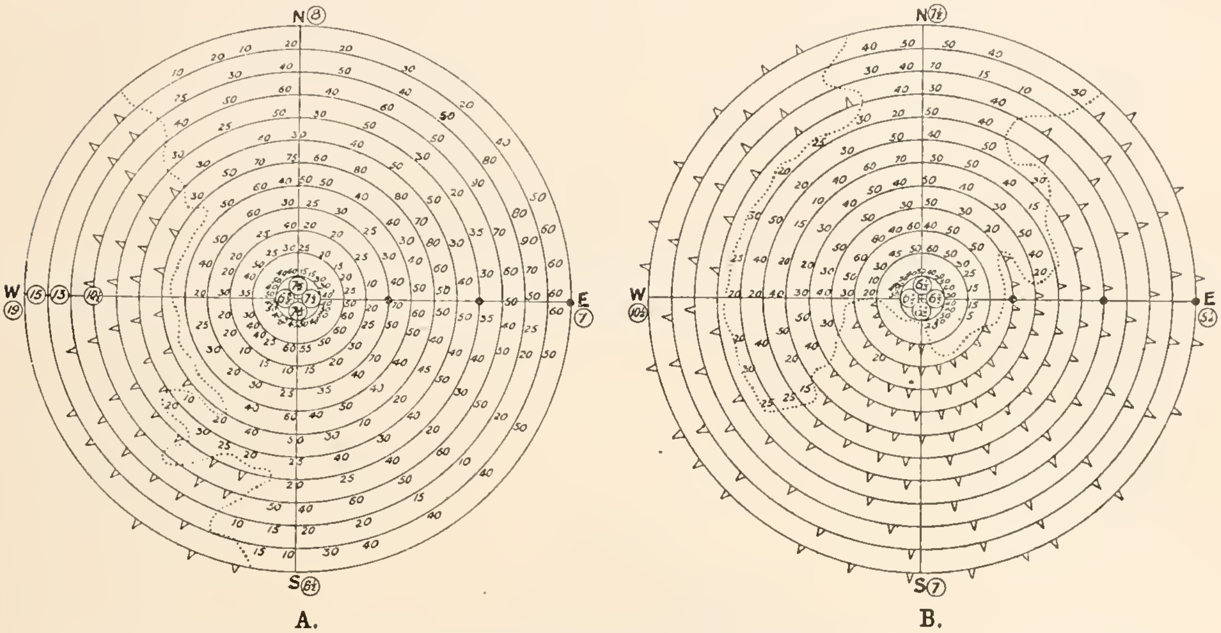


Fig. 39. Inspection charts of (A) northern and (B) southern parts of Muttuvaratu Paar in November, 1902. There are four concentric circles made by the divers' boats between the centre and the ¼-mile buoy, four between that and the ½-mile buoy, and four from that to the ¾-mile. Each complete area is therefore 1½ mile in diameter. The numbers enclosed in rings indicate depths in fathoms. The numbers on the concentric circles give the quantities of oysters brought up at a dive on that spot. The cones indicate dives on a rocky bottom with no oysters. The dotted line therefore surrounds the oyster-bearing area.

connection with this abundance of *Balistes*, that the oysters examined here are infested with Tetrarhynchus cysts to a much greater degree than those from any other bank.

This paar is essentially a rocky bank, well adapted for the deposit of spat, but less suitable than the Cheval Paar for rearing adult well-grown healthy oysters. It is the same type of paar as the Dutch Modragam and the Karativo. Amongst the other animals seen were the sponge *Phyllospongia holdsworthi*, the starfishes *Pentaceros lincki*, *Nardoa tuberculata*, *Ophiocoma scolopendrina* and *Linckia lævigata*, various living corals (*Turbinaria*, *Montipora*), *Sarcophytum*, *Socarnes schmardæ*, *Tridacna* sp., and *Arca* sp.

This paar yielded important fisheries in 1889, 1890, and 1891, the last being one of the most valuable fisheries that has ever been held, over 44 million oysters being fished at a return to Government of over 963,000 rupees. The bank had never been recorded as fished before 1889, and it is said that it was unknown to the Dutch in 1757, although we believe we have evidence that it was the source of fisheries in earlier Portuguese times. Captain DONNAN says that a bed of oysters died on this paar unfished in 1860; another bed disappeared in 1899.

To the north and east of the paar proper, in 7 to 8 fathoms, we found a hard and in some places rough bottom with plenty of "rock" and other hard fragments which would serve as "culch" for oysters. In places there are large branching Madrepores and great vase-like elephants-ear corals (*Turbinaria*); also *Phyllospongia holdsworthi* and other sponges. While the greater part of the ground, like the Cheval, the Modragams and the Periya Paar could be readily worked with the dredge, there are certain parts of this paar and the neighbouring ground which are unsuitable for dredging, and would, if that method of obtaining the pearl oysters were adopted to the exclusion of diving, form valuable preserves where the necessary stock of breeding oysters might remain undisturbed.

There is a diseased condition that the Muttuvaratu pearl oysters seem liable to, in which the body is stunted and shrunken, and the mantle and other tissues become of a markedly opaque yellow colour. This yellow condition has been noticed in the past by Sir W. TWYNAM and by Captain DONNAN. We found some affected specimens during our first cruise in the "Lady Havelock" in February, 1902, and others on every occasion when the bank has been visited since. On 14th April, 1903, out of 227 oysters examined, 25 were affected with the yellow disease, over 11 per cent. This condition, which seems to cause considerable mortality amongst adult oysters, will be discussed in the account of our laboratory work later on in the Report.

HAMILTON'S MUTTUVARATU PAAR.

This bank lies 2 miles south-east of HAMILTON'S Alantura Paar and $2\frac{1}{2}$ miles off Karativo Island. It is 1 mile in diameter, and the depth is from $4\frac{1}{4}$ to $6\frac{1}{4}$ fathoms. The bottom is irregular, partly rock and partly sand.

There were no oysters, and this paar is unimportant.

MUDALAIKULI PAAR.

This lies 3 to 4 miles south of Muttuvaratu Paar and 1 to 2 miles off Mutwal Island. It consists of two areas, an outer rocky part $1\frac{1}{2}$ mile in diameter and $4\frac{1}{2}$ to 8 fathoms in depth, and an inner more sandy part 1 mile in diameter and from $2\frac{3}{4}$ to 5 fathoms in depth.

This and a few small neighbouring paars are comparatively unimportant. They have not, so far as is known, yielded fisheries, but may bear crops of young oysters and so be of use under a system of cultivation.

Talaivillu Paar.

This lies 1 mile off Talaivillu on Kalpentyn Island, and is $2\frac{1}{2}$ miles from north to south, and 1 mile wide. The depth is from 4 to 9 fathoms, and there is much deeper water just over the outer edge. The bottom of the paar is irregular and rocky.

Navakaddu Paar.

This lies about 9 miles south of Talaivillu, less than 2 miles off shore, and 8 miles due west of Putlam Fort. It is over 2 miles from north to south and 1 mile from east to west. The depth is 4 to 14 fathoms, and the bottom irregular and rocky.

Jokkenpiddi Paar.

Jokkenpiddi Paar is one of the paars lying oft Chilaw. In this region there are many little hard patches known as paars, although they rarely bear oysters. Their exact positions are unimportant, as the whole area is potentially paar-ground.

On the bottom patches of "rock" alternate with sandy areas. Out of 312 dives on the southern part of the paar, 236 were on "rock," and 76 on sand. The samples of hard bottom we obtained consist of coarse quartz sand cemented into masses evidently of recent origin, which may be described as a coarse calcrete (fig. 40),

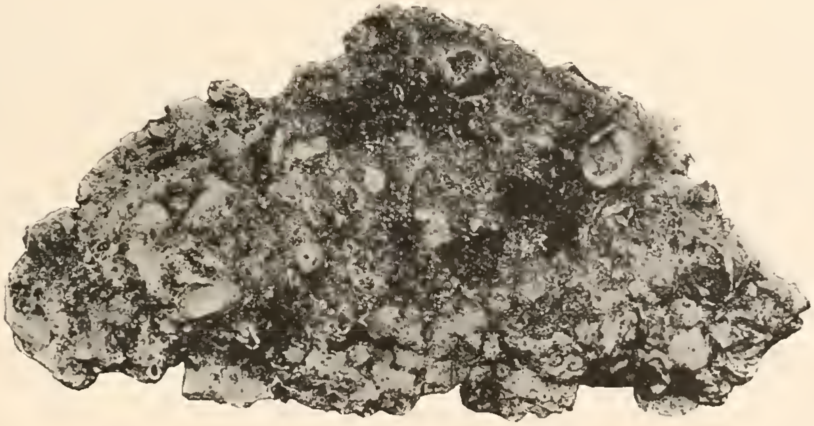


Fig. 40. Lump of calcrete showing large quartz grains and felspars with fragments of coral, shells and worm tubes, along with many Polyzoa colonies. From Jokkenpiddi Paar.

together with blocks of dead and some living coral. All the materials are largely cemented together by colonies of Polyzoa. There are also dark brown ferruginous nodules of phosphates.

We found a plentiful supply of small oysters (1 to 3 months) on some parts of the paar, along with very many dead shells. The living Coral consists of Madrepores and two species of *Turbinaria*. We also noticed :—*Axinella donnani*, *Echinostrephus molare*, *Ophiothrix* sp., *Asterina cepheus*, *Pentaceros lincki*, *Nardoa tuberculata*, *Filigrana* sp., *Trophonia* sp., Serpulids, Sabellaria, Pagurid (scarlet-maroon, hairy) in chank shell, and *Murex regius*, Pearl Oysters, *Avicula*, *Chama*, *Modiola* (suran), and *Vermetus*.

Captain DONNAN reports that a million and a half of large oysters which he found on this paar in April, 1878, had disappeared in the November following. This may become a valuable ground for obtaining a stock for other paars.

CHILAW PAARS.

The outer, largest paar lies about 7 miles off the mouth of the Dedera-oya River, near Chilaw, and is over 8 miles in length and about 2 miles in average breadth. It has a depth of 8 to 9½ fathoms.

The bottom is sand and masses of calcareous sandstone, which may be described as a medium-grained calcrete, with a few larger quartz grains up to ¾ inch diameter.

We found considerable quantities of small pearl oysters (6 months old) in large clusters, attached to one another by byssus and lying on sand, when not attached to the cemented masses. Amongst other animals found were :—Branched Gorgonids, with specimens of *Avicula radiata*, *Salmacis dussumieri*, and a species of *Hesione*.

A large supply of young oysters found here by Captain DONNAN in April, 1875, gradually disappeared during the next three years. Although there have been no fisheries on the Chilaw Paars during recent years, they yielded important fisheries in the past (1803, 1815, and 1884), and there seems no reason why a crop of pearl oysters should not mature upon them at any time. We have evidence* that the Pearl Fisheries controlled by the Singhalese Kings of Kandy were those lying off Negombo and Chilaw, while those of Manaar and Aripu were in the hands of the Tamil Kings of Jaffnapatam.

There are also several smaller paars off Chilaw lying nearer the shore, about 3 or 4 miles off land, and averaging about 1 mile each in diameter; and two further out north-east of the large paar and about 5 miles off-shore; in addition, many other hard patches in this neighbourhood are named as paars by the natives. In fact, there is a good deal of ground here that might at any time become a "paar" and bear crops of pearl oysters.

KARKOPANNI PAAR.

This paar lies off Karkopanni, to the North of Chilaw, about 3 miles off-shore, and at a depth of 7½ fathoms. The bottom is rock and sand intermingled, the latter

* From the Singhalese poem, 'Kovul Sandésaya' (about 1460), and IBU BATUTA'S 'Travels' (1344), and also various Dutch records of the eighteenth century. These have been searched by Mr. HORNELL, who expresses his indebtedness to Mr. P. E. PIERIS, C.C.S., for translations from the Singhalese.

greatly predominating. Only a few pearl oysters were found, on the small patches of rock, when we examined the ground.

The sand here is a coarse, yellow quartz sand, and the "rock" is a coarse, calcareous sandstone—or calcrete—the large quartz grains, up to an inch in length, being apparently embedded in a matrix of carbonate of lime. There are dark, ochreous patches in places. Out of 187 dives, 140 were on sand and 47 on rock.

Scarcely any living Coral was seen, and no Algæ; amongst the commoner animals were:—Branched Gorgonids and Hydroids, Terebellids (many, large), *Arca* sp., *Avicula radiata* (on Gorgonids), and *Leptoclinum* sp.

Oolawitti Paar.

This lies about 8 miles north of Negombo, at a depth of $7\frac{1}{2}$ to $8\frac{1}{2}$ fathoms. On the bottom coarse, yellow quartz sand predominates; but there is "rock" in patches, and there some small (6 months) pearl oysters were found.

The "rock" is consolidated sand, of a dark brown colour, as if iron were present in the cementing material. Mr. Lomas describes it as a "reddish-brown calcrete with the sand rather loosely united."

On these masses, and penetrating them, are found upright, branched, tough leathery tubes in abundance. Professor M'Intosh, in the "Challenger" Report on the Polychæta, figures a similar tube from the Gulf of Manaar, and states his belief that it will prove to be the home of a Eunicid. Mr. Hornell has been able to establish the correctness of this suggestion, as he has removed two fine Eunicids* from these tubes.

Negombo Paar.

This lies off Negombo, about 3 miles off-shore, at a depth of 8 to 9 fathoms. The bottom is sand and patches of "rock" (reddish-brown blocks of calcrete), exactly similar to that of the Oolawitti Paar. The oysters present when we examined the paar were probably from 2 to 6 months old, and were mostly attached to the rock, some in clusters on the sand. They were in considerable abundance.

There is another small paar, south of Negombo, which was found by Captain Donnan in 1901. It is similar in character to the Oolawitti Paar. Neither of these Negombo Paars, however, corresponds to the spot off Negombo where we dredged up young pearl oysters from the "Lady Havelock" in February, 1902. Mr. Hornell, who has been examining the early charts, is of opinion that the "Lady Havelock" paar is the original Oolawitti Paar. That does not matter much. What is of real importance, is to recognise that there are a number of small, more or less hard areas in the shifting sand, on which from time to time "strikes" of young oysters may make their appearance, and may possibly grow to maturity, but more usually become thinned out by their natural enemies or overwhelmed by sand. These small paars

* To be described in Mr. Hornell's Report on the Polychæta, in a later Part.

close to the deep water are evidently unreliable, and yet may be made use of in cultivation, and have probably in the past, on occasions, borne a crop of mature oysters.

The history of the Pearl Fisheries in the past, especially during the nineteenth century, has shown that :—

(1.) Some of these paars, such as Jagerboom, Kallatidal, Aripu, Anaivelundan, and others, are practically worthless from an economic point of view.

(2.) Some, such as the Periya Paar, might be used as most valuable sources of supply of young brood oysters for transplantation; but cannot be relied upon to produce an adult stock suitable for fishing.

(3.) Some, such as the great Cheval Paar, with its various sub-divisions, and the North and South Modragams, the Periya Paar Kerrai, and the Muttuvaratu Paar, are very valuable and reliable grounds upon which most of the successful fisheries of the past century have taken place. Others, such as those off Chilaw and Karativo, are less reliable, but may be valuable on occasions.

It became clear to us during our work on the "Lady Havelock," when we began to understand why it is that the Periya Paar is unreliable and the Cheval so much more satisfactory, that the main hope of introducing constancy of result and a regular succession of fisheries must rest upon a system of transplanting young strikes or broods of oysters when they make their appearance upon useless or unreliable paars, to wherever there is room for them at the time upon ground where we know they will have a better chance of living and growing to maturity.

This raises the whole question of the causes of death of the Pearl Oyster, the reasons of the intermittence in the history of the fisheries, and the conditions which render some paars more reliable than others. As we propose to have a section later on dealing with our observations and experiments on the Pearl Oyster and ending with our Recommendations, into which these matters will naturally fall, it will be sufficient here to give the following summary of our results :—

(1.) The most important agent in causing wide-spread death of Pearl Oysters, both young and old, in the Gulf of Manaar, is the shifting of sand due to the strong currents, to the south-west monsoon, and no doubt occasionally to exceptional storms. We obtained a good deal of evidence as to the manner in which the sand is carried about and piled up by the currents, and is churned up in places by the heavy seas at the time of the south-west monsoon, and we made observations as to the effect of burying oysters of different sizes in various amounts of sand. The successive broods which have appeared and as regularly disappeared upon the Periya Paar during the last quarter-century have, there can be no doubt, been overwhelmed by the bottom currents caused by the monsoon upon the bank which faces the deep water of the Indian Ocean.

(2.) Next in importance come, we consider, the ravages of natural enemies—the most destructive of which are :—

(*a.*) Voracious fishes—chiefly Rays (*Trygon uarnak*) and File-fishes (*Balistes mitis* and *B. stellatus*) ;
(*b.*) Boring Molluscs—chiefly *Sistrum spectrum* and *Pinaxia coronata*, along with species of *Nassa*, *Murex*, *Purpura* and *Turbinella;*
(*c.*) The boring sponge *Clione indica;*
(*d.*) Boring worms (*Leucodore*) ;
(*e.*) Star-fishes—chiefly *Pentaceros* and *Luidea;*
(*f.*) Smothering Mollusca—such as *Modiola barbata*, the "Suran," which weaves nests and other entanglements around masses of young oysters, and may, when present in quantity, cause serious mortality.

(3.) There are still three other causes of death that require mention, and may on occasions be serious, perhaps disastrous, viz. :—

(*a.*) *Overcrowding.*—The older are sometimes buried in masses of younger ones. The young are often piled together in such profusion as to interfere with each other's nutrition and growth. Thinning out must and does take place. If it were done artificially all or nearly all might be preserved ; if we leave it to be effected naturally by survival of the fittest the survivors may be very few indeed ;
(*b.*) *Disease* due to the invasion of parasites—either (1) worm parasites, which are moderately large and usually not very numerous, and which, unless abnormally abundant, do little harm ; or (2) the more minute Protozoon parasites, which may be present in enormous quantities and probably cause epidemic diseases ;
(*c.*) *Overfishing.*—That is, the exhaustion of the breeding stock of the district at a time when no further supplies of young in the larval stages were being brought by currents from neighbouring grounds. This will comparatively rarely happen, and is only likely to be serious during the last year of a series of fisheries. So long as there are three and four-year old oysters on adjoining paars which will be fished in the two succeeding years, it is safe to take every older oyster that can be got off the ground, as those coming on, although not yet ready to fish, are sexually mature and may be relied upon to supply spat ; but in the final year of a series, when no further mature oysters remain for future years, it is important to leave a sufficient stock for breeding purposes.

In the future, however, if transplanting is adopted, it may be expected that such a state of affairs as the last fishery of a series with no younger oysters growing up in the neighbourhood will be very unlikely to recur.

OBSERVATIONS ON THE SEA AROUND CEYLON, AND ESPECIALLY IN THE GULF OF MANAAR.

Although we were not prepared to make detailed physical observations on the sea-water, as I had not considered that necessary for our purpose, we kept a daily record of such approximate temperatures and densities as we could obtain with ordinary laboratory thermometers and hydrometers, sufficient to enable us to compare localities and seasons. During the cruises of the "Lady Havelock" the temperature and specific gravity were taken twice daily, in the morning after we had started the dredging operations—generally at 7 A.M.—and in the evening when work was finished, about 7 P.M. After I left, Mr. Hornell continued the records at Galle, and on occasions at Trincomalee and in the Gulf of Manaar, and took the observations once daily, between 8 and 10 in the morning, generally at 8.30. We also took all opportunities of making such observations as were possible on the surface drift of the sea, and obtained such information as we could as to prevailing currents at different seasons, as these movements of the water must be of great importance in connection with the distribution of the young pearl oysters.

During the period (January to April, 1902) of the two cruises in the "Lady Havelock" and our first inspection of the pearl banks, the sea temperature was steadily rising. At the beginning of the time, in the Gulf of Manaar, it was about 77° F., in February it averaged 79° F., in March 84° F., and in April 86° F. The specific gravity was nearly constant at 1·0230 in the Gulf of Manaar, while at Trincomalee, in February, it was lower—varying from 1·017 to 1·020.

In July, 1902, the sea temperature at Galle ran up to 86° F., and the specific gravity was constant at 1·0236. Mr. Hornell found that the temperature of the water in our shaded aquarium tanks was considerably lower (say 3° F.) than that of the sea outside.

In August the temperature of the water in our aquarium reservoir, taken at 8 A.M., ranged from 78° F. to 82° F., the average being 80·37° F.

In September the temperatures were taken in the open water at the jetty and ranged from 81·5° F. to 85° F., and the specific gravity from 1·0216 to 1·0220.

In October the temperature at Galle jetty fell from 86° F. to 82·5° F.; at Trincomalee the range was 84° F. to 89·5° F., and in Tamblegam Lake 87° F. to 90° F.

In November Mr. Hornell was again on the pearl banks and found that the sea temperatures ranged from 83° F. to 85° F., and the specific gravity from 1·0200 to 1·0227. At Galle jetty at the end of the month the sea temperature was 85° F.

In December, at Galle jetty, the sea temperature was nearly always at 84·5° F., the extremes in range being only 83·5° F. and 85° F.

In January, 1903, at Galle jetty, the range was from 82° F. to 84¼° F., and the specific gravity was close on 1·022. At the end of the month, in the Gulf of Manaar, the sea temperature was 82° F., and the specific gravity slightly above 1·023.

In February, on the pearl banks, the sea temperatures ranged from $80\frac{3}{4}$° F. to $84\frac{3}{4}$° F., and the specific gravities from 1·0229 to 1·0239.

In March, in the same locality, the temperature rose from 83° F. to $86\frac{1}{2}$° F., while the specific gravities lay between 1·0228 and 1·0234.

Finally, in April, in the same locality, the temperature rose from 86° F. to 88° F., while the specific gravity was very constant at 1·0228.

These observations, extending over 15 months, show a range of only 13° F. in the year, 77° F. to 90° F., for the seas around Ceylon; while in the Gulf of Manaar the lowest and highest recorded temperatures are 77° F. and 88° F. THURSTON found the temperature at Rameswaram in July, 1888, to vary from 79° F. to 91° F.

The specific gravity in the Gulf of Manaar is fairly constant at about 1·023, except at occasional spots; off Chilaw, on 22nd November, 1903, it was 1·0194, and on the Muttuvaratu Paar in the same month it varied about 1·0200; while at Galle it is rather lower than the Gulf of Manaar, averaging 1·022, and at Trincomalee it is lower still, 1·019, and at Tamblegam goes down to 1·015.

Further exact knowledge as to the movements of the water over the pearl banks in the Gulf of Manaar is urgently needed. On the "Lady Havelock" we had neither the means nor the time necessary for undertaking this investigation. It is probably the most important matter still requiring settlement, involving as it does the normal distribution of pearl-oyster spat. Till we know more accurately how the surface-drift acts at the chief spatting seasons, we cannot be certain of the source of supply to particular beds, or of the destiny of the larvæ produced from our adult oysters. We have not yet the means of arriving at conclusions as to the conditions of wind and weather which are required in order to constitute a favourable spatting season for the replenishment of say the Periya Paar or the Inner Vankali Paar, where young oysters frequently appear. Nor are we able to say with certainty whether the Cheval Paar supplies the Muttuvaratu, or the southern paars replenish the northern, or whether there is any definite relation as to spat-supply between the Ceylon pearl banks as a whole and those off Tuticorin on the Indian Coast.

We know that there is a general drift of the water over the banks from south to north from about the end of April to the end of September, and from north to south during the height of the north-east monsoon, with intermediate periods of calms and variable winds from February to April and usually again in November. Now it is essential that we should have more definite knowledge as to the resulting surface-drifts in these periods of variable winds between the monsoons, for it is during November and in March and April that the chief spatting seasons of the pearl oyster occur. Information in regard to the stronger and more constant currents which may be sufficient for the purposes of navigation will not suffice for fisheries purposes. We require to know where floating bodies, liberated at certain spots under known conditions, will drift to during given periods of days at different seasons; and this can only be ascertained by systematic "drift-bottle" experiments such as have recently been made for fisheries purposes in several European seas (see, *e.g.*, 'Fishes and Fisheries of the Irish Sea,' by HERDMAN and DAWSON, London, 1902, p. 7). Moreover, it is only after such work has been carried on systematically for two or three years at least, that it will be possible to determine the course taken by the larval pearl oysters between the time of hatching and the deposit of spat, and again between the attachment to floating Algæ and the appearance as young oysters on a paar. These are details which it was impossible for us to settle in the time at our disposal in 1902, but which will naturally, in the future, form an important part of the work of a marine biologist resident in Ceylon.

Our inspection barque "Sultan Iskander" towing the divers' boats to a new position.

OBSERVATIONS AND EXPERIMENTS ON THE LIFE-HISTORY AND HABITS OF THE PEARL OYSTER.

I. Determination of Sex.

At an early date in the investigation it became clear that the pearl oyster is diœcious or of one sex only—whether permanently so or only temporarily was a matter that could not be settled in one season, but which Mr. Hornell determined later on in the Galle laboratory. The dissections made during the cruises of the "Lady Havelock" in the Gulf of Manaar and in Trincomalee showed that each mature individual functions as male or female only. In no cases were even stray ova found in the gonads that were determined as male, nor any spermatozoa in the females—although such traces of hermaphroditism were carefully looked for.

In the Gulf of Manaar, during February and March, 1902, our dissections showed a considerable preponderance of males over females, and further work by Mr. Hornell at Galle showed the same disproportion, to the extent of about 10 per cent. of the total number examined, during other parts of the year. We have several lists, of which the following may be taken as a sample. Here out of 210 oysters from four distinct localities the sex of 158 was determined, 87 being male and 71 female—the remainder were indeterminable owing either to immaturity or their spent condition.

Date.	Males.	Females.	Spent or immature.	Locality.
16 October, 1902 . . .	13	9	4	Trincomalee.
5 November, ,, . . .	13	13	4	Cheval Paar.
6 ,, ,, . . .	9	4	2	,, ,,
6 ,, ,, . . .	5	3	—	,, ,,
7 ,, ,, . . .	6	9	1	,, ,,
9 ,, ,, . . .	5	3	2	Periya Paar Kerrai.
11 ,, ,, . . .	4	6	10	Cheval Paar.
12 ,, ,, . . .	7	6	7	,, ,,
14 ,, ,, . . .	4	4	8	,, ,,
15 ,, ,, . . .	18	9	4	,, ,,
18 ,, ,, . . .	3	5	10	Dutch Modragam.
Totals	87	71	52	

The further question—the permanence of the sexual condition—was one of those points which could only be settled in a marine laboratory, where the animals could be kept under observation from season to season, and formed a part of the work which I left Mr. Hornell to settle at Galle.

On May 17th, 1902, four of the pearl oysters in our aquarium were found to be emitting sexual elements, three being determined as males and one as female. They were marked individually and put in a separate tank, and later in a cage suspended from a buoy in the bay. On September 23rd two of these verified males were brought into the laboratory and both proved, on dissection (October 1st), to be still in the male condition. Over four months had elapsed since the end of the observed emission of sperms, and the gonads had filled up again for the next breeding season. The larger individual especially showed vigorous growth in all parts, the shell had increased from $\frac{1}{4}$ to $\frac{5}{16}$ inch, in addition to a great development of marginal processes. The gonad was fully developed, creamy yellow in colour, and swollen with active spermatozoa. The two remaining verified individuals were brought in and dissected on October 3rd, and were found after the $4\frac{1}{2}$ months' interval to be still of their respective sexes. The male contained ripe spermatozoa, and the female had the gonad large and swollen with ova in exactly the same condition as those emitted in May. Spawning might have taken place within a day or two had they lived.

Mr. Hornell has observed the natural emission of the eggs in a $2\frac{1}{2}$ years old pearl oyster living healthily in the aquarium tanks of the Galle Laboratory. He was also able, by pouring some of the sea-water charged with freshly laid ova into a tank containing other pearl oysters, to stimulate three ripe males to discharge spermatozoa. The first male commenced within two minutes of the addition of the ova to the tank, and while the stream issued as a milky cloud from the exhalent orifice the animal at intervals snapped its valves together several times, thus effectively dispersing the spermatozoa through the water. One minute after the first a second male commenced to spout and continued to pour out a stream for six minutes. After an hour's interval it re-commenced for four minutes, followed by occasional puffs for nearly half an hour, when the emission ceased finally. The third male became active some hours later, but all proceeded in a similar manner.

These observations show that the ova are extruded direct from the oviducts, by means of the supra-branchial passage, to the sea. They do not pass any time within or upon the gills—and do not undergo fertilization within the parent. The development of the larva takes place entirely in the sea.

II. Embryology and Early Life-History.

We tried artificial fertilization on several occasions, and although we have not yet reared the pearl oyster from the egg to a young shelled Mollusc that would be recognised by the divers, still we have had, in our tanks and under our microscopes, all stages from the fertilized ovum to free-swimming larvæ, similar to those we caught in the tow-net on the pearl banks, and which again we traced into the attached spat on the Algæ. So that we have seen, either in our experimental tanks or in collections from the sea, every stage from the egg to the adult pearl oyster. Mr. HORNELL has made a careful study of the young stages as observed by him at Galle in May, 1902, but as we hope to get still further details, the full account of the embryology will be given later on in this report. It will suffice to state now that the ovum when extruded is pyriform and floats, after fertilization it becomes spherical. The segmentation is complete but unequal, and within 2 hours results in an embryo of one large macromere and six micromeres. After 4 hours, segmentation was completed and the embryos were swimming freely by means of cilia, while about 20 hours after fertilization they were in the trochosphere stage, with a well-marked pre-equatorial band of long cilia, an apical pre-oral tuft and a patch or circlet of cilia at the opposite pole. As the body elongates, the equatorial band moves further and further forwards and becomes a pre-oral circlet, most strongly marked along the anterior margin which becomes the velum. Towards the end of the second day the larva is a veliger, and the shell has commenced to form posteriorly. On the third day the velum was considerably reduced in size and the bipartite shell increased, and this brought the larva to a stage corresponding with the forms we caught in our tow-nets, which bridged over the gap between the latest stage reared from the egg in the tanks and the earliest attached stage or "spat."

From a consideration of the sizes of the free-swimming larvæ and the youngest spat, and knowing the age at which the veliger obtains a shell, we are of opinion that attachment may be made within five days of fertilization. At the same time, from the large size of some of the free-swimming larvæ, it is probable that under certain circumstances, such as the absence of suitable areas for attachment, the period of free-swimming existence may be considerably extended.

One of the earliest free-swimming stages was taken in the tow-net on February 2nd, 1903, on Modragam Paar. It shows some slight advance upon the oldest stage reared in the Galle Laboratory, as rudiments of three branchial filaments and of the otocysts are present. Otherwise, in the form of the shell, the large size of the velum and the sub-central position of the digestive gland the two agree. The digestive gland is yellowish and granular, the cells being filled with large oil-globules.

In the same haul numbers of an older stage (fig. 41, I.), nearly twice the diameter of the last, were also present. In these the shell had developed prominent umbones placed equidistant from the two ends. A few more branchial filaments had appeared and the velum was relatively smaller. The digestive gland is now conspicuously two-lobed, and by great increase in size has come to occupy the interior of the umbones dorsally as well as extending ventrally beyond the plane of the otocysts. The rudiment of the adductor muscle at the anterior end was also visible.

A fortnight later (16th February), while on the Cheval Paar, in plankton taken between 8 A.M. and noon, we obtained a great multitude of shelled larvæ, many of which were in a later stage. The shell-valves showed for the first time a slight asymmetry, the anterior end being now rather sharper than the posterior (fig. 41, II.). The velum was greatly reduced, occupying only a comparatively small space between the anterior adductor muscle and the anterior margin of the gills. The gill filaments were 6 to 7 in number and of larger size. A posterior adductor muscle was also present, and the digestive gland, still markedly two-lobed, had increased in size. In

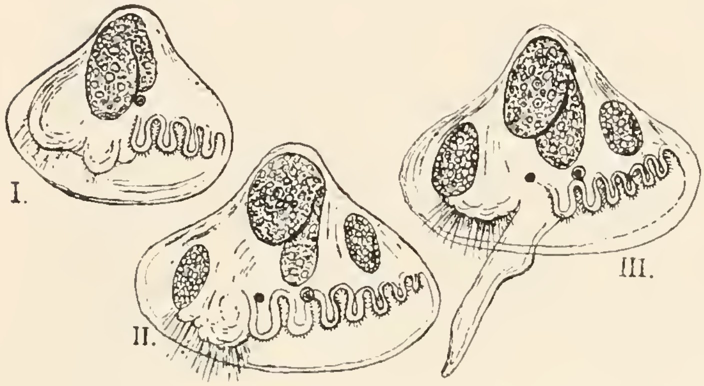


Fig. 41. Free-swimming larval stages of pearl-oyster caught in the tow-net. I. has the ciliated velum retracted. II. and III. show the stage at which the larva becomes attached to Algæ. III. has the mobile foot extended.

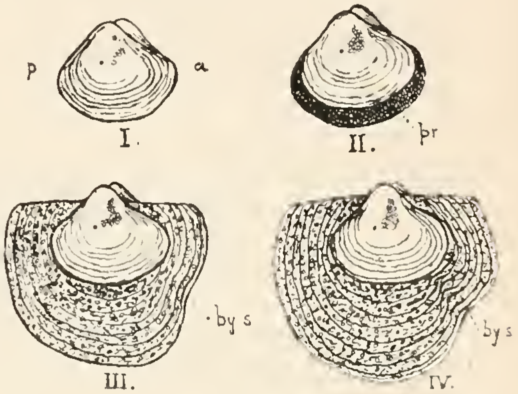


Fig. 42. Stages in the growth of the shell after the attachment of the larva. I. is identical with the latest free-swimming stage; *a*, anterior, *p*, posterior end. II. shows the first formation of prismatic shell (*pr.*). III. and IV. show the change in shape and the byssal sinus (*by. s.*).

several of these larvæ the foot was prominent and active, being frequently protruded and moved about in a tactile manner; a distinct prominence (the byssal gland) is seen about the middle of the posterior edge (fig. 41, III.). The otocysts lie close to the base of the foot, and each is a large clear sac containing 6 to 9 tiny otoliths which were in constant vibratory motion. The shell is still clear and transparent, with no pigment and no sign as yet of prismatic structure.

From this stage, ready to make attachment, we pass to the earliest attached stage ("spat"), where the little Mollusc begins to form shell layers of a different character.

Our youngest spat was found clinging to the Hydroid Zoophyte *Campanularia juncea*, in November, and later stages, still very young, on the Algæ *Hypnea musciformis* and species of *Sargassum*, *Cladophora* and *Polysiphonia* on the Cheval Paar in February and March, 1902. The smallest stage, 0·1 millim. in antero-posterior extent, is identical with the oldest free stage referred to above, and is presumably just attached. From this to a shell length of 0·175, increase is effected by marginal additions which are clear and transparent like the larval shell. These additions show, however, faint circumferential lines, but no prismatic appearance (fig. 42, I.). The dark digestive gland shows conspicuously in the umbonal region, and the rows of branchial filaments are also visible through the thin shell.

After a size of about 0·175 is reached, prismatic shell substance begins to be deposited marginally, as seen in fig. 42, II., III., IV. The embryonic shell persists, but the shape of the valve changes to one which is recognisable as the adult type. The umbones become less prominent, and, as a result of the asymmetrical marginal growth, become more anterior in position. Even at this early period the byssal sinus (*by.s.*, fig. 42) is recognisable, and a very delicate byssus can be seen anchoring the little Mollusc. If the spat be attached, as the young stages, in our experience, generally are, to floating—or for a time rooted—Algæ, they seek the under, shady, side of the branches, and sooner or later drop off and sink to the bottom, being dislodged either by shaking or by the disintegration of the floating weed The further history will then depend upon whether they fall upon ground where there is suitable "culch" for attachment, or upon sandy areas where they probably get buried, scoured out, or rasped to pieces by the constant movements of the sand grains. The enormous number of minute shells of the fry or spat of pearl oysters which we found in some sandy deposits indicates the extent of the destruction which is going on, and which might, in part at least, be prevented by artificially increasing the area covered by "culch."

We have also evidence that the ground may vary from year to year in the covering of fine Algæ which it affords for the attachment of the young spat. This is shown by the following observations :—

On the south end of the Cheval Paar, not far from the Shoal buoy, on February 26th, 1902, we hauled up great masses of mostly green delicate Algæ thickly covered with oyster spat. The Algæ proved to be *Hypnea musciformis,* along with a *Cladophora*, a *Ceramium*, and some *Chætomorpha* and *Polysiphonia*, mostly infested with Cyanophyceæ and various microscopic animals. Much the same assemblage of plants, but of a redder colour, was found on the Modragam paars on March 10th, and we also obtained them in smaller amount elsewhere on the pearl banks. In all cases these weeds supported vast quantities of spat. Later on in the season we found masses of the weed detached and floating on the surface. This season, however (1903), Mr. Hornell finds, after a careful examination of the same grounds in a diving suit, that the weed is entirely absent, and that the sand in these localities is bare and shows no spat. This marked difference in the condition of the bottom on two consecutive years throws an interesting light on the factors which may determine on occasions the productivity of a bed, and lends support to our contention that putting "culch" on the bottom at selected spots would lead to an increase in the amount of spat deposited.

III. The Byssus and Locomotion.

Although the formation of the byssus threads comes more appropriately in the section on the Structure of the Pearl Oyster, still the connection of the byssus with fixation, locomotion, and possible migration or transplantation is so close and so important that we shall give here the results of our experiments on the matter.

Kelaart showed, in 1858, that the young pearl oyster can move from place to place, can detach its byssus and can re-attach in a new spot. Sullivan Thomas, in 1886, added some fresh observations on young oysters, about $\frac{1}{2}$ inch in diameter, which he found moved up the smooth side of a glass 4 inches in 8 or 9 minutes. He also made some observations on the byssus, and found that a young oyster, measuring $1\frac{1}{4}$ inches in diameter, withstood steady tension measured with a spring balance till it reached $2\frac{3}{4}$ lbs., when the byssus came away at the root. He adds:—"I conclude that a pearl oyster is not likely to be dislodged by the force of wave action or current, and that, if it moves, it moves voluntarily."*

Some of our observations on the rapid movements of very young pearl oysters—much younger than those dealt with by Kelaart and Thomas—and on the readiness with which they detach and re-attach, were given in the "Narrative" (p. 68), and we have many others, which, however, it is unnecessary to give in detail. But although the very young are thus actively locomotive, it has been doubted, and may still be doubted by some, whether the adult oyster is capable of movement, or even of re-attaching, if the byssus be torn. Our observations settle this point definitely, as the following examples show:—

A $2\frac{1}{2}$ years old pearl oyster, obtained from the Muttuvaratu Paar on April 11th, 1902, had the byssus broken by being torn from its attachment to rock. Two days later it was marked and suspended in a wire-net cage in Galle Harbour under observation. After 3 days it was found to have re-attached to another oyster in the same cage. On May 9th it was removed to a tank in the Biological Station, and the new byssus was then found to be normal, stout-fibred, and of a bronze-green colour. It was then torn across by force, thus breaking the byssal strands, and was placed in a small glass dish sunk in the tank. On May 10th an inch and a half of sand was put over the top of the oyster. On May 11th it had freed the ventral margin of the valves from the sand, and appeared healthy. On May 12th the shells were half uncovered, and the animal was breathing and feeding normally. On May 13th and 14th the animal still lay unattached. On May 15th, at 8 a.m., the old byssus was still present; at 9 a.m. the foot was protruded, and shortly after a new byssal strand had been formed attaching the oyster to the side of the glass. The old byssus was still retained, but was ejected during the night, as at 8 a.m., on May 16th, it lay just beyond the byssal sinus of the shell, and two additional strands had been added to the new cable. The rest may be quoted from the laboratory diary kept by Mr. Hornell:—

May 17th, 8.10 a.m.—The oyster had travelled $3\frac{1}{4}$ inches during the night, sloughing the 3 byssal strands, formed the night before, together with the common root. The thrown-off byssus remained attached to the glass. At the place of second re-attachment, 5 pale-coloured strands connected the oyster with the glass.

* 'Madras Journ. of Literature and Science' for Session 1886–87.

At 7 P.M.—Watching the same individual by candle light, as it showed signs of unrest, frequently protruding the tip of the foot, I at length saw the foot thrust out to the utmost extent (about 1 inch from the tip to the opening of the byssal gland)

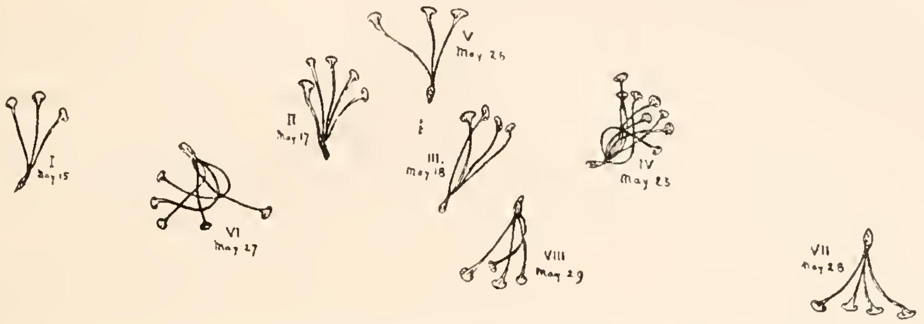


Fig. 43. Diagram showing the eight successive positions in which a pearl oyster formed new byssus strands in a fortnight. One-half natural size.

straight in front of the byssal sinus. A strong contraction then shortened the foot, pulling the animal forwards. For a few seconds it rested, then repeated the operation, during which the base of the last-formed byssus slipped out from within the shell and was cast off. The pearl oyster was now free of its mooring, and in the course of the next hour and a half, after several rests, it travelled $1\frac{1}{2}$ inches. It then settled down; the foot, after feeling about tentatively, remained quiescent at its fullest extent (1 inch) for about 5 minutes, then retracted within the shell, revealing a newly formed byssal thread, clear and almost colourless, attached at the distal end to the glass by an elliptical disc. After an interval of 7 minutes the foot was again protruded, and another strand was added in the same way as the first.

May 18*th*, 8 A.M.—Two additional strands had been formed during the night, making 4 in all (fig. 43, III.).

May 23*rd*, 8 A.M.—During the preceding night this oyster travelled $1\frac{1}{4}$ inches further, re-attaching by 5 new strands, and sloughing the old byssus.

May 25*th*, 8 A.M.—Four additional strands have been formed since 23rd inst. This last move was the fourth re-attachment since brought ashore, and the fifth since removal from the "paar." At sunset, signs of restlessness were again apparent, the foot being occasionally extended in a tentative way. At 6.45 P.M. it began crawling in a definite direction, returning upon its previous course. At the second "step" the byssal root came away. At 7.15, it was still progressing, and had covered 2 inches within 30 minutes.

May 26*th*, 8 A.M.—It had come to anchor $2\frac{1}{2}$ inches from the preceding day's position, with 3 new strands formed (fig. 43, V.).

May 27*th*.—Another nocturnal move of 3 inches—5 new strands.

May 28*th*.—The longest single journey yet made had taken place during the night, to position VII. (fig. 43, where the distances are half actual size).

May 29th.—Another of the usual nightly moves. This time a distance of $3\frac{3}{4}$ inches had been covered, 4 strands being formed at the new anchorage—this was the seventh journey within 14 days. From this date to the time when replaced in the cage at the harbour buoy, 10 days later, no further movements took place—the animal at last appearing contented with its position.

Individual No. 2 was of the same age as No. 1, and had a similar history. On May 9th it was placed in No. 1 tank, and $5\frac{1}{2}$ days later was found anchored by a stout, pale-yellow tinted byssal strand to the outside of a glass vessel, against which it rested. Close by lay its old byssal bundle, with white sloughed-off root. The attachment had been made (as usual) during the night. Pearl oysters are always most active after sunset.

May 16th, 8 A.M.—Three new byssal strands were formed during the night. The older one had now assumed a dark-green colour.

May 17th, 8.30 A.M.—Five new strands have been made since the preceding sunset.

May 18th.—This morning this oyster was removed to another tank, and the byssal attachment was forcibly torn. It was laid under the inflow-pipe, and within 5 minutes thereafter the foot was protruded, feeling slowly all around. Then, after one or two momentary withdrawals into the shell, the foot was placed in position, the anterior part being pressed sucker-like against the tank side. In $4\frac{1}{2}$ minutes the foot withdrew, showing a new byssal thread anchoring the oyster to the tank. The old byssus was thrown out in the course of the next hour. During the rest of the day 4 other strands were formed, and 16 more in the course of the ensuing two days.

May 21st, 8 A.M.—During the night this oyster had cast off the byssus, travelled 2 inches, and then made a re-attachment by 14 new byssal strands.

May 24th showed another night march to have taken place. The distance travelled was 1 inch. The new byssus, the fourth since being brought into the aquarium, consisted of 3 strands. The next night again showed another move of $2\frac{1}{4}$ inches, with re-attachment by 9 new stout silvery fibres. After this it made no further change, remaining affixed to the bottom of the tank till July 3rd, when it was removed. The length of its fully extended foot was $1\frac{1}{4}$ inches from the tip to the centre of the mouth of the byssal gland.

The other oysters of this batch took from 5 to 7 days to form their first re-attachment after being brought in from the cages in the harbour. Subsequently, when the water-circulation in the aquarium was improved, re-attachment of freshly introduced individuals took place much more quickly. Thus, of a number placed in the tanks on June 1st, at 12.30 P.M., one threw off the old byssus, crawled 2 inches, and re-attached, all within 2 hours after being brought in. At 6.30 P.M. (sunset) the same day all the remainder became active—the first sign in nearly every case being the casting away of the old byssal root. A few crawled a short distance, but the majority merely protruded the foot, feeling round, and then at once began the work of forming new cables. At 8.30 P.M., the greater number had made new attachments, and the remainder had thrown off their old byssus and were preparing to attach, probably waiting for the observer's candle to be extinguished.

The next morning all had attached. Several had crawled very long distances; one had gone nearly to the opposite side of the tank, 27 inches (the greatest distance we have seen covered in the 12 hours), another had travelled 8 inches, and a third, 13 inches. This rapidity of re-attachment under healthy conditions (one within 2 hours, the majority within 8, and all within 20 hours) has obviously an important bearing upon the proposed transplantation operations on the pearl banks.

Pearl oysters are extremely sensitive to light when preparing to attach, and there is always difficulty in seeing the actual operation of byssal fixation. While watching the oysters in one tank, those in another will be fixing, and when the light is brought to bear upon these last, they will withdraw the foot as soon as the strand they are engaged upon is finished, and refuse to again protrude until the light is removed.

When the pearl oyster is crawling, while advancing the foot the valves are widely open. When fully protruded the animal contracts the foot to the utmost, thus dragging forward the body. At the same time the valves are usually brought together with a snap, whereby the advance is materially aided.

Our observations show that the disc of attachment of a byssal thread is not formed, as KELAART supposed, by a fosset-like expansion of the pedal groove at the tip of the foot. In reality the pedal groove subserves two distinct functions, the anterior or distal part being used wholly for locomotion and having nothing to do with byssus formation, which is effected by the hinder region of the groove alone. The front end of this hinder section, at its junction with the locomotor surface and about midway between the pedal tip and the anterior margin of the byssal pouch, expands to form an oblong cup-shaped pit or sucker. Behind this again the margins of the groove are usually curved inwards, meeting medianly, to form an extemporised laterally compressed cavity, the pedo-byssal tube: anteriorly this communicates with the median sucker-pit and posteriorly with the byssal pouch.

When the foot is protruded for the purpose of forming a byssal thread, the fore part of the pedal groove is flattened out to act as a sucker, holding the foot in position. The lips of the median pit also expand, forming an oval sucker attachment, while the edges of the hinder part of the pedal surface remain approximated, and may not even touch the surface to which attachment is to be made. For about 4 to 6 minutes, the oyster remains at rest in this position, while a secretion is flowing actively from the byssogenic glands into the extemporised tube along the hinder part of the foot, and so into the median sucker-pit. The latter is the only spot at which the secretion is in contact with the exterior. At the end of the time mentioned the distal part of the pedal surface frees itself, the margins of the proximal tubular region open, and the foot as a whole is gently withdrawn within the shell, leaving behind a pale, glassy-looking, laterally compressed thread attached distally to the extraneous body by an oval disc, and at the inner end to the base of the byssal pouch. The oval attachment-disc is the internal mould of the median pit, and the body of the thread that of the laterally compressed tube formed by the approximation of the margins of the proximal part of the pedal groove. The secretion forming the byssus hardens upon contact with sea water. At first it is pale yellowish in colour and almost transparent; in the course of 48 hours it becomes opaque and of a deep bronze-green with extremely lustrous surface. The sensitiveness to bright light of pearl oysters on the move after sunset, when crawling or when forming new byssal threads, has been noted above. When visiting the tanks it was noticed that no sooner did the candle flash upon them than they either withdrew the foot instantly or did so the moment the thread they were secreting was finished. Locomotion during daylight is very seldom seen, the habit is undoubtedly to travel after darkness sets in—a time when danger from predaceous animals is no doubt reduced.

Pearl oysters are equally sensitive to passing shadows during daylight. In the aquarium tanks the hand passed slowly between them and the sun will cause them to snap-to their valves; and on the sea bottom, at a depth of 6 to 9 fathoms, the same result of a passing shadow can be seen. It must be remembered that on the pearl banks of the Gulf of Manaar the water is so clear that at the depths named the sea bottom is brilliantly illuminated when a bright sun is shining.

To some extent the habits of very young spat are exceptional. Thus when the spat that adhere to floating weed are shaken off into an aquarium tank, they do not, as older individuals would, lie quiescent on the bottom till after sunset, but at once, whatever the condition of the light, start crawling up the sides of the tank, and fix themselves on any objects well above the bottom. Probably an instinctive impulse makes them endeavour to attain a higher level in order to avoid the risk of being buried in the sand on the sea bottom. And it is remarkable what comparatively long distances they cover within a few minutes. We have already shown ("Narrative," p. 68) that minute spat from floating weeds can crawl at the rate of 1 inch a minute.

IV. Food and Feeding Habits.

The food of the pearl oyster is microscopic and of similar character to that of allied Molluscs; it consists largely of unicellular organisms--spores of Algæ, Diatoms, Infusorians, and Foraminifera in the main, with smaller numbers of Radiolarians, the minute embryos and larvæ of various animals, and occasional considerable quantities of delicate algal filaments (chiefly Rhodophyceæ). Non-nutritious particles are also met with in fair amount, such as the spicules of Alcyonarians and of sponges, with small numbers of minute sand grains. On the whole, Diatoms, spores, and embryos are the most important sources of food supply.

Under natural conditions the pearl oyster lies with the right or less convex valve beneath, and with the posterior edge of the shell elevated at an angle of about 20 degrees. If a detached oyster be placed on the bottom on its left or deeply convex valve, its first movement before making a byssal re-attachment is to protrude the foot to the utmost extent, and give a violent contraction so as to cant the shell over on to the right side. When lying undisturbed the pearl oyster separates the ventral edges of the shell to the extent of about $\frac{1}{3}$ inch. This aperture is, however, reduced to a mere slit by the inwardly directed edges of the pallial lobes from either side which nearly meet, and interlock by means of the marginal digitate tentacles.

Through this sieve-like slit, guarded by these sensitive branched processes, an indraught of water is carried by the constant lashing of the cilia covering the gill surfaces. Any large particle unsuitable for food, or any intruding animal touching the pallial tentacles, causes the valves to close with a snap. Otherwise a constant stream of small particles, diatoms, spores, protozoa, and other microscopic organisms, is carried in with the water flowing towards the branchiæ, which function as very fine strainers, able to sift out and arrest every particle from the incoming current. The food particles so arrested are carried by the cilia along the furrows to the crest of the branchial lamella. There the band of specialised cilia forms a path from end to end, along which the particles pass forwards at a rapid rate to the anterior branchial apex, where they are carried into the palpar gutter of that side. In all, four ciliated pathways lead along the branchial crests to the palpar gutters, two on each side.

Occasionally, too, particles find their way into one of the six ciliated paths at the base of the branchial lamellæ. In this case they may either be propelled forward along this basal pathway, or, as usually happens, be drawn away, after travelling a short distance, by the ciliary current of the branchial furrows, and so be transferred to the crest and follow the normal course.

Observations show that the palps can exercise a power of rejection. Thus if there be sediment in the water, the particles of mud after being sifted out by the gills and passed to the palps are retained by the latter until enough accumulate to form a tiny pellet. This is rotated slowly just within the truncated ends of the palps for a time, and is then suddenly ejected by a slight movement of the palps on to the surface of the broad ciliated band that runs outwards to the pallial edge from the base of the palps. Along this the rejected pellet is carried, round the inside of the pallial edge, till, arriving opposite the posterior tips of the branchiæ, it is thrust out. The ciliated path there terminates at the distal end of the lip-like twist of the pallial margin on the ventral border of the exhalent orifice. As the pellet leaves the pallial edge it comes under the influence of the excurrent stream from the gills, and thus is carried some little distance away from the oyster.

On the other hand, nutritious particles received on the palpar surfaces from the branchial ciliated paths are passed on at once to the mouth.

V. Shell-Growth and Repair.

Such subjects as rate of normal shell-growth, power and extent of shell-reparation, and cases of arrest of growth, are all closely related, and may be considered together.

1. Size and Growth.

There are two ways of assessing the rate of shell-growth, first the direct one of keeping marked individuals under observation and noting accurately the dimensions from time to time, and second the indirect method of visiting certain banks periodically and, by taking the average measurements of a number of individuals at each visit, deducing the average growth from period to period. Both these plans were adopted during the present investigation, and the following may be stated as a summary of the conclusions arrived at.

Growth during the first two years of life is very vigorous under healthy conditions and in the presence of an abundant food supply. During the third year the rate of increase is reduced, and in the fourth still further so. After that there is little or no increase superficially, although the shell may grow greatly in thickness.

During the first three years the marginal outgrowths or "fingers" show great development under healthy conditions. Thereafter there is less and less tendency to produce these processes, the activity of the oyster's shell-growth in later years being concentrated upon thickening the nacreous internal layer, largely to counteract the ravages of boring enemies such as sponges and annelids. With variation in the food supply, consequent upon the more or less overcrowded condition seen on several of the "paars," there is marked variation in the rate of growth of the shell (fig. 44).

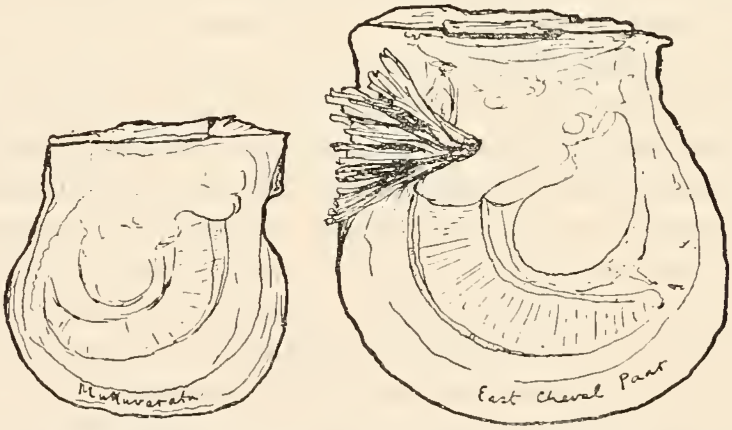


Fig. 44. Pearl oysters of the same age from the Muttuvaratu and East Cheval paars, to show difference in size. Traced from a photograph.

Large numbers of measurements of oyster samples from different paars have been made in the course of this enquiry. It is unnecessary to publish these in full,* so we give here the results of our tables and such comparisons and conclusions as it seems possible to draw. It must be stated that in computing the ages of the oldest oysters now on the pearl banks, we have relied upon the accuracy of Captain DONNAN'S

* I have in my hands considerable lists, tabulated by Mr. HORNELL, which may possibly be inserted as an appendix at the end of the report if it seems desirable.

estimate in March, 1900. In his report on the inspection of that date he announced the discovery of two wide-spread falls of spat over the Cheval and Muttuvaratu paars, which must have taken place about June and December, 1899, respectively, as he gave the ages, when found in March, 1900, as from 3 to 9 months. Consequently the oysters fished from the East Cheval Paar in the spring of 1903 cannot have been older than 3 to $3\frac{3}{4}$ years, a conclusion which makes the yield of pearls in this last fishery an eminently satisfactory one considering the comparative immaturity of the oysters. We must also conclude that, notwithstanding differences in size and appearance, the oldest oysters on the Muttuvaratu Paar and on the Cheval Paar are of the same age, as they are grown from the spat which DONNAN found in March, 1900.

A sample of 50 adult oysters from the Muttuvaratu Paar, measured in April, 1902, gave as the average $2\frac{6}{32} \times 2\frac{1}{64}$ inches, or $55{\cdot}50 \times 51{\cdot}0$ millims.* A sample of 38 oysters from the same bank, measured in November, 1902, gave an average of $58{\cdot}84 \times 54{\cdot}32$ millims., by 22·07 millims. in thickness. Twelve oysters from the same locality, measured in March, 1903, gave an average of $57{\cdot}54 \times 54{\cdot}0$ millims., by 24·42 millims. in thickness.

These figures show an increase during 7 months (April to November, 1902) of 3·34 millims. $\times$ 3·32 millims., with a slight decrease during the ensuing 4 months. The very slight increase during the former period, and the arrest of growth after that, agrees well with the impression we formed as to this bank from the oysters we have seen. Coral growths are very rich on the valves along with other incrusting organisms—Polyzoa, Sponges, Tunicates, and Algæ chiefly. The oysters are small but thick, with no marginal processes or "fingers." If they have ceased to grow superficially, they are adding to the thickness of the shell. Our field notes say (November, 1902): "The pearl oysters on this bank are more thickly crowded than on any other; their size is the most stunted of any yet seen, and they are thin and miserable within, with little food in the alimentary canal in most cases." In March, 1903, when Mr. HORNELL inspected the bank with the diving apparatus, he found that the oysters were densely crowded together, approximately 125 to the square yard, along with various other animals, chiefly corals, which were both on and around the oysters. He noted "The oysters were all small and stunted and unhealthy looking, showing no vigorous shell growth and no marginal processes. On dissection, it was found that all those collected had internally the same stunted appearance. The bodies of all were equally shrunken and thin, the gonads spent or not seasonably developed, and at the best, extremely small; indeed all tissues were equally meagre, even the byssus weak and of few strands." We have other observations, and extracts might be multiplied, all tending to show that the poorly nourished and diseased condition of the oysters on the Muttuvaratu Paar is due to overcrowding.

* The first measurement given is always the depth (dorso-ventrally, at right angles to the hinge), and the second the length (antero-posteriorly).

In marked contrast to the poor growth seen on this bank was the rapid rate of increase shown on transplantation to a locality under better conditions. Two of our experiments may be cited to show this :—

(1.) A number of oysters collected on April 11th, 1902, from the Muttuvaratu Paar, were suspended 5 days later in wire-net cages, at a depth of $3\frac{1}{2}$ fathoms, from the outrigger of a native boat moored in Galle Bay (see fig. 23). By May 9th a marginal increase varying from 1·20 millim. to 1·50 millim. had been effected, and, in addition, numbers of long finger-like processes had appeared, an evidence of very vigorous growth—due, no doubt, to the abundance of food with which the stomach and intestine of specimens examined were found to be crammed. The internal parts had undergone a corresponding increase, and the tissues from being thin and shrunken had now become plump and healthy in appearance. We have the detailed measurements of a number of transplanted individuals, from which we may select three as samples :—

Specimen B, on April 13th, measured 58·50 × 54·50 millims., and by May 9th it had reached 61·60 × 56·70 millims., an increase of 3·10 millims. × 2·20 millims. during 26 days, and not including the finger processes which had begun to form along the margin.

Specimen C (omitting details), from April 15th to May 9th, showed an increase

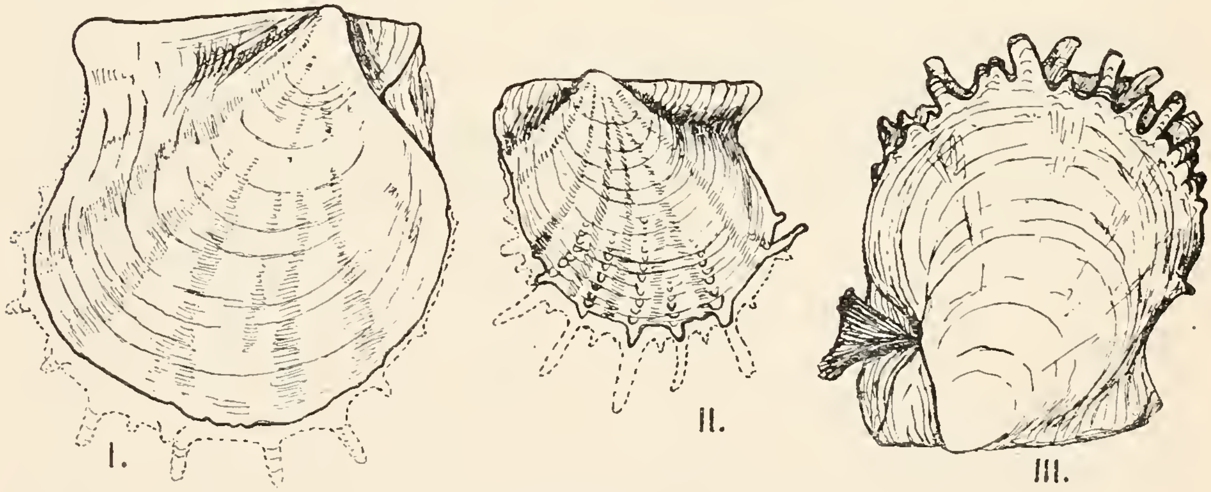


Fig. 45. Three transplanted pearl-oysters showing rapid growth. I. The dotted line shows the new shell formed in 23 days. II. The dotted line shows the new shell formed in 21 days. III. Oyster taken from Muttuvaratu to Cheval, showing a month's growth. All natural size.

varying round the margin from 0·75 millim. to 3·80 millims. ; while if the fingers be included, the growth during these 23 days was 9·50 millims. (see fig. 45, I.).

Specimen D was younger, 6 months old, brought from Chilaw Paar. From April 15th to May 7th the increase was 1·85 millim. on the average, not including "fingers." The latter were present when put out at the buoy in Galle Bay, but a new set, enormously larger, were formed under the more favourable conditions, and some of these were 10 millims. to 11 millims. long (fig. 45, II.).

(2.) A number of the same pearl oysters were transplanted the following year, during the fishery, from the Muttuvaratu Paar, on March 14th, 1903, to the Cheval Paar, where they were kept under observation until April 19th. The great improvement both in external size and internal appearance was especially interesting, since we had an excellent control experiment in the similar oysters left on the Muttuvaratu, which were examined on April 14th and found to be practically unchanged. Those taken to the Cheval Paar had the margin thick and entire, with no new growth and no fingers. After 36 days 4 of them showed the following increase of size (one of these is shown in fig. 45, III.) :—

A	added to	margin	7	millims.,	and fingers	9	millims.	in length.
B	,,	,,	6	,,	,,	8	,,	,,
C	,,	,,	6	,,	,,	10	,,	,,
D	,,	,,	5	,,	,,	$12\frac{1}{2}$	,,	,,

A very striking result, due in part possibly to suspension above the bottom; but the point is that the animal even when adult will re-act rapidly to improved conditions.

Some additional records from our lists of the average sizes of oysters from different localities and of different ages may be of use. They may be conveniently given in tabular form as follows :—

Locality.	Date.	Number.	Age.	Average of measurements.
			months	millims.
South-east Cheval . .	November, 1902	21	11 to 14	50·57 × 47·52.
North-west Cheval . .	,, ,,	14	11 ,, 14	47·64 × 44·36.
South-east Cheval . .	March, 1903	34	15 ,, 18	54·41 × 49·75 × 20·38.
North Modragam . .	,, ,,	12	15 ,, 18	61·17 × 54·50 × 24·28.

These, then, are young oysters in the beginning of their second year, and it will be seen, comparing those of like age, that the North Modragam are larger than the South-east Cheval, and the latter are larger than the North-west Cheval.

Those given below are older oysters, mostly in their fourth year (see next page).

Locality.	Date.	Age.	Number.	Average of measurements.
		years		millims.
Periya Paar Kerrai . .	November, 1902	$2\frac{11}{12}$ to $3\frac{5}{12}$	22	74·36 × 68·59.
,, ,, . .	March, 1903	$3\frac{1}{4}$,, $3\frac{3}{4}$	33	74·76 × 67·15 × 31·25.
North-east Cheval . .	November, 1902	$2\frac{11}{12}$,, $3\frac{5}{12}$	16	80·25 × 74·06.
,, ,, . .	March, 1903	$3\frac{1}{4}$,, $3\frac{3}{4}$	20	76·05 × 71·45 × 31·45.
Mid-east Cheval . . .	November, 1902	$2\frac{11}{12}$,, $3\frac{5}{12}$	8	74·12 × 67·5.
,, ,, . . .	March, 1903	$3\frac{1}{4}$,, $3\frac{3}{4}$	31	75·45 × 68·55 × 31·10.
South-east Cheval . . .	November, 1902	$2\frac{11}{12}$,, $3\frac{5}{12}$	36	69·81 × 64·44.
,, ,, . . .	March, 1903	$3\frac{1}{4}$,, $3\frac{3}{4}$	35	75·77 × 69·57 × 31·00.
North-west Cheval . .	November, 1902	$2\frac{11}{12}$,, $3\frac{5}{12}$	6	71·33 × 67·83 (sandy ground).
,, ,, . .	March, 1903	$3\frac{1}{4}$,, $3\frac{3}{4}$	3	61·5 × 58·33 × 26·83 (rocky).
South-west Cheval . .	November, 1902	$2\frac{11}{12}$,, $3\frac{5}{12}$	36	71·25 × 65·39.
Mid-west Cheval . . .	,, ,,	$2\frac{11}{12}$,, $3\frac{5}{12}$	31	65·68 × 60·39.
Dutch Modragam . . .	,, ,,	$2\frac{11}{12}$,, $3\frac{5}{12}$	18	64·0 × 61·0.
Muttuvaratu	,, ,,	$2\frac{11}{12}$,, $3\frac{5}{12}$	—	58·84 × 54·32.
,, ...	March, 1903	$3\frac{1}{4}$,, $3\frac{3}{4}$	—	57·54 × 54·00 × 24·42.

Taking now the average for all the banks at the November, 1902, and March, 1903, inspections separately, we find that the (say) 3-year-old oysters average 69·96 × 64·79 millims. for all localities, and the (say) $3\frac{1}{2}$-year-old oysters average 70·18 × 64·84 × 29·33 millims. It is, however, probably not instructive to take an average for all of the banks, since two distinct types of oyster occur—those exemplified by the Eastern Cheval and the Muttuvaratu respectively. It is, therefore, better to group the Periya Paar Kerrai with the East Cheval in order to ascertain the normal rate of increase under favourable conditions, at the age considered :—

Locality.	Average size in millimetres. November, 1902, $2\frac{11}{12}$ to $3\frac{5}{12}$ years.	Average size in millimetres. March, 1903, $3\frac{1}{4}$ to $3\frac{3}{4}$ years.
Periya Paar Kerrai	74·36 × 68·59	74·76 × 67·15
North-east Cheval	80·25 × 74·06	76·05 × 71·45
Mid-east Cheval	74·12 × 67·05	75·45 × 68·55
South-east Cheval	69·81 × 64·44	75·77 × 69·57
The averages at the two dates being .	74·63 × 68·53	75·51 × 69·18

This gives an increase of only 0·88 × 0·65 millim. for the 4 months ending March, 1903, which bears out the statement made above that growth after the third year is very slow. Comparison with the growth of the much younger (second year) oysters on the South-west Cheval, from 50·57 × 47·52 millims. in November, 1902, to 54·41 × 49·75 millims. in March, 1903, shows how very rapid the increase is at this age, 3·84 × 2·23 millims. in 4 months.

As, however, the shell can grow in thickness of valve as well as in superficial extent, it is of some importance to consider the weight in relation to age. We are able to give a table of the weights of shells of one generation of pearl oysters as determined by Captain DONNAN annually from the first year to the time when fished at 4 and 5 years of age. As after the third year there is but little increase in size, the figures for the later years may be taken as indicating the additions to the thickness of the shell.

WEIGHT of Cleaned Pearl-oyster Shells.

Locality and date.	Age.	Number weighed.	Average weight per pair of valves.
	year	pairs	drams
North-west Cheval—			
March, 1871	1	13	4
,, 1872	2	13	12
,, 1873	3	50	19
November, 1873	$3\frac{3}{4}$	100	$20\frac{1}{2}$
March, 1874	4 (fished)	45	$24\frac{1}{2}$
,, 1875	5 (fished)	47	30
South-east Cheval—			
March, 1874	1	33	$3\frac{2}{3}$
,, 1875	2	60	$13\frac{1}{2}$
,, 1876	3	150	$21\frac{1}{2}$
,, 1877	4 (fished)	51	30

The stunted condition of the oysters on the Western Cheval which we saw on the ground, and have noted elsewhere in this report, is shown by these figures to have been as marked a quarter of a century ago. While the South-east Cheval produced shells which at 3 years of age weighed $21\frac{1}{2}$ drams each and at 4 years 30 drams, those of the same ages from the North-west Cheval weighed only 19 drams and $24\frac{1}{2}$ drams respectively.

All the above figures, as well as the non-numerical observations which we made upon the banks during two inspections and a fishery, tend to show that, of the reliable paars, the Southern and Eastern parts of the Cheval, the Periya Paar Kerrai and the North Modragam are, at present, those that produce the most rapid growth and healthy development of the pearl oysters. The conditions at these paars which seem to determine the good results are :—

(1.) The local abundance of microscopic food. This was shown by the richness of the plankton in our tow-net gatherings.

(2.) The absence of competing organisms, such as those that are present in quantity on coral ground.

(3.) The impossibility of overcrowding, as there are no extensive sheets of rock emerging from the sand, and therefore the pearl oysters cannot, at these localities, form a continuous layer almost hiding the underlying rock, as they do in some places.

These are all important points, especially perhaps the last. The oysters on these more favoured grounds, although abundant enough, are not overcrowded, but lie in separate bunches or little isolated groups. Sometimes, as on the Periya Paar Kerrai, the foothold consists of little patches of flat rock (see fig. 36, p. 109), 3 or 4 feet in extent and separated by sandy tracts 2 or 3 yards in width. At other places, as on the South Cheval, little or no rock appears on the bottom, and the oysters are attached in bunches to the scattered natural "culch," fragments of dead coral and of calcretes, broken shells and Lithothamnion masses, lying on the sand. A certain amount of sandy bottom, interspersed with harder tracts, and with plenty of "culch" —natural or artificial—scattered over the sand, is probably the most favourable ground for the Ceylon pearl oyster from the point of view of those interested in the fisheries. The presence of more culch in many places would, however, be an improvement. It would give more foothold for new broods of oysters, and at the same time would probably help to stiffen the shifting sand and prevent, in some degree, the wash-out and turn-over of the surface which is caused by a heavy swell.

The reliable paars which produce less rapid growth and are characterised by their stunted oysters (the "Koddaipakku" variety of the divers and the Inspectors' reports) are the Muttuvaratu, much of the West Cheval and the Dutch Modragam. These are all localities with great stretches of continuous rocky bottom which may be covered, during favourable seasons, by myriads of pearl oysters closely crowded together. Thus Captain DONNAN estimated, in 1902, that on the sandy East Cheval (11,804,676 acres) there were 74,413,000 pearl oysters, while on the rocky West Cheval (10,500,000 acres) there were 123,357,600, showing a much denser population per acre in the latter case, but not equalling the density on the Muttuvaratu Paar, where an area of rather less extent (10,206,725 acres) supported in March, 1902, the enormous total of 277,000,000 pearl oysters—which have since suffered great losses, due no doubt to their overcrowded condition.

2. Shell-Repair.

Pearl oysters have considerable recuperative power after injury, and can usually repair damage done to the shell. This is of importance from two points of view, first in connection with the ravages of some of their natural enemies, and secondly, because of its bearing upon occasional pearl-formation. Many cases were noticed in our field work where injuries had been effectively repaired, and it is significant that a number of these were found on the Periya Paar Kerrai during March, 1903, immediately after the time when we have evidence that Rays (*Trygon uarnak*) were feeding on the bank and had crunched up many shells. Some of the oysters we found showed that fragments of the ventral margin had been broken off, others that the anterior or the posterior "ear" had been smashed—all had been repaired more or less perfectly so as to enclose the animal and enable the valves to function.

To ascertain the extent and rapidity of the process of repair, a number of experiments were made both on the pearl banks and at Galle. The following give the details of a few typical cases :—

(A.) During the removal of oysters from the "Serendib" at Galle in April, 1902, a $2\frac{1}{2}$-year old oyster had a large semi-circular fragment broken from the right valve. The oyster remained for the next 26 days suspended in a wire-net cage from one of the buoys in the bay. On May 9th, when brought into the laboratory, the gap was mended completely and an additional marginal growth of 1·4 to 2 millims. had formed. The only departure noticeable from the original condition was that neither of the two involved radial bands of colour had been continued in the repaired area, the pigment being spread out instead in a diffused manner.

(B.) In February, 1903, a number of oysters from the Cheval Paar were purposely damaged in various ways. When examined on the 23rd, 8 days later, they all showed extensive repair. In one case $5\frac{1}{2}$ millims. of new shell had been added at the damaged spot, and in two others $3\frac{1}{2}$ millims.

(C.) This was another oyster which had a piece fully 15 millims. in vertical depth removed from the right valve on February 15th. In 9 days a fresh growth, measuring 7 millims. in depth, had formed, while by March 8th the whole of the damage was made good by a further growth of 8 millims., so that within 21 days a total growth of 15 millims. depth of new shell had taken place.

(D.) Even more rapid repair was shown by some oysters damaged on February 27th, due possibly to the fact that they were suspended in the purest sea-water on the banks for the whole period of the experiment, whereas (B.) and (C.) above were kept in muddy water off Chilavaturai for several days. The growth shown in (D.) was very uniform, and the damage was completely repaired in all cases. Of three photographed on March 8th (two are shown in fig. 46) :—

No. 1	showed	9	millims.	of new	solid shell,	12	millims.	including	the	"fingers,"
,, 2	,,	7	,,	,,	,,	13	,,	,,	,,	,,
,, 3	,,	$7\frac{1}{2}$	,,	,,	,,	12	,,	,,	,,	,,

a surprising growth for 9 days. The colours of the new shell were very brilliant in these cases, rich brown-red and bright yellow.

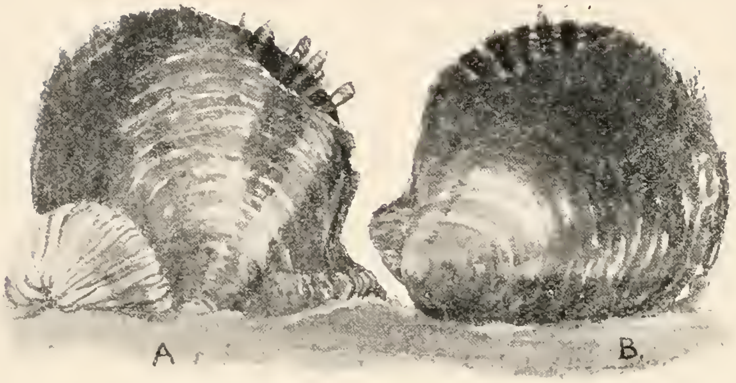


Fig. 46. Two pearl-oysters showing damaged shells repaired in 9 days (February 27th to March 8th).—Copied from the photograph.

Two other oysters of this same series (D.) were photographed on March 10th. Within the 10 days, one had formed 6 millims. of new solid shell and 15 millims. in

Fig. 47. Pearl-oyster damaged on February 27th and photographed on March 10th to show complete repair. The arrows point to the new growth.

all including the "fingers," the other (fig. 47) had formed $11\frac{1}{2}$ millims. of shell and $16\frac{1}{2}$ millims. to the end of the "fingers."

(E.) In the case of a number of oysters damaged on April 21st, new growth varying from 2 to 5 millims. in extent was seen in 2 days.

Many other instances might be given from our note-books, but the above will suffice to show the rapidity and thoroughness with which the pearl oyster makes good injury to its shell, and to effectually dispose of any objections that might be raised to extensive transplantation on the score that the oysters might be damaged and would not survive the operation.

Observations on the damaged oysters kept in our aquarium tanks at Galle throw light upon the methods of repair. Damage may either be marginal or superficial. If the latter, the cause is usually a blow fracturing one of the valves through both nacreous and prismatic layers and depressing the shell on the distal side of the break. In a specimen purposely so injured, the mantle-lobe separated from the proximal part of the shell for some $\frac{1}{4}$ inch, leaving a wedge-shaped recess under the shell-margin at the fracture. In this new position the external pallial epithelium secreted a fresh deposit of nacre, thus perpetuating permanently the crevice under the proximal fractured edge.

Cases where the mantle is extensively pierced or lacerated by the injury may be fatal, not apparently because the animal is unable to make good the damage, but rather because of the difficulty of keeping out small carnivorous animals such as worms and molluscs. In several cases, however, we have seen complete recovery from extensive laceration, the margins of the wound gradually approximating and finally uniting. While the temporary aperture exists, water may be drawn in through it, and the tip of the foot is sometimes protruded through the hole in the mantle and moved round the rough edge of the broken shell, with the result that loose fragments and dirt particles that accumulate between the mantle and the nacre, and which probably cause irritation, are removed. No repair-nacre is secreted until the damage to the mantle is made good.

When a fragment of the shell-margin is broken away, the mantle within is retracted in proportion to the extent of the damage, not only at the place of injury but for some distance on either side. Consequently, when the pallial edge begins to form a new shell-margin, it starts in the uninjured part from a point about $\frac{1}{8}$ to $\frac{3}{16}$ inch behind (internal to) the former edge. Along the line of fracture the pallial edge is advanced much closer, or quite up to the margin, beyond which the pallial tentacles can be seen projecting. This method of starting the new growth behind the existing edge in the case of injuries is also the normal method of adding to the margin of the valves in growth. Under normal conditions growth is discontinuous, periods of activity alternating with what appear to be periods of rest. Each fresh layer begins from a line about $\frac{1}{16}$ inch inside the edge; which process results in the formation of a number of successive layers of shell with projecting margins outside, the older overlapping the younger in imbricate fashion. Young rapidly growing pearl oysters show this imbrication most markedly, especially during the first two years. As they get older, attrition and the ravages of attacking and incrusting animals tend to remove the thin projecting margins and their delicate processes, and new ones are less frequently formed as the shell ceases to grow in extent but becomes thicker by deposits of nacre on the inside. The distance apart of the successive marginal ridges is a good guide to the vigour of the oysters, healthy conditions being indicated when the distances are considerable, and overcrowding or scarcity of food when they are massed thickly together, especially at the margin. Many of the Muttuvaratu oysters show this latter appearance to a marked degree, the edges of the shell, instead of being thin and delicate as they are on the South-east Cheval, being comparatively thick and formed of a number of very slight layers of growth, which do not imbricate, but are massed at the same level, so as to show like the edges of a pack of cards.

The connection of shell-repair with occasional pearl formation depends upon the fact that the pearl oyster has to withstand the attacks of various animals—sponges, worms, molluscs—which bore into the shell. In attempting to repair such ravages the oyster thickens the nacreous layer, and in some cases piles up pearly excrescences on the interior of the shell which may be separated as pearls of an inferior quality. It is probable, also, that when the shell is damaged fine particles, either splinters of nacre or foreign bodies, gaining access to the interior, may serve as the nuclei of free pearls. Finally, it must be remembered that shell-growth and pearl-growth are similar and comparable processes. In both cases limy salts in an organic matrix are deposited by the living tissues—in the one process on the outside of the body, and in the other around some internal particle, which in the case of the finest pearls is the Cestode larval *Tetrarhynchus*. I shall return to these matters in the later section of this Report, which will treat of pearl formation.

REPORT

ON

SEA-BOTTOMS AND CALCRETES

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH ONE PLATE AND TEXT FIGURES.]

THE samples of sea-bottom, about thirty in number, were dredged mainly from four districts round the coasts of Ceylon :—(1) About Point de Galle, (2) Trincomalee Bay, (3) Palk Bay, and (4) the Gulf of Manaar—and most of them were from the last locality (see map, p. 161).

In addition to the material brought up by the dredge, about twenty specimens of rock were broken off from the bottom by divers, chiefly from the paars in the Gulf of Manaar and along the west coast of Ceylon.

The majority of the deposits were obtained from shallow water, 4 to 10 fathoms, but a few from the Gulf of Manaar and off Galle are from a greater depth.

POINT DE GALLE AND NEIGHBOURHOOD.

In **Galle Bay,** from depths of 6 to 8 fathoms, shells with sand were dredged. Large drifted shells, such as *Arca*, *Anomia*, *Ostrea*, *Cucullæa*, and *Turritella*, mostly in a rotten condition, made up the bulk of the coarse material, along with large barnacle valves and a few shark's teeth. The shells were worn, many brown in colour and polished, indicating a partial conversion into a phosphatic condition. Encrustations of Nullipores, Serpulæ, and Polyzoa covered the shells, and *Clione* borings were common in those shells composed of calcite, while aragonite shells were often not affected.

The finer material, obtained by sifting through a sieve with a mesh of 1 millim., contained from 61·41 to 62·52 per cent. of carbonate of lime, and included small Molluscs, Echinoid spines, plates and anchors of Holothurids, spicules of *Alcyonium* and *Leptoclinum*, as well as numerous Foraminifera, such as *Heterostegina*, *Globigerina*, *Textularia*, and *Spiroloculina*, Nullipores and *Crisia*. While the smaller organisms have a fresh appearance, and are indicative of the life at present in the district, the larger organisms are mostly dead, and evidently very old.

The inorganic constituents were quartz grains, clear and well rounded, not very plentiful, kyanite, corundum, zircon, rutile, tourmaline, and mica. A considerable amount of coal, well rolled, in pieces ranging up to $\frac{3}{4}$ inch in diameter, is no doubt due to the proximity of a coaling station.

At **Welligam,** to the east of Galle Bay, two samples were dredged. One, a fine calcareous mud with shells, yielded 76·50 per cent. of carbonate of lime; and another, obtained from a depth of 4 to 6 fathoms, contained many rotten shells, brown in colour and bored by *Clione*, barnacle valves and *Halimeda* in a fresh condition; a few quartz fragments, angular, ranged up to $\frac{1}{2}$ inch in diameter. The fine material in both hauls consists of a smooth mud which cakes on drying, and contains a few small quartz grains, tourmaline, zircon, spicules of sponges and *Leptoclinum*, Holothurian plates, and diatoms, especially *Coscinodiscus*. Foraminifera are not common.

Trincomalee Bay.

Off the mouth of Trincomalee Bay, at a depth of 12 fathoms, Foraminiferal sand was dredged, containing 67·7 per cent. of one form, *Heterostegina depressa*. Mollusca, including *Arca*, *Trochus* and *Patella*, mostly rolled and encrusted, made up 4·8 per cent., Corals and Polyzoa (*Retepora* and *Cellepora*) 0·2 per cent., Nullipores 8·0 per cent., *Alveolina* (two species) 0·9 per cent., and a few specimens of *Echinocyamus*. The material which passed through the fine sieve, 16·5 per cent., consisted almost entirely of small Foraminifera, including *Pulvinulina*, *Textularia*, *Discorbina*, *Miliolina*, *Cristellaria*, *Nonionina*, *Polytrema*, and *Nummulites*. Pteropods and *Alcyonium*, Holothurid and Sponge spicules were fairly abundant.

The inorganic constituents include quartz grains, well rounded and ranging up to 3 millims. in diameter, and a black powder, much of which could be removed by a magnet. The non-magnetic portion was fractionated by means of the double iodides of mercury and barium, and showed a great number of small garnets, corundum, tourmaline, and kyanite in the heavier fractions, while a little sub-angular quartz and a few grains of mica made up the lighter portions.

Palk Bay.

North of Rameswaram, in Palk Bay, where shallow water (6 to 7 fathoms) conditions extend over a great area, and where there is an almost complete absence of currents, a very extraordinary deposit occurs: it consists mainly of concretions, irregular in form, with here and there a cast of shell and a few large shells in a fairly fresh but broken condition. The shells include *Arca*, *Cardium*, *Chama*, *Pecten*, *Murex*, *Nassa*, and the pearl oyster. No double valves are found and the calcite shells are sometimes bored by *Clione*. The concretions on treatment with a weak acid effervesce strongly and yield a large percentage of fairly coarse sand. Plate I., fig. 1, shows shells, casts and concretions from this deposit.

The casts, which contain 64·80 per cent. of carbonate of lime and 2·2 per cent. of phosphate of lime, fall to mud when placed in water, and it was necessary to soak in thin balsam and harden before a section could be obtained. Round the periphery of the casts is a thin layer of calcite, which moulds itself into the inequalities of the shell's interior surface; this is succeeded by a darker layer, and then the whole interior is seen to consist of sand grains, quartz, tourmaline, felspar, and zircon embedded in a mass of secondary calcite. The sand grains increase in size on proceeding from the exterior inwards (fig. 1), and remind one of the well-known fact that when grains of different dimensions are shaken in a basin, the finer material sinks to the bottom and the coarser rises to the surface. It is probable, then, that the grains were rocked to and fro when in a loose condition inside the shell, and the cementing took place subsequently. Afterwards, owing to altered conditions, the outer shell was dissolved and the cast left. It is impossible, owing to the rolled and imperfect condition of the casts, to tell what shells formerly held the casts, but most of them have a form not unlike Natica. It is noteworthy that felspars are found in these casts, while they are absent, as a rule, from sea sands. They were probably embedded soon after breaking away from the parent rocks and before kaolinisation could reduce them to clay.

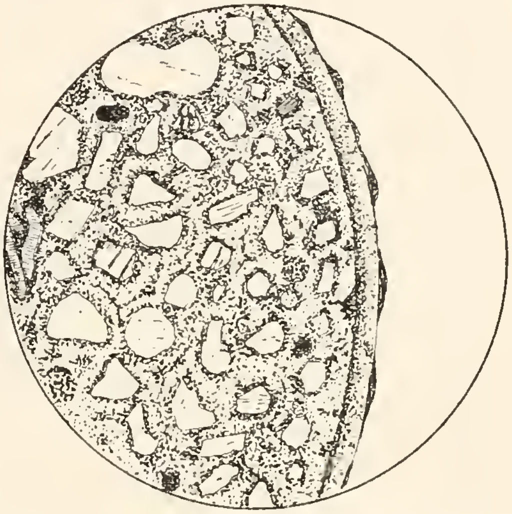


Fig. 1. Section of internal cast of shell from Palk Bay; showing the part in contact with the shell, and sand grains cemented by carbonate of lime in the interior. × 25.

The inorganic material dissolved out from the concretions by acids and fractionated showed a great preponderance of garnets. The heavier portions were pink in colour on this account. Other minerals found were corundum, tourmaline, zircon (enclosed in garnet and free), kyanite, quartz, mica (biotite), and felspar. A number of black grains were composed of ilmenite.

Further East and North of Adam's Bridge, at a depth of 7 fathoms, a fine black mud occurs which, on analysis, gives:—

Silica	55·00 per cent.	Alumina	15·80 per cent.
Carbonate of lime .	3·50 ,,	Magnesia	2·75 ,,
Phosphate of lime.	2·25 ,,	Water and organic matter	16·60 ,,
Ferric oxide. . .	4·10 ,,		

A few heavy minerals, zircon, tourmaline, and kyanite, occur; but the bulk is made up of a fine impalpable mud, smooth to the feel, with minute grains of quartz. Only a few organisms, one Foraminifer and a small shell fragment, were found in the sample examined.

Gulf of Manaar.

South of Palk Bay, and separating it from the Gulf of Manaar, is Adam's Bridge. Rameswaram Island and Manaar Island, which form the two chief links in the chain of islands almost joining Ceylon with Southern India, consist, according to Foote* and Walther,† of calcareous sandstone. This is continued across the Pamban Strait and forms the "sandstone quay" of the Tonitoray spit on the west and the coastal part of North Ceylon on the east. The smaller islands between Rameswaram and Manaar also show a similar rock, while through the passages separating them are loose drifting sands. The north coast of Rameswaram is fringed by an ancient coral reef, while living reefs are found in shallow water immediately to the north and to the south.

South of Adam's Bridge, the Gulf of Manaar stretches as a low sloping beach, deepening fairly evenly at the rate of about 1 fathom in two miles to 20 fathoms, where it sinks more rapidly to great depths. Along the west coast the slope of the shore is more rapid, and deep water is reached sooner. At places along the west coast, and also south of Manaar Island, spits of sand stretch across the platform, mainly near the mouths of rivers. They probably result from the detritus brought down by the rivers, and their general trend towards the north-west may be due to the combined flow of the streams and the prevailing inshore currents.

On the western shores of the Gulf, and in Palk Bay, the rivers form deltas of large size, and similar spits of sand extend near the river mouths towards the north-east. The coasts of India and Ceylon are swept by great marine currents running up or down the coast according to the monsoons, but owing to the longer duration of the south-west monsoon it produces greater effects, and all rivers flowing into the Gulf have a tendency to extend their deltas towards the north.‡ The sands covering the floor of the Gulf become coarser on approaching the west, and there can be no doubt that the material has been carried down from the high grounds by rivers and then distributed by currents on the ocean floor. The granulitic rocks of central Ceylon

* 'Memoirs of Geol. Survey of India'—Geology of the Madura and Tinnevelly Districts.

† Petermann's 'Mittheilungen,' Ergänzungsheft No. 102, 1891.

‡ Foote, *op. cit.*

are usually found in a friable sandy condition,* and thus provide material already disintegrated which can easily be transported by rivers to the sea. The sand forming the floor of the Gulf has, in many places, been cemented *in situ* into calcareous sandstones or "calcretes," locally known as "paars." In the north part the paars arrange themselves roughly into three groups, running parallel with Adam's Bridge, north-north-west to south-south-east. The first line is found at a depth of $3\frac{1}{2}$ to $4\frac{1}{2}$ fathoms, the second at 6 to 8 fathoms, and the third at 9 to 10 fathoms. Further south, on the West Coast, they have a north and south alignment, here again following the outline of the coast.

It would appear that the calcretes have grown out radially from centres, the smaller ones are mainly circular in outline, while the larger ones seem to have been formed by the growth and fusion of a number of smaller ones. Outliers exist in many cases near the larger paars, which seem to suggest that they too will eventually become fused with the main paars. Dredging and diving operations were mainly conducted in the neighbourhood of the paars, and most of the samples handed to me for examination were obtained from these localities. Hence the descriptions which follow readily group themselves round the most important paars.

Periya Paar.—This is the most westerly of the paars, and lies about 20 miles south-west of Manaar Island. It extends 11 miles north-west—south-east, and averages about $1\frac{1}{2}$ miles in width. Smaller paars exist as outliers at the northern and southern extremities. The rocky bottom has a depth varying from $8\frac{1}{2}$ to 10 fathoms, with a thin layer of sand covering the flat surface of the calcrete.

Outside the paar, to the west, the bottom rapidly sinks to 20 fathoms, and further out 80 fathoms and over are reached. Five specimens of the bottom were dredged in the neighbourhood of the paar and calcretes from three localities were broken off by hammers and brought to the surface by divers.

West and South-west of the North end of Periya Paar, at a depth of 10 fathoms, the contents of the dredge showed many shells in a fresh condition, Polyzoa, such as *Cellaria* and *Scrupocellaria*, *Halimeda*, and numerous Nullipores. These were accompanied by a fairly coarse angular quartz sand. The fine material yielded 27·64 per cent. of carbonate of lime, and under the microscope was seen to consist of quartz, sometimes stained with iron, many black grains of ilmenite and magnetite, tourmaline and zircon, and, as organic constituents, numerous Foraminifera, *Crisia*, and sponge spicules.

North-west of the Paar, at 12 fathoms, Foraminiferal sand with shells was dredged. The shells included *Pectunculus*, *Arca*, *Chama*, *Venus*, pearl oyster, and with these, forming the coarse material, were *Heteropsammia*, Echinoderms and a brown Alga. The smaller forms were Foraminifera—*Heterostegina* in great profusion—Nullipores, Polyzoa and Serpulæ. Only a few clear quartz grains were present.

* A. K. Coomáraswámy, 'Geol. Mag.,' August, 1903, p. 348.

From the surface of the actual Bank, at 9 fathoms, a quartz sand was obtained. It contained, in addition, numerous shells, not overgrown with encrusting organisms, *Lithothamnion*, brown Algæ and horny worm tubes. The fine material—24·20 per cent. of carbonate of lime—was principally clear quartz sand well rounded, and as rarer constituents, tourmaline, garnets, zircon, kyanite, rutile, and ilmenite.

Comminuted shell fragments, Echinoid spines, and Foraminifera—*Heterostegina* principally—made up the bulk of the calcareous portion.

Outside the Paar, to the West, at 20 fathoms, a Foraminiferal sand containing very little inorganic matter was obtained. The fine stuff yielded 85·86 per cent. of carbonate of lime. *Heterostegina depressa* and *Alveolina* were the principal constituents, and there were also included Polyzoa—*Crisia* and *Scrupocellaria*—*Alcyonium* spicules, Holothurian plates, and the spat of young bivalves.

Another haul, Outside, on the West, from 80 fathoms, brought up Foraminiferal sand with no large forms except a few broken shells. It contained 76·50 per cent. of carbonate of lime. Unlike the Foraminiferal sand from shallower depths, *Heterostegina* was not abundant, giving place in this group to small *Nummulites*, *Globigerina*, and *Textularia*; while Pteropods, the fry of Molluscs, Echinoid spines, nodes of *Crisia*, Nullipores, *Halimeda*, *Alcyonium* and *Leptoclinum* spicules, and a simple Coral were the other notable contents.

Turning now to the rocks occurring on this paar, we find :—

The North Part is composed of a fine-grained calcareous sandstone or calcrete, grey in colour, and containing a considerable number of black grains in patches.* The block brought up is thickly encrusted with Polyzoa, both adnate and erect, and Nullipores, green and white. Shells, such as *Chama*, are attached to the stone, and these in turn are covered with encrusting organisms. On the fractured surface, the centre is seen to be compact, but a thin band of less compact texture separates the interior from the organisms on the surface. Sometimes the Polyzoa lie directly on the sandstone, at other times a thin layer of Nullipore intervenes.

The quartz is clear and of fairly even grain, and between the particles the calcite is seen filling up spaces or lying as thin rods across the grains. A few shell fragments and Foraminifera occur along with the quartz.

A thin slice examined under the microscope shows quartz, mostly angular, and averaging about 1 millim. in diameter, with inclusions of apatite, zircon and tourmaline, felspars, both orthoclase and plagioclase, showing no signs of kaolinisation, green tourmaline, shell fragments, and sections of Nummulites.

Calcite occurs as a granular mass filling up spaces between the grains, and often as curved rods. The rods, as a rule, enclose sand grains; they are sometimes pitted transversely, and a dark line in some cases runs down the length of the rod. Brown

* FOOTE, *op. cit.*, mentions a sandstone containing magnetic iron sand as occurring in Valimukkam Cliffs, on the coast of India.

chitinous patches are often associated with the calcite rods. Their nature and origin will be discussed in the next example from the middle portion of the Paar.

Middle Part.—Nine specimens, labelled "*half way up Periya Paar*," consisted of loose porous calcretes, white in colour and heavily encrusted, and a large Chank shell filled with calcareous sand and coated with Polyzoa, Nullipore, calcareous worm tubes, byssus of pearl oysters, and sponges. Sections of the calcretes were obtained showing the encrusting organisms *in situ*. This was a matter of some difficulty, owing to the friable nature of the material, but on soaking in thin balsam and hardening, slices were cut and rubbed down on carborundum blocks.

On examining a thin slice with recent colonies on the outside, the surface layers showed Polyzoan cells arranged in parallel rows, two or three deep, with the avicularia, vibracula, and opercula in position. The irregular surfaces served to entrap and retain sand grains and Foraminifera drifting over them. Naturally, only those were held which fitted closely into the spaces provided, and thus a sifting action took place. Occasionally two small grains would fill the space in place of one of larger dimensions. Below the surface layer other cells were seen, nearly all of which contained a grain. The base and side walls were perfect, but the top wall had broken down to admit the sand grain, carrying with it the chitinous operculum. Proceeding towards the centre, succeeding layers have less prominent walls, owing to secondary calcite growing from them in tiny scalenohedra towards the interior of the cell, and finally we reach a stage when a thin dark line marking the junction of adjacent walls, the roughly linear arrangement of uniform grains, and the occasional remains of chitinous opercula are all that remain to indicate the former presence of Polyzoa. Cells which escape being occupied by sand grains become filled with secondary calcite showing a radial structure (see fig. 2).

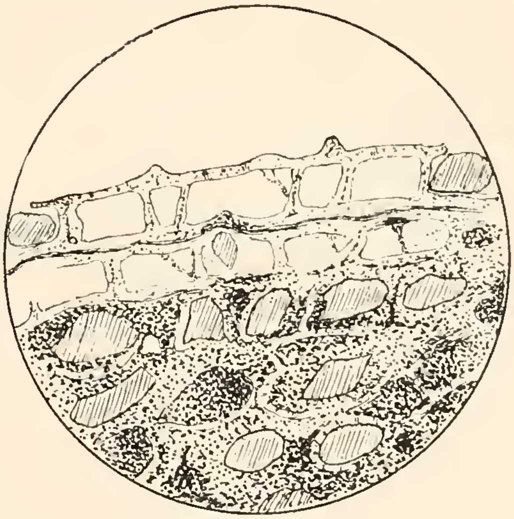


Fig. 2. Section of Calcrete with recent Polyzoa on surface, from Periya Paar Kerrai. The two upper layers represent sections of Polyzoon cells, and the lower part shows sand grains (shaded) in a calcareous matrix and fragments of the walls and opercula of the Polyzoa. × 25.

Nullipores sometimes alternate with Polyzoa and enclose grains, but it is not difficult to distinguish between the two even when structure has been lost. The grains cemented by Nullipore are sporadic in their distribution, there is no sifting into grains of uniform size, and when they appear in linear series they are mostly radial, not concentric. The action can be seen in masses of *Lithothamnion*, which send out club-shaped extensions from their surfaces. The spaces between the branches are often filled with loosely-held sand grains, and subsequent growth may enclose them. *Lithodomus* crypts and worm tubes, when deserted by their occupants, may also be filled with sand and become incorporated in the substances of the Nullipore. We shall return to this subject when discussing a Nullipore deposit from Chilaw. It is sufficient for the present to point out the importance of Polyzoa as cementing organisms, and indicate the criteria by which we can recognise their action.

South end of Periya Paar.—Here four pieces were obtained. Three of these were calcretes cemented mainly by Polyzoa, exactly similar to the one described, and containing grains of quartz, rutile, tourmaline, felspar, corundum and ilmenite, with shell fragments, Foraminifera, and sponge spicules; while the fourth was a piece of dead Coral, very rotten, covered with encrusting organisms, and bored by *Saxicava*.

Cheval Paar.—This paar lies to the south-east of Periya Paar. It is U-shaped, consisting of east and west arms with a connecting bar at the south.

The east arm is 6 miles long by 1 mile broad, and the depth averages $6\frac{1}{2}$ fathoms. Outliers to the north are seen at Periya Paar Kerrai, and Vankali Paar, and to the south lie Kondatchi and Jaggerboom paars.

The west arm measures 4 miles long by $1\frac{1}{2}$ to 2 miles broad, the depth is 7 to 8 fathoms. The connecting piece at the south end is 5 miles broad, runs north-east to south-west with a prolongation at the middle towards the south-east. Two small isolated paars, North Modragam and South Modragam, extend south-east from the prolongation.

Seven samples of the dredged material were kept from the parts surrounding the Paar, and 10 specimens of rock were obtained from the Paar itself and Periya Paar Kerrai.

Pearl Banks off Chilavaturai, $6\frac{1}{2}$ fathoms.—The coarser part of this haul consisted mainly of drifted shells, including Pearl Oyster, *Mactra*, *Pectunculus*, *Venus*, *Nassa*, and *Trochus*. They were nearly all broken, rotten, and some were bored by *Clione* and encrusted with Nullipore, Polyzoa, and Serpulæ. Echinids and Starfish also contributed to the contents of the sample as dredged. The only living organisms were Polyzoa.

The portion of medium size consisted of clear and milky quartz grains, well rounded and polished, averaging 5 millims. in diameter, echinoid spines and a few shell fragments.

The part which passed through a sieve of 1 millim. mesh was mostly quartz sand with 7·04 per cent. of carbonate of lime. On concentrating the heavy minerals by a high-density fluid magnetite, ilmenite and leucoxene, garnets, kyanite, tourmaline, rutile, corundum, and zircon were found; while in the lighter fractions were comminuted shells, Nullipores, Foraminifera, Echinoid spines, and spicules of *Holothuria*, *Alcyonium*, and sponges.

The material has all the appearances of a drifted shell bank swept by strong currents.

North of Cheval Paar, 7 fathoms. This consisted of a fine quartz sand with black grains, contained 28·36 per cent. of carbonate of lime, and included a few encrusted shells and *Echinocyamus*.

South-west Corner of Cheval Paar, 8 fathoms.—A fairly coarse shelly sand, with uniform grains about 5 millims. diameter, made up the bulk of the material. *Natica*, Pearl Oysters. Starfish arms, large *Heterostegina*, Nullipores and spines of Echinoderms also occurred in the coarser part.

The finer portion contained very little quartz, a little ilmenite and kyanite, sponge spicules, and the 34·32 per cent. of carbonate of lime was made up principally of Foraminifera and young Molluscs.

Middle of South End of Cheval Paar, 7 fathoms, immediately North of Shoal Buoy. This was nearly all fine sand of a light grey colour.

Pearl Oyster, *Pectunculus*, *Lima*, *Natica*, *Modiola*, and Chank shells were common, not very fresh and thickly encrusted. Barnacle valves, Sabellaria tubes and Echinoderms also occurred. Several pieces, about 1 inch long, of a chalky white stone on cutting proved to be decomposed Nullipore on the outside, and dark brown compact limestone with quartz and garnets in the interior.

The fine material yielded 22·20 per cent. of carbonate of lime, and contained quartz, zircon, kyanite, garnets, tourmaline, corundum, rutile, and mica with shell fragments, Foraminifera, and sponge spicules.

Shoal Buoy, $3\frac{3}{4}$ fathoms, is near the north-west termination of a spit of sand which extends from Karativo to Cheval Paar.

The bottom consisted of clean white sand with shells, 3·09 per cent. of carbonate of lime, and included a number of small black grains. The largest sand grain was 7 millims. in diameter. The shells were fresh, and some had the two valves in position.

In addition to quartz, garnets, kyanite, corundum, tourmaline, rutile, and ilmenite, were a few Foraminifera.

South Cheval Paar, $5\frac{1}{2}$ fathoms.—This was made up of a coarse sand with shells, some of the latter very fresh, with valves in apposition and retaining the epidermis.

The sand cakes on drying, owing to the presence of a considerable amount of mud. Pearl Oysters, *Modiola*, *Arca*, *Pectunculus*, *Nassa*, *Murex*, *Lithothamnion*, and a shark's tooth, occurred in the coarser stuff, and quartz well rounded, ilmenite, magnetite, garnet; tourmaline, zircon, and sillimanite were contained in the finer. No sponge spicules and very few Foraminifera were found.

South of Cheval Paar a coarse quartz sand occurs.

Dealing now with the rocks brought up from the Cheval Paar we find:—

Northernmost end of East Cheval is a mass of broken down coral. It is white in colour, with black grains filling in the pores. There is a slight iron stain round each grain. Only a few pieces of quartz are found adhering. The mass is bored with *Lithodomus*, and worm tubes are seen in section on the bottom surface. Some of these have a few grains of sand attached to the interior of the tube.

A few Nullipore patches of a white colour, scarcely distinguishable from the coral, are attached to the surface, but no Polyzoa.

A thin slice examined under the microscope shows that one or two pieces of shell and quartz have been enclosed in the walls of the coral, and towards the margin the thecas have been filled with secondary calcite and numerous Foraminifera.

North Central part of East Cheval and the Middle of West Cheval have calcretes exactly like those described from Periya Paar. They are thickly encrusted with Polyzoa, Nullipore, and worm tubes, and in section evidence of Polyzoa structure can be seen even in the middle parts of the blocks. The masses are cavernous, especially near the surface, and large worm tubes adhere to one side only of the cavities. The cavities have not been formed by boring animals, but are probably due to influences proceeding from the movements of the worm itself in setting up currents and thus preventing the growth of cementing organisms in the immediate neighbourhood. One block which has no worm tubes attached is not cavernous.

In the South Central part of East Cheval, the Central part of the Southern portion, North end of West Arm, and in the South-west part of the Paar a brown compact limestone occurs. It is usually encrusted with Polyzoa, Nullipores, and worm tubes. affords attachment to the byssus of the pearl oyster, and shells, especially *Chama*, are frequently adherent. In all cases the limestone is bored by Molluscs and *Clione*, but only for a short distance from the margin. It is slightly phosphatic, two specimens examined contained 0·21 and 0·36 per cent. respectively of phosphate of lime. In section we find a fine granular, light brown matrix with spots and streaks of reddish material at intervals. Traversing the matrix are zig-zag and branching lines of clear calcite, evidently filled-in cracks. Patches of Coral are seen showing clear calcite outlines with dark granular infilling. Quartz grains, mostly angular, occur, sometimes in patches, at other times in lines. Zircon, apatite, and garnet accompany the quartz, and magnetite occurs sporadically, usually showing a reddish border, which is, no doubt, due to the alteration of this mineral. The ground mass is mostly composed of shell fragments, Foraminifera, and small broken pieces of Nullipore. Incipient oolitic structure occurs round some of the grains. I should regard this limestone as the ultimate stage in the alteration of a coral reef. Coral structure is still to be seen in places, and we can trace the changes, step by step, by which a coral rock like that occurring at the north end of East Cheval is converted into compact limestone.

Periya Paar Kerrai.—Samples were obtained from three localities. Two of them were calcretes, showing Polyzoa and Nullipore structure among the grains, the third consisted of casts of drifted shells (Plate I., fig. 2).

Casts of pearl oysters were most frequent. All the valves were turned in one direction and overlapping. Lying on the sea floor with their concave surfaces facing upwards, they have been filled with sand. This has afterwards been cemented, and the shells subsequently dissolved. Thus viewing the specimen from one side we see the smooth cast of the interior of the shells, and on turning over only sand is visible. Other shells attached to the mass and still retaining their tests are *Cardium*, *Pecten*, *Murex*, and *Cerithium*. Colonies of Polyzoa and worm tubes have attached themselves to the smooth surfaces of the casts since the shells were removed.

Dutch Modragam Paar, to the southwards, lies 10 miles due west of Kodramallai Point. It is $1\frac{1}{2}$ miles in diameter and has a depth of 8 to 14 fathoms.

From this paar two specimens were obtained, one a piece of Madrepore coral about 2 inches thick, with numerous borings of Molluscs proceeding downwards and obliquely from the upper surface. White Nullipore covered parts of the upper surface, and the byssus of pearl oysters occurred attached to both the top and bottom.

The other sample was a coarse calcrete, consisting of sand grains very uniform in size, each measuring 3 to 4 millims. in diameter. The grains were clear, well rounded quartz and felspar, loosely cemented by carbonate of lime and thickly encrusted by Nullipore and Polyzoa.

Muttuvaratu Paar lies 5 miles west of Karativo, and has a depth of 5 to 10 fathoms. Here dead coral, bored in all directions by Molluscs, was brought up. It was covered by green Nullipore, a few colonies of Polyzoa and worm tubes, and much byssus of pearl oysters was adherent to both upper and lower surfaces.

Dredging in the neighbourhood, at a depth of 7 fathoms, showed the bottom to consist of calcareous sand containing 78·36 per cent. of carbonate of lime. *Heterostegina depressa* was the chief constituent, and some of the larger forms were covered with green Nullipore. Other organisms present were *Alveolina*, small univalves, Diatoms, and spicules of *Leptoclinum*, Holothurian plates and shell fragments.

Chilaw Paar, the largest paar on this southern part of the west coast, lies 7 miles west of Chilaw. It is 8 miles in length and averages 2 miles in width. The depth varies from $9\frac{1}{2}$ to 10 fathoms.

N o r t h o f t h e P a a r, at 10 fathoms, a calcareous sand was obtained, the finer material of which on analysis gave 95·5 per cent. of carbonate of lime. The small amount of inorganic matter present consisted of quartz grains, ·5 millim. in diameter, plagioclase felspar, zircon, garnet, tourmaline, kyanite and rutile.

Among the larger organisms present were shells and Nullipores in about equal proportions, containing such forms as *Pecten*, *Arca*, *Pectunculus*, *Astarte*, *Turbinella*, *Capulus*, *Nassa*, *Turritella* and *Echinocyamus*. Most of these were rotten and covered with Nullipores, Polyzoa and Serpulæ.

The finer material comprised many Foraminifera, including *Heterostegina*, *Polytrema*, *Alveolina* and *Globigerina*, Echinoid spines, young Molluscs, *Crisia*, Pteropods, and spicules of sponges, *Holothuria*, *Alcyonium* and *Leptoclinum*.

S o u t h o f C h i l a w, at $8\frac{1}{2}$ fathoms, the bottom was mostly composed of Nullipores, corals and Sabellaria. *Lithothamnion fruticulosum* was the commonest species among the Nullipores, and many of the balls were overgrown with Polyzoa and worm tubes, and fine sand frequently adhered in the spaces between the branches.

On breaking, the exterior was seen to be white and compact (Plate I., fig. 4), while the interior consisted of a brick-red spongy mass, almost of a powdery consistency and containing grains of sand. A thin slice examined under the microscope showed the white margin to be composed of fresh Nullipore with clusters of quartz grains and magnetite enclosed and irregularly disposed. Nearer the interior the plant structure became less distinct, and no trace of structure could be distinguished at the centre. The spongy core evidently has resulted from the breaking down of the Nullipore and the staining is due to the hydration of the magnetite. The sand can be accounted for by irregular growth of the Nullipore enclosing grains attached to the surface.

Two pieces of calcrete from Chilaw Paar were very like those obtained from Dutch Modragam, except that the grains were larger and less uniform in size.

Jokenpiddi Paar.—The floor is found to be composed of a very coarse calcareous conglomerate. It contains large well-rounded clear quartz, felspars, and rounded pieces of a brown limestone resembling that described from Cheval Paar. Simple Corals, *Chama*, and tangled masses of calcareous worm tubes cover the block, and colonies of Polyzoa find lodgment in sheltered cavities. A delicate tracery of Polyzoa can be seen among the sand grains on a freshly fractured surface (Plate I., fig. 3).

Karkopany Paar, lying off Chilaw at $7\frac{1}{2}$ fathoms, consists of a medium grained calcrete with a few large well-rolled pebbles of quartz of larger size. Dark brown ochreous patches occur in places. Some parts are compact, others loosely cemented. Polyzoan walls can be seen with the naked eye all through the mass cementing and covering the grains. Large shells, corals, and worm tubes cover the exterior.

Oolawittee Paar lies north of Negombo, at $8\frac{1}{2}$ fathoms. Here two samples were obtained. They consist of a loose sandy reddish-brown material, with a white coating of Polyzoa completely covering the exterior. Simple Corals, *Chama* and worm tubes are attached to the surface, the latter being mostly found lining the walls of cavities.

The rock from Negombo Paar is exactly like that obtained from Oolawittee. In a thin section we see clear quartz and felspar embedded in a dark brown opaque matrix. Polyzoa structure is visible, and can readily be traced out from among the sand grains.

General Remarks.

In considering the deposits as a whole, one cannot help commenting on the fact that nothing has been found in them which gives the slightest clue to the character of the solid rocks forming the bottom of the sea. All are of recent origin and can be accounted for by the action of causes now at work. Rivers bring down large quantities of disintegrated material from the interior of the land, particularly in the season of the south-west monsoon; this is spread over the sea floor by the combined action of the rivers and ocean currents, and organisms living in the surrounding seas are responsible for the calcareous material which forms a considerable proportion of the deposits laid down in places distant from the shore.

As no rocks of undoubted Tertiary age are found on the adjacent coasts, it would appear that all through that period the district has been in a state of equilibrium. SUESS* has remarked on the fact that no distinct line can be drawn between the Miocene and succeeding formations in the east, no break is seen in the deposition, and newer beds have quietly overlapped those of earlier date. In the absence of any signs of tectonic movements during the Tertiary period, which, if they had existed, would certainly have left some traces in the rocks of Ceylon and India, we are driven to the conclusion that the shallow platform surrounding Ceylon and connecting it with India on the north is due to the filling up of the sea by detritus derived from the land (see map, p. 161).

On the west coast of Ceylon, near the mouths of rivers, spits of sand stretch across the submerged platform, towards the north-west, while across the Gulf of Manaar from the opposing shores of Southern India similar banks of sand extend to the north-east. Near the coasts the spits consist of coarse fragments, while further out the sands become successively of finer grain. Long continued growth of these spits would result in the formation of a platform arching to the north and produce exactly the conditions we find in the Gulf of Manaar and Palk Bay. WALTHER† records that to the north of Palk Bay, between Calimene Point and Jaffnapatam, there extends a string of shoals less than 3 fathoms under the surface, and these may represent a bank in the act of forming.

In describing the deposits it has been shown that in the Gulf of Manaar the loose material is at the present day being cemented into calcareous sandstones or calcretes at the "paars," chiefly through the agency of Polyzoa and Nullipores.

The important part played by Polyzoa in this connection has not hitherto been recognised. I am convinced that many square miles of the rocky paars are due to this cause alone. Coral reefs in all stages of decay, from living reefs to compact limestones showing but few traces of coral structure, are associated with the calcretes.

If an area of this character were raised above the sea level and acted upon by the waves of the sea, we should expect the harder paars and limestones to exist as islands, between which would be areas of loose drifting sand. Such is exactly the structure of Adam's Bridge—a remarkable chain of islands and shoals which stretches across the platform from Ceylon to India. According to FOOTE‡ and WALTHER§ one of these islands, Rameswaram, has an ancient coral reef along its northern border, and a

* 'Das Antlitz der Erde,' vol. 2, p. 648.

† "Die Adamsbrücke und die Korallenriffe der Palk-Strasse." Ergänzungsheft No. 102 zu PETERMANN'S 'Mittheilungen,' 1891.

‡ 'Memoirs of the Geological Survey of India.' "On the Geology of the Madura and Tinnevelly Districts."

§ *Op. cit.*

further exposure of coral rock, which has been described as a fossil atoll, lies in the interior immediately to the North of the Temple of Rameswaram. A large part of the island is covered by sand dunes which extend as a long spit as far as Thanni-Kodi on the south-east. These dunes hide the solid rocks of which the island is built, but a series of trial borings made across the island from north to south, two miles east of Pamban Town, did not show any southward extension of the coral reef, but a coarse calcareous sandstone—very modern looking and imperfectly consolidated. It is unfortunate that a piece of this rock was not available for comparison with the calcretes found on the paars, but from the detailed descriptions of FOOTE and WALTHER, it corresponds exactly with those found in the Periya and Cheval paar areas.

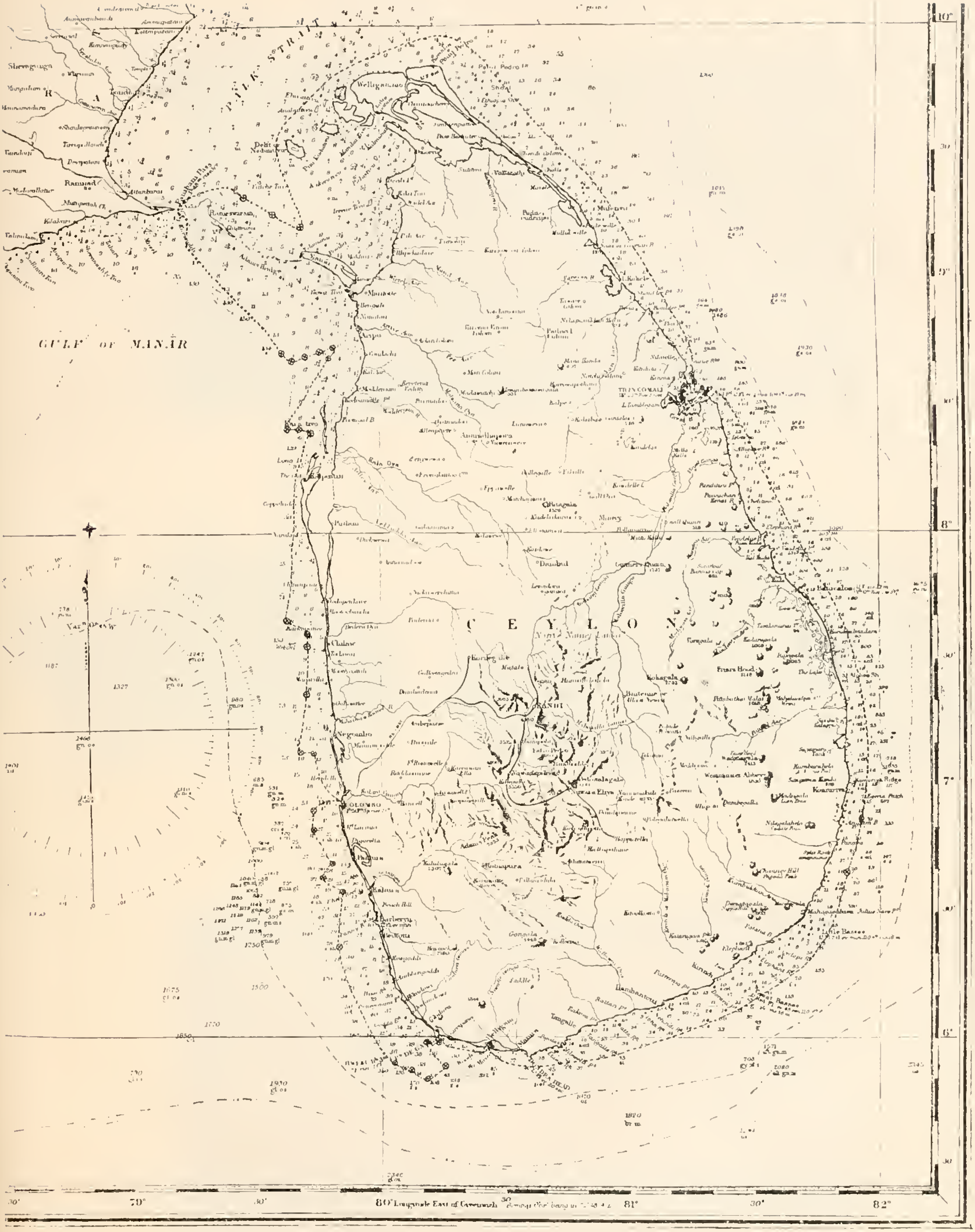
The chain of small islands east of Thanni-Kodi, and Manaar Island itself, also consist of similar calcareous sandstones. They are continued to the west across Pamban Strait and are seen bordering the coasts of Tonitoray Spit. On the east, according to RICHTHOVEN, the low lying plain forming the northern extremity of Ceylon has a coralline formation for its substratum. Similar rocks can be seen at intervals all along the East Coast of India, and have been described under the name of Cuddalore Sandstone. Again, along the West Coast of India, occurs the "littoral concrete," described by OLDHAM* as "an agglutinated calcareous shelly grit raised a little above sea level in several places." "It consists of shells, corals, pebbles, and sand cemented more or less thoroughly by carbonate of lime." "The beds may have originally been sand spits or beach deposits." All these deposits contain none but recent shells, exactly like those now living in the neighbouring seas.

SUESS† attributes the emergence of Adam's Bridge and the "littoral concrete" to a negative eustatic movement of the sea level in post-Tertiary times, and brings together a mass of evidence to show that the negative movement was widespread, embracing a large portion of the northern hemisphere. He surmises that the emergence may have been so recent that the great Hindu epic, the Ramayana, which treats of the building of Adam's Bridge, may be a poetical rendering of events witnessed by man. Although we have no certain evidence that the Bridge was at any time continuous, we have historic data to prove that the Island of Rameswaram was once united with Tonitoray Spit. If, as I suggest, the various links in the chain of islands represent emerged "paars," we have no reason to suppose, judging from the distribution of those now forming, that they were ever united.

In any case, the barrier, whether continuous or broken, would profoundly influence the deposits laid down in Palk Bay. Cut off from the currents sweeping up the coasts from the south, the conditions would be favourable to the deposition of mud, such as we find covering the floor of the bay, and sand would be confined to the shores. It will be noticed, however (p. 149), that casts of shells occur in the mud, and these are composed of sand. The shells have been completely removed, and the

* 'Manual of the Geology of India,' 1893.

† 'Das Antlitz der Erde,' vol. 2, p. 647.


GULF OF MANĀR
C E Y L O N
TRINCOMALI
KANDY
Negombo
Chilaw
Kalutara
Batticaloa
Hambantota
Little Basses
Great Basses
Pedro Pt.
Mullaittivu
Welliganwo
10°
9°
8°
7°
6°
79°
80° Longitude East of Greenwich
81°
82°

Y

casts themselves, in many instances, have been reduced to shapeless spongy masses of cemented sand. It is not improbable that these shells were filled with sand previous to the building of the Bridge, when the currents were sufficiently powerful to carry coarser material.

Some of the deposits, as at Galle Bay and Palk Bay, are evidently very old. They represent the remains of a fauna where solution and chemical changes have been at work. The shells left are mostly composed of calcite, not aragonite, and many of them have become partially converted into phosphate of lime.

Stable minerals such as quartz, garnet, kyanite, tourmaline, and zircon are found everywhere, whereas the less resistent felspars only occur near the coasts in the Gulf of Manaar in places where material has been recently deposited, or in calcretes, or in the interior of shells where they have been preserved from kaolinisation.

My thanks are due to Professor Herdman for much kindly help, and to Mr. C. C. Moore, F.I.C., of Liverpool, for the care he has taken in analysing some of the deposits for the purpose of this report.

EXPLANATION OF PLATE I.

Fig. 1. Concretions, shells and casts from Palk Bay.

Fig. 2. Casts of Pearl Oyster and other shells cemented together—from Periya Paar Kerrai.

Fig. 3. Coarse calcrete from Jokenpiddi Paar.

Fig. 4. Nullipore balls, some broken to show red spongy interior. A fragment of *Sabellaria* is shown at the extreme right of the middle line—from South of Chilaw Paar.

FIG. 1.

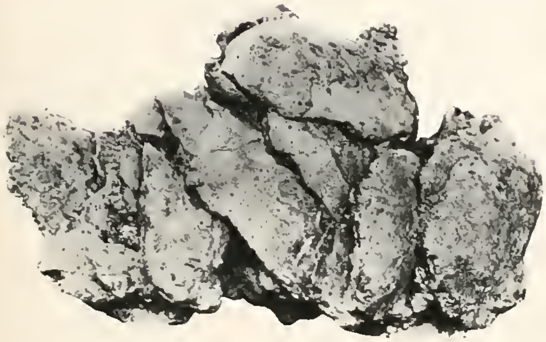


FIG. 2.

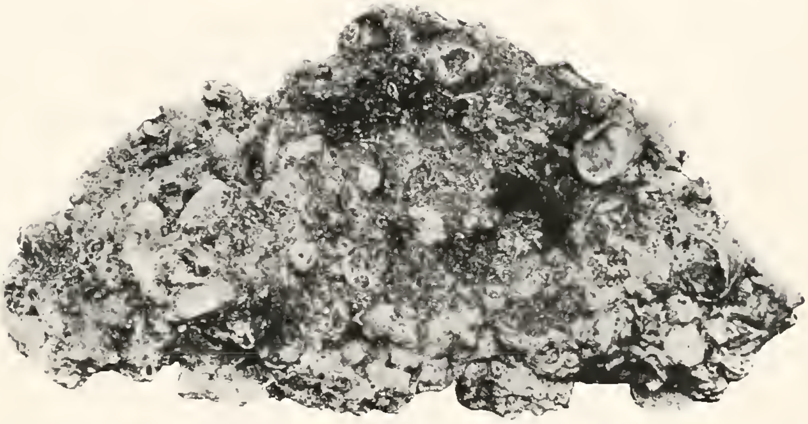


FIG. 3.

FIG. 4.

LIST

OF

MARINE ALGÆ

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902,

WITH

A NOTE ON THE FRUCTIFICATION OF HALIMEDA.

BY

ETHEL S. BARTON (MRS. A. GEPP).

[WITH TEXT FIGURES.]

THE list of species represented in the small collection of ALGÆ from the Gulf of Manaar sent to me by Professor HERDMAN is as follows:—

CHLOROPHYCEÆ.

Codium tenue, KÜTZ.

Geogr. distr. :—Indian Ocean, Red Sea, West Indies.

C. ovale, ZAN.

Geogr. distr. :—New Guinea.

C. sp. (? *elongatum*, AG.).

Valonia, sp. ; a fragment only.

Caulerpa fergusonii, G. MURR.

Geogr. distr. :—Ceylon.

C. plumaris, AG.

Geogr. distr. :—All tropical seas.

Avrainvillea papuana, MURR. et BOODLE.

Geogr. distr. :—Indian and Pacific Oceans.

Halimeda tuna, LAM., forma *platydisca*, BART.

Geogr. distr. :—Mediterranean Sea, Atlantic, Indian and Pacific Oceans.

H. gracilis, HARV., with sporangia (see below, p. 165).

Geogr. distr. :—Indian and Pacific Oceans.

H. opuntia, LAM.

Geogr. distr. :—Tropical zone.

PHÆOPHYCEÆ.

Padina commersonii, BORY.

Geogr. distr. :—Indian, N. and S. Pacific and tropical Atlantic Oceans.

Dictyota, sp.

Sargassum; a fragment only, but Professor HERDMAN'S notes show that a species is present in great profusion on some parts of the pearl banks, and is of importance in connection with the attachment of the young pearl oysters.

FLORIDEÆ.

Galaxaura obtusata, LAM.

Geogr. distr. :—Warm Atlantic and N.W. Pacific Oceans.

G. rugosa, LAM.

Geogr. distr. :—Warm Atlantic, Indian and Pacific Oceans.

Actinotrichia rigida, DECNE.

Geogr. distr. :—Red Sea, Indian and N. and tropical Pacific Oceans.

Brachycladia marginata, SCHMITZ.

Geogr. distr. :—Indian, Pacific and tropical Atlantic Oceans.

Gastroclonium opuntia, KÜTZ.

Geogr. distr. :—Indian Ocean.

Hypnea musciformis, LAM.

Geogr. distr. :—Mediterranean Sea, tropical and sub-tropical oceans.

Dr. HERDMAN informs me that this species is of a green colour when alive, and that, along with a species of *Cladophora*, a *Ceramium*, *Chætomorpha* and *Polysiphonia*, all infested with Cyanophyceæ, it forms great masses, mostly of a green colour, on parts of the Cheval and Modragam banks, where it has many young pearl oysters attached to it.

Laurencia sp.; young plants.

Neurymenia fraxinifolia, J. AG.

Geogr. distr. :—Indian Ocean.

Polysiphonia sp.; sterile.

Dasya sp.; fragment with tetraspores.

Ptilota fergusoni, GRUN.

Geogr. distr. :—Ceylon.

Haloplegma preissii, SOND., var. *flabelliformis*, HARV.

Geogr. distr. :—Australia, Tasmania.

Dr. HERDMAN noted the presence of a few Algæ on the Coral reef at Galle, but was unable to bring any specimens. From what he says of them, and the rough sketches, I should suggest that they might be the following species, but it must be understood that this is mere suggestion :—

Caulerpa racemosa, var. *uvifera*, J. AG., or *C. sedoides*, AG.

Halimeda tuna, LAM.

Padina commersonii, HARV.

Peyssonelia rubra, J. AG.

Caulerpa plumaris, AG.

Vanvoorstia spectabilis, HARV.

Corallina sp.

A characteristic of the above is that they were all observed on dead corals.

A *Caulerpa*, which he noted as occurring on the Pearl banks, in the Gulf of Manaar, but of which he has no specimen, would appear from his sketch to be *C. scalpelliformis*, AG. Associated with it in quantity was a plant with ovate glossy dark green leaves, which from the sketch appears to be *Halophila ovata*, GAUDICH. They were growing through coarse quartz sand at a depth of 5 or 6 fathoms, about 10 miles from land.

The field diaries kept by Professor HERDMAN and Mr. HORNELL also contain records of the following Algæ from the Pearl banks :—

Halimeda tuna, f. *platydisca*, *Chrysymenia uvaria*, *Udotea flabellata*, *Dictyurus purpurascens*, *Zonaria lobata* (?), *Kallymenia perforata*, *Laurencia* sp., *Polysiphonia* sp., *Corallina* sp., *Acetabularia* sp., and "great quantities of *Sargassum* sp. both on the bottom and floating on the surface." These are all forms which are quite likely to have occurred.

Dr. HERDMAN has asked me whether any comparison can be drawn between the Algæ of the Maldive and Laccadive Islands and those of Ceylon. The only collection known from the former groups of islands was made by Mr. J. STANLEY GARDINER, and gathered on the coral reefs. It contained 23 species, chiefly of the Indian Ocean type, more than half of which had previously been recorded from Ceylon. The actual number of species common to that collection and Dr. HERDMAN'S is only two: *Halimeda tuna*, f. *platydisca*, and *Galaxaura rugosa*.

NOTE ON THE FRUCTIFICATION OF HALIMEDA.

Many of the specimens of *Halimeda gracilis*, HARV., are in fruit, a condition of this species which has never been noted or described. The only species of *Halimeda* of which the sporangia have hitherto been observed, are *H. tuna*, LAM., *H. platydisca*, DECNE, and *H. macroloba*, DECNE. In a paper published in December, 1901 ('The genus Halimeda, Siboga-Expeditie, Monographe LX.,' Leiden) I showed that *H. platydisca* should be regarded as a form of *H. tuna*, although Professor SCHMITZ

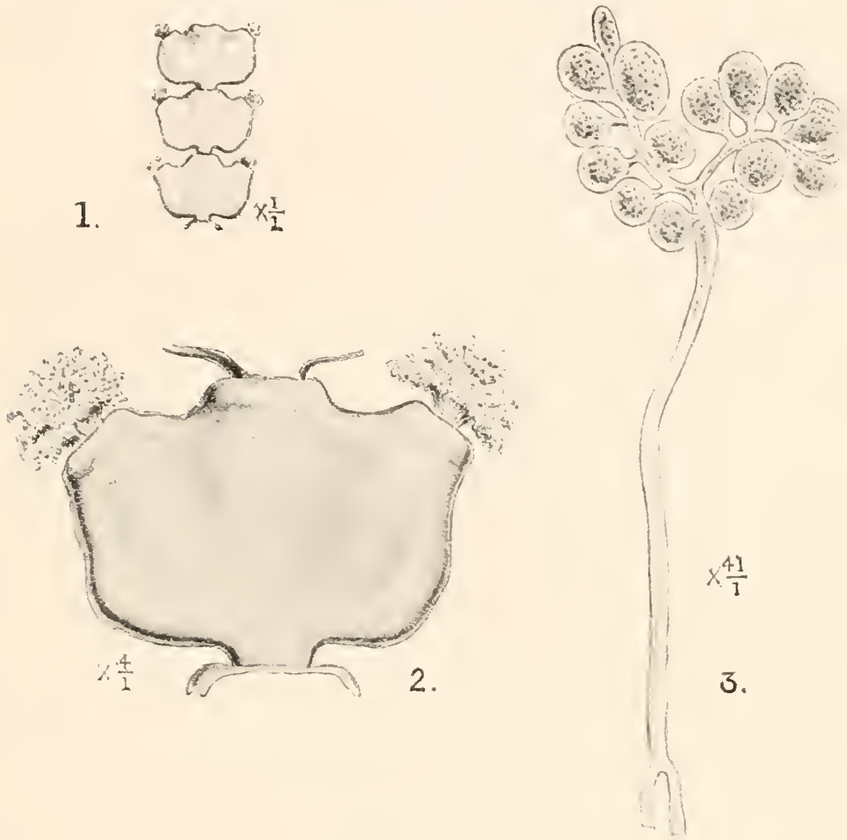
('Sitzungsber. d. Nied.-rhein. Gesellsch., Bonn, 14. Juni 1880,' p. 146) maintains that there are differences between *H. tuna* and *H. platydisca*, as regards the position of the sporangia on the sporangiophores, but he does not give any figures.

As to *H. macroloba*, the sporangia are mentioned by ZANARDINI ('Icon. Phyc. Adriat. et. Medit.,' vol. 3, p. 131) as having been seen by him, and they are stated to be similar to those of *H. tuna*. This remark on the fruits of *H. macroloba*, DECNE, is inserted by ZANARDINI in his description of Plate CXII., which represents a fruiting specimen of *H. tuna*. Hence the reader might be led to imagine that the fructification figured was that of *H. macroloba* and not that of *H. tuna*; ZANARDINI, however, merely emphasizes the point that he had not himself personally collected the fruiting specimens of *H. tuna* which he figures, and that he had in his possession fruiting plants of *H. macroloba*, from the Red Sea, a district which was outside the scope of his memoir. There is, therefore, no figure extant of the fruits of either *H. platydisca* or *H. macroloba*.

The fruits of *H. gracilis* grow out in small, short tufts from the margin of a joint (see text-figures), but these tufts are confined to those points on the margin at which the branches of the central strand emerge; and these branches, instead of continuing their course so as to form a new side-joint, grow out into tufts of fruiting filaments (figs. 1 and 2). In appearance, the fruiting joints of *H. gracilis* differ from those of *H. tuna*, which, according to the figures, bear a fringe of fruiting filaments along the upper margin, and in some cases even in an isolated tuft from the flattened surface of the joint. It is not quite easy to understand how this wide, marginal fringe in *H. tuna* can arise, since the strand of central filaments, from which the sporangiophores spring directly, runs up through the centre of the plant and branches inside a joint to form the side joints. If, as is always stated, the fruiting filaments of *Halimeda* arise only from the filaments of the central strand and its branches, then the points on the margin (or rarely surface) of a joint, where these strands emerge from the thallus, are clearly the only points at which fruiting filaments can be borne.

An examination of the fruiting material of *H. gracilis* shows that the sporangia are borne, as in *H. tuna*, on sporangiophores, which form a continuation of the filaments of the branches of the central strand. According to the system of classification of species followed in my paper referred to above, the distinguishing feature of *H. gracilis* lies in the complete fusion of the filaments of the central strand in pairs at the apex of a joint, the fused portion branching later trichotomously in the next joint. When the fused portion is destined, however, to bear sporangiophores instead, it branches dichotomously to form two sporangiophores, from which the sporangia emerge all round and form a kind of loose raceme (fig. 3). In the material from the Pearl banks of the Gulf of Manaar, most of the sporangia are empty, but it has been possible to find specimens in which the protoplasm still fills the sporangia and the apex of the sporangiophore. The protoplasm is studded with small, black dots, and the condition is probably one shortly preceding the ejection of the zoospores.

MM. Derbés and Solier ("Mém. Physiol. d. Algues," 'Compt. Rend.,' Suppl., vol. I., 1856, Plate XII., fig. 3) have figured a condition of the fruits of *H. tuna*, showing the sporangiophores and sporangia filled, all but the actual apex, with a dense, dark



Halimeda gracilis.

Fig. 1. Joints with fructification. Nat. size.

Fig. 2. One joint with fructification. × 4.

Fig. 3. Sporangiophores bearing sporangia in a condition shortly preceding the ejection of the zoospores. The point of fusion of the two filaments of the central strand is shown at the base. × 41.

green protoplasm. In the condition figured in this note, the development has advanced a stage further, and the dense protoplasm has become almost entirely concentrated in the sporangia and the apex of the sporangiophore.

Of the subsequent escape of the zoospores I can say nothing.

REPORT

ON THE

GEPHYREA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

ARTHUR E. SHIPLEY,

FELLOW AND TUTOR OF CHRIST'S COLLEGE, CAMBRIDGE, AND UNIVERSITY LECTURER ON THE ADVANCED MORPHOLOGY OF THE INVERTEBRATA.

[WITH ONE PLATE.]

THE collection of Gephyrea, made in Ceylon by Professor HERDMAN during his Expedition to inquire into the Pearl Fisheries of that Island, was small, but it contained at least two specimens of great morphological and systematic interest. These two specimens, obviously belonging to the same species, I have placed in a new genus which I have called *Centrosiphon*, their nearest allies amongst the Sipunculoids being *Aspidosiphon* and *Cloeosiphon*, and I have dedicated the species to its discoverer. The collection also included many specimens of the coral *Heteropsammia michelini*, ED. and H., with its associated commensal *Aspidosiphon corallicola*, SLUIT. There were also specimens of the corals *Heterocyathus æquicostatus*, ED. and H., and *Stephanoseris rousseaui*, ED. and H., which no doubt contain also their appropriate species of *Aspidosiphon.* Further, there were three specimens of *As. spiralis*, SLUIT., a single specimen of *As. steenstrupii*, DIES., a single specimen of *Cloeosiphon aspergillum*, QUATR., a few specimens of three species of *Physcosoma*, and a fragment of a *Sipunculus.* The Echiuroids were represented by a single specimen of *Bonellia pumicea*, SLUIT.

SIPUNCULOIDEA.

Aspidosiphon corallicola, SLUITER, Plate I., figs. 1, 2, 3, 11 and 12.

A few specimens of this species, recently described by SLUITER,* were found living in coiled tubes which penetrate the calcareous skeleton of the solitary coral

* C. PH. SLUITER, 'Die Sipunculiden und Echiuriden der Siboga-Expedition,' Leiden, 1902.

Heteropsammia michelini, Ed. and H., kindly identified for me by Mr. J. Stanley Gardiner. The specimens were all in a highly contracted condition, and most of them showed hardly any portion at all of the introvert, but Mr. Gardiner was able to place at my disposal a collection of the same species, made off Madras by Ramunni K. Menon, a former pupil of mine. The external appearance of one or two of these is shown in Plate I., figs. 1 and 2.

Sluiter's material enabled him to confirm Bouvier's view that the original home of the *Aspidosiphon* is a Gasteropod shell on which the young coral comes to rest. This shell becomes gradually embedded in the stony framework of the *Heteropsammia*. The smallest of Sluiter's examples showed the small Gasteropod shell, belonging to the genera *Cerithium*, *Natica*, and others, only partly overgrown and the young Gephyrean living wholly within the shell. In older stages the corallum spreads until it reaches and finally grows past the mouth of the shell, but the shell, according to Sluiter, is not absorbed, but can still be detected if carefully sought for.

On the body, mostly towards the posterior end and therefore, as the animal lies most remote from the opening, of several of Professor Herdman's examples, were a number of minute molluscs which Mr. Edgar A. Smith has kindly examined, and he is of the opinion that they might range with the genus *Mysella* of Angas. The animals are, however, so minute, that their exact determination is a matter of great difficulty.

These were so closely adpressed to the skin of the *Aspidosiphon* as to indent it, appearing as little pearls set in a matrix. The advantage they obtained by taking up such a position is not very evident, but there they were, and as far as one could judge they were, until Professor Herdman dropped them into his collecting jar, flourishing.

The whole question of such commensalism as exists between the *Aspidosiphon* and the coral is an interesting one. Commensalism is usually looked upon as conferring some mutual advantage on the contracting parties, and one or the other of these usually seeks the other out. But in the case in question the mutual advantage is far to seek. It can hardly help the coral to have a large portion of its base burrowed by a spacious canal, but the fact that the Gephyrean pulls the otherwise immovable coral about may be, and probably is, an advantage to the Cœlenterate. On the other hand, the Gephyrean gains protection and a home more spacious than the Gasteropod shell affords. The *Aspidosiphon* can hardly find, or attract the larval coral to come to rest on its burrowed shell, and it is unlikely that the larva is especially on the outlook for such shells as are inhabited by Gephyrea. It seems more probable that the *Aspidosiphon* may select for its home a Mollusc shell which already bears a young coral, but the whole matter seems to demand more careful study. It is certainly remarkable that three distinct genera of coral, each with but one species, should be inhabited by three distinct species of *Aspidosiphon*, and that neither commensal has hitherto been found apart from the other.

The specimens were obtained at various localities in the Gulf of Manaar (Stns. I., II., IV., &c.), and also off Trincomalee (Stns. XX., XXII.), and off Galle (Stns. XXXIX., XLII., and XLIII.).

The Ceylon collection also contains specimens of the corals *Heterocyathus æquicostatus*, Ed. and H., and *Stephanoseris rousseaui*, Ed. and H., showing perforations obviously made by burrowing Gephyrea.

Aspidosiphon spiralis, Sluiter.

Three specimens of this interesting species described by Sluiter from the Siboga Expedition were found living in the shell of three species of *Murex*, *M. fuscus*, *M. haustellum*, and *M. tenuispina*. The species is interesting because it resembles *Phascolion* in living in Mollusc shells, and because in the slight development of the posterior shield, and in the absence of a sharp line of division between the shields and the general surface of the body, it resembles *Physcosoma*.

The body is highly adapted to its home. Coiled spirally, it closely follows the contours of the Murex shell. The stout, tough circular anterior shield, on which the introvert opens excentrically but not quite at the edge, forms an effective guard to the entrance of the shell. This shield is supported by a stout, very muscular part of the body-wall which extends for some tenth or twelfth of the total body-length ; after this the skin becomes extremely thin and transparent. In two of the specimens collected by Professor Herdman the anterior shields were deep black, in the third it had a pinkish hue.

Between the Gephyrean and the Mollusc shell was a packing of sand held together by some secretion. This had a permanent opening at the mouth of the shell through which the introvert could be protruded.

Aspidosiphon steenstrupii, Diesing.

A single specimen, probably a young one, as the calcareous deposit was not visible. The musculature agreed, however, with that of this species, and differed clearly from that of *A. truncatus*. *A. steenstrupii* is the commonest *Aspidosiphon* in the Indian Ocean. The specimen in question was taken at East Cheval Paar, in the Gulf of Manaar, from a cavity in a block of coral.

Centrosiphon herdmani, n. g. et sp.—Plate I., figs. 4–10.

The length of the two specimens, taken at Cheval Paar, Gulf of Manaar, from the oral shield to the posterior end was 3 centims. The diameter of the oral shield was 3 millims., of the posterior shield 2·5 millims. The body between these shields was of rather smaller diameter, and from each shield the skin seemed gradually to grow thinner as it passed towards the centre of the body.

The colour in the spirit specimens was in the main a yellowish-gray, with tinges of a chestnut-brown. In one specimen this colour was very marked around the edge of the oval shield and extended a little way down the body, further on one side than on the other, and then gradually faded out to reappear in a slighter degree on the posterior shield. The same specimen also showed a few irregularly placed and ill-defined blotches of chestnut colour near the centre of the body.

The proboscis was not fully extended in either specimen. It was protruded from the *centre* of the oral shield and extended in one specimen some 3 millims., in the other somewhat less. The proboscis bears anteriorly several rows of chitinized processes obviously homologous with the hooks of other forms. Further back it bears prominent rounded papillæ, which are continuous with those on the anterior shield (fig. 5). This shield, like the posterior one, is separated from the sides of the body by a well marked rim. The papillæ on the anterior shield are uniformly scattered, but on the posterior shield they run in radiating lines from the rim to the thickened and somewhat indented centre. The walls of the body are comparatively smooth, with at best a few low papillæ, and these mostly at the two ends.

I opened one specimen with a longitudinal incision, and the following is an account of the arrangement of the internal organs. Unfortunately the specimen had had its alimentary canal broken, and the contents, consisting of sand and fragments of shell, were all over the place, and much impeded observation.

The longitudinal muscles of the skin are continuous, as in some of the species of *Aspidosiphon*, and the interior of that covering presents a smooth glistening gray surface. The alimentary canal seemed slightly coiled, but it was impossible to determine if there was a spindle muscle or not.

There are four retractor muscles, two ventral and two dorsal; only two, and these are often fused, occur in *Aspidosiphon* (fig. 8). The ventral are far stouter than the dorsal, and arise further back at about the level of the junction of the anterior quarter with the posterior three-quarters of the animal. The dorsal muscles are hardly half so thick as the ventral. They have their origin a little to right and left of the anus and at about the same level, which is some 2 or 3 millims. behind the edge of the oral shield.

At the base of the attachment of the large ventral muscles is a well marked fringe which obviously gives rise to the reproductive cells.

A single pair of nephridia lie one on each side of the anus. Their external openings lie close to the edge of the dorsal shield, and probably just behind it.

The introvert of both specimens was half everted, and I cut sections of one of them. Unfortunately there was a little sand in the interior of the introvert, and some of the sections were much broken. I was, however, able to make out that the number of tentacles is somewhere about twelve to fifteen. Each tentacle is triangular in section, with a well marked ciliated groove continued down into one of the grooves which line the beginning of the œsophagus. The transverse section also shows the three spaces continuous with the body cavity which communicate at the tip, and which by allowing the entrance of the cœlomic fluid extend the tentacle. As far as I could make out, the tentacles arise from a ring and not from a horseshoe, and the mouth is in the centre of the ring.

Behind the bases of the tentacles were little projections of the epidermis bearing thickened, cuticular projections (fig. 10). These morphologically resemble hooks, but no part of the tip is bent over, and the whole structure is something like a blunt spear-head. They are undoubtedly the homologues of the hooks in other unarmed Gephyrea, and in structure they fairly closely resemble the processes called "hooks" in *Sipunculus australis*, the only member of the genus *Sipunculus* which has "hooks." The spear-head projections were apparently arranged in rings, but with the somewhat broken sections, obliquely cut, it was not possible to definitely make out how many rings there were. Figure 10 also shows the very prominent papillæ of the posterior part of the introvert—the outer layer in the figure—the continuous layer of muscles, the nervous system cut twice, and the almost completed fusion of the retractor muscles around the base of the head.

Part of the brain is shown in section in figure 9, which has been cut through the pigmented, concave layer of cells which forms the eye.

Genus: **Centrosiphon**, n. g.

The new genus may be characterized as follows:—Sipunculoids with circular anterior and circular posterior thickened, chitinoid shields; the introvert emerges from the anterior shield in the centre, and is not inclined to one side more than to any other, it is quite central; both shields are separated from the side walls of the cylindrical animal by a prominent ridge; the papillæ are very prominent on the introvert, and on it and the anterior shield they are uniformly scattered, on the posterior shield they are in radiating lines; anteriorly and just behind the mouth are rows of spear-head-shaped chitinized projections obviously homologous with the hooks of other species.

Species: **Centrosiphon herdmani**, n. g. et sp., Plate I., figs. 4, 5, 6, 7, 8, 9 and 10.

With only two specimens at one's disposal, and those of the same species, to attempt to pick out the specific characters partakes of the nature of prophecy, but, judging by other and allied Gephyrea, the following, or some of them, will probably rank as specific characters:—Longitudinal muscles in a continuous sheath; four retractor muscles, of these the ventral are very thick and inserted about a quarter of the animal's length behind the anterior shield, and the dorsal are very slim and inserted one on either side of the anus, a very little way behind the anterior shield; the nephridia are rather dorsal in position and open close to the edge of the dorsal shield; the tentacles are few in number, some twelve or fifteen, and probably surround the mouth as a simple ring; eyes well developed; no calcareous deposits on either shield.

Systematic Position.

Centrosiphon belongs to the same group of Sipunculoids as *Aspidosiphon* and *Cloeosiphon.* All three genera possess a posterior and an anterior shield, the latter being placed but slightly in front of the anus and at the base of the introvert. *Centrosiphon* differs from *Aspidogaster* in that its introvert emerges from the centre of a round shield, quite symmetrically, and in a line corresponding with the long axis of the body. In *Aspidosiphon* the anterior shield is shaped something like a cockle-shell, and the introvert emerges at or near the narrow end and is at an angle with the main axis of the body. *Centrosiphon* differs from *Cloeosiphon* in the absence of the very characteristic calcareous ring round the base of the siphon, with its lozenge-shaped areas, and in the absence of true hooks, though the latter are represented by chitinized prominences. It resembles *Cloeosiphon* in its central proboscis and in its continuous sheath of longitudinal muscles. In *Aspidosiphon* the sheath may or may not be continuous. It differs from both genera in possessing four retractor muscles, and in the fact that its anterior shield forms a flat platform and not a radially or bilaterally symmetrical cone.

Cloeosiphon aspergillum, Quatr.

A single specimen, from Stn. XLIV., West of Pantura, 30 fathoms. This species is common in the Indian Ocean and parts of the Pacific. The "Siboga" took this form at thirteen stations, and in his account of the Gephyrea collected by the Expedition on that vessel, Sluiter records his view that the variety *javanicum* should be dropped.

Physcosoma agassizii, Sel. and de Man.

A single specimen was taken at Stn. LV., South-west of Periya Paar, in the Gulf of Manaar; depth, 11–14 fathoms.

Physcosoma asser, Sel. and de Man.

Three specimens; one from the Pearl Banks off Aripu (Stn. LIV.), and another from the Lagoon, Galle. Since my paper in the 'Fauna and Geography of the Maldive and Laccadive Islands,' this form has been recorded by Sluiter from four of the "Siboga" stations.

Physcosoma scolops, Sel. and de Man.

Three specimens of this genus are described as coming "out of a scarlet-ball sponge (*Axinella tubulata*), Cheval Paar (Stn. IX., 7 fathoms)," and also West of Periya Paar, 12–14 fathoms, in the same sponge. The species is very common all over the Indian Ocean from the Red Sea and the East Coast of Africa to the East Indies.

Sipunculus, sp.

A fragment of a *Sipunculus*, which was insufficient to allow of identification, was taken at Stn. LVI., south of Dutch Modragam Paar; depth, 8–9 fathoms.

ECHIUROIDEA.

Bonellia pumicea, Sluit.

The only Echiuroid in the collection was a *Bonellia*, from Galle, which I rather doubtfully identify with Sluiter's *Bonellia pumicea* ('Natuurk. Tijdschr. v. Nederl. Ind.,' vol. 50, 1890, p. 111).

EXPLANATION OF PLATE I.

Figs. 1, 2, 3, 11, and 12 are of *Aspidosiphon corallicola*; figs. 4–10, inclusive, are of *Centrosiphon herdmani*.

Fig. 1. Side view of *Aspidosiphon corallicola*, Sluit. × 10. The introvert is extended, but not quite to its full extent.

Fig. 2. View of anus of the same species, with the thickenings of the anterior shield sloping away from it.

Fig. 3. View of head of the same species showing the ring of tentacles.

Fig. 4. Side view of *Centrosiphon herdmani*, n. g. et sp., with the introvert slightly extended from the anterior shield. × 8. The chestnut-coloured patches seen on one of the specimens are well shown here.

Fig. 5. A view of the anterior plate and introvert of the same specimen seen from above. × 8.

Fig. 6. A view of the posterior plate of the same specimen seen from below. × 8.

Fig. 7. A transverse section through one of the papillæ around the base of the head of the same species showing the chitinous thickening. Highly magnified.

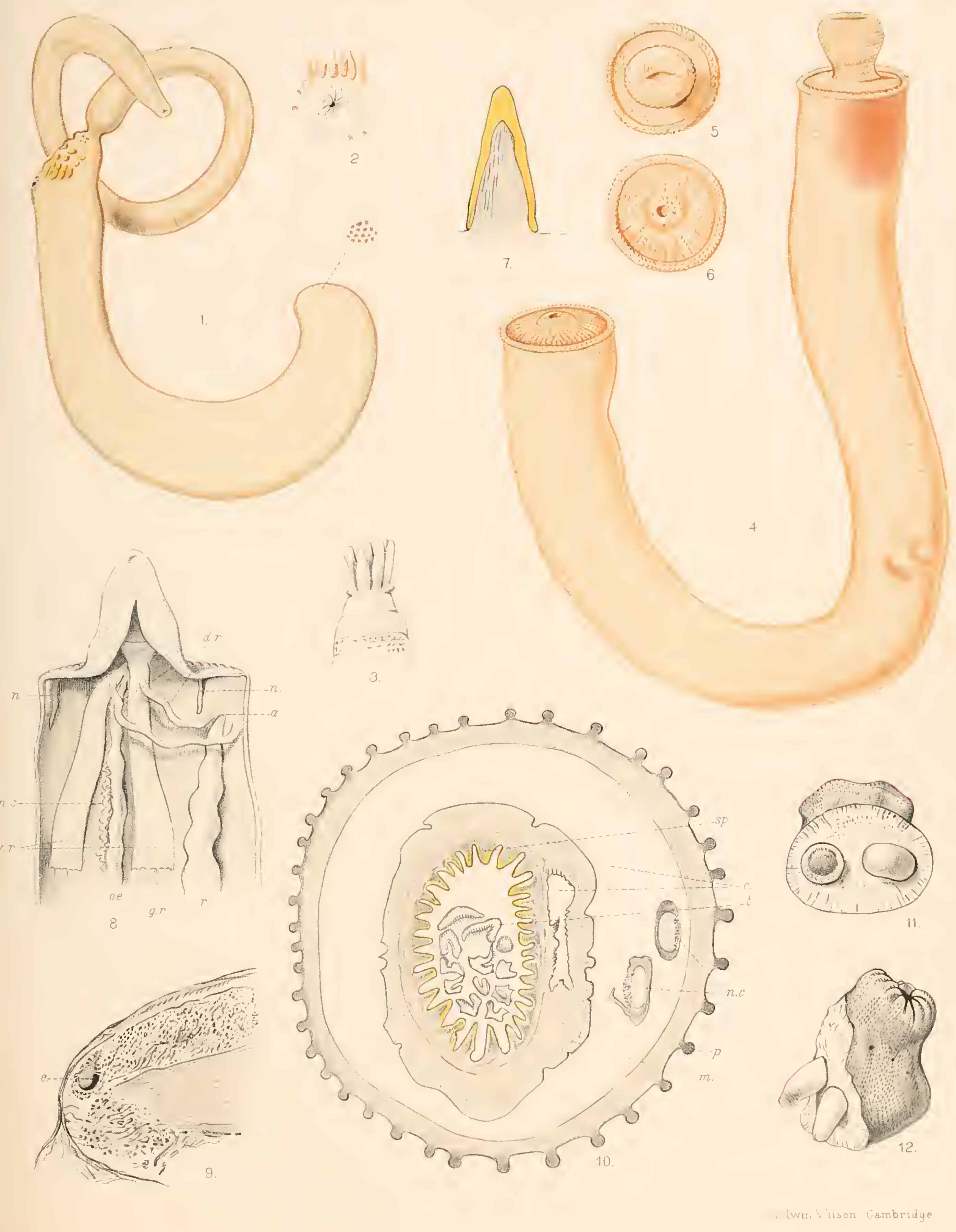
Fig. 8. View of the anterior end of the same species, cut open so as to expose the viscera. × 16 *a.*, position of anus; *d.r.*, the short, slender dorsal retractor muscles; *œ.*, œsophagus; *g.r.*, genital ridge at the base of the ventral retractor muscles; *n.*, nephridia; *n.c.*, ventral nerve cord; *r.*, rectum; *r.r.*, ventral retractor muscles.

Fig. 9. View of a section through the supra-œsophageal ganglion of the same showing *e.*, the eye. Highly magnified.

Fig. 10. Transverse section through the introvert partly retracted, showing the small group of grooved tentacles and the rows of chitinized spines. Highly magnified. *c.*, body-cavity, the isolated portion of this space runs up between the ventral retractors and soon disappears, as the four retractors fuse to form the muscular sheath *m.* round the head; *n.c.* nerve cord, which, owing to the retraction of the introvert, is bent, and thus cut across twice; *p.*, papillæ on the lower part of introvert; *s.p.*, chitinized spines round the base of the head; *t.*, transverse sections of tentacles.

Fig. 11. A *Heteropsammia michelini*, Ed. and H., broken across transversely, showing the head end to the left, and the tail end to the right of an *Aspidosiphon corallicola*, Sluit. × 2.

Fig. 12. Another specimen of the same, fractured longitudinally. The head end of the *Aspidosiphon* is above. The coral shows three pores on its side which communicate with the coiled tube in which the Gephyrean lives.



Edwin Wilson Cambridge

SIPUNCULIDS FROM CEYLON.

REPORT

ON THE

POLYPLACOPHORA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

E. R. SYKES, B.A., F.L.S.

[WITH ONE PLATE.]

THE large proportion of species described as new in the following pages is not so surprising as it might appear, since we know but little of the fauna of Ceylon, so far as the Chitons are concerned.

The collection includes nine species. Of these, three are identified (one doubtfully) with known forms; five are described as new; and, in one case, that of a single specimen of an *Ischnochiton*, I have thought it wiser to give no specific name.

Callochiton sublævis, n. sp.—Plate I., fig. 3.

Shell in shape, sculpture and girdle pattern similar to *C. lævis* (MONT.). Colour a uniform dark red, the interior of the valves being the same colour. The valves slightly concave in front of the line dividing the lateral and central areas. Valve slits: anterior 14, median 1, posterior 15.

Length, when alive, about 12 millims.

Hab. :—Navakaddua Paar, 7 fathoms, on Coral (one specimen).

The only salient features that I can trace to sever this form from the European *C. lævis* are the median valves having only one slit, the dark red colour inside the valves, and the slight concavity before the line dividing the lateral and central areas.

There is, in the British Museum, a single specimen from the Philippines, bearing the manuscript name of *sublævis*, CARPENTER, which probably belongs to the present species.

Callochiton platessa (Gould) ?

A single specimen, not in very good condition, from the lagoon inside the coral reef at Galle.

Ischnochiton ravanæ, n. sp.—Plate I., fig. 4.

Shell elongate, well elevated. Ground colour white, blotched and marbled with varying colours, black and purple predominating. Sculpture on the lateral areas, well-marked riblets, generally with an angle in the centre of the ribs, pointing towards the girdle; median areas smooth to the eye, but microscopically punctate. Sculpture of the posterior portion of the posterior valve similar to the lateral areas. The anterior valve is marked by slight depressed distant riblets, similar to lines of growth. Interior white, slightly tinted with yellow. Anterior valve with 8, median 1, posterior 15 slits.

Girdle scales broad, flat, thick, strongly striated.

Length, when alive, about 25 millims.

Hab. :—Donnan's Muttuvaratu Paar, 8 fathoms (one specimen).

Ischnochiton herdmani, n. sp.—Plate I., fig. 6.

Shell much elongated, narrow, moderately elevated. Ground colour a greenish-grey with delicate marking of brown, green, yellow, &c.

The sculpture is difficult to describe; the anterior valve and posterior area of the posterior valve are marked by a number of concentric ridges, the edges of these ridges being broken and roughened; the lateral areas of the median valves are similarly sculptured; the anterior portion of the posterior valve and the median areas are marked by a number of crossing lines, which give the appearance of the shell having been stabbed with a broad, blunt dagger; on the jugal tract these lines lengthen out and the stab-marks become finer and much more elongate. Interior white, tinged with pink. Anterior and posterior valves with 9, median with 1 slit.

Girdle wide, with squarish flat, well striated, scales.

Length, when alive, about 40 millims.

Hab. :—The lagoon inside the coral reef at Galle (three specimens).

Related to *I. alatus*, Sby, but more depressed and differing in sculpture.

Ischnochiton ferreus, n. sp.—Plate I., fig. 5.

Shell ovate, eroded and covered with a brown rusty staining, but apparently whitish below. Sculptured on the median valves with about ten radiating riblets on the lateral areas and distant longitudinal riblets on the median areas. The anterior valve and posterior valve (behind the mucro) appear to be sculptured as the lateral areas.

Interior white, stained with brown. Anterior valve with 13, median 1, posterior 13 slits.

Girdle with broad, flat, finely striated scales; some scales do not show the sculpture, but this is, I think, due to erosion.

Length, when alive, about 15 millims.

Hab. :—Trincomalee (one specimen).

Ischnochiton, sp.

A single specimen, from the Gulf of Manaar.

Craspedochiton laqueatus (SBY).—Plate I., fig. 7.

> **Chiton laqueatus**, SBY: 'P. Zool. Soc.,' 1841, p. 104.
>
> ———————: REEVE, 'Conch. Icon.,' Plate XX., fig. 135.
>
> **Craspedochiton laqueatus**, SBY: SHUTTLEWORTH, 'Bern. Mittheil.,' 1853, p. 67; PILSBRY, 'Man. Conch.,' vol. 14, p. 285.
>
> **Angasia tetrica**, CARPENTER: PILSBRY, 'Man. Conch.,' vol. 14, p. 287.

Hab. :—South of Modragam Paar (Stn. LXIV.), 5 fathoms; and North of the Gulf of Manaar (Stn. LXII.), 7–13 fathoms (several specimens).

I am unable to sever the Philippine shell from the Ceylon form described as *A. tetrica*. The species has a varied generic history, as it forms the type of *Craspedochiton*, SHUTTLEW., *Angasia*, CARPENTER, nec WHITE, and *Phacellozona*, PILSBRY.

A single specimen from "Palk Bay, February, 1902," I refer here with some doubt, as it is slightly more elevate, the posterior valve shows no trace of the radiating lines, and there are other minor differences.

Acanthochites penicillatus (DESH.)—Plate I., fig. 2.

> **Chiton penicillatus**, DESHAYES: 'Moll. Réunion,' p. 41, Plate VI., figs. 8–10.
>
> **Chiton (Acanthochites) penicillatus**, DESH.: MARTENS in MÖBIUS' 'Reise Mauritius,' p. 300.
>
> **Acanthochites penicillatus**, DESH.: PILSBRY, 'Man. Conch.,' vol. 15, p. 15, Plate IV., fig. 84, Plate VIII., figs. 29, 30.

Hab. :—Gulf of Manaar (two specimens).

I identify the Ceylon with the Mauritian shell with a little doubt, as I know the latter only from figures and descriptions.

Tonicia pectinoides, n. sp.—Plate I., fig. 1.

Shell ovate, broad, elevated. Colour, reddish to yellowish-green. Lateral areas well raised. The central areas and anterior portion of the posterior valve are sculptured with longitudinal, broad, flattened riblets, the interstices marked by minute, crossing riblets, somewhat as is frequently seen in the Pectinidæ. Anterior valve, posterior portion of posterior valve, and lateral areas marked with flattened nodules, those on the median valves being fewer in number, irregular in size, and more widely separated. Mucro posterior and much elevated.

Interior white. Median valves with 1, anterior with 8, posterior valve with numerous small slits.

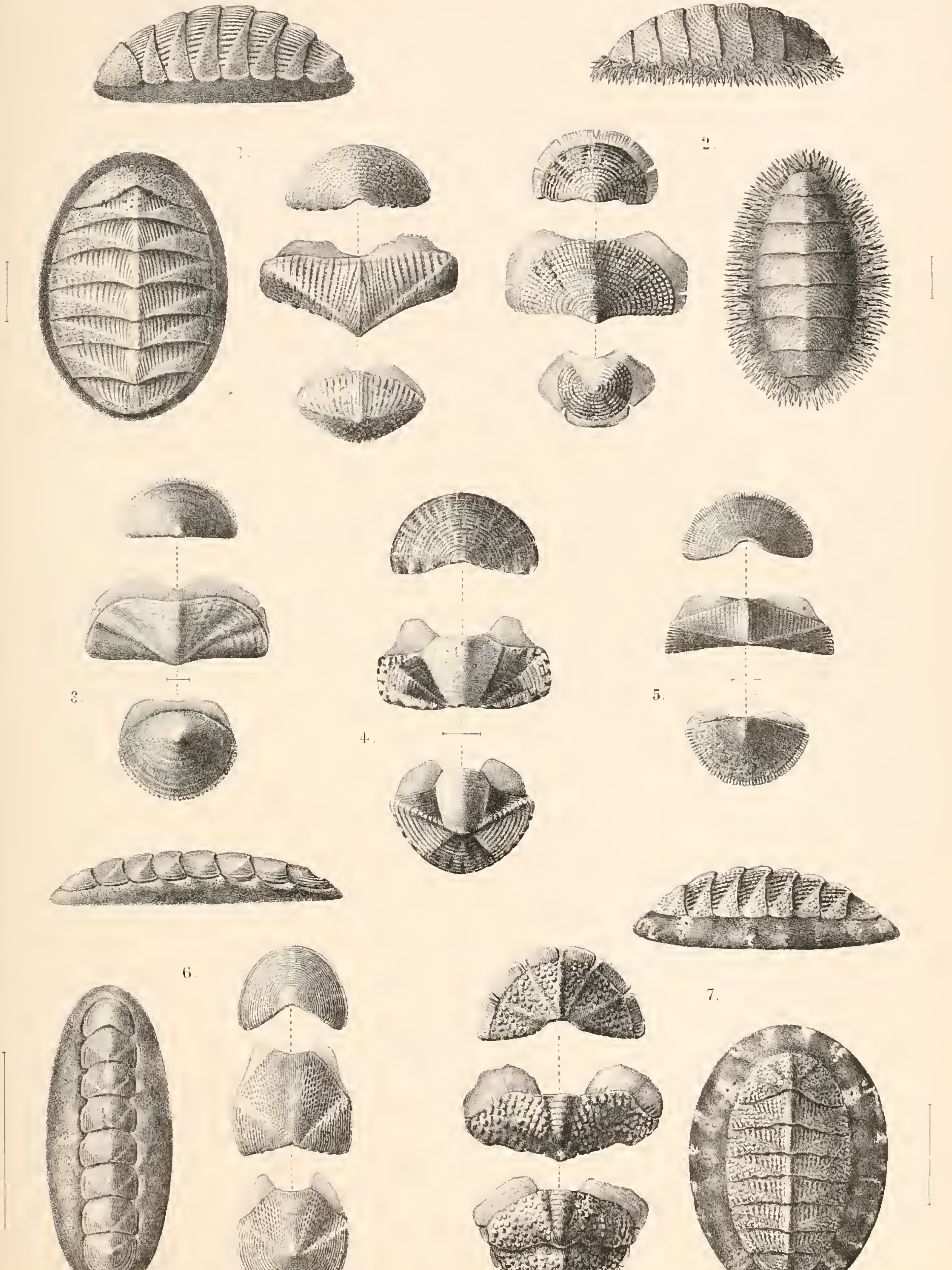
Girdle microscopically setose.

Length, when alive, about 18 millims.

Hab.:—Pearl-banks in the Gulf of Manaar and deep water off Galle (Stn. XL.), 34 fathoms (two specimens).

EXPLANATION OF PLATE I.

Fig. 1. *Tonicia pectinoides*, n. sp.
Fig. 2. *Acanthochites penicillatus* (Desh).
Fig. 3. *Callochiton sublævis*, n. sp.
Fig. 4. *Ischnochiton ravanæ*, n. sp.
Fig. 5. *Ischnochiton ferreus*, n. sp.
Fig. 6. *Ischnochiton herdmani*, n. sp.
Fig. 7. *Craspedochiton laqueatus* (Sby).



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SPECIES OF POLYPLACOPHORA

REPORT

ON THE

HOLOTHURIOIDEA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH PLATES I. TO III.]

THE HOLOTHURIANS obtained by Professor HERDMAN during his expedition to Ceylon have proved to be a very interesting and extensive series.

The collection consists of 70 specimens, which are distributed amongst 10 genera and about 30 species. Of these I find that seven are new to science and there are also at least two new varieties. One of the new species requires the formation of a new genus, *Havelockia*, near to *Colochirus* in the Dendrochirotæ.

In the main I have followed the classification and nomenclature adopted by LUDWIG (12).* I have, however, taken JEFFREY BELL'S (16, 17) suggestion with regard to the generic name *Actinopyga*.

The following is a list of the species in the collection :—

Synapta striata, Sluiter.
Synapta beselii, Jäger.
Synapta, sp. (?).
Synapta, sp. (?).
Cucumaria tricolor, Sluiter.
C. turbinata (Hutton).
C. imbricata (Semper).
C. conjungens, Semper.
Thyone fusus, var. *papuensis*, Théel.
Thyone sacellus (Selenka).
Thyone (?) *fusca*, n. sp.
Thyone (?) *hornelli*, n. sp.
Thyone (?) *calcarea*, n. sp.
Phyllophorus cebuensis (Semper).
Actinocucumis donnani, n. sp.
Colochirus quadrangularis, Lesson.
Col. quadrangularis, var. *mollis*, nov.
Col. doliolum (Pallas).

* The numbers in brackets refer to the List of Literature on p. 206.

Colochirus, sp. (?).
Havelockia herdmani, n. gen. & sp.
Actinopyga mauritiana (Quoy and Gaimard).
Actinopyga serratidens, n. sp.
Holothuria kurti, Ludwig.
H. monacaria (Lesson).
H. vagabunda, Selenka.
H. tenuissima, Semper.
H. marmorata (Jäger).
H. atra, Jäger.
H. gallensis, n. sp.
Stichopus chloronotus, Brandt.
St. chloronotus, var. *fuscus*, nov.
St. variegatus, Semper.

In addition to these, the field notes made by Professor HERDMAN and Mr. HORNELL show that they observed two species (or varieties) of *Psolus*, the one black and the other grey, on the East Cheval Paar.

So far as I am aware, this is much the largest collection of Holothurians that has been yet obtained from the seas of Ceylon. Until about twenty years ago no Holothurians had been definitely recorded from that coast. Owing mainly to the work of Drs. PAUL and FRITZ SARASIN, of Mr. EDGAR THURSTON, of Madras, and others, the number on record had lately reached the total of 37 species. Professor HERDMAN'S Holothurian collection, in addition to a number of the forms previously known, contains at least 20 species and distinct varieties which are now recorded from Ceylon for the first time, thus bringing the total number of known species and varieties up to 57, as shown in the following list. The first column gives those species reported by Mr. THURSTON (**19**) from the Gulf of Manaar, the second those described by Professor JEFFREY BELL (**8**), the third shows those collected by Drs. P. and F. SARASIN, chiefly at Trincomalee, and described by Professor LUDWIG (**9**), the fourth those few collected by Professor HAECKEL, and described by Dr. WALTER (**18**), and the fifth column gives those collected by Professor HERDMAN in 1902, and described in the present report.

LIST of Ceylon Holothurians.

Name of Species.	THURSTON.	BELL.	SARASIN.	HAECKEL.	HERDMAN.
Synapta beselii, Jäger		×			×
S. grisea, Semper		×			
S. recta, Semper	×				
S. striata, Sluiter					×
S. sp. (? n. sp.)					×
S. sp. (? n. sp.)					×
Chirodota rufescens, Brandt		×			
Ch. dubia, Semper				×	
Haplodactyla molpadioides, Semper		×			
Hap. australis, Semper	×		×		

List of Ceylon Holothurians—continued.

Name of Species.	THURSTON.	BELL.	SARASIN.	HAECKEL.	HERDMAN.
Cucumaria semperi, Bell	×				
C. turbinata (Hutton)					×
C. tricolor, Sluiter					×
C. imbricata (Semper)			×		×
C. conjungens, Semper					×
Thyone sacellus (Selenka)	×				×
Th. fusus, var. *papuensis*, Théel					×
Th. (?) *fusca*, n. sp.					×
Th. (?) *hornelli*, n. sp.					×
Th. (?) *calcarea*, n. sp.					×
Phyllophorus cebuensis (Semper)					×
Actinocucumis typica, Ludwig	×				
Actinocucumis donnani, n. sp.					×
Colochirus quadrangularis, Lesson	×				×
Col. quadrangularis, var. *mollis*, nov.					×
Col. doliolum (Pallas)					×
Col. armatus, Marenzeller		×			
Col. sp. (?)					×
Havelockia herdmani, n. gen. et sp.					×
Actinopyga mauritiana (Q. and G.)		×			×
Act. miliaris, Q. and G.		×	×		
Act. echinites, Jäger			×		
Act. lecanora, Jäger			×		
Act. serratidens, n. sp.					×
Act. sp. (Walter)				×	
Holothuria argus, Jäger		×			
H. atra, Jäger	×	×	×		×
H. caesarea, Ludwig		×			
H. impatiens, Forskaal		×	×		
H. ondaatjei, Bell		×			
H. marmorata, Jäger	×				×
H. monacaria, Lesson	×		×		×
H. vagabunda, Selenka	×				×
H. scabra, Jäger			×		
H. pulchella, Selenka		×			

List of Ceylon Holothurians—continued.

Name of Species.	Thurston.	Bell.	Sarasin.	Haeckel.	Herdman.
H. spinifera, Théel			×		
H. pardalis, Selenka			×		
H. fusco-cinerea, Jäger			×		
H. edulis, Lesson			×		
H. imitans, Ludwig			×		
H. marenzelleri, Ludwig			×		
H. kurti, Ludwig					×
H. gallensis, n. sp.					×
H. tenuissima, Semper					×
Stichopus variegatus, Semper			×		×
St. chloronotus, Brandt			×		×
St. chloronotus, var. *fuscus*, nov.					×

Geographical Distribution.

An examination of the geographical distribution of the Ceylon Holothurians shows clearly that they are typically Indo-Pacific forms; and that their recorded occurrences form an equatorial belt, ranging from the east coast of Africa to the South Pacific.

It will be seen from the following table that only four of the 53 named species have been found in the North Pacific, namely, *Holothuria fusco-cinerea*, *Colochirus armatus*, *Thyone sacellus* and *Actinocucumis typica*; while the Atlantic fauna is only represented by three species, which occur, two in the Caribbean Sea (*Holothuria atra* and *H. impatiens*) and one at the Cape of Good Hope (*Colochirus doliolum*).

The table shows the recorded distribution of Ceylon Holothurians in the great oceans of the world. The concentration in the right-hand columns, which indicate the Indo-Pacific region, is most marked.

Name of Species.	N. Atlantic.	S. Atlantic.	N. Pacific.	S. Pacific.	Indian Ocean.	E. Indies (Malay Seas).	Australasia.
Synapta beselii, Jäger				×	×	×	
S. grisea, Semper					×	×	×
S. recta, Semper						×	
S. striata, Sluiter						×	

Name of Species.	N. Atlantic.	S. Atlantic.	N. Pacific.	S. Pacific.	Indian Ocean.	E. Indies (Malay Seas).	Australasia.
Chirodota rufescens, Brandt						×	
Chir. dubia, Semper					×		
Haplodactyla molpadioides, Semper					×	×	
Hap. australis, Semper						×	
Cucumaria semperi, Bell						×	×
C. turbinata (Hutton)					×		×
C. tricolor, Sluiter					×	×	
C. imbricata (Semper)					×	×	
C. conjungens, Semper					×	×	
Thyone sacellus (Selenka)			×		×	×	
Th. fusus, var. *papuensis*, Théel							×
Th. (?) *fusca*, n. sp.					×		
Th. (?) *hornelli*, n. sp.					×		
Th. (?) *calcarea*, n. sp.					×		
Phyllophorus cebuensis (Semper)					×	×	
Actinocucumis typica, Ludwig			×		×		×
Actinocucumis donnani, n. sp.					×		
Colochirus quadrangularis, Lesson					×	×	×
Col. quadrangularis, var. *mollis*, nov.					×		
Colochirus doliolum (Pallas)		×					×
Col. armatus, Marenzeller			×		×		
Havelockia herdmani, n. gen. & sp.					×		
Actinopyga mauritiana (Q. and G.)				×	×	×	
Act. miliaris (Q. and G.)				×	×	×	
Act. echinites, Jäger					×	×	
Act. lecanora, Jäger				×	×	×	
Act. serratidens, n. sp.					×		
Holothuria argus, Jäger				×		×	
H. atra, Jäger	×			×	×	×	
H. caesarea, Ludwig				×			
H. impatiens, Forskaal	×			×	×	×	
H. ondaatjei, Bell					×		
H. marmorata, Jäger				×	×	×	
H. monacaria, Lesson				×	×	×	×

Name of Species.	N. Atlantic.	S. Atlantic.	N. Pacific.	S. Pacific.	Indian Ocean.	E. Indies (Malay Seas).	Australasia.
H. vagabunda, Selenka				×	×	×	
H. scabra, Jäger					×	×	
H. pulchella, Selenka				×	×	×	
H. spinifera, Théel						×	
H. pardalis, Selenka				×	×		
H. fusco-cinerea, Jäger			×	×		×	
H. edulis, Lesson					×	×	
H. imitans, Ludwig				×			
H. marenzelleri, Ludwig					×		
H. kurti, Ludwig					×	×	
H. gallensis, n. sp.					×		
H. tenuissima, Semper				×	×	×	
Stichopus variegatus, Semper					×	×	
St. chloronotus, Brandt				×	×	×	
St. chloronotus, var. *fuscus*, nov.					×		

I wish finally to express my thanks to Professor Herdman for allowing me to examine this most interesting collection, as well as for the advice and assistance which he was always willing to give in the solution of points of difficulty.

HOLOTHURIOIDEA.

Order: PARACTINOPODA.

Family: SYNAPTIDÆ.

Synapta striata, Sluiter (10)—Plate I., fig. 1.

Eight specimens from the outer part of Yard Cave, Trincomalee (Stn. XXVI.), 2–8 fathoms.

Lengths range from 15 millims. to 85 millims. The smaller specimens are evidently in a contracted condition.

The following is Professor Herdman's description taken from the living animal;—

"Living amid sponge branches. Colour, striped lilac on a white ground. The five rays of the body are marked by five narrow white bands. The region between these rays is marked with numerous delicate lilac stripes forming a pattern which is variable in different individuals. The tentacles are used for progression and are flattened for two-thirds of the way from the apex."

There are 13 tentacles present, each having 19 digits. Plate I., fig. 1, shows the flattened extremity of a tentacle, as drawn from the living animal in Professor HERDMAN'S note-book.

There are about 18 Polian vesicles in the specimen dissected, 6 being large and the rest smaller. There is one madreporic canal. The alimentary canal is looped.

The deposits agree with SLUITER'S figures. I have found, however, that some of the anchor plates differ from the usual form in having *smooth* holes. There are also present in the skin numerous miliary granules which are arranged in groups of six or seven, having typically one central granule surrounded by numerous granules in a circle. This species appears to be very closely allied to *S. recta* and *S. indivisa.*

This species is now recorded from Ceylon for the first time.

Distribution :—Java and Ceylon.

[**Synapta beselii**, JÄGER.

A large *Synapta*, measuring 6 feet in length, was found by Mr. HORNELL at Galle. The specimen has not reached me, but the size and description agreed so well with *S. beselii*, already known from Ceylon, that there can be little doubt as to the species.

Distribution :—Indian Ocean, Philippines, South Pacific and East Indies.]

Synapta, sp. (? n. sp.).

This is a fragment from the south west of Palk Bay (Stn. XVIII.), 7 fathoms, in mud. Only the posterior portion of the body remains.

The fragment is 50 millims. long, and the body is evidently in a very contracted condition. All the internal organs are torn away. Still the specimen clearly belongs to a species of *Synapta.*

Deposits :—The anchor plates are in all cases imperfect. The plates are covered with short spines and are perforated by a large number of small holes of various sizes. The anchors are large, and the handle is serrated. So far as I am able to determine, these spicules do not resemble those of any known species, but the incomplete state of the specimen does not permit me to make a definite decision with regard to its identity, nor to describe it more fully.

Synapta, sp. (? n. sp.).

One specimen from Galle. This specimen is in a poor state of preservation, so that I cannot be absolutely certain as to its identity.

There are 12 tentacles, each having 5 digits.

Deposits:—The anchor arms are not always symmetrically placed. They are slightly serrated. The anchor handles are strongly serrated. The anchor plate is perforated irregularly—the arrangement differing in different plates. There are several larger holes with serrated margins, and also several smaller smooth holes. There is no handle to the plate. There are also a number of short rods scattered throughout the skin, having a small hole at each end.

Neither this nor the preceding species can possibly belong to any of the species previously recorded from Ceylon, viz., *S. striata*, *S. recta*, *S. grisea*, and *S. beselii*, and in their spicules they seem to differ from all known species of the genus. Consequently, they probably both of them represent new species, but they are too fragmentary to be described.

Order: ACTINOPODA.

Family: DENDROCHIROTÆ.

Cucumaria tricolor, Sluiter (15).

One specimen from near Donnan's Paar (Stn. LX.), Gulf of Manaar, 28 fathoms.

Length of body, 30 millims.

The following is a description of the colour of the living animal as noted by Professor Herdman:—"The interambulacra are violet-purple, and the ambulacra appear as light yellow bands, on which are situated pedicels of a deeper yellow." There are also a couple of sketches in the notes which agree with Sluiter's figures and show the characteristic form of body.

The body is curved so that the anus is thrown on to the dorsal surface, thus making the trivium longer than the bivium. The pedicels on the trivium are arranged in three well-defined series, each series being composed of two or three rows. The pedicels on the bivium are not so easily determined, and only on careful examination can an irregular and feebly marked single row of scattered pedicels be distinguished on each side of the dorsum.

The mouth, which is terminal, is surrounded by five very prominent rows of protuberances which terminate the five ambulacra of the body. These prominences, of which there are three in each row, do not appear to be tube feet, but are more probably papillæ. The anus is armed with five teeth, and is surrounded by four papillæ similar to those surrounding the mouth. Gonads are not present.

No deposits were found in the skin.

The calcareous ring is small and consists of ten pieces, without any posterior prolongations. It agrees with Sluiter's drawing.

The only serious difference between Sluiter's description and the above is with regard to the calcareous deposits. The Ceylon specimen has no deposits; but since it has been kept for several months in a solution of formol, it is by no means safe to attach importance to this fact.

There is a slight disagreement in the arrangement of the pedicels. SLUITER'S specimen had five well-marked series of pedicels, those on the trivium consisting of five or six rows, and those on the bivium of two or three rows. But the smaller number of pedicels on the Ceylon specimen may be explained by the fact that it is evidently much younger, being only one-fifth the size.

There is also a slight difference of colour. The pedicels of SLUITER'S specimen were red; those of the Ceylon specimen were a "deep yellow." This is probably of no importance.

This species is now recorded from Ceylon for the first time. Its known distribution is Aru Islands and Ceylon.

Cucumaria turbinata (HUTTON), Plate I., figs. 2–6.

Labidodesmus turbinata, HUTTON (3), 1878.

One specimen from Gulf of Manaar (Stn. VI.), 6 to 9 fathoms.

HUTTON described this species under the name *Labidodesmus turbinata*, but THÉEL, in his "Challenger" report, places it in the genus *Cucumaria*, with the remark that a re-description of the animal is necessary.

So far as I can ascertain from HUTTON'S scanty description, the Ceylon specimen is identical with his New Zealand species, the type specimen of which is now in the British Museum. Professor HERDMAN has kindly examined for me the British Museum specimen, and compared it with my description and drawings of the Ceylon specimen, and was convinced that both belong to the same species. As HUTTON, in his description, said nothing about deposits, Professor F. JEFFREY BELL kindly allowed me to examine a small piece of the skin of the British Museum specimen. I found that there were no deposits present, but since the specimen has been preserved for 25 years, it is by no means safe to conclude that the skin of the living animal was devoid of calcareous spicules. I am now, therefore, able to supply what THÉEL stated was necessary, namely, a re-description of HUTTON'S species.

The following is a description of the Ceylon specimen, which I believe to be that species:—

Length, 25 millims. Greatest width, 12 millims.

The colour of the spirit specimen is dark brown on the bivium, and lighter brown on the trivium. The body (Plate I., fig. 6) is widest at the middle, and at the anterior end tapers into a cylindrical neck which is about one-third of the length of the body. At the posterior end the body suddenly contracts and ends in a point at the anus.

The New Zealand specimen ends in a "short pointed tail" at the posterior end. There is no actual process or "tail" in the Ceylon specimen, but it is not inconceivable that during life the animal may have had a short posterior projection which has become retracted. The difference, however, between the British Museum specimen and the Ceylon specimen is, Professor HERDMAN informs me, not now very marked in this respect.

There are five series of pedicels; each series consists of a double row on the "neck," but on the wider portion of the body each series of the trivium consists of about four rows, while each series of the bivium consists of two or three rows. At the posterior end the series are not so well defined, each having only one or two rows of pedicels. There are also one or two pedicels on the interambulacra.

The sucking discs of the pedicels are dark brown or almost black in colour, thus being easily distinguished on the lighter skin.

There are no anal teeth. The tentacles have been cast off.

Deposits:—The spicules (Plate I., figs. 2 to 4) are of one kind and are numerous. Typically they are like a cross having four arms in one plane and with two additional arms arising at right angles to this plane at the junction of the four arms. There are many variations of this, some appearing like a short rod covered with many spines.

The calcareous ring (Plate I., fig. 5) is 5 millims. long and consists of ten pieces. The inter-radials are small and are separate from the radials. The radials are bifurcated posteriorly, and the bifurcations are composed of several small pieces.

There is one stone canal and one Polian vesicle.

The retractor muscles are remarkably long, and are attached to the longitudinal muscles halfway down the body.

Distribution:—New Zealand, Ceylon. Now recorded from the Indian Ocean for the first time.

Cucumaria imbricata (SEMPER).

Ocnus imbricatus, SEMPER (2), 1868. **Ocnus javanicus**, SLUITER, 1880. **Ocnus typicus**, THÉEL (7), 1886.

Ten specimens from (1) Pearl Banks (Stn. LXVI.), Gulf of Manaar, (2) West of Kaltura (Stn. XLIII.), 22 fathoms, and (3) Back Bay, Trincomalee (Stns. XX. and XXI.). Lengths varying from 20 millims. to 50 millims.

Although THÉEL in his "Challenger" report retained the genus *Ocnus*, he expressed some doubts as to its validity. LUDWIG believed that the three forms *O. imbricatus*, *O. javanicus*, and *O. typicus* were identical, and in his Holothurians of BRONN'S "Klassen und Ordnungen des Thierreichs" he placed them all in the genus *Cucumaria*, under the name *C. imbricata*.

Eight of the Ceylon specimens I identified as THÉEL'S species *O. typicus*, and the other two I considered at first to be SLUITER'S species *O. javanicus*. But except for some slight differences in the calcareous ring, in the arrangement of the pedicels, and in the scales and colour of the body, the two forms appear to be very similar. So, on the whole, I now think it best to unite them.

The number of the pedicels on each of the five rows shows some variation, one specimen only having from eight to ten pedicels in each row, whilst those of the *O. javanicus* type have as many as from twenty to twenty-three. The average number, however, in each row is about eighteen. In one specimen the rows of pedicels showed a somewhat irregular arrangement. In the anterior half of the body all of the five rows are in a straight line. At the middle of the body, however, each of the rows makes a deviation and then continues to the posterior end of the body in a straight line. So that the five rows in the posterior half alternate with the five rows in the anterior half of the body.

Another specimen which is very much flattened dorso-ventrally is remarkable in having the pedicels arranged in distinct rows only on the trivium. At a rough glance the bivium appears to be altogether devoid of pedicels, and it is only on a very close examination that a few very small and irregularly scattered pedicels can be distinguished.

The character of the scales is not similar in all the specimens.

It happens that all the individuals which I had identified as *O. typicus* are yellowish-white, in alcohol; and the two others (the *O. javanicus* form) were of a dark brown colour.

The deposits in all the specimens are very similar, and agree with the description of *O. typicus* given by Théel.

Distribution :—Hong-Kong, Bay of Bengal, Java, Ceylon.

Cucumaria conjungens (Semper) (2).

One specimen from Pearl Banks, Gulf of Manaar. Length, 14 millims.

The specimen agrees very closely with Semper's description, both in the nature of the deposits and the calcareous ring.

Owing to the small size of the specimen, the arrangement of the dorsal pedicels into three rows, as described by Semper, is not very clearly marked. The pedicels on the ventral surface are much more numerous than the dorsal pedicels and are irregularly scattered.

The body tapers at both ends, being more pointed at the posterior end.

This is recorded from Ceylon for the first time.

Distribution :—Bay of Manilla, Ceylon.

Thyone fusus (Müller), var. **papuensis,** Théel (7)—Plate I., figs. 7, 8.

Two specimens from the Gulf of Manaar (Stn. IV.), 6–9 fathoms.

Lengths, 25 millims. and 22 millims.

The body is pointed at both ends. The pedicels are scattered all over the body, but show an arrangement into longitudinal series not only on the ambulacra but also on the interambulacra. This arrangement is somewhat obscure in some parts of the body.

The calcareous ring is, comparatively, of very large size, being 11 millims. long in the smaller specimen. The posterior prolongations are composed of several smaller pieces.

The deposits consist of tables which are very thinly scattered. They have four large central holes and also four smaller peripheral holes. In the larger of the two specimens the tables are imperfect, the circumference being broken at several places (Plate I., fig. 8). Whatever may have been the cause of this breaking up, there is no doubt they were originally similar to those of the smaller specimen (fig. 7), which agree with Théel's figure.

There is no doubt that these specimens agree more closely with Théel's variety, *papuensis*, than with the species. *Thyone fusus* is a northern form, and Théel's variety was obtained by the "Challenger" Expedition in Torres Straits. It is now recorded from Ceylon for the first time.

Thyone sacellus (Selenka)—Plate I., figs. 9, 10.

Stolus sacella, Sel. (1), 1867. **Thyone rigida**, Semper (2), 1868. **Stereoderma Murrayi**, Bell (4), 1883.

Two specimens from five miles off Negombo (Stn. I.), 12–20 fathoms, January 31, 1902. Lengths, 75 millims. and 50 millims.

Colour in spirit—light yellow with irregular brown spots.

The skin is hard and rigid. The tentacles are retracted.

The pedicels are irregularly scattered over the body. They are very small and numerous, showing an arrangement in three double rows on the trivium. These rows are not continued to the extremities, but are confined to the middle of the body.

The calcareous ring is typical of the species.

Deposits:—These consist of four-holed plates having on each side a half ring arising from the centre of the plate at right angles (fig. 9). In addition to these I find numerous plates having more than four holes and having short spines on the surface (fig. 10).

These specimens are evidently the same as Bell's *Stereoderma murrayi*, which is now included in Selenka's species, *Thyone sacellus*.

Distribution:—Kurachee, East Coast of Africa, Torres Straits, Japan, and Ceylon.

Thyone (?) **fusca**, n. sp.—Plate I., figs. 11–13.

One specimen from Back Bay, Trincomalee (Stn. XXI.), 8–12 fathoms; 18 millims. long and 10 millims. broad.

The colour of the spirit specimen is brown. The pedicels are the same colour as the general integument.

There are no tentacles present in the preserved specimen.

The pedicels are irregularly scattered all over the body, being slightly more crowded on the ventral surface than on the dorsal. There are no papillæ present.

The calcareous ring is small, being only 4 millims. long. It is composed of ten separate pieces. The radials are notched anteriorly and bifurcated posteriorly. Each posterior prolongation is composed of about four small pieces. The inter-radials are simple (fig. 11).

There is one stone canal and one Polian vesicle. There are no gonads present in this specimen and the alimentary canal is eviscerated. Both the right and the left branches of the respiratory tree are well developed. There are no anal teeth.

Deposits :—These are very scarce, and imperfectly formed. This leads me to believe that the animal may have been preserved originally in formol, but I have no record of this. The deposits are small plates having many holes, and probably slightly hollow (figs. 12 and 13). These are very rare. The pedicels have well-developed terminal plates.

Owing to the tentacles being absent, I am unable to assign the specimen to its genus with certainty, although it is, in all probability, a *Thyone*.

Thyone (?) hornelli, n. sp.—Plate I., figs. 14–16.

One specimen from the lagoon inside the Reef, Galle.

Length, 50 millims. ; breadth, 20 millims.

It is broader at the anterior end, and is slightly narrower at the posterior end.

The colour of the formol specimen is light brown, spotted irregularly with small black marks. The sucking discs of the pedicels in some parts of the body are of a rusty-red colour, and in other parts they are the same colour as the general integument. Beneath the brown epidermis the skin is of a very light violet hue.

The pedicels, which are large, numerous and well formed, are irregularly distributed over the body, showing no arrangement into rows. There are no papillæ.

The tentacles are absent, and there are no anal teeth.

The calcareous ring is composed of five radial pieces and five inter-radials, which are, however, not clearly separated from one another. The radials are notched anteriorly and are bifurcated posteriorly, the posterior prolongations being composed of several smaller pieces. The calcareous ring is fairly massive, being 15 millims. long (fig. 14). There is one Polian vesicle and one stone canal.

The gonads are attached to the dorsal mesentery in one bunch.

The right and left branches of the respiratory tree are large, and both extend to the anterior end of the body.

The internal organs and mesenteries are coloured a light violet, like the skin.

The longitudinal muscle bands are very well developed.

Deposits :—The spicules are very thinly scattered, and consist of small perforated plates having a spiny surface (figs. 15 and 16). Since the animal has been preserved in formol, it is doubtful whether this was originally the exact shape of the deposits.

I cannot be quite certain as to the genus of this form since the tentacles are not present, but it is probably a *Thyone*.

Thyone (?) calcarea, n. sp.—Plate I., figs. 17–20.

One specimen from Cod Bay, Trincomalee (Stn. XXVII.), 6 fathoms.

Length, 20 millims.

The colour in spirit is yellowish-white.

The tentacles are not present.

The pedicels are small and numerous, and are the same colour as the skin. They are scattered all over the body, and are more numerous on the ventral surface than the dorsal. They form a double row on the five ambulacra, but only at the central portion of the body. Those on the three rows of the trivium are longer and more distinct than those of the two rows of the bivium.

There are five small calcareous teeth. The integument is thin but fairly hard.

The animal has a remarkably large calcareous ring, which is half the length of the body. It consists of ten pieces, the five radials having posterior bifurcations which are made up of a number of small pieces. Both radials and inter-radials are notched anteriorly. The inter-radial pieces of the ring are not all of the same length (fig. 17).

There is one Polian vesicle, 4 millims. long, and one madreporite. The gonads are attached to the dorsal mesentery. The alimentary canal is much convoluted.

Deposits:—The spicules are numerous and overlapping. They consist of tables only. These are irregular in shape, mostly triangular or polygonal, and have from five to a dozen holes. The spire consists of two upright rods which join at the top and terminate in one or two blunt points (figs. 18–20).

As in the two previous species, the genus of this form, although probably *Thyone*, cannot be decided with certainty because of the absence of the tentacles.

Phyllophorus cebuensis (Semper)—Plate II., figs. 22–24.

Thyonidium cebuense, Semper (2), 1868. See also Théel (7).

One specimen from Gulf of Manaar (Stn. II.), 8–9 fathoms (see Note, p. 205).

Length, 22 millims., and breadth, 13 millims.

Colour in spirit:—Brown epidermis covering a white skin.

The mouth is slightly dorsal, so that the trivium is a little longer than the bivium.

In the middle of the body the pedicels are irregularly scattered, being more numerous on the trivium than on the bivium. At each end of the body, however, the pedicels are arranged in five double rows.

There are five small anal teeth.

The calcareous ring agrees with Semper's description. Each of the radials has four anterior processes, and also two posterior prolongations, each of which is made up of four small pieces. The inter-radials are simple (fig. 24).

Deposits:—Numerous tables of one kind only. Each table has a central hole surrounded by about eight slightly smaller holes. The spire is tall and massive, and consists of four upright rods, the adjacent ones being connected by four or five bars.

The top of the spire is hemispherical and is covered by numerous spines (figs. 22 and 23).

The Ceylon specimen agrees very closely with SEMPER'S description. Unfortunately that author does not give any satisfactory account or figures of the spicules. THÉEL found amongst the "Challenger" Holothurians one which he believed to be identical with SEMPER'S species. The deposits in the "Challenger" specimen were of two* kinds and differed considerably from those of the Ceylon specimen (see THÉEL (7)). Seeing that there is this difference in the deposits, the "Challenger" specimen and the Ceylon specimen cannot be identical. And yet the Ceylon specimen agrees very closely with SEMPER'S original description. On the other hand, THÉEL expresses some doubt as to the identity of the "Challenger" specimen with SEMPER'S species. Consequently I feel justified in assigning the Ceylon specimen to SEMPER'S species; and I suggest that the "Challenger" specimen be placed as a variety of the species, which might be named var. *théeli.*

Distribution :—Philippines, Ceylon.

Actinocucumis donnani, n. sp.—Plate II., figs. 25–30.

One specimen, from deep water off Galle (Stn. XLI.).

It is 15 millims. long, and 9 millims. broad at the widest portion of the body.

The colour of the spirit specimen is white.

The body is in a contracted condition, so that the exact arrangement of the pedicels is not very easy to determine. There appear to be, however, five series of pedicels, each series consisting of four or five fairly straight rows. The dorsal rows are more irregular than the ventral ones. Owing to the width of each of the five series, the interambulacral spaces are very narrow. The pedicels have well-developed sucking discs, and in the preserved specimen are very short and distinctly cylindrical. Amongst the pedicels of both the dorsal and ventral surface there are scattered a few papillæ, which are easily distinguished from the pedicels, because of their greater length, their shape, and their delicate appearance.

There are no anal teeth.

Deposits :—These are very thinly scattered, and consist of small oval perforated plates (figs. 26–28). In the pedicels there are numerous small slightly branched bodies similar to those described by THÉEL as "incomplete rosettes" (figs. 29 and 30). The pedicels have well-developed terminal plates.

The calcareous ring is comparatively large, being 8 millims. long. Each of the five radials is composed of two separate pieces, both of which are prolonged posteriorly. The inter-radials are five in number. They do not extend so far anteriorly as the radials, neither have they any posterior prolongations. The radials and inter-radials are made up of a number of small pieces (fig. 25).

* SEMPER'S species evidently had only one kind of table.

There is one large Polian vesicle, 4 millims. long, and a single stone canal.

The gonads are present only on the right side of the dorsal mesentery.

Although the tentacles are not present, I have decided to place this specimen in the genus *Actinocucumis*, because of the arrangement of the pedicels, and also because of the presence of papillæ.

Colochirus quadrangularis, Lesson.

Colochirus cœruleus, Semper (2), 1868. See also Théel (7).

Four specimens from South of Adam's Bridge (Stn. LIV.).

Lengths, 75 millims., 60 millims., 30 millims., and 40 millims.

These specimens agree well with Théel's description.

Colour in spirit :—Yellow and dark brown, with a very faint tinge of violet.

Distribution :—Philippines, E. Africa, Australia, E. Indies, Ceylon.

Colochirus quadrangularis, var. **mollis**, nov.—Plate II., fig. 21.

One specimen from South of Thanni-Kodi, Adam's Bridge (Stn. LIV.), 8½ fathoms. Length 100 millims.

This differs from *Colochirus quadrangularis* in the texture of the body wall. Instead of being very hard, thick, and rough, as in *Col. quadrangularis*, the skin is soft, thin, and comparatively smooth.

Although this specimen is larger than any of those of *Col. quadrangularis* in the collection, yet the papillæ at the four angles of the body are much smaller comparatively.

The colour of the animal also differs from that of the Ceylon specimens of *Col. quadrangularis*. The following is the account of the colour of the living animal, as noted by Professor Herdman :—

"Colour of body a uniform orange, slightly mottled with a paler tint. The crown of tentacles are mottled yellow on a dark brown ground. The region between the five valves at the base of the tentacles is white." Plate II., fig. 21, is from a drawing in Professor Herdman's notes showing the living animal with tentacles expanded.

I think it advisable to call this specimen a new variety of *Col. quadrangularis*, with which it agrees in other characters.

Colochirus doliolum (Pallas).

Actinia doliolum, Pallas, 1766. **Colochirus australis**, Ludwig (9), 1875. Also Théel (7).

Two specimens from South of Adam's Bridge (Stn. LIV.).

Lengths, 20 millims. and 8 millims.

The larger of these specimens agrees very closely with the descriptions of this species, both in the form of the body and also in the nature of the deposits.

The smaller specimen is evidently of the same species, although its small size and its contracted condition prevent me from verifying all the characters in detail.

This species is new to the Ceylon fauna.

Distribution :—Australia, Ceylon.

Colochirus, sp. (?).

Navakaddua Paar (Stn. LXVIII.), 8–18½ fathoms.

This specimen, which is only 7 millims. long, is too small to identify with any certainty. The general external form of the body, together with the nature of the deposits, leads to the conclusion that it is a *Colochirus*.

The body is quadrangular, having the pedicels on the trivium arranged in three double rows. The body tapers at the posterior end.

Deposits :—These consist of reticulate cups, knobbed buttons, and very large perforated plates.

The specimen is evidently young, but does not obviously fall into any of the other species. It is perhaps nearest to *C. doliolum*, but differs in the tapering posterior extremity.

Havelockia herdmani, n. gen. et sp.—Plate II., figs. 31–35.

One specimen from South of Adam's Bridge (Stn. LIV.), 4–40 fathoms.

Length 45 millims. and greatest breadth 17 millims.

The colour of the spirit specimen is brown with a dark streak of violet along the middle of each side.

The body is indistinctly quadrangular, but pentagonal at each end. The mouth is surrounded by five valves and there are five smaller valves around the anus.

The ambulacral appendages consist of pedicels and papillæ. The pedicels are confined to the ventral surface. They are arranged in three series traversing the entire length of the ventral surface from the mouth to the anus. The central series consists of about eight rows of pedicels, and the other two series are not quite so broad. There are also a few scattered pedicels on the ventral interambulacra. The papillæ are absent on the ventral surface, but are scattered irregularly over the remaining three sides, being most thinly scattered along the middle of the sides (fig. 31). The anus is devoid of calcareous teeth.

The tentacles are not present. They have evidently been thrown off.

Deposits :—These consist entirely of numerous tables, which are of two kinds :—

(1) Those scattered throughout the skin generally.—These are small tables, generally having four large holes and four smaller peripheral holes (fig. 32). The number of the holes, however, varies. The spire is made up of two rods which unite at the top and give off generally four short projections (fig. 33).

(2) Tables in the papillæ.—These are much larger than those of the general integument, and are not regular in shape (fig. 34). They have a similar spire to the smaller tables.

The calcareous ring is not very large, being 8 millims. long and 8 millims. broad. It consists of ten pieces. The five radials are slightly notched anteriorly and are bifurcated posteriorly. The posterior prolongations are composed of a number of smaller pieces. The five inter-radials have no posterior prolongations and are pointed anteriorly. Retractor muscles are present (fig. 35).

There is one Polian vesicle, and no stone canal can be seen. The gonads are present in two bunches—one on each side of the dorsal mesentery. The right respiratory tree is larger than the left. There are no Cuvierian organs.

The presence of posterior prolongations to the calcareous ring, together with the possession of retractors, prove that this form is a Dendrochirote, although the tentacles are absent.

It possesses a certain external resemblance to the genus *Colochirus* in the general shape of the body; in the arrangement of the pedicels in three rows on the ventral surface, and of the papillæ on the dorsal surface; and also in the presence of the five valves around the mouth.

But there is no doubt that the species is *not* a *Colochirus*, because:—

(1) The pedicels extend the *entire* length of the ventral surface (in *Colochirus* they are absent at both ends).

(2) The deposits, which consist entirely of tables, are different from those of the genus *Colochirus*.

(3) The calcareous ring has posterior prolongations.

Neither does this species agree with any other genus of the Dendrochirotæ, so that I feel compelled to form for it a new genus which may be defined as follows:—

Havelockia,* n. gen.

The body is indistinctly quadrangular, and the mouth and anus are each surrounded by five valves. The ambulacral appendages consist of (1) pedicels, arranged in three series on the ventral surface, each series extending from the mouth to the anus, and consisting of several rows of pedicels; (2) papillæ, which are scattered irregularly over the bivium.

The deposits consist entirely of tables. Each table has a spire consisting of two rods, which are surmounted by three or four short blunt projections.

The calcareous ring has posterior radial bifurcations.

* Named after the SS. "Lady Havelock," from which Professor HERDMAN worked during the greater part of his expedition in the seas round Ceylon.

Family: ASPIDOCHIROTÆ.

Actinopyga mauritiana (Quoy and Gaimard).

> **Holothuria mauritiana**, Q. & G., 1833. **Mülleria varians**, Selenka, 1867. **Mülleria mauritiana**, Semper, 1868. See also Théel (7).

One specimen from the lagoon inside the Reef, Galle. Length, 140 millims.

The specimen possesses most of the characters of the species. There are, however, no white rings around the dorsal papillæ.

On the ventral surface there is a well-marked white symmetrical patch which is quite distinct from the brown dorsal surface.

In Théel's description this marked difference in colouring is not emphasised, and he leads one to believe that the brown on the dorsal surface is *gradually* changed for the lighter colour of the ventral surface. It is interesting to note that the specimens of this species, which Professor Herdman kindly examined for me, with Professor Jeffrey Bell, in the British Museum, showed transitions between those described by Théel and the striking condition seen in the Ceylon specimen. So that it is evident that the nature of the colouring of the ventral surface, with relation to its distinctness from that of the dorsal surface, is susceptible of considerable variation in the species.

The pedicels of the ventral surface are capable of great extension, and have white sucking discs. The white integument of the ventral surface is closely covered with small but conspicuous pores, suggesting the singular appearance of a white colony of the Compound Ascidian *Leptoclinum*.

Distribution:—Indian Ocean from E. Africa to East Indies; Funafuti, in the central Pacific.

Actinopyga serratidens, n. sp.—Plate III., figs. 36–41.

One specimen from the lagoon inside the Reef, Galle. Length, 180 millims.

Colour of spirit specimen is brownish-black.

The tentacles are partly retracted, so that it is difficult to ascertain their exact number. There are, however, 20 tentacular ampullæ, so that there will also be 20 tentacles. The colour of the tentacles is dark brown.

The mouth is ventral, and is surrounded by a distinct brim formed by a folding of the integument. The anus is surrounded by five distinctly serrated teeth, each tooth being 3 millims. in length.

The pedicels are irregularly scattered over the ventral surface, showing no arrangement in rows. They are distinctly cylindrical with well-developed sucking discs. The dorsal surface is covered with papillæ, which are more slender than the pedicels. They appear, in many cases, to have small rudimentary terminal discs, so that it is difficult to distinguish them from true pedicels. Both pedicels and papillæ are of the same colour as the general integument, so that they are not very conspicuous.

The specimen has a typical Aspidochirote calcareous ring.

There is one large Polian vesicle, 30 millims. long, and there are about eight stone canals attached to the dorsal mesentery.

The right respiratory tree is much larger than the left. This form also possesses Cuvierian organs.

The general body wall is very thick, about 5 millims. This is probably, to a certain extent, due to contraction.

Deposits :—Not very thickly scattered. They consist typically of a short straight rod with dichotomising ends (figs. 36–38). Sometimes the spicules are dumb-bell shaped or bone-shaped (figs. 39–41). The pedicels have no supporting rods, nor spicules of any kind, except a terminal plate. The character from which I have taken the specific name, viz., the serration of the anal teeth, is a very distinct one, and would serve alone to distinguish the species.

Holothuria kurti, Ludwig.—Plate III.; figs. 42–45.

H. lamperti, Sluiter, 1889 **(10)**, **(15)**.

One specimen from Pearl Banks, Gulf of Manaar (Stn. LXVI.); three specimens from south of Adam's Bridge (Stn LIV.), 4 to 40 fathoms.

The lengths of the specimens vary from 25 millims. to 40 millims. The specimens agree with Sluiter's description.

Deposits :—The spicules agree in the main with Sluiter's description. There are two kinds of table—round tables and cross-shaped tables, each kind being surmounted by a comparatively tall tower ending in numerous teeth. The size of the tables varies very much. In the papillæ there are also knobbed "buttons," having six or seven pairs of holes as figured by Sluiter. In some of the specimens there are also some smooth buttons scattered about in the skin, having six or seven pairs of holes.

So far as I can determine, the cross-shaped tables are derived from the round tables by pieces having become broken or dissolved away; so that there is really only originally the one kind of table, the cross-shaped form being only a stage in the dissolution of the round form. I found all stages between the two extremes (see figs. 42–45). Consequently, in a young specimen, we should expect the round form to predominate, and as the animal grows bigger, the cross-shaped form of table would increase in number.

This species is now recorded from Ceylon for the first time.

Distribution :—Java, Ceylon.

Holothuria monacaria (Lesson).

Psolus monacaria, Lesson, 1830. See also Théel (7).

One specimen from Aripu reef (March 18th); and one specimen from northern part of Gulf of Manaar (Stn. LIV.), 4 to 40 fathoms.

Lengths, 75 millims. and 38 millims.

The colour in alcohol is brown, with yellow rings around the papillæ. The pedicels are light brown. The tentacles are yellow.

There are papillæ on the dorsal surface, and pedicels on the ventral surface. At the anterior third of the body the papillæ are arranged in five distinct longitudinal rows. In the posterior two-thirds they are more irregular. The pedicels are also arranged in five more or less irregular rows on the anterior third of the ventral surface, and they are more irregularly scattered over the remaining two-thirds.

The mouth is surrounded by a crown of small papillæ.

Deposits:—These agree with those figured by Théel. Although the Ceylon specimens differ in the arrangement of the pedicels and papillæ from Théel's description of *H. monacaria*, yet I think there is no doubt as to their identity with that species.

Distribution:—Indian Ocean, E. Indies, Australia, Pacific Islands.

Holothuria vagabunda, Selenka.

Stichopus (sub-genus **Gymnochirota**) **leucospilota**, Brandt, 1835. See also Selenka (1), Semper (2), Théel (7).

One specimen from the lagoon inside the Reef, Galle. Length, 180 millims.

This specimen agrees with the descriptions of the species.

Distribution:—E. Africa, Indian Ocean, E. Indies, Hong Kong, Pacific Islands.

Holothuria tenuissima, Semper (2). See also Théel (7).

Two specimens from the lagoon inside the Reef, Galle; one specimen from off Negombo (Stn. I.). Also elsewhere in Gulf of Manaar (Stn. IX.), 7 fathoms.

Lengths of two specimens, which were in a very contracted condition, 130 millims. Length of other specimen, 80 millims.

The specimens agree with the descriptions of the species.

The pedicels, which are scattered irregularly all over the body, are more numerous on the ventral surface. The anus is slightly pentagonal, with a group of papillæ at each angle.

The smallest of the specimens is evidently a young form, but it agrees with the larger specimens in most respects. Its body wall is very thin, doubtless owing to its immature condition. There is also a small circular area around the mouth—about 15 millims. in diameter—where the skin is much thinner and devoid of pedicels.

These specimens also agree with the descriptions of *H. vitiensis*, *H. kœllikeri*, and *H. clemens*, and it is very probable, as THÉEL suggests, that they all belong to one and the same species, which is susceptible of great variation.

Distribution :—Indo-Pacific region.

Holothuria marmorata (JÄGER).

Bohadschia marmorata, JÄGER, 1833. See also THÉEL (7).

One specimen from the lagoon inside the Reef, Galle. The species was also, Professor HERDMAN'S notes show, found at Trincomalee. Length, 240 millims.

Colour in alcohol.—The ventral surface is a dark brown with a violet tinge. The dorsal surface is lighter, especially at the posterior end. The colour on the dorsal surface is not uniform, but there is not the striped appearance that is typical of the species.

The pedicels are scattered all over the body, the skin being considerably darker at the base of each pedicel.

The anus is pentagonal and is surrounded by five groups of papillæ, each group consisting of five papillæ.

The deposits are typical.

This specimen is very similar in most respects to *H. tenuissima*. It differs slightly from the latter in the nature of the deposits, the spicules not dichotomising to such an extent but having rather the appearance of perforated granules. The papillæ around the anus also are more prominent than in *H. tenuissima*. Nevertheless, in spite of these differences, it is highly probable, as THÉEL suggests, that *H. marmorata*, *H. tenuissima*, together with other allied forms are only, at the most, varieties of the one species.

Distribution :—Indo-Pacific region generally.

Holothuria atra, JÄGER.

H. (sub-genus **Microthele**) **affinis**, BRANDT, 1835. See also THÉEL (7).

There are seven specimens, most of them being very much contracted. This species was found at various localities round Ceylon—in the Gulf of Manaar, at Trincomalee, and at Galle.

The colour in alcohol is dark brown on the dorsal surface and lighter on the ventral. Professor HERDMAN'S notes state that at least some of the specimens when alive were quite black above, but of a pink colour below.

The dorsal papillæ are smaller than the ventral pedicels.

The deposits are typical. The discs of the tables are smooth and have no peripheral perforations.

The gonads are absent in all specimens. Cuvierian organs also are not present in any of the specimens, so that it is highly probable that this species does not possess Cuvierian organs.

In all the specimens the spicules are similar in density and form.

Although the tentacles are retracted in most of the specimens, there appear to be 20 tentacular ampullæ in each specimen.

In every specimen the left respiratory tree is much larger than the right, the former extending to the extreme anterior end of the body.

Appended is a table showing some of the variations noticed in the seven specimens examined :—

Locality.	Length.	Greatest breadth.	Polian vesicles.		Stone canals.	Longest tentacular ampullæ.
			Number.	Greatest length.		
	millims.	millims.		millims.		millims.
Pearl Banks, off Aripu .	125	23	4	22	19	25
Trincomalee	155	38	—	—	17	15
Off Periya Paar	185	34	1	14	11	15
Reef Galle	155	34	5	12	12	14
Off Galle	105	28	2	18	9	10
G. of Manaar.	75	30	1	15	27	7
S.W. Cheval Paar . . .	135	35	1	9	13	14

Holothuria gallensis, n. sp.—Plate III., figs. 46–50.

Three specimens from the lagoon inside the Reef, Galle.*

Lengths, 230 millims., 150 millims., and 70 millims.

The tentacles are not present in any of the specimens; but there are 20 tentacular ampullæ, so that although the tentacles themselves are absent, we may safely conclude that the animal had 20 tentacles.

The body is divided into a distinct dorsal and ventral surface. The dorsal surface is black and is crossed by numerous conspicuous transverse yellow streaks (Plate III., fig. 46). The pattern, however, varies somewhat in different specimens, the yellow streaks in the smallest not being very evident. On the ventral surface the colour is light yellow, mottled all over with small dark grey patches.

Ambulacral appendages :—On the dorsal surface there are small papillæ, which are very thinly scattered and inconspicuous. The appendages on the ventral surface are much more numerous, and are easily distinguished because each one is generally situated in the centre of a dark grey patch. These appendages, which are mostly retracted, are evidently true pedicels. They have only a small terminal plate, and they are strengthened by spicules similar to those found in the general integument.

* This species was, evidently, from Professor HERDMAN'S notes, also found in China Bay, Trincomalee.

The mouth is ventral, and is surrounded by a small brim of papillæ. There are no anal teeth.

Deposits consist of two kinds :—

(1.) Closely packed tables having, in the older specimens, a large central hole and about eight smaller peripheral holes. This is surmounted by a spire having four upright bars. There is one tier of horizontal bars. The spire terminates in a round top having numerous spines (figs. 47 and 49).

(2.) Knobbed "buttons," having generally three pairs of holes (fig. 48).

The tables in the smallest specimen are much better developed than in the older specimens. The buttons in the youngest animal have about five pairs of holes, whilst those in the older specimens invariably have only three (see figs. 49 and 50). These facts incidentally bear out MITSUKURI'S (14) statement with regard to the changes in growth of spicules.

The calcareous ring is simple, like that of a typical Aspidochirote.

There are two long Polian vesicles in the specimen dissected. No stone canals are seen.

It is noteworthy that although this species has never been previously described, it is evidently a fairly common form on the Ceylon coast. It is one of the species used as "Trepang," and has apparently not been distinguished from some of the other large species of *Holothuria*. Possibly, on account of its mottled appearance, it has been confused with *H. marmorata*, from which, however, it differs in many respects. The yellow transverse stripes (see Plate III., fig. 46) on the dorsal surface and the mottling on the ventral are very characteristic.

Stichopus chloronotus, BRANDT.

St. cylindricus, HAACKE, 1880. See also THÉEL (7).

One specimen from East Cheval paar, $5\frac{1}{2}$ fathoms. Length, 140 millims.

This specimen agrees very closely with THÉEL'S description. There are, however, only 19 tentacles in the Ceylon specimen.

There are four longitudinal series of protuberances on the dorsum, the two dorsal series being double, while the two ventral series have a more or less zig-zag arrangement.

The pedicels are irregularly distributed over the ventral surface. Professor HERDMAN'S notes state that the body was of a dark green colour when alive.

Distribution :—Pacific Islands, Indian Ocean from E. Africa to Malay Peninsula.

Stichopus chloronotus, var. **fuscus**, nov.

Three specimens from Pearl Banks, Gulf of Manaar (Stn. LVIII.), 9–26 fathoms. Lengths, 170 millims., 200 millims., and 110 millims.

The mouth is surrounded by a crown of papillæ.

The number of tentacles is different in each specimen. There are 18 in the largest, 14 in the next, and 16 in the smallest. In the two latter it is highly probable that some tentacles are retracted.

There are four irregular rows of protuberances—one row along each side of the body. In this it differs from *Stichopus chloronotus*, which has two *double* rows on the dorsal surface. The pedicels are irregularly scattered on the ventral surface, showing a slight indication of forming three rows.

The deposits agree with those of *Stichopus chloronotus*, except that the C-shaped deposits are very rare indeed.

These two spirit specimens are very much darker in colour than the spirit specimen of *St. chloronotus*, the former being a dark chocolate-brown.

I consider that the differences between these specimens and *St. chloronotus* justify the formation of a new variety.

Stichopus variegatus, Semper.

St. naso, Haacke, 1880. See Semper (2), Théel (7).

Two specimens from S.W. of Periya Paar (Stn. LV.), 11–24 fathoms.

Lengths, 85 millims. and 75 millims.

The specimens are very much contracted and in a poor state of preservation.

The tentacles in one specimen are dark brown and in the other yellow. I am unable to count them owing to their poor state of preservation, but in other respects the specimens agree with Semper's description.

The pedicels are arranged in three series on the ventral surface, each series having about four rows.

Distribution :—Indo-Pacific, Mauritius, E. Indies, Ceylon.

Note.—While this Report was in the press another specimen (from Gulf of Manaar, February, 1902) was found which is nearly related to *Phyllophorus cebuensis*, but may be distinct, as it differs in the deposits, having additional rosette-shaped buttons.

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(6.) Lampert.—'Archipel der Philippinen. Die Seewalzen,' 1885.

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EXPLANATION OF PLATES.

List of Reference Letters.

a., anus ; *ant.*, anterior end ; *dors. p.*, dorsal papillæ ; *i.*, inter-radial ; *m.*, mouth ; *p.b.*, pedicels of the bivium ; *p.p.*, posterior prolongations of radials ; *p.t.*, pedicels of the trivium ; *r.*, radial ; *s.*, spire of table.

PLATE I.

Fig. 1. Tentacles of *Synapta striata*, Sluiter, from life.
Fig. 2–4. Spicules of *Cucumaria turbinata* (Hutton).
Fig. 5. Calcareous ring of same.
Fig. 6. Side view of *C. turbinata* ; three times natural size.
Fig. 7. Top view of a complete table of *Thyone fusus*, var. *papuensis*, Théel.
Fig. 8. Top view of an incomplete table of same.
Fig. 9–10. Spicules of *Thyone sacellus* (Selenka).
Fig. 11. Calcareous ring of *Thyone* (?) *fusca*, n. sp.
Fig. 12–13. Spicules of same.
Fig. 14. Calcareous ring of *Thyone* (?) *hornelli*, n. sp.
Fig. 15–16. Spicules of same.
Fig. 17. Calcareous ring of *Thyone* (?) *calcarea*, n. sp.
Fig. 18–20. Spicules of same. (Fig. 19 is side view of table.)

PLATE II.

Fig. 21. *Colochirus quadrangularis*, var. *mollis*, nov. ; natural size, from life.
Fig. 22. Side view of spicule of *Phyllophorus cebuense* (Semper).
Fig. 23. Underneath view of same.
Fig. 24. Calcareous ring of *Phyllophorus cebuense.*
Fig. 25. Calcareous ring of *Actinocucumis donnani*, n. sp.
Fig. 26–28. Spicules in general integument of same.
Fig. 29–30. Spicules of tube feet of same.
Fig. 31. Side view of *Havelockia herdmani*, n. gen. et sp. ; twice natural size.
Fig. 32. Top view of "table" in the general integument of same.
Fig. 33. Side view of "table" in the general integument of same.
Fig. 34. Top view of "table" of the papillæ of same.
Fig. 35. Calcareous ring of *Havelockia herdmani.*

PLATE III.

Fig. 36–38. Small dichotomising rods of *Actinopyga serratidens*, n. sp.

Fig. 39–41. Bone-shaped spicules of same.

Fig. 42–45. Showing transformation from a round "table" to a cross-shaped "table" in *Holothuria kurti*, Ludwig.

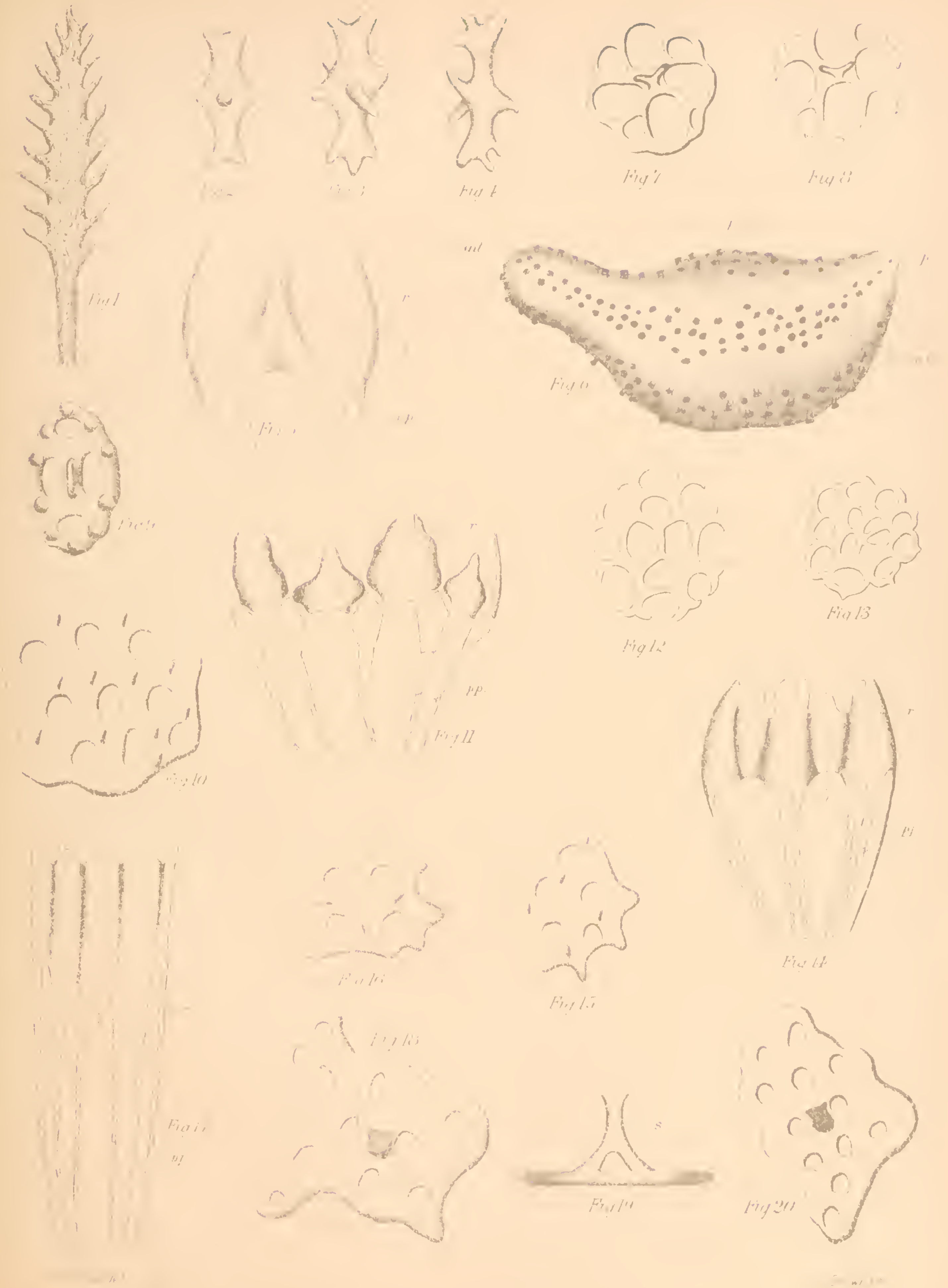
Fig. 46. *Holothuria gallensis*, n. sp., dorsal surface; natural size.

Fig. 47. Side view of "table" of *Holothuria gallensis*, n. sp.

Fig. 48. "Knobbed button" of same.

Fig. 49. Underneath view of "table" in older specimen of *H. gallensis*.

Fig. 50. View of "table" in younger specimen of *H. gallensis*.



[illegible] Figs. 7, 8, Thyone fusus, var. [illegible]
[illegible] Figs. 14-16, Thyone hornelli
Figs. 17-20, Thyone calcarea

J. Pearson del

[illegible]

Fig. 21, Colochirus quadrangularis, var. mollis. Figs. 22–24, Phyllophorus [illegible]
Figs. 25–30, Actinocucumis donnani. Figs. 31–35, Havelockia [illegible]

FIGS. 36-41, ACTINOPYGA SERRATIDENS. FIGS. 42-45, HOLOTHURIA KURTI. FIGS. 46-50, HOLOTHURIA GALLENSIS.

REPORT

ON THE

CEPHALOCHORDA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH ONE PLATE.]

INTRODUCTION.

THE collection of Acraniates made by Professor HERDMAN during his recent expedition to Ceylon was kindly placed in my hands for examination during my year of post-graduate research work at University College, Liverpool. I here wish to express my thanks to Professor HERDMAN for giving me the opportunity of examining this most interesting series, and also for the ever-willing and kindly help which he has given me in the discussion of literature and other difficulties. The collection was a most interesting one, and comprised in all 98 specimens, 92 obtained by dredging and 6 taken in the surface tow-net. They were collected for the most part in the shallower waters round Ceylon between February 1st and April 1st, 1902; and as the specimens belong to no fewer than seven usually recognised species, they serve to indicate the richness of the Acraniate fauna of the Ceylon seas.

The previous knowledge of the Cephalochorda of the Ceylon coast is very scanty. ANDREWS (3),* in Appendix I. to his paper on *Asymmetron*, notes *Branchiostoma lanceolatum* as doubtfully known to him from Ceylon. In Appendix II. to the same paper, in which the Lancelets of the Smithsonian Museum are enumerated, bottle 34,003 is labelled—"Amphioxus sp., 5 soft specimens from Ceylon." Miss KIRKALDY (6) examined these specimens later and found that four belonged to a new species, which she named *A. cingalense*. The other one she placed provisionally and doubtfully in

* The numbers in brackets refer to the List of Literature cited on p. 226.

the species *B. belcheri*. Thus, at most, three species, represented by six specimens, were then known from Ceylon; and during the course of Miss KIRKALDY'S work she received four more specimens from Ceylon which proved to be *A. cingalense*.

The present collection, therefore, is by far the largest yet made known from Ceylon. The species include—*Branchiostoma lanceolatum*, *B. lanceolatum*, var. *belcheri*, *Asymmetron* (*Heteropleuron*) *cingalense*, *Asymmetron* (*Heteropleuron*) *cultellum*, *Branchiostoma* (*Dolichorhynchus*) *indicum*, *Branchiostoma pelagicum* (the six tow-net specimens), and *B. californiense* (?).

The specimens were preserved, some in alcohol and others in formol, and the latter were in a most excellent state of preservation, being rendered slightly transparent, while the exact outlines and shapes of the fins were splendidly maintained. The spirit specimens were not nearly so good, so far as regards the external appearance, although better in some respects for histological examination.

The group Cephalochorda has a single family, Branchiostomatidæ, containing two genera, *Branchiostoma* and *Asymmetron*. In discussing the Ceylon species, I shall follow the classification and nomenclature given in my recent paper published by the Liverpool Biological Society (**10**).

GENUS I.—BRANCHIOSTOMA, COSTA.

Metapleural folds end symmetrically just behind the anus, separated by the ventral fin; gonads disposed in two lateral series; ventral fin with fin chambers which may or may not have fin rays; oral cirri when present have sense-papillæ; atrial chamber prolonged behind the atriopore in a single (right) cæcum.

Branchiostoma lanceolatum (PALLAS)—Plate I., figs. 1, 2.

Limax lanceolatus, PALLAS, 1776.

Branchiostoma lubricum, COSTA, 1834 and 1843.

Amphioxus lanceolatus, YARRELL, 1836, and others.

Branchiostoma lanceolatum, GRAY, 1851, and others.

This species, which has only before been doubtfully recorded from Ceylon (ANDREWS (**3**)), was represented by ten specimens in the collection.

They were from the following localities:—

(1.) Galle (Stn. XXXV.), February 14th, 7 fathoms. Two specimens.
(2.) Ten miles North of Cheval Paar (Stn. LIII.), March 6th, $7\frac{1}{2}$ fathoms. Three specimens.
(3.) Periya Paar Kerrai (Stn. LIII.), March 4th, $7\frac{1}{2}$ fathoms. One specimen.
(4.) Off Watering Point, Galle (Stn. XXXVIII.), February 17th, 9 fathoms. Four specimens.

The various measurements of these ten specimens will be found in Table I. at the end of the report. The greatest length recorded is 41 millims. and the least 26 millims., the average for the ten being 34·5 millims., considerably lower than Kirkaldy's average figures (6).

Of the ten, four were males and two females, the males being of greater average length, while the sex of the remaining four could not be determined. These latter were those found off Watering Point, Galle, and one of them had a double row of exceedingly minute gonads as if just developing, while the other three had none whatever. This possibly gives us a clue to the spawning time of the species in tropical seas. It will be noticed from Table I. (p. 222) that these four and the two first males from Galle were caught at least a fortnight before the other specimens, and their gonads were in various stages of development. Those caught 14 to 20 days later had larger and almost mature gonads, in spite of the fact that one at least was considerably smaller than those caught at the earlier date. This would give us the middle of March to the beginning of April as the probable spawning time of these Ceylon specimens of *B. lanceolatum*.

In those specimens in which gonads were present they formed a double series of pouches, generally equal in number on the two sides. The average number present was 23 on each side, rather below Kirkaldy's average (6). The Galle specimens, preserved in formol, are of a pink tint and almost transparent; the rest, which are in spirit, vary in colour from fawn to a deep orange and are much more opaque.

The number of myotomes varied between 59–61, not a great range; but the arrangement of the somites varied considerably, as Table I. shows. The preatrioporal myotomes ranged from 35 to 37, the average being 36. This is rather more than Kirkaldy's figures show, but Andrews (3) records several with 37 and one with 38 preatrioporal myotomes. The preanal myotomes varied between 11 and 14, the average being 13. Nos. III. and V. on Table I. show only 11 preanal myotomes. This is the lowest number recorded for the species, but repeated countings have confirmed the figure. This is one more instance of the great variability in the arrangement of the myotomes within a given total. The postanal myotomes vary between 11 and 13, the usual figures for the species.

The fins of these specimens agree closely with Kirkaldy's figures, especially the caudal fin (fig. 1), which is remarkably constant throughout.

The ventral fin has a double series of fin rays, in fin chambers, extending its whole length. The ventral fin chambers are prolonged postanally for a considerable length (fig. 1), and in II., Table I., there certainly is a postanal extension of the fin rays—in spite of Lankester's and Benham's statements to the contrary. The fin rays appear to be better developed both in the dorsal and ventral fins in the older specimens.

The relation of the anterior ends of the notochord and dorsal fin is in all cases as Kirkaldy figures it, *i.e.* the dorsal fin ends conterminously with the myotomes, while the notochord is prolonged further forwards a little way. The nervous system, however, does not always project beyond the dorsal fin, as in one or two of the

Ceylon specimens they ended together. The "Räderorgan" is well developed in these specimens, and has a median dorsal lobe and five or six large lateral lobes on each side. In one specimen examined one of the lateral lobes was branched.

No. IV., Table I., showed an unusual dark oval patch anterior to the dorsal fin and just dorsal to the notochord (fig. 2). No structure could be made out, but when cleared up in clove oil the dark patch was found to have a ventral extension on the left side. Unfortunately the specimen had not been preserved specially for histological work, and so the sections that were made showed no additional structure, the only appearance being a large patch dorsally and to the left side of the notochord, which stained deeply with hæmatoxylin.

Branchiostoma lanceolatum, var. **belcheri**, GRAY.—Plate I., fig. 3.

> **Branchiostoma belcheri**, GRAY, 1847, and others.
>
> **Amphioxus belcheri**, KIRKALDY.

This variety, which is usually regarded as a distinct species, formed the greater part of the collection, being a total of 58 specimens out of 98. It has only been previously recorded from the neighbourhood of Ceylon by THURSTON* in 1890, who mentions the species being dredged 30 miles south of Madras in 1887–88; in fact it has been found but sparingly anywhere before. This large collection, therefore, has offered opportunity for a closer examination of this form, which, I think, has shown that we cannot any longer regard it as specifically distinct from *B. lanceolatum*. This matter is dealt with in detail in my recent paper in the 'Transactions of the Liverpool Biological Society,' where I have given tables compiled from the observations of different workers, showing how the characters of the one form fade gradually into those of the other.

The Ceylon specimens were found in the following localities:—

(1.) Ten miles north of Cheval Paar, June 3rd, 1902, $7\frac{1}{2}$ fathoms. Seven specimens.

(2.) Outside Karativo Paar (Stn. LVIII.), March 10th, 10 fathoms. Two specimens.

(3.) Off Karkopani (Stn. IV.), February 2nd, 8 fathoms. Two specimens.

(4.) Off Mutwal Island (Stn. LXVII.), March 19th, 14 fathoms. Three specimens.

(5.) Periya Paar Kerrai (Stn. L.), $7\frac{1}{2}$ fathoms, sand, March 4th. Four specimens.

(6.) Off Chilaw Paar (Stn. LXIX.), 10 fathoms, March 20th. Six specimens.

(7.) West Cheval Paar (Stn. LXV.), March 18th, $7\frac{1}{2}$ fathoms. Nine specimens.

(8.) Near Periya Paar (Stn. LXII.), March 13th, in Foraminiferal sand, 11 fathoms. Eleven specimens.

(9.) South-west of Cheval Paar (Stn. XLIX.), March 1st, $8\frac{1}{2}$ fathoms. Fourteen specimens.

* Madras Government Museum, Bulletin No. 1, p. 26.

The colour of these specimens varied somewhat. Those found outside Karativo Paar and off Mutwal Island were a deep orange colour; those found near Periya Paar and south-west of Cheval Paar were pure white, while those from west of Cheval Paar, on March 18th, were of a purplish-pink colour.

The measurements of these specimens are recorded in Table II., pp. 223, 224.

In length they vary considerably, from 25 millims. to 56 millims., the average being 41·5 millims. One specimen, XXIV., Table II., was much damaged, all the postanal and one half of the part between the anus and atriopore being missing. The remainder measured, however, 53 millims., giving us 70 millims. as the probable length of the whole animal—quite a giant amongst Acraniates.

Out of the 58 specimens, 28 were females, and only 10 were proved to be males; the sex of 20 could not be determined owing to the absence of gonads.

The size of the animal appears to bear a relation to the period of sexual maturity, which is contrary to what FORSTER-COOPER (8) found for *Asymmetron lucayanum*. Here it is the largest that have well-developed gonads and the smallest that are immature. All the immature ones were under 36 millims. in length. This would show that at a length of about 40 millims. the form *B. belcheri* becomes adult. All these specimens, it may be noted, were caught at about the same time of the year and in much the same locality, and there can be no question of some being taken at the spawning season and others not. It must be that the larger ones only were adult and the others immature. In the spirit specimens the gonads could not, in all cases, be counted, owing to the opacity of the metapleural folds, but in the formol-preserved specimens they were determined with ease.

In all the specimens counted, except one, the gonads of the right side were more numerous than those of the left, the average being 25 right to 23 left. The lowest number was 15 (some had evidently been already shed), and the highest was 30.

A few specimens had peculiar gonads. No. XX., Table II., had unusually small gonads, though itself a large specimen; while No. XXVI., Table II., showed a curious arrangement, some of the gonads being quite small and alternating with large mature ones. Late in March and early in April seems to be about the spawning time of this variety in the Gulf of Manaar.

The variation in the myotomes is striking, not so much in the total number as in the distribution. The total myotomes ranged from 63 to 66, 64 being the average. The commonest formula was 38, 17, 9, which agrees closely with KIRKALDY'S figures (6), and differs considerably from GÜNTHER'S (1). The number of preatrioporal myotomes varied from 36 to 39, by far the greater number, 34 out of 58, having 38. The number of preanal myotomes varied from 16 to 18, 17 being the average; while the postanal myotomes numbered 8 to 10, 9 being the commonest number.

From these figures it will be seen that *B. belcheri* from Ceylon agrees closely with those from Australia examined by KIRKALDY (6), and the two are undoubtedly the same species, and not distinct forms as Miss KIRKALDY suggested.

The fins of *B. belcheri* are fairly constant (fig. 3) and agree with KIRKALDY'S figure, except that she figures the rostral fin proportionately rather small. In ours it is well developed, rather long, and more pointed than her figure shows. In some specimens it is so well developed as to suggest a transition from *B. lanceolatus* to *B. indicus*. The ventral fin has fin chambers and a double series of ventral fin rays.

The extent of development of fin rays appears to vary with the age of the animal.

In the smallest specimens no ventral or dorsal fin rays are present. In those a little larger, dorsal fin rays appear, the ventral ones being still undeveloped; while in those a little larger again, both series are seen.

The fin chambers are not prolonged postanally. The nervous system and the dorsal fin end conterminously, while the notochord is prolonged a little way in front of both.

A fæcal pellet adhering to the anus of No. LIII., Table II., on examination was found to be rich in skeletons of diatoms, which gives an indication of the food.

The intertentacular membrane between the oral cirri of *B. belcheri* is low, and the sensory-papillæ are very large and prominent.

The "Räderorgan" is exceptionally well developed, there being a large median dorsal lobe and six lateral lobes on each side. The liver is exceptionally large and extends for three-quarters of the length of the pharynx on the right side.

Branchiostoma pelagicum, GÜNTHER (1889).—Plate I., fig. 16.

The six specimens taken in the tow-net were found to be poorly preserved, and being also extremely small, their identification is a matter of some difficulty. I think, however, that there can be little doubt that they are *B. pelagicum*, GÜNTHER (2).

Of the six, one was taken in a coarse tow-net in the Indian Ocean, to the south-east of Sokotra, about halfway between Perim and the Maldives, on January 16th, 1902; while the other five were taken with a fine net on January 20th, 1902, in the Indian Ocean, after passing Minikoy Atoll, and therefore between the Maldives and the Gulf of Manaar. There is therefore no doubt as to their all being truly pelagic forms.

The largest measured 8·5 millims., the smallest 4·5 millims., the average for the six being 6 millims. The greatest breadth of the largest specimen was 1 millim. All six are undoubtedly the same species, and agree in detail as far as can be made out.

The notochord extends from the extreme tip of the snout to the end of the tail, projecting some little way beyond the myotomes.

The nervous system stops short of the end of the notochord at both extremities. The eye spot is very large and conspicuous, far larger in proportion to the size of the animal than in the other species. This, in itself, is suggestive of a pelagic life. All along the nerve cord, at regular intervals, occur groups of five or six large pigment spots (fig. 16). This is a character noted in GÜNTHER'S *B. pelagicum*.

The number of myotomes (as nearly as could be determined from the imperfect preservation) was 65. GÜNTHER'S *B. pelagicum* had 67; while one specimen described by FORSTER-COOPER (8) had 60. This specimen was 21 millims. long, twice as long as GÜNTHER'S.

There was no trace of oral cirri to be seen, nor did FORSTER-COOPER find any in his specimen (8). This then appears to be a true character of the species, and not to be due to any imperfection in preservation. It is, moreover, what might be expected. The oral cirri probably have, as one of their functions, to direct currents of water into the oral hood and so to the mouth and alimentary canal. This is absolutely necessary in an animal which leads a sedentary life. But a pelagic form, by virtue of its mode of life and motion through the water, would cause currents in the right direction, and thus the oral cirri would be rendered unnecessary.

No gonads could be observed in any of the six specimens. They were probably immature. In none were the dorsal, ventral, or caudal fins preserved sufficiently well to indicate, in any way, their shape and size. One specimen had traces of a caudal fin which indicated that it was very well developed.

On the whole, it may be said that in general shape, size, number of myotomes, absence of oral cirri, large size of eye-spot, and pigment spots on the nerve cord, our specimens agree with GÜNTHER'S *B. pelagicum*, and it seems quite safe to refer them to this species.

Branchiostoma indicum (WILLEY).—Plate I., figs. 11–13.

Dolichorhynchus indicus, WILLEY, 1901.

Two specimens, one from Galle (Stn. XXXVI.), in $4\frac{3}{4}$ fathoms, and the other taken off Watering Point (Stn. XXXVIII.) in the same locality, in 9 fathoms, I am disposed to refer to this species, although the absence of some details in WILLEY'S description and the lack of figures render the identification a little uncertain.

Both my specimens have long and well-marked preoral lobes, but the proportional length of the lobes does not appear to be quite as great as in WILLEY'S specimens (fig. 11). Moreover, the preoral lobes of the Ceylon specimens do not appear bent as WILLEY'S figures show; but it may well be that the bending was due to some accident or injury, and that the lobes are not bent in life.

One of our specimens measures 17 millims., and the other 36 millims. The latter is a male, and has 29 right gonads and 25 left. The smaller one has no gonads and is evidently immature. The larger one has a myotome formula of 43, 14, 13—total, 70; while the smaller one has 41, 14, 14—total, 69. Both these formulæ agree closely with WILLEY'S description.

The dorsal fin is low and ends conterminously with the myotomes. Its outline in the large specimens is interrupted by a peculiar wavy break (fig. 12), possibly due to an injury and subsequent healing up. The notochord extends a long way in front of the dorsal fin. The nervous system is overlapped by the dorsal fin, while in WILLEY'S description the arrangement is the reverse of that.

The posterior extension of the notochord past the myotomes is not very great. The ventral fin has fin chambers which are also extended postanally, as in *B. lanceolatum* and *Asymmetron hectori*. In the latter species the chambers extend postanally to the antepenultimate myotome, while here they extend only five myotomes posterior to the anus. The ventral fin rays are double, and are not extended postanally as in *A. hectori*. Willey did not notice the postanal extension of the fin chambers in his specimens. Only the larger specimen here has ventral fin rays, showing again what was noticed under *B. lanceolatum*, var. *belcheri*, that it is only in the larger specimens that the ventral fin rays are well developed.

The caudal fin is here well marked off from the dorsal and ventral fins, there being a well marked supra- and infra-caudal lobe in both specimens (figs. 11 and 13). There are about 35 to 40 oral cirri of the usual type, bearing sense-papillæ. On the whole it seems fairly certain that these two specimens belong to the species *Branchiostoma indicum*. The distribution also favours this conclusion, for the Orissa Coast of India, where the species was found, is not far north of Ceylon.

Branchiostoma californiense (?), J. G. Cooper.—Plate I., figs. 14, 15.

(?) **B. capense**, Gilchrist.

There is one specimen, No. V., Table IV., in the collection the identity of which is a little uncertain. I refer it, with some little hesitation, to *Branchiostoma californiense*, J. Cooper. In another paper (**10**) I have expressed doubt as to the distinctness of *B. californiense* and *B. capense*. Since then Professor Herdman has received from Dr. Gilchrist eight well-preserved specimens of his *B. capense*, and has placed them in my hands for examination. In these I find no trace of an eye-spot. The specimens range from 51 to 63 millims. in length, and the number of myotomes from 74 to 76. The formula varies within 46 to 48, 18 or 19, 9 or 10—47, 19, 9 being the most frequent form. There are 35 pairs of gonads. This formula is so close to that of *B. californiense*, and the two agree so well in proportions and characters of the head, that notwithstanding the absence of an eye-spot I should hesitate to consider the Cape form distinct until further specimens of the Californian species have been examined.

The Ceylon specimen was taken in the Cheval district (Stn. XI.), at 6 fathoms, on February 4th, and was 42 millims. long. It had no gonads and was evidently immature. Its myotome formula was 40, 20, 12—total, 72.

The rostral fin is separated from the dorsal fin by a shallow notch. The dorsal fin is low, and has a series of fin rays. The caudal fin is very slightly marked off from the ventral and dorsal fins and has its infra-caudal lobe slightly the larger and deeper. The ventral fin is very long indeed, and has a series of double fin rays running its whole length. Neither the ventral fin rays nor chambers are prolonged postanally. The metapleura have a symmetrical termination, thus determining the genus to which the specimen belongs.

The oral cirri are long, and number about 30. They bear well-marked sense-papillæ. The "Räderorgan" is of the usual type, and has a median dorsal lobe and two or three lateral lobes on each side.

The notochord projects far in front of the anterior end of the myotomes and projects posteriorly a little way beyond the last myotome. The dorsal fin ends conterminously with the myotomes. The nervous system projects anteriorly beyond the dorsal fin. A well-marked eye-spot is present.

From the above description it will be noticed that this specimen agrees with *B. californiense* in all particulars except in the arrangement of the myotomes.

The total number of myotomes is the same in both, but the preatrioporal part is shorter, and the postanal portion longer in ours than in *B. californiense*. The geographical distribution may, at first sight, be supposed to be against this identification, for the species is only recorded from San Diego Bay, California, and it is certainly a noteworthy fact that it should turn up at the other extreme end of the Indo-Pacific region. But it is not more remarkable than the case of *Asymmetron lucayanum*, which was first found in the Atlantic and then in the Pacific Ocean.

Our specimen differs from *B. capense*, as described by Gilchrist (**9**), in the number and arrangement of the myotomes and in the presence of an eye-spot, which is absent in *B. capense*. But variation has not yet been much studied in *B. capense*, and possibly the full range of the myotomes is not known. It may be, therefore, that this specimen, and those named *B. capense*, are only variations of *B. californiense*, similar to those shown for other species in the tables at the end of this report.

The habitat of *B. capense* (Cape Colony) bridges the gap between California and Ceylon, and it may be added that other species of Acraniates known from the Maldive Archipelago have been found also at Zanzibar.

It will be seen, therefore, that our Ceylon specimen differs but very slightly from either *B. californiense* or *B. capense*. Both these forms are still comparatively little known, and a re-examination of both is highly desirable, and would probably confirm the view I have ventured to express, that these two species are not really distinct. I believe I am justified in referring this specimen provisionally to *B. californiense*.

Genus II.—ASYMMETRON, Andrews.

Left metapleuron stops just behind the anus, the right is continuous with the median ventral fin; gonads disposed in a single (right) series; oral cirri with or without sense-papillæ; intra-buccal tentacles 10 to 16; ventral fin with or without fin chambers or rays; post-atrioporal cæca 1 to 2 in number.

Asymmetron cingalense (Kirkaldy).—Plate I., figs. 4–7.

Heteropleuron cingalense, Kirkaldy, 1895.

This species was represented by nineteen specimens found sporadically, like *B. lanceolatum*, var. *belcheri*, in Foraminiferal sand in the Gulf of Manaar.

The colour of this species had practically the same range as the others—deep orange, purplish-pink, and pale fawn tints being found. The dimensions of the specimens are recorded in Table III. The total length varied from 20 to 36 millims., the average being 26·5 millims.

The specimens were found in the following localities:—

(1.) Half a mile East of Dutch Modragam Paar (Stn. LVI.), March 10th, 8 fathoms. Two specimens.

(2.) South of Adam's Bridge (Stn. LIV.), March 8th, 8 fathoms. One specimen.

(3.) Off Karkopani (Stn. IV.), February 2nd, 8 fathoms. One specimen.

(4.) Between the Cheval Paars (Stn. XLVIII.), March 4th, $7\frac{1}{2}$ fathoms. One specimen.

(5.) South-west of Cheval Paar (Stn. XLIX.), March 1st, 8 fathoms. Two specimens.

(6.) West of Periya Paar (Stn. XVII.), February 4th, 11 fathoms. Eight specimens.

(7.) West of Periya Paar (Stn. LXI.), March 12th, 12 fathoms. Four specimens.

Although so small compared with the specimens of the form *B. belcheri*, nearly all were sexually mature—thus showing that the average length of the adult *A. cingalense* is much smaller than that of the adult *B. belcheri*.

Of the nineteen specimens, ten were males and seven were females, while the sex of two could not be determined. The number of gonads varied from 18 to 26, always on the right side, the average being 24.

The total number of myotomes varied between 61 and 64, 63 being the average and most frequent number. The most common myotome formula was 39, 16, 8, which occurred 10 times out of 19 specimens. The preatrioporal myotomes varied between 37-39, the preanal between 15 and 17, and the postanal between 6 and 8. This species thus has a comparatively short postanal portion.

The variation in the total number of the myotomes and in their arrangement is less in this species than in any other species of the group. The fins are fairly constant throughout the specimens (figs. 4 and 6), and agree well with KIRKALDY'S figures (**6**). The dorsal fin is deeper anteriorly than in the rest of its extent, recalling in a lesser degree the condition of *A. cultellum* (PETERS). It has fin chambers with single fin rays. The dorsal fin in all cases overlaps the nervous system. The ventral fin is very shallow and has fin chambers with double fin rays which are very small and difficult to see. The ventral fin chambers are not prolonged postanally.

In only one of the 19 specimens is the relation of the dorsal fin to the anterior end of the notochord as figured by KIRKALDY. In that figure the anterior end of the notochord is but a little way in front of the anterior end of the dorsal fin. This is seen in but one of the Ceylon specimens, No. X., Table III. (see fig. 5). In the remaining 18 (fig. 6) the anterior end of the dorsal fin is much further behind the anterior end of the notochord. The relation of these two structures to one another is evidently susceptible of some variation. This receives support from what we know in another species. In *Asymmetron lucayanum*, from the Maldive Archipelago, FORSTER-COOPER (8) has figured the dorsal fin and notochord as ending almost conterminously at the anterior end, while in ANDREWS' original figure (3) and in KIRKALDY'S figure (6) of that species the anterior end of the notochord is far in front of that of the dorsal fin.

In one or two specimens I was able to count the oral cirri. They vary from 26 to 32 in number. The intertentacular membrane between the oral cirri of this species is much deeper than is seen in *B lanceolatum*, var. *belcheri*, and extends from one-third to half the way up. The sensory-papillæ, on the other hand, are much less marked. In one preparation of the oral cirri of this species one cirrus was seen to be branched about one-third of the way up, and the branch was about half as long as the cirrus.

In No. XIII., Table III., a curious structure (fig. 7) was noticed in the dorsal fin just behind the level of the mouth. At this place a break in the fin occurs. A slit runs downwards and backwards for about the length of 2 myotomes. The slit is lined throughout by the epithelium that covers the rest of the body. Posterior to the slit, and continuous with it, is a darker stretch of tissue which looks like a closure of a former extension of the slit. Sections do not show much more, but the structure seems to be confined to the dorsal fin. The nervous system, notochord, and other neighbouring organs are quite unaffected. It is probably the result of some accident arresting the growth of the fin at this spot during its development.

Asymmetron cultellum (PETERS).—Plate I., figs. 8–10.

Epigonichthys cultellus, PETERS, 1876; GILL, 1895; WILLEY, 1901.

Branchiostoma cultellum, GÜNTHER, 1884; and WILLEY, 1894.

Heteropleuron cultellum, KIRKALDY, 1895.

Only two specimens of this interesting species were present in the collection, one from near the coral reefs off Vangali (Stn. LII.), March 5th, in 3 fathoms, and the other from the East Cheval (Stn. XI.), February 4th, in 6 fathoms. They were both quite small, one measuring 23 millims. and the other 25 millims. Both had well-developed gonads, one being a male (the smaller of the two), and the other a female.

It is evident, therefore, that this species, like *A. cingalense*, is a small one as compared with *B. lanceolatum* and its variety *belcheri*.

The male had 17 gonads and the female 20 gonads, both on the right side. The myotome formula for the male specimen was 35, 12, 7—total, 54; while that of the female was 35, 12, 8—total, 55. There is, therefore, quite a close agreement between the two.

The best distinguishing feature of this species is the dorsal fin, which is so markedly swollen at its anterior end. This feature alone is usually quite a sufficient indication of the species (fig. 8). In *A. cingalense* the dorsal fin is slightly swollen at its anterior end. This condition is somewhat more emphasised in *A. maldivense*, a new species lately described by FORSTER-COOPER, from the Maldives (8). This new species seems to bear a remarkable resemblance to the specimens of *A. cultellum*, from Ceylon. The resemblance in the shape of the fins in particular is striking. In both the Ceylon specimens of *A. cultellum* the fin rays are absent from the ventral fin chambers.

The female specimen is well preserved and shows the notochord to be distinctly knobbed, one of the chief characters of the species (fig. 8). The male specimen is not so well preserved and does not show this knobbed notochord. In both specimens the dorsal fin overlaps the nervous system, and the notochord is prolonged in front of the dorsal fin rather more than KIRKALDY shows (figs. 8 and 9). The caudal fin also differs somewhat from KIRKALDY's figures, for while in the latter it is deeper and well marked off from the rest of the fins, in the Ceylon specimens the dorsal and ventral fins fade insensibly into the caudal fin, as shown in *A. maldivense* (8).

I have been able to confirm KIRKALDY in finding sensory-papillæ on the oral cirri of this species. WILLEY (4) had previously stated that the cirri were smooth. The papillæ were distinctly present in the female specimen from Ceylon.

CONCLUSIONS.

The whole collection has proved of very great interest in many ways. Although no new species are recorded, the fact that seven species (including var. *belcheri*) of the group occur round Ceylon, indicates the great wealth of the Acraniate fauna of these waters.

Four species are recorded from this neighbourhood for the first time—*Branchiostoma pelagicum*, *B. californiense*, *B. indicum*, and *Asymmetron cultellum*; while our knowledge of the geographical distribution of nearly all the species has been extended by this collection.

As regards the habitat of the animals, we have some indication in this collection that they live commonly in a clean coarse sand, made up, at least to some extent, of the shells of the large Foraminifera *Orbitolites* and *Heterostegina*.

The depths at which the specimens were taken range from 3 to 14 fathoms, in all cases comparatively shallow water.

The food of these tropical forms appears to consist largely of diatoms, especially of forms found growing over zoophytes, corals, shells, and other submarine objects. In nearly all, the alimentary canal was seen to contain the skeletons of such forms, and fæcal pellets showed the same.

The tables at the end of the report show how extremely variable the species of the group are, and the more extended our knowledge of this group becomes, the less distinctly do the species appear to be separated. The spawning time of the group in tropical seas appears to be the latter half of March, rather earlier in the year than in more temperate seas.

B. lanceolatum is recorded from the Indian Ocean for the first time. It appears to be a cosmopolitan species, being by far the most widely distributed of all the species. The tropical forms differ but slightly from their Mediterranean relations.

The variety (as I consider it) *B. belcheri* is the predominant form in these waters, and constitutes 60 per cent. of the present collection.

A. cingalense, as might be expected, is also well represented in the collection.

The fact that only two specimens of *A. cultellum* were found, suggests that Ceylon may be nearly at the limit of its distribution, and that it becomes more numerous as we approach Australia.

The re-discovery of *B. indicum* is interesting, and extends somewhat its known distribution.

Perhaps the most interesting specimens of the collection were those I have referred to *B. pelagicum*, and it is to be regretted that their state of preservation did not admit of a more complete study of their anatomy, which would probably show points of interest. The collection demonstrated, however, definitely, that this species is truly pelagic.

The most surprising find is *B. californiense*, which, though showing some slight variation, is in most respects the same as its American relations.

Finally, this tropical part of the Indian Ocean seems to be either the home of this group, or is exceedingly well populated, as no less than eight out of the eleven well characterised species have now been recorded from the seas around Ceylon, as follows:—

Branchiostoma lanceolatum	Ceylon	(Herdman), (Andrews ?)
Ditto, var. *belcheri*	Ceylon	(Herdman),
	Singapore	(Bedford).
Branchiostoma indicum	Orissa Coast of India	(Willey),
	Ceylon	(Herdman)
Branchiostoma pelagicum	Indian Ocean	(Gardiner)
	Gulf of Manaar	(Herdman)

Branchiostoma californiense (?)	Gulf of Manaar	(Herdman).
Asymmetron cingalense . . .	Ceylon	(Kirkaldy), (Herdman).
Asymmetron maldivense . . .	Maldives and Zanzibar . .	(Gardiner).
Asymmetron cultellum . . .	Ceylon	(Herdman).
Asymmetron lucayanum . . .	Maldives	(Gardiner),
	Zanzibar	(Crossland).

The following tables give the numerical details in regard to every specimen in the collection :—

Table I.—*Branchiostoma lanceolatum* (10 specimens).

Locality.	Serial number.	Length.	Sex.	Number of gonads.	Myotome formula. Pre-atrial.	Pre-anal.	Post-anal.	Total.
		millims.						
(1.) Galle, 7 fathoms	I.	40	m.	21 R. 21 L.	37	12	11	60
	II.	36	m.	21 R. 21 L.	37	13	11	61
(2.) 10 miles North of Cheval Paar, 7½ fathoms . . .	III.	41	m.	not determined	36	11	13	60
	IV.	36	f.	24 R. 24 L.	35	14	12	61
	V.	26	f.	22 R. 22 L.	37	11	11	59
(3.) Periya Paar Kerrai, 7½ fathoms	VI.	35	m.	24 R. 24 L.	36	13	12	61
(4.) Off Watering Point, Galle, 9 fathoms . . .	VII.	33	—	gonads small	35	14	12	61
	VIII.	35	—	none	37	12	12	61
	IX.	30	—	,,	36	13	11	60
	X.	31·5	—	,,	36	12	12	60
Mean	—	34·35	4 m. 2 f.	22·4 R. 22·4 L.	36·2	12·5	11·7	60·1
Mode	—	—	—	—	36	13	12	61
Range	—	16	—	4	3	4	3	3

Table II.—*B. lanceolatum*, var. *belcheri* (58 specimens).

Locality.	Serial number.	Length.	Sex.	Number of gonads.	Myotome formula. Pre-atrial.	Pre-anal.	Post-anal.	Total.
(1.) 10 miles North of Cheval Paar, 7½ fathoms . . .	I.	millims. 52	f.	—	37	18	9	64
	II.	48	f.	—	37	17	9	63
	III.	52	f.	—	37	18	9	64
	IV.	56	f.	—	37	18	9	64
	V.	50	m.	—	37	17	9	63
	VI.	46	f.	—	38	18	8	64
	VII.	32	f. immature	—	38	17	9	64
(2.) Off Karativo Paar, 10 fathoms . .	VIII.	46	f.	—	38	17	10	65
	IX.	40	m.	—	38	17	9	64
(3.) Off Karkopani, 8 fathoms . . .	X.	49	m.	20 R. 20 L.	38	17	8	63
	XI.	39	none	—	39	17	8	64
(4.) Off Mutwal Island, 14 fathoms . .	XII.	43	f.	—	39	17	10	66
	XIII.	42	f.	—	39	17	damaged.	
	XIV.	27	—	immature	38	16	10	64
(5.) Periya Paar Kerrai, 7½ fathoms .	XV.	54	f.	26 R. 26 L.	38	17	9	64
	XVI.	52	f.	27 R. 25 L.	37	17	9	63
	XVII.	55	f.	24 R. 26 L.	38	18	8	64
	XVIII.	48	m.	29 R. 26 L.	37	17	9	63
(6.) Off Chilaw Paar, 10 fathoms . .	XIX.	50	f.	24 R. 24 L.	38	17	9	64
	XX.	53	m.	21 R. 19 L.	38	17	9	64
	XXI.	42	—	none	38	16	10	64
	XXII.	43	f.	23 R. 20 L.	37	17	9	63
	XXIII.	35	—	none	38	17	9	64
	XXIV.	53	f.	28 R. 26 L.	38	—	damaged.	
(7.) West Cheval Paar, 7½ fathoms . .	XXV.	55	f.	25 R. 25 L.	38	17	9	64
	XXVI.	48	f.	27 R. 25 L.	37	16	10	63
	XXVII.	52	f.	30 R. 27 L.	38	17	10	65
	XXVIII.	49	f.	(?) R. 15 L.	37	17	9	63
	XXIX.	48	f.	27 R. 24 L.	38	17	9	64
	XXX.	52	f.	27 R. 23 L.	38	17	9	64
	XXXI.	52	f.	25 R. 25 L.	38	17	9	64
	XXXII.	46	m.	30 R. 27 L.	38	17	9	64
	XXXIII.	27	—	none	37	17	9	63
(8.) Near Periya Paar, 11 fathoms . .	XXXIV.	32	—	,,	38	17	9	64
	XXXV.	35	—	,,	39	17	9	65
	XXXVI.	33	—	,,	38	18	9	65
	XXXVII.	28	—	,,	38	17	9	64
	XXXVIII.	30	—	,,	37	17	9	63
	XXXIX.	28	—	,,	38	17	8	63
	XL.	26	—	,,	38	18	9	65
	XLI.	26	—	,,	39	17	9	65
	XLII.	26	—	,,	38	17	9	64
	XLIII.	28	—	,,	39	17	9	65
	XLIV.	32	—	,,	39	17	9	65

TABLE II.—*B. lanceolatum*, var. *belcheri* (58 specimens)—continued.

Locality.	Serial number.	Length.	Sex.	Number of gonads.	Myotome formula. Pre-atrial.	Pre-anal.	Post-anal.	Total.
		millims.						
(9.) South-west of Cheval Paar, $8\frac{1}{2}$ fathoms . . .	XLV.	47	m.	not counted	37	17	9	63
	XLVI.	54	f.	,,	38	18	8	64
	XLVII.	40	m.	,,	39	17	8	64
	XLVIII.	43	f.	,,	39	17	8	64
	XLIX.	43	m.	,,	38	17	9	64
	L.	45	f.	,,	38	17	10	65
	LI.	49	f.	,,	38	17	8	63
	LII.	33	—	,,	38	17	9	64
	LIII.	25	—	,,	36	18	9	63
	LIV.	27	—	,,	39	17	8	64
	LV.	29	—	,,	38	17	9	64
	LVI.	35	f.	,,	38	—	damaged.	
	LVII.	44	m.	,,	38	17	9	64
	LVIII.	46	f.	,,	38	17	9	64
Mean	—	41·64	28 f. 10 m.	—	37·9	17·4	9	64·3
Mode	—	—	—	—	38	17	9	64
Range	—	32	—	—	3	3	3	4

TABLE IV.—I., II., *Asymmetron cultellum*; III., IV., *Branchiostoma indicum*; V., *B. californiense* (?).

Locality.	Serial number.	Length, millims.	Sex.	Number of gonads.	Myotome formula. Pre-atrial.	Pre-anal.	Post-anal.	Total.
Coral Reefs off Vangali, 3 fathoms .	I.	23	m.	17 R.	35	12	7	54
East Cheval Paar, 6 fathoms	II.	25	f.	20 R.	35	12	8	55
Galle, $4\frac{3}{4}$ fathoms . .	III.	36	m.	25 L. 29 R.	43	14	13	70
Off Watering Point, Galle, 9 fathoms .	IV.	17	—	none	41	14	14	69
Cheval Paar, 6 fathoms	V.	42	—	none	40	20	12	72

Table III.—*Asymmetron cingalense* (19 specimens).

Locality.	Serial number.	Length.	Sex.	Number of gonads.	Myotome formula. Pre-atrial.	Pre-anal.	Post-anal.	Total.
		millims.						
(1.) Half mile East of Dutch Modragam, 8 fathoms.	I.	30	f.	22 R.	39	16	8	63
	II.	31	f.	25 R.	39	15	8	62
(2.) South of Adam's Bridge, 8 fathoms . . .	III.	32·5	m.	26 R.	39	16	9	64
(3.) Off Karkopani, 8 fathoms . . .	IV.	36	f.	25 R.	39	17	6	62
(4.) Cheval Paar, 7½ fathoms . . .	V.	25	m.	23 R.	37	16	9	62
(5.) South-west of Cheval Paar, 8 fathoms . . .	VI.	25	m.	22 R.	39	16	9	64
	VII.	29	f.	uncertain	37	17	7	61
(6.) West of Periya Paar, 11 fathoms	VIII.	31·5	m.	18 R.	39	17	8	64
	IX.	30	m.	23 R.	39	16	8	63
	X.	31	m.	23 R.	39	16	8	63
	XI.	23	f.	24 R.	39	16	8	63
	XII.	24	m.	22 R.	39	16	8	63
	XIII.	24	f.	25 R.	39	16	8	63
	XIV.	23	m.	23 R.	39	16	8	63
	XV.	20	m.	18 R.	39	16	8	63
(7.) West of Periya Paar, 12 fathoms	XVI.	21	—	24 R.	39	16	8	63
	XVII.	25	f.	24 R.	39	16	8	63
	XVIII.	22	m.	21 R.	39	16	8	63
	XIX.	23	—	22 R.	39	16	8	63
Mean	—	26·5	7 f. 10 m.	21·6 R.	38·8	16·1	8	63·7
Mode	—	—	—	—	39	16	8	63
Range	—	17	—	9	3	3	4	4

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EXPLANATION OF PLATE.

Fig. 1. Caudal fin of *Branchiostoma lanceolatum*. All the Ceylon specimens conform more or less to this type.

Fig. 2. Head of No. IV., Table I., *B. lanceolatum*, to show the dark patch anterior to the dorsal fin and dorsal to the notochord.

Fig. 3. Caudal fin of *B. lanceolatum*, var. *belcheri*. Very uniform throughout the Ceylon specimens.

Fig. 4. Caudal fin of *Asymmetron cingalense*.

Fig. 5. Anterior end of No. X., Table III., *A. cingalense*, the only one in which relation of notochord to dorsal fin anteriorly is the same as in Kirkaldy's figure.

Fig. 6. The general arrangement of the anterior end of the Ceylon specimens of *A. cingalense*.

Fig. 7. Anterior end of No. XIII., Table III., *A. cingalense*, to show peculiar structure in the dorsal fin.

Fig. 8. Female *A. cultellum*.

Fig. 9. Anterior end of male *A. cultellum*. Notochord not definitely clubbed.

Fig. 10. Caudal fin of male *A. cultellum*.

Fig. 11. *B. indicum*.

Fig. 12. Anterior end of large *B. indicum*.

Fig. 13. Caudal fin of large *B. indicum*.

Fig. 14. Anterior end of *B. californiense* (?).

Fig. 15. Posterior end of *B. californiense* (?).

Fig. 16. *B. pelagicum*.

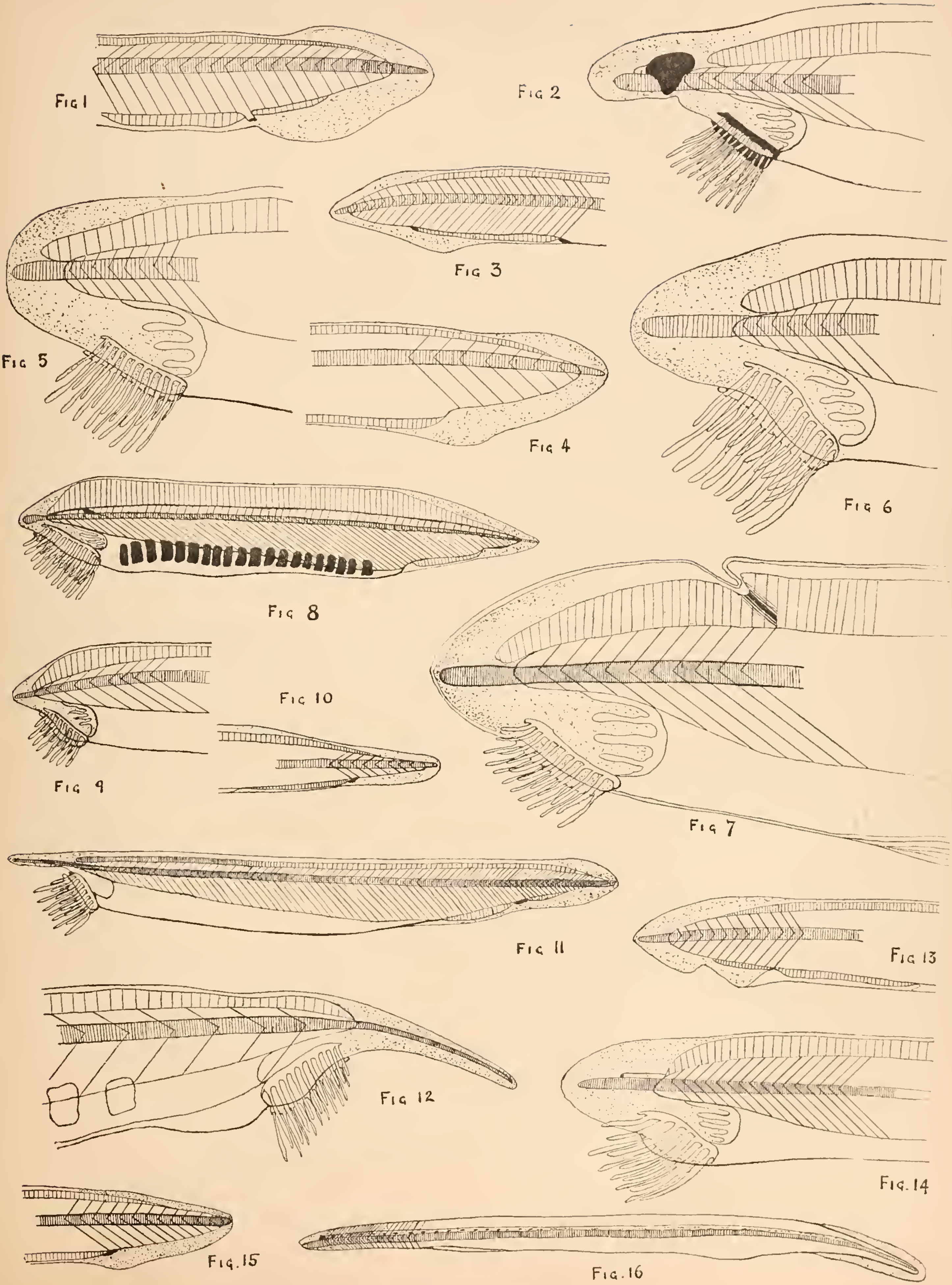
Fig 1
Fig 2
Fig 3
Fig 4
Fig 5
Fig 6
Fig 7
Fig 8
Fig 9
Fig 10
Fig 11
Fig 12
Fig 13
Fig. 14
Fig. 15
Fig. 16

REPORT

ON THE

COPEPODA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

ISAAC C. THOMPSON, F.L.S., AND ANDREW SCOTT, A.L.S.

[WITH PLATES I. TO XX.]

THE COPEPODA contained in the collections brought home by Professor HERDMAN may be conveniently divided into four sections, viz. :—(1) those obtained during the voyages out and home; (2) those collected by the tow-net around the Island of Ceylon; (3) those obtained by examination of washings from dredged material (Ascidians, Sponges, Corals, Pearl Oysters, &c.); and (4) the parasitic species found attached to fishes. The collection was contained in 122 bottles, each bottle representing a gathering from one of the stations shown in the appended list. The free-swimming species naturally form by far the largest part of the collection, although they do not contain most of the novelties. Some of the gatherings were preserved in formol, and others in alcohol. Out of the total number, those marked 1 to 41 were collected on the voyages to Ceylon and home, and most of the others during Professor HERDMAN's three months' work round Ceylon, while some have been sent since by Mr. HORNELL as the result of his further work. Professor HERDMAN's method of collecting material from a fast steamer has already been described in the 'Transactions of the Liverpool Biological Society.' The water containing the material enters the ship some feet below the surface and is pumped into the tank from which baths, &c., are supplied. On this occasion he was fortunate enough to have the entire use of one of the bath-rooms, a tow-net being fixed to the tap so that sea-water was running through it day and night. By this means it is practicable to collect material from the whole of the route traversed, and mostly in good condition.

This collection of Copepoda has proved to be exceedingly rich and varied, containing as it does no less than 283 species, of which 76 are new to science, while at least ten new genera are required. The list of new forms is as follows :—

Ridgewayia typica, n. gen. & sp.
Centropages tenuiremis, n. sp.
C. dorsispinatus, n. sp.
Pontella danæ, var. *ceylonica*, nov.
Labidocera pectinata, n. sp.
L. kroyeri, var. *stylifera*, nov.
,, var. *gallensis*, nov.
Pontellopsis herdmani, n. sp.
Sunaristes inopinata, n. sp.
S. longipes, n. sp.
S. curticaudata, n. sp.
Tegastes imthurni, n. sp.
T. donnani, n. sp.
T. twynami, n. sp.
T. chalmersi, n. sp.
Stenhelia brevicornis, n. sp.
S. gracilicaudata, n. sp.
S. longicornis, n. sp.
S. perplexa, n. sp.
S. dentipes, n. sp.
S. minuta, n. sp.
S. knoxi, n. sp.
Parastenhelia hornelli, n. gen. & sp.
P. similis, n. sp.
Ameira minor, n. sp.
A. tenuipes, n. sp.
Ceylonia aculeata, n. gen. & sp.
Laophonte hirsuta, n. sp.
Laophontella typica, n. gen. & sp.
Tetragoniceps dubia, n. sp.
T. minor, n. sp.
Dactylophusia dentata, n. sp.
D. havelocki, n. sp.
D. hirsuta, n. sp.
D. ceylonica, n. sp.
D. hamiltoni, n. sp.
D. robusta, n. sp.
D. laticaudata, n. sp.
D. æmula, n. sp.
D. platysoma, n. sp.
Peltidium ovale, n. sp.
P. angulatum, n. sp.
P. speciosum, n. sp.
P. serratum, n. sp.
P. perplexum, n. sp.
Porcellidium brevicaudatum, n. sp.
P. acuticaudatum, n. sp.
P. ravanæ, n. sp.
Pseudanthessius maximus, n. sp.
P. chelifer, n. sp.
P. concinnus, n. sp.
Lichomolgus gracilis, n. sp.
L. ieversi, n. sp.
L. lankensis, n. sp.
L. buddhensis, n. sp.
L. simplex, n. sp.
L. elegans, n. sp.
L. robustus, n. sp.
L. gigas, n. sp.
L. dentipes, n. sp.
Paralichomolgus curticaudatus n. gen. & sp.
P. longicaudatus, n. sp.
Hermannella robusta, n. sp.
H. serendibica, n. sp.
Hersiliodes leggii, n. sp.
H. tamilensis, n. sp.
H. dubia, n. sp.
Asterocheres manaarensis, n. sp.
A. major, n. sp.
A. minor, n. sp.
Asteropontius typicus, n. gen. & sp.
A. attenuatus, n. sp.
Collocheres giesbrechti, n. sp.
Lepeopsyllus typicus, n. gen. & sp.
L. ovalis, n. sp.
Doropontius denticornis, n. gen. & sp.
Cletopontius serratus, n. gen. & sp.
Stephopontius typicus, n. gen. & sp.
Chondracanthus cynoglottidis, n. sp.

The large majority of these new species were found in the gatherings from the pearl banks in the Gulf of Manaar, where Professor HERDMAN and Mr. HORNELL were working for some weeks. The dissection and drawing of so many new forms has involved a vast amount of close labour and diligent research, and Mr. THOMPSON must here be allowed to state that this portion of the work, and indeed the chief part of the laborious examination of the material, was undertaken and has been skilfully carried out by Mr. ANDREW SCOTT, whose previous experience of this group of animals makes his co-operation invaluable.

The species, known and new, from the collection represent the families as follows :—

Calanidæ	44 species.	Oncæidæ	8 species.
Centropagidæ . . .	29 ,,	Corycæidæ	29 ,,
Pseudocyclopidæ . .	1 ,,	Lichomolgidæ . . .	13 ,,
Candaciidæ	10 ,,	Asterocheridæ . . .	18 ,,
Pontellidæ	31 ,,	Ergasilidæ	2 ,,
Cyclopidæ	8 ,,	Caligidæ	4 ,,
Ascidicolidæ	3 ,,	Chondracanthidæ .	2 ,,
Harpacticidæ . . .	78 ,,	Lernæopodidæ . . .	3 ,,

LIST OF COLLECTING STATIONS.

I. Voyage Out (Stations 1 to 24).

1.	English Channel to Gibraltar	(36 species)	Dec. 28–31, 1901.
2.	Gibraltar to Marseilles	(25 ,,)	Jan. 2, 1902.
3.	Marseilles to Messina	(38 ,,)	,, 5

ERRATUM.

For *Dactylophusia* read *Dactylopusia* throughout Report on Copepoda.

16.	[illegible]	[illegible]	[illegible]
17.	,, ,, ,, (fine net)	(41 ,,)	,, 17
18.	,, ,, ,, (coarse net)	(39 ,,)	,, 17
19.	,, ,, ,, (mostly fine net) . . .	(36 ,,)	,, 18
20.	,, ,, ,, (coarse net)	(35 ,,)	,, 18
21.	,, ,, off Minikoi (coarse net)	(56 ,,)	,, 19
22.	,, ,, ,, (fine net)	(56 ,,)	,, 19
23.	,, ,, Maldives to G. of Manaar (coarse net)	(40 ,,)	,, 20
24.	,, ,, ,, ,, ,, (fine net)	(42 ,,)	,, 20

as it does no less than 283 species, of which 76 are new to science, while at least ten new genera are required. The list of new forms is as follows :—

Ridgewayia typica, n. gen. & sp.
Centropages tenuiremis, n. sp.
C. dorsispinatus, n. sp.
Pontella danæ, var. *ceylonica*, nov.
Labidocera pectinata, n. sp.
L. kroyeri, var. *stylifera*, nov.
,, var. *gallensis*, nov.
Pontellopsis herdmani, n. sp.
Sunaristes inopinata, n. sp.
S. longipes, n. sp.
S. curticaudata, n. sp.
Tegastes imthurni, n. sp.
T. donnani, n. sp.
T. twynami, n. sp.
T. chalmersi, n. sp.
Stenhelia brevicornis, n. sp.
S. gracilicaudata, n. sp.
S. longicornis, n. sp.
S. perplexa, n. sp.
S. dentipes, n. sp.
S. minuta, n. sp.

[illegible]

D. robusta, n. sp.
D. laticaudata, n. sp.
D. æmula, n. sp.
D. platysoma, n. sp.

Peltidium ovale, n. sp.
P. angulatum, n. sp.
P. speciosum, n. sp.
P. serratum, n. sp.
P. perplexum, n. sp.
Porcellidium brevicaudatum, n. sp.
P. acuticaudatum, n. sp.
P. ravanæ, n. sp.
Pseudanthessius maximus, n. sp.
P. chelifer, n. sp.
P. concinnus, n. sp.
Lichomolgus gracilis, n. sp.
L. ieversi, n. sp.
L. lankensis, n. sp.
L. buddhensis, n. sp.
L. simplex, n. sp.
L. elegans, n. sp.
L. robustus, n. sp.
L. gigas, n. sp.
L. dentipes, n. sp.
[illegible]

[illegible], n. gen. & sp.
Cletopontius serratus, n. gen. & sp.
Stephopontius typicus, n. gen. & sp.
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Pontellidæ	31 ,,	Ergasilidæ	2 ,,
Cyclopidæ	8 ,,	Caligidæ	4 ,,
Ascidicolidæ	3 ,,	Chondracanthidæ	2 ,,
Harpacticidæ	78 ,,	Lernæopodidæ	3 ,,

List of Collecting Stations.

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3.	Marseilles to Messina	(38 ,,)	,, 5
4.	Messina to Port Said	(38 ,,)	,, 8
5.	Port Said to Suez	(31 ,,)	,, 9
6.	Gulf of Suez	(28 ,,)	,, 10
7.	South end of Gulf of Suez to 300 miles south	(44 ,,)	,, 11
8.	Red Sea	(43 ,,)	,, 12
9.	South end of Red Sea (coarse net)	(37 ,,)	,, 13
10.	,, ,, (fine net)	(45 ,,)	,, 13
11.	Perim to 200 miles into Indian Ocean (fine net)	(43 ,,)	,, 14
12.	,, ,, ,, (coarse net)	(33 ,,)	,, 14
13.	Indian Ocean, south of Socotra (fine net)	(53 ,,)	,, 15
14.	,, ,, ,, ,, (coarse net)	(53 ,,)	,, 15
15.	,, ,, going east (fine net)	(59 ,,)	,, 16
16.	,, ,, ,, (coarse net)	(47 ,,)	,, 16
17.	,, ,, ,, (fine net)	(41 ,,)	,, 17
18.	,, ,, ,, (coarse net)	(39 ,,)	,, 17
19.	,, ,, ,, (mostly fine net)	(36 ,,)	,, 18
20.	,, ,, ,, (coarse net)	(35 ,,)	,, 18
21.	,, ,, off Minikoi (coarse net)	(56 ,,)	,, 19
22.	,, ,, ,, (fine net)	(56 ,,)	,, 19
23.	,, ,, Maldives to G. of Manaar (coarse net)	(40 ,,)	,, 20
24.	,, ,, ,, ,, ,, (fine net)	(42 ,,)	,, 20

II. Voyage Back (Stations 25 to 41).

25.	Colombo to Minikoi (return voyage)	(17 species)	April 8–9, 1902.
26.	Minikoi onwards to west	(41 ,,)	,, 9–10
27.	Indian Ocean, further west	(41 ,,)	,, 10–11
28.	,, ,, ,,	(36 ,,)	,, 11–12
29.	,, ,, ,,	(40 ,,)	,, 12–13
30.	,, ,, ,,	(33 ,,)	,, 13–14
31.	South of Aden to Red Sea	(27 ,,)	,, 14–15
32.	Red Sea	(33 ,,)	,, 15–16
33.	,,	(22 ,,)	,, 16–17
34.	,,	(26 ,,)	,, 17–18
35.	Gulf of Suez and Suez Canal	(21 ,,)	,, 18–19
36.	Suez Canal (12 hours)	(12 ,,)	,, 19
37.	Port Said, Mediterranean onwards	(23 ,,)	,, 20–21
38.	South of Crete (air 63° F., sea 63·5° F.)	(20 ,,)	,, 21–22
39.	Crete to Messina	(16 ,,)	,, 22–23
40.	Messina to Sardinia	(6 ,,)	,, 23–24
41.	Strait of Bonifacio to Marseilles	(9 ,,)	,, 24

III. Round Ceylon.

42.	Four hauls off Negombo (Station I.*)	(11 species)	Jan. 31, 1902.
43.	Off Chilaw (Station III.)	(25 ,,)	Feb. 1
44.	Chilaw Paar (Station V.)	(18 ,,)	,, 2
45.	Off Kalpentyn Island—night and early morning	(11 ,,)	,, 2–3
46.	Muttuvaratu Paar, 11.30 A.M.	(18 ,,)	,, 3
47.	Cheval and Periya paars	(29 ,,)	,, 4
48.	Pamban Pass, 8 A.M.	(18 ,,)	,, 5
49.	Palk Bay (Station XVIII.)	(6 ,,)	,, 6
50.	Back Bay, Trincomalee (Station XX.)	(8 ,,)	,, 7
51.	,, &c., Trincomalee	(9 ,,)	,, 8
52.	Surface, 5 miles east of Arugam Bay	(26 ,,)	,, 12
53.	Galle, after dark, 9 P.M.	(11 ,,)	,, 14
54.	,, ,, 8 P.M.	(9 ,,)	,, 15
55.	,, surface outside bay, daylight	(36 ,,)	,, 17
56.	Off Pantura, south of Colombo	(26 ,,)	,, 19
57.	North of Karativo, Kodramallai Point	(22 ,,)	,, 25
58.	$2\frac{3}{4}$ miles S.S.W. of Chilavaturi, bottom 15 fathoms	(14 ,,)	,, 26
59.	To south of Cheval Paar	(41 ,,)	,, 26
60.	Modragam Paar	(19 ,,)	March 1

* Stations with roman numerals, in brackets, are the dredging stations (see "Narrative," p. 17).

61.	Off south bar, Manaar, surface.	(10 species)	March	3, 1902.
62.	Off Manaar Island	(12 ,,)	,,	3
63.	Cheval Paar	(35 ,,)	,,	4
64.	,, ,, ...	(21 ,,)	,,	4
65.	North of East Cheval Paar (Station LII.) . . .	(28 ,,)	,,	5
66.	10 miles N. of Cheval, bottom net, 7 fms. (Sta. LIII.)	(22 ,,)	,,	6
67.	South of Adam's Bridge, 12 fathoms.	(15 ,,)	,,	7
68.	,, ,, ,, surface	(23 ,,)	,,	7
69.	,, ,, ,, ,, ...	(22 ,,)	,,	8
70.	Dutch Modragam Paar, surface	(17 ,,)	,,	10
71.	Karativo Paar, 6 to 10 fathoms	(23 ,,)	,,	10
72.	Donnan's Muttuvaratu Paar, 8 fathoms . . .	(28 ,,)	,,	11
73.	West of Periya Paar, deep net	(15 ,,)	,,	13
74.	Vankali Paar, 9 fathoms (phosphorescent) . . .	(15 ,,)	,,	13
75.	South-east of Modragam	(10 ,,)	,,	17
76.	Off Mutwal Island	(12 ,,)	,,	19
77.	Chilaw Paar (Station LXIX.)	(12 ,,)	,,	20
78.	Donnan's Muttuvaratu Paar	(35 ,,)	,,	29
79.	Mudalaikuli Paar	(21 ,,)	,,	30
80.	Talaivillu Paar, all day	(22 ,,)	April	1
81.	Navakaddu Paar	(11 ,,)	,,	2
82.	Galle	(5 ,,)	June	5
83.	,, Bay	(4 ,,)	,,	14
84.	,, Harbour	(7 ,,)	July	3
85.	,, 9 A.M.	(3 ,,)	,,	7
86.	,, Harbour	(8 ,,)	,,	12
87.	,, ,, ...	(16 ,,)	,,	15
88.	,, ,, 8 A.M.	(3 ,,)	,,	20
89.	,, ,, 9 A.M.	(2 ,,)	,,	31
90.	,, ...	(6 ,,)	August	1
91.	,, 5 P.M.	(1 ,,)	,,	8
92.	Pearl banks, washed from Medusæ	(11 ,,)	(no date)	
93.	Galle, 3 P.M.	(4 ,,)	August	12
94.	South-east Cheval Paar, at anchor	(15 ,,)	Nov.	11
95.	East Cheval Paar, centre	(2 ,,)	,,	6
96.	,, ,, ...	(9 ,,)	,,	7
97.	,, ,, ...	(3 ,,)	,,	8
98.	Periya Paar Kerrai, daylight	(10 ,,)	,,	9
99.	,, ,, night	(9 ,,)	,,	9
100.	West Cheval	(12 ,,)	,,	10
101.	,, ,, ...	(8 ,,)	,,	11

102. Periya Paar, night	(9 species)	Nov.	13, 1902.
103. South-west Cheval	(2 ,,)	,,	14
104. Kondatchi Paar	(5 ,,)	,,	17
105. Muttuvaratu Paar	(4 ,,)	,,	19
106. ,, pearl oyster washings	(46 ,,)	,,	19
107. Cheval Paar	(8 ,,)	Feb. & Mar., 1902.	
108. Pearl banks, washings from dredged débris.	(6 ,,)	,,	
109. Washings from young pearl oysters	(3 ,,)	,,	
110. ,, ,, deep water dredgings, Pt. de Galle	(3 ,,)	,,	
111. General washings of dredged Invertebrates	(41 ,,)	,,	
112. Washings from dredgings, G. of Manaar sponges.	(13 ,,)	,,	
113. Tow-net off Marichchukaddi	(11 ,,)	Feb.	1, 1903.
114. Modragam Paar, surface	(15 ,,)	,,	2
115. Karativo, shoal buoy	(14 ,,)	,,	2
116. South-east Cheval Paar, surface	(12 ,,)	,,	4–5
117. East Cheval, surface	(8 ,,)	,,	7
118. Cheval Paar	(14 ,,)	,,	9
119. ,, ,,	(only young *Calanus vulgaris*)	March	10
120. ,, ,,	,, ,, ,, ,,	,,	20
121. East Cheval Paar	(5 species)	April	18
122. Washings from Cheval Paar pearl oysters	(1 ,,)	,,	

Distribution of Species.

The Numbers refer to the Stations in the preceding List.

Calanus helgolandicus, 1, 2, 3, 37, 38, 41.

,, gracilis, 4, 21, 22, 38.

,, minor, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 22, 24, 31, 34, 38, 39, 41, 43, 46, 47, 48, 49, 69, 78, 81, 92.

,, pauper, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 19, 21, 22, 24, 26, 27, 28, 29, 30, 31, 32, 33, 34, 42, 43, 47, 49, 51, 52, 54, 55, 56, 60, 62, 63, 64, 65, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 79, 80, 94, 96, 98, 99, 102, 113.

,, darwini, 5, 9, 10, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 54, 68, 74, 80, 103.

,, vulgaris, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 34, 42, 44, 45, 46, 47, 49, 50, 52, 53, 55, 56, 57, 59, 60, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 92, 94, 100, 101, 102, 104, 116, 117, 118, 119, 120.

Calanus robustior, 21.
Eucalanus attenuatus, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 59, 64, 71.
,, pileatus, 8, 9, 24, 55.
,, crassus, 9, 56, 57, 100, 117.
,, subcrassus, 9, 10, 12, 21, 32, 47, 50, 55, 57, 63, 66, 69, 72, 93, 95, 97, 98, 99, 100, 101, 102, 104, 105, 107, 115, 116, 118
,, subtenuis, 47, 55, 62, 63, 65, 74, 76, 78, 79.
,, monachus, 46, 79.
Rhincalanus cornutus, 13, 14, 15, 16, 17, 18, 19, 56, 57, 78.
,, nasutus, 14, 15, 17, 18, 20, 21, 56, 64.
Mecynocera clausi, 7, 8, 13, 14, 15, 18, 19, 20, 21, 22, 25, 27, 28, 29, 30, 31, 32, 33, 34, 37, 42, 43, 56, 65, 71, 72, 76.
Paracalanus parvus, 1, 2, 3, 4, 6, 7, 8, 10, 11, 13, 14, 15, 16, 17, 18, 21, 22, 24, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 42, 43, 45, 47, 50, 51, 52, 53, 55, 56, 58, 59, 60, 64, 65, 66, 68, 69, 70, 71, 72, 76, 78, 79, 80, 81, 94, 95, 96, 107, 113, 114, 115, 116, 117, 118, 121.
,, crassirostris, 42, 43, 47, 50, 51, 55, 63, 65, 68, 69, 70, 78, 79, 80, 94, 113.
Metacalanus aurivillii, 26, 27, 28, 29, 43, 47, 48, 55, 58, 59, 60, 64, 65, 66, 69, 70, 71, 72, 92, 96, 107, 113, 114, 115, 116, 118, 121.
Acrocalanus gibber, 6, 22, 59, 64.
,, longicornis, 7, 8, 9, 10, 11, 13, 15, 16, 18, 24, 28, 32, 34, 42, 43, 55, 56, 59, 60, 63, 65, 66, 67, 68, 73, 78, 79, 94, 96, 107, 114, 115, 117.
,, gracilis, 7, 10, 11, 19, 20, 21, 22, 27. 64.
,, monachus, 27, 29.
Calocalanus pavo, 1, 2, 3, 4, 7, 8, 11, 13, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 32, 33, 37, 52, 55, 69, 72, 74, 75, 78.
,, plumulosus, 4, 5, 7, 10, 11, 15, 18, 22, 24, 56, 71, 78.
Clausocalanus furcatus, 1, 3, 4, 6, 7, 8, 10, 11, 13, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34, 37, 38, 39, 40, 41, 42, 43, 52, 55, 56, 62, 68, 70, 71, 72, 73, 74, 75, 77, 78.
,, arcuicornis, 1, 2, 3, 4, 6, 8, 9, 15, 26, 27, 28, 29, 30, 31, 37, 38, 39, 40, 41, 68.
Pseudocalanus elongatus, 1, 2, 3, 4, 6.
Ætideus armatus, 3, 4, 6.
Undeuchæta minor, 1, 16, 21.
Euchirella rostrata, 21, 23.
,, messinensis, 26.

Euchæta marina, 1, 2, 3, 4, 7, 8, 9, 10, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 50, 55, 56, 57, 71, 74, 78, 94, 99.
,, spinosa, 2, 3, 30.
,, acuta, 3, 4.
,, concinna, 9, 10, 34, 100, 102, 104, 105.
,, barbata, 28, 29.

Scolecithrix danæ, 12, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 74, 77.
,, bradyi, 3, 14, 15, 21. 22, 23.
,, chelipes, 34.
,, auropecten, 8.
,, tenuipes, 8.

Ridgewayia typica, n. gen. & sp., 106.

Phænna spinifera, 1, 9, 20.

Centropages chierchiæ, 1, 2, 21, 22, 64.
,, typicus, 2, 3, 37.
,, violaceus, 3, 7, 13, 16, 18, 37, 38, 40, 41, 52, 59.
,, furcatus, 6, 9, 10, 11, 13, 14, 15, 16, 24, 26, 27, 31, 32, 34, 35, 46, 48, 55, 56, 59, 63, 64, 65, 66, 68, 69, 74, 78, 115.
,, elongatus, 7, 15, 21, 22, 24, 27, 30, 34.
,, gracilis, 7, 10, 16, 17, 18, 22, 26, 28, 29, 30, 34, 35, 55, 56.
,, kroyeri, 13, 14.
,, calaninus, 15, 17, 18, 19, 20, 21, 26, 27, 56, 59, 72.
,, orsini, 30, 46, 59, 64, 65, 70, 71, 76, 78, 79, 80.
,, tenuiremis, n. sp., 13, 43, 47, 53, 54, 56, 59, 60, 63, 64, 65, 69, 70, 71, 79, 94, 96, 98, 99, 101, 107.
,, dorsispinatus, n. sp., 75.

Isias clavipes, 1.

Pseudodiaptomus salinus, 5, 6, 7, 35, 36, 37.
,, serricaudatus, 11, 13, 15, 43, 53, 54, 55, 57, 58, 59, 61, 70, 71, 72, 79, 80, 91, 92, 107, 113.
,, aurivillii, 47, 48, 59, 60, 65, 66, 69, 80.

Temoropia mayumbænsis, 6, 7.

Temora longicornis, 1, 4.
,, discaudata, 4, 5, 6, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 35, 42, 43, 45, 47, 48, 52, 55, 56, 57, 59, 60, 61, 63, 64, 65, 66, 68, 69, 70, 71, 73, 74, 75, 76, 98, 99, 100, 101, 114, 116, 118.
,, stylifera, 9, 10, 11, 12, 13, 14, 15, 16, 17, 20, 21, 22, 23, 24, 43, 52.
,, turbinata, 43, 59, 64, 73, 82.

Metridia lucens, 1, 2, 3, 4, 5.

Pleuromamma gracilis, 1, 2, 3, 4, 11, 12, 13, 14, 15, 16, 21, 22, 23, 24, 26, 27, 28, 29, 30, 32, 33, 34, 35, 39.

Pleuromamma xiphias, 1.
,, abdominalis, 3, 4, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 32, 33, 34, 35.
Lucicutia flavicornis, 1, 2, 3, 4, 5, 7, 8, 13, 15, 21, 22, 23, 26, 27, 28, 29, 30, 37, 38, 39, 78.
Heterorhabdus spinifrons, 3, 11, 13, 14, 16, 21, 22.
,, papilliger, 12.
,, abyssalis, 12.
,, clausi, 27.
Pseudocyclops obtusatus, 15, 108, 122.
Candacia armata, 1.
,, simplex, 3, 9, 10, 11, 13, 14, 16, 23, 32, 55, 59, 63, 64, 94, 98, 99, 100, 101, 102.
,, bispinosa, 3, 9, 37.
,, bradyi, 7, 9, 10, 11, 13, 15, 20, 24.
,, truncata, 7, 8, 13, 14, 16, 17, 20, 21, 22, 23, 24, 26, 29, 33, 34, 55, 56, 100, 117.
,, catula, 7, 8, 13, 15, 16, 21, 22, 26, 27, 29, 32, 34, 55, 56, 59, 77, 78.
,, longimana, 9, 10, 11.
,, æthiopica, 9, 13, 14, 16, 17, 18, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 72.
,, curta, 9, 10, 11, 14, 56, 99.
,, pachydactyla, 14, 16, 17, 20, 21, 22, 23, 30, 56, 72, 74.
Calanopia elliptica, 5, 7, 9, 10, 11, 12, 13, 14, 21, 22, 23, 24, 32, 35, 36, 37, 43, 47, 48, 49, 52, 54, 55, 57, 58, 59, 64, 67, 68, 69, 72, 75, 77, 79, 102, 114, 116.
,, minor, 7, 9, 10, 14, 15, 22, 23, 24, 26, 32, 35, 36, 42, 43, 47, 48, 59, 64, 66, 70, 78, 79, 92, 94, 96.
,, aurivillii, 82, 83, 85, 90, 114, 115, 118, 121.
Labidocera acuta, 5, 9, 10, 11, 12, 13, 14, 15, 20, 21, 23, 26, 31, 32, 45, 46, 47, 48, 49, 52, 55, 57, 59, 60, 61, 63, 64, 65, 66, 69, 73, 74, 75, 76, 102, 103, 113, 116, 117.
,, minuta, 9, 12, 13, 14, 15, 16, 31, 33, 43, 46, 47, 48, 55, 59, 68, 71, 73, 98, 99, 100.
,, detruncata, 17, 19, 20, 21, 26, 27, 50.
,, pavo, 46, 50, 51, 53, 54, 55, 57, 58, 59, 60, 61, 65, 93, 98.
,, kroyeri, 45, 46, 57, 65, 98, 99, 100, 101, 102, 103, 117.
,, ,, var. stylifera, 72, 75, 76, 77, 93.
,, ,, var. gallensis, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58.
,, pectinata, n. sp., 48.
Pontella danæ, var. ceylonica, 46, 57, 60, 63, 65.

Botryllophilus ruber, from Sponges, Ceylon.
Sunaristes paguri, 111.
,, inopinata, n. sp., 111.
,, longipes, n. sp., 111.
,, curticaudata, n. sp., 111.
Longipedia coronata, 35, 36, 38.
,, minor, 113.
Canuella perplexa, 5.
Ectinosoma atlanticum, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 39, 40, 41, 42, 43, 45, 46, 47, 51, 52, 54, 56, 57, 58, 60, 61, 64, 65, 66, 67, 68, 69, 71, 72, 73, 78, 79, 80, 81, 92, 113, 115.
,, roseum, 2, 5, 6, 7, 8, 10, 11, 13, 14, 15, 17, 18, 19, 21, 22, 23, 24, 25, 26, 28, 29, 30, 31, 32, 33, 34, 35, 37, 42, 43, 45, 46, 48, 52, 53, 54, 56, 57, 58, 60, 61, 62, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 78, 79, 80, 81, 92, 114, 115.
,, normani, 106, 111.
,, propinquum, 106, 111.
Setella gracilis, 3, 6, 7, 8, 11, 13, 14, 15, 16, 18, 19, 21, 22, 23, 24, 25, 27, 30, 31, 33, 34, 35, 37, 38, 43, 47, 51, 52, 55, 56, 59, 62, 64, 66, 71, 72, 73, 78, 79, 80, 81, 115, 116, 118.
Miracia efferata, 19, 22, 24, 26.
,, minor, 1, 13, 15.
Euterpina acutifrons, 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, 14, 15, 18, 25, 29, 32, 35, 36, 39, 45, 46, 47, 48, 51, 52, 53, 56, 57, 58, 59, 60, 61, 63, 64, 66, 67, 68, 69, 73, 78, 80, 92, 113, 115, 116, 117, 118.
Tachidius littoralis, 6.
Clytemnestra scutellata, 11, 12, 13, 14, 15, 18, 19, 21, 22, 24, 56 62, 118.
,, rostrata, 15, 16, 27, 28, 30, 31, 33, 37, 78.
Tegastes sphærica, 5.
,, nigrans, 106.
,, imthurni, n. sp., 106.
,, donnani, n. sp., 106.
,, twynami, n. sp., 106.
,, chalmersi, n. sp., 106.
Stenhelia brevicornis, n. sp., 106.
,, gracilicaudata, n. sp., 106.
,, longicornis, n. sp., 106.
,, perplexa, n. sp., 106.
,, dentipes, n. sp., 106.

Scottocheres elongatus, 111.
,, longifurca, 111.
Lepeopsyllus typicus, n. gen. & sp., 106.
,, ovalis, n. sp., 111.
Doropontius denticornis, n. gen. & sp., 111.
Cletopontius serratus, n. gen. & sp., 111.
Stephopontius typicus, n. gen. & sp., 111.
Bradypontius siphonatus, 111.
Artotrogus orbicularis, 111.
Bomolochus scomberesocis.
,, unicirrus.
Caligus dakari.
,, diaphanus.
,, benedeni.
Lepeophtheirus thompsoni. Fish Parasites.
Chondracanthus cornutus.
,, cynoglottidis, n. sp.
Brachiella thynni.
,, merluccii.
Anchorella uncinata.

COPEPODA.

Family: CALANIDÆ.

Calanus helgolandicus (Claus).

One of the commonest northern species. Taken at 6 stations in this collection, but not further south than the Mediterranean.

Calanus gracilis, Dana.

Less common than the preceding species, occurring at 4 stations, but similar in distribution.

Calanus minor (Claus).

Common throughout the route traversed, from the Mediterranean to the Indian Ocean, occurring at 33 stations.

Calanus pauper, Giesbr.

Taken at 58 stations; distribution similar to that of the last species.

Calanus darwini (Lubbock).

Less plentiful than the two preceding species, occurring at 27 stations, from the Red Sea southwards through the Indian Ocean.

Calanus vulgaris (DANA).

The most generally distributed of any species throughout the route traversed, occurring at 70 stations, from the Red Sea southwards.

Calanus robustior, GIESBR.

Only once taken, at Station 21, off Minikoi, in the Indian Ocean; previously known from the Atlantic and Pacific Oceans.

Eucalanus attenuatus (DANA).

Occurred plentifully at 18 stations, from the Red Sea southwards through the Indian Ocean to Ceylon.

Eucalanus pileatus, GIESBR.

Taken at 4 stations only, twice in the Red Sea and twice in the Indian Ocean, which adds to its hitherto known distribution in the Atlantic and Pacific.

Eucalanus crassus, GIESBR.

Occurred once in the Red Sea and at 4 stations round Ceylon; previously reported from the Indian Ocean.

Eucalanus subcrassus, GIESBR.

Occurred at 27 stations; twice in the Red Sea, and throughout the Indian Ocean.

Eucalanus subtenuis, GIESBR.

A few specimens were found from 9 stations, all in the sea round Ceylon.

Eucalanus monachus, GIESBR.

A rare species hitherto known only from the Mediterranean. Specimens were found, off Ceylon, at 2 stations, thus extending its known range to the Indian Ocean.

Rhincalanus cornutus (DANA).

Reported from 10 stations, all in the Indian Ocean. Previously known from the Mediterranean, the Atlantic, and the Pacific.

Rhincalanus nasutus, GIESBR.

Similar in distribution to the last species. Occurred at 8 stations in the collection.

Mecynocera clausi, I. C. THOMPSON.

Found at 27 stations, extending from the Red Sea throughout the Indian Ocean, the latter being an addition to its hitherto known distribution.

Paracalanus parvus (Claus).

One of the most widely distributed species throughout the regions traversed. Occurred at 65 stations, extending from the British coasts to the Ceylon pearl banks.

Paracalanus crassirostris, F. Dahl.

Found at 16 stations, all in the sea round Ceylon; not previously known from the Indian Ocean.

Metacalanus aurivillii, Cleve—Plate II., figs. 18 to 20.

Occurred at 27 stations, all in the sea round Ceylon; previously known only from the Malay Archipelago. We show the female abdomen and the male and female fifth natatory legs of this species, as they are not represented in sufficient detail by Cleve.

Acrocalanus gibber, Giesbr.

Found sparingly at 4 stations, from the Gulf of Suez and Indian Ocean.

Acrocalanus longicornis, Giesbr.

A much commoner species than the preceding, occurred at 33 stations, extending from the Red Sea throughout the Indian Ocean and around Ceylon.

Acrocalanus gracilis, Giesbr.

Occurred at 9 stations; general distribution similar to that of the two preceding species.

Acrocalanus monachus, Giesbr.

A few specimens of this rarer form were found at 2 stations between Minikoi and Sokotra. Previously known from the Pacific and Indian Oceans.

Calocalanus pavo (Dana).

This beautiful species, easily recognised by its elegant plumose furcal setæ, although rarely found perfect, has a wide range throughout the Atlantic, Pacific and Indian Oceans, and occurred at 33 stations, extending from Gibraltar through the Mediterranean, Red Sea, Indian Ocean, and around Ceylon.

Calocalanus plumulosus (Claus).

Similar in distribution to the last species, but less common. It occurred at 12 stations.

Clausocalanus furcatus (Brady).

Well distributed throughout the entire traverse, occurring at 47 stations.

Clausocalanus arcuicornis (Dana).

Rarer than the preceding species, but similarly distributed. It occurred at 20 stations.

Pseudocalanus elongatus (Boeck).

One of the commonest British species; occurred at 6 stations, extending as far south as the Gulf of Suez.

Ætideus armatus, Brady.

A species widely distributed throughout the Atlantic, Pacific and Indian Oceans, but only taken at 3 stations in this collection, from the Mediterranean to the Gulf of Suez.

Undeuchæta minor, Giesbr.

Occurred off Gibraltar, and at 2 stations in the Indian Ocean; the latter are additions to its hitherto known range.

Euchirella rostrata (Claus).

Occurred twice in the Indian Ocean.

Euchirella messinensis (Claus).

Only once taken, off Minikoi, west of Ceylon, thus considerably extending its southern range; the Mediterranean and the Gulf of Gascony being the only previous records.

Euchæta marina (Prestand.).

A common ocean species; occurred at 36 stations, extending throughout the entire traverse.

Euchæta spinosa, Giesbr.

Found very sparingly off Gibraltar and in the Mediterranean, and again off Ceylon; not previously reported from the Indian Ocean.

Euchæta acuta, Giesbr.

Taken at 2 Mediterranean stations, between Messina and Port Said.

Euchæta concinna, Dana.

Occurred at 3 stations in the Red Sea and at 4 stations round Ceylon.

Euchæta barbata, Brady.

Occurred at 2 stations in the Indian Ocean near Ceylon. Known previously only from the Atlantic.

Scolecithrix danæ (LUBBOCK).

Taken at 18 stations in the Indian Ocean and round Ceylon.

Scolecithrix bradyi, GIESBR.

Occurred once in the Mediterranean, and at 6 stations in the Indian Ocean, the latter being an addition to its known range.

Scolecithrix chelipes, GIESBR.

Taken only at one station, in the Red Sea, its only known habitat.

Scolecithrix auropecten, GIESBR.

A rare species—was found in the Red Sea, an addition to its known range in the Mediterranean and Atlantic.

Scolecithrix tenuipes, T. SCOTT.

Like the preceding species, this was found in the Red Sea, its only previously known habitat being the Gulf of Guinea.

Ridgewayia, n. gen.

Body cyclopoid in form, 6 cephalothoracic segments well defined. Abdomen 4-jointed, anterior antennæ 25-jointed. Posterior antennæ 2-branched, the outer branch consisting of 2 joints, the inner branch of many joints and longer than the outer. Mouth organs very similar to those of *Calanus* and *Temora*.

Outer and inner branches of 1st to 4th natatory legs all 3-jointed. Outer branch of 5th pair 3-jointed; inner branch 2-jointed.

The male of the one species occupying this genus being unknown, it is not easy to fix with certainty the exact systematic position. In the anterior and posterior antennæ, as well as in the mouth organs of the female, it closely resembles the Calaninæ. In the segmentation of the first 4 pairs of natatory legs it agrees with *Calanus*, but not in the 5th pair. On the whole we think that the position of the genus should be amongst the Calanidæ. At the suggestion of Professor HERDMAN we have named this genus in honour of Sir WEST RIDGEWAY, who was Governor of Ceylon when the pearl oyster investigation was carried on.

Ridgewayia typica, n. sp.—Plate I., figs. 1 to 13.

Length, female 0·85 millim.; male unknown.

Cephalothorax 6-jointed, the cephalic segment equal in length to the four following combined. The 5th thoracic segment has a strong hook pointing downwards on its ventral surface. Rostrum short, broad and pointed. Abdomen 4-jointed, the genital segment very wide and equal in length to the following two united; it bears a similar hook to that of the last thoracic segment on its right side posteriorly. Furcal rami about twice as long as broad, each bearing 4 long terminal setæ.

Anterior antennæ 25-jointed, nearly equalling in length the cephalothorax. The proportional lengths of the joints are as follows :—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
15.	20.	7.	7.	7.	7.	7.	7.	7.	7.	7.	7.	8.	8.	8.	9.	8.	8.	8.	7.	7.	11.	17.	21.	20.

Posterior antennæ 2-branched, the outer branch consisting of 2 joints, the inner of 8, the 2 basal and the apical joints being each about double the length of the intermediate ones. Mandible broad with 9 or 10 small teeth, palp 2-branched, one branch having 2, the other 4 joints. Maxilla well developed, inner branch composed of 2 large setiferous digits. First and second maxillipeds similar to those of the Calanidæ.

Natatory legs 1 to 4 with outer and inner branches all 3-jointed, the lateral and terminal spines destitute of serrations and hairs. The inner branch of 5th pair is 2-jointed ; the outer branch 3-jointed, bearing lanceolate spines with serrated edges ; the 3rd joint is attached to the centre of the 2nd joint.

Two specimens, both females, were found in the Muttuvaratu pearl-oyster washings.

This, the only known representative of the genus *Ridgewayia*, is easily recognised by the inner branch of the posterior antennæ, by the hooks on the last thoracic and genital segments, and by the 5th pair of natatory legs.

Phænna spinifera, Claus.

Occurred at 3 stations, near Gibraltar, in the Red Sea, and in the Indian Ocean.

Family : CENTROPAGIDÆ.

Centropages chierchiæ, Giesbr.

Occurred at 5 stations, near Gibraltar, in the Indian Ocean, and about the Cheval Paar and other pearl banks, Ceylon. Not previously reported from the Indian Ocean.

Centropages typicus, Kröyer.

A well-known northern species, common around the British coasts. Occurred at 3 stations in the Mediterranean.

Centropages violaceus, Claus.

Found at 11 stations, extending from the Mediterranean to the Red Sea, and throughout the Indian Ocean.

Centropages furcatus (Dana).

One of the commoner species of this genus. Occurred at 29 stations, from the Red Sea throughout the Indian Ocean.

Centropages elongatus, Giesbr.

Found at 8 stations, from the Gulf of Suez throughout the Indian Ocean.

Centropages gracilis (DANA).

Occurred at 14 stations, the range being much the same as that of the preceding species.

Centropages kroyeri, GIESBR.

Found twice in the northern Indian Ocean, in the vicinity of Socotra. The western Mediterranean appears to be its only previously known habitat.

Centropages calaninus (DANA).

Occurred at 11 stations in the Indian Ocean.

Centropages orsini, GIESBR.

This, like the preceding species, occurs at 11 stations, all in the Indian Ocean.

Centropages tenuiremis, n. sp.—Plate I., figs. 14 to 18.

Length, female 2·0 millims.; male 1·8 millims.

Body somewhat angular, widest anteriorly, slightly tapering to last segment of thorax, which is terminated by long outwardly extended lateral acute projections. Anterior antennæ of female 24-jointed, the proportional lengths being as follows :—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
3.	4.	2.	2.	3.	3.	2.	3.	3.	4.	4.	5.	6.	7.	8.	8.	8.	8.	7.	5.	5.	5.	5.	5.

Male right antenna 24-jointed; joints 13 to 17 are considerably thickened; a geniculation occurs between the 18th and 19th joints.

Abdomen of female 4-jointed, of male 5-jointed, the last one very small.

Furcal ramus sub-linear, the length about three times the width. Terminal caudal setæ in the female have the basal portion thickened.

The basal joint of the right 5th natatory leg in the female is acutely produced on the inner side and bears three rows of minute teeth. The 5th legs in the male are in general similar to those of *C. typicus*, as are the other appendages not alluded to.

Large numbers of specimens, both male and female, were found at 21 stations round Ceylon.

The acute lateral terminal thoracic spines, the 5th natatory legs in the female, and the abdomen and furcal rami are the distinguishing features of this species.

Centropages dorsispinatus, n. sp.—Plate I., figs. 19 to 25.

Length, female 1·37 millims.; male 1·24 millims.

Cephalothorax ovate, the posterior segment having a rounded acute terminal projection. Rostrum short, broad and triangular. A remarkable curved beak-like hook adorns the median dorsal line of the posterior edge of the cephalic segment. Anterior antennæ of the female 24-jointed, the proportional lengths being as follows :—

1.	2.	3.	4.	5	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.
3.	5.	1.	1.	1.	1.	1.	1.	2.	2.	3.	3.	5.	5.	5.	6.	6.	6.	6.	5.	4.	3.	3.	4.

The 2nd, 5th, 10th and 11th joints bear spinous projections. Male right anterior antennæ 23-jointed, with a geniculation between the 18th and 19th joints.

Abdomen of female 4-jointed; of male 5-jointed, the last joint very small. Furcal rami slightly curved inwards, about twice as long as the width. Fifth natatory legs attenuated; the second joint of right leg in female has a long plain projecting spine on inner side. The chela of the male right natatory leg is clothed with short hair on the outer side.

The other appendages are similar to those of *C. typicus*. A number of specimens, male and female, were taken in Palk Straits, Ceylon.

The species is easily distinguished by the median dorsal cephalic hook, and by the 5th pair of natatory legs and the abdomen and furcal rami.

Isias clavipes, Boeck.

This British species was only taken once, in the first gathering. It ranges to the Mediterranean and Atlantic Ocean.

Pseudodiaptomus salinus, Giesbr.—Plate II., figs. 21 to 23.

Occurred at 3 stations in the Gulf of Suez and at 3 stations in the Indian Ocean, its only previous record being from the Red Sea.

Giesbrecht's specimen was a female, the male remaining unknown until now; we have the satisfaction to record it from the same stations at which the females were found. The male measures 1·25 millims., and its characters are shown by figs. 22 and 23, on Plate II. The female also measures 1·25 millims., and its fifth pair of legs are shown at fig. 21, Plate II.

Pseudodiaptomus serricaudatus (T. Scott).

Occurred at 20 stations throughout the Indian Ocean and about Ceylon.

Pseudodiaptomus aurivillii, Cleve—Plate II., figs. 24 to 26.

Found at 8 stations in the Indian Ocean. Fortunately the specimens include the male hitherto unknown. The female measures 1·2 millims. and the male ·93 millim. The characteristic appendages of both sexes are shown by figs. 24 to 26, on Plate II.

Temoropia mayumbænsis, T. Scott.

Two records for this rare species were added in the Gulf of Suez. The Gulf of Guinea is its only previously known habitat.

Temora longicornis (Müller).

This common British species was found at 2 stations, from the English Channel to the Mediterranean.

Temora discaudata, Giesbr.

One of the most widely distributed species throughout the regions traversed.

Occurred at 60 stations, from the Mediterranean southwards, throughout the Indian Ocean. and round Ceylon.

Temora stylifera (Dana).

Occurred at 16 stations, from the Red Sea southwards, through the Indian Ocean, and about Ceylon.

Temora turbinata (Dana).

Occurred first in the Gulf of Manaar, and at 4 other stations about the Ceylon Pearl Banks. Has been previously reported from the Pacific, New Zealand, and the Gulf of Guinea, but not from the Indian Ocean.

Metridia lucens, Boeck.

Fairly common, from the English Channel, through the Mediterranean, and as far as the Gulf of Suez, but not further south.

Both the latter localities are an extension of its known range of distribution.

Pleuromamma gracilis, Claus.

Occurred at 24 stations, from the English Channel onwards to the Indian Ocean, and in the open sea around Ceylon.

Pleuromamma xiphias, Giesbr.

This was taken in the first gathering only, probably near Gibraltar.

Its previously known range includes the Atlantic, Pacific and Indian Oceans.

Pleuromamma abdominalis (Lubbock).

Found at 28 stations, from the Mediterranean to the Indian Ocean, as far as Ceylon.

Lucicutia flavicornis (Claus).

Occurred at 21 stations, extending from the English Channel to the Indian Ocean, as far as Ceylon.

Heterorhabdus spinifrons (Claus).

Found once in the Mediterranean and again at 4 stations in the Indian Ocean and twice off Minikoi, near Ceylon.

Heterorhabdus papilliger (Claus).

Heterorhabdus abyssalis (Giesbr.).

Heterorhabdus clausi (Giesbr.).

The above three species were each taken once only. The two former between Perim and 200 miles into the Indian Ocean—the latter near Minikoi. Each record is an addition to the known distribution of the species.

Family: PSEUDOCYCLOPIDÆ.

Pseudocyclops obtusatus, Brady and Robertson.

A few specimens only were obtained in the northern Indian Ocean and about the pearl banks and Cheval Paar, Ceylon.

The British coast appears to be the only previously recorded habitat.

Family: CANDACIIDÆ.

Candacia armata (Boeck).

Taken only in the first gathering. between the English Channel and Gibraltar. It is probable that the tropical records of this species, long known as *C. pectinata*, Brady, refer to other Candacias, as more than one species is included in the figures of *C. pectinata* in the Report on the "Challenger" Copepoda, but none of them are identical with Boeck's *C. armata*.

Candacia simplex (Giesbr.).

Occurred at 19 stations, from the Mediterranean onwards through the Indian Ocean and at several of the Ceylon stations. Not before recorded from the Indian Ocean.

Candacia bispinosa (Claus).

Found on three occasions in the Mediterranean and the Red Sea. Previously reported from the Indian Ocean.

Candacia bradyi, A. Scott.

Occurred at 8 stations, extending from the Gulf of Suez into the Indian Ocean.

Mr. Scott's previous record was from Aden. It is probable that some of the previous records of *C. pectinata* from tropical seas are really this species.

Candacia truncata (Dana).

Occurred at 18 stations, from the Gulf of Suez onwards through the Indian Ocean to Ceylon.

Candacia catula (Giesbr.).

Occurred at 17 stations, the range being similar to that of the preceding species.

Candacia longimana (Claus).

Obtained at 3 stations only, from the south of the Red Sea and from Perim into the Indian Ocean.

Candacia æthiopica (Dana).

Range of this species is similar to that of *C. catula*; obtained at 17 stations.

Candacia curta (Dana).

Of similar range to the last species, but less plentiful; was found at 6 stations.

Candacia pachydactyla (Dana).

Obtained at 11 stations in the Indian Ocean and round Ceylon.

Family: PONTELLIDÆ.

Calanopia elliptica (Dana).

Taken between Port Said and Suez and then fairly continuously through the Indian Ocean and round Ceylon. Occurred at 37 stations.

Calanopia minor, A. Scott.

Of similar range to *C. elliptica*—occurred 25 times.

Calanopia aurivillii, Cleve.

Obtained at 4 stations in the vicinity of Galle and at 4 on the pearl banks. Cleve's specimens were from the Malay Archipelago.

Labidocera acuta (Dana).

Common from Port Said throughout the Indian Ocean and round Ceylon—occurred at 39 stations.

Labidocera minuta, Giesbr.

Occurred first at the southern end of the Gulf of Suez and then at 20 stations throughout the Indian Ocean and round Ceylon.

Labidocera detruncata (Dana).

Occurred at 7 stations in the Indian Ocean, and also found at Back Bay, Trincomalee.

Labidocera pavo, Giesbr.

Obtained at 14 Ceylon stations. Known previously only from the Red Sea.

Labidocera kroyeri (Brady).

Similar in distribution to last species: obtained at 11 Ceylon stations.

Labidocera kroyeri (Brady), var. **gallensis**, nov.—Plate II., figs. 6, 7.

Male differs from *L. kroyeri* in several particulars. The posterior thoracic segment in this variety is rounded at base, and has a trifid projection on the left side instead of a bifid one as in *L. kroyeri*. The 1st abdominal segment has a long narrow spine on its right basal corner. The end of basal portion of the claspers in the 5th natatory legs is very short and the chela more spinous than that of *L. kroyeri*. In other respects there is a close similarity between the species and this variety.

Taken in surface tow-nettings from Galle Harbour and elsewhere, Ceylon.

Labidocera kroyeri (Brady), var. **stylifera**, nov.—Plate II., figs. 8, 9.

Male differs from *L. kroyeri* like the variety *gallensis* in the last thoracic segment and in the 5th natatory legs. The basal portion of the latter is produced into a long rod-like projection. Several specimens were taken at different stations round Ceylon.

Labidocera pectinata, n. sp.—Plate II., figs. 10 to 14.

Length, female, 2·1 millims. Male unknown.

Cephalothorax 5-jointed, robust in centre, slightly tapering towards each end, the terminal segment having strong lateral spinous projections. Rostrum short, bifid at apex. Anterior antennæ 23-jointed, in length about equal to the cephalothorax.

The relative lengths of the joints are as follows :—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	22.	23.
6.	16.	2.	2.	2.	4.	4.	6.	5.	5.	8.	10.	10.	12.	16.	14.	16.	16.	10.	10.	10.	9.	9.

Posterior antennæ and mouth organs and 1st to 4th pairs of natatory legs as in the other members of this genus. Abdomen 3-jointed, about one-third as long as the cephalothorax ; the right basal extremity of the genital segment is produced into two curved spines ; the middle joint bears a knobbed protuberance. The furcal rami are slightly asymmetrical, the right one being nearly half as large again as the left ; the inner side of each is lined with fine hairs ; each furca terminating in five short setæ. Fifth natatory legs, each composed of two 1-jointed branches, asymmetrical, the inner branches being differently denticulated ; both branches of the left leg are larger than those of the right. The characters of the abdomen and 5th natatory legs are unlike those of any other species known to us.

Four specimens, all females, were taken in Palk Straits, Ceylon.

Pontella fera, Dana.

Found at 3 stations, viz., twice off Minikoi, Indian Ocean, and at Vankali Paar, Ceylon.

Pontella securifer, Brady.

Taken off Minikoi, Indian Ocean, and at 10 stations round Ceylon.

Pontella princeps, Dana.

Was found once only, at Chilaw Paar, Ceylon.

Pontella tenuiremis, Giesbr.

Was found once only, in Palk Strait, Ceylon. Giesbrecht's specimen was from the Pacific Ocean.

Pontella danæ, var. **ceylonica**, nov.—Plate II., figs. 1 to 5.

Length, female 3·4 millims.

Cephalothorax of nearly the same width throughout, in this respect differing from

P. danæ, which tapers gradually from the second to the posterior thoracic segment. Rostrum nearly straight, length about double the width, and has bifid apex. Fifth natatory legs asymmetrical, the left having outer and inner branches larger than the right branches; the outer one has a large and small spine on the outer side.

First joint of abdomen somewhat globular, whereas that of *P. danæ* is more quadrate. A number of specimens, all females, were found at 5 stations around Ceylon. The 5th natatory legs and the shape of the abdomen serve to distinguish the variety from *P. danæ*, GIESBRECHT.

Pontellina plumata, DANA.

Occurred at 17 stations, south of Gulf of Suez, in the Indian Ocean, and round Ceylon.

Pontellopsis armata (GIESBR.).

Occurred first between the Maldives and the Gulf of Manaar, and then at 9 Ceylon stations. Previously known from the Pacific and Indian Oceans.

Pontellopsis krameri (GIESBR.).

Occurred at 4 Red Sea stations. GIESBRECHT's specimens were also from the Red Sea. The species has been recorded from Fortescue Strait by A. SCOTT.

Pontellopsis regalis, DANA.

The only specimen of this species was taken in the Mediterranean, near Messina.

Pontellopsis strenua (DANA).

Found only at Cheval and Periya paars, Ceylon.

Pontellopsis perspicax (DANA).

Like the last species, this was only taken on the Cheval and Periya paars.

Pontellopsis herdmani, n. sp.—Plate II., figs. 15 to 17.

Length, female 1·9 millims.; male unknown.

Cephalothorax about twice as long as its breadth, having 5 segments, the posterior segment terminating on each side with a triangular acuminated spine. Rostrum long, narrow, and bifid. Anterior antennæ 16-jointed, the relative lengths of the joints being as follows: $\dfrac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.\ 9.\ 10.\ 11.\ 12.\ 13.\ 14.\ 15.\ 16.}{6.\ 7.\ 5.\ 8.\ 3.\ 5.\ 3.\ 5.\ 5.\ \ 6.\ \ 9.\ \ 6.\ \ 6.\ \ 7.\ \ 6.\ \ 6.}$

Posterior antennæ, mouth organs and 1 to 4 pairs of natatory legs as in the other species of *Pontellopsis*. Abdomen about half the length of the cephalothorax, composed of 2 joints, the first being about double the size of the second and having 2 thorn-like projections on the right side. Furcal rami twice as long as broad, with fine hairs on the inner surface and each terminating in 5 short non-plumose setæ.

Fifth pair of natatory legs each 2-branched; each branch composed of one bifid joint, the outer branches each having 3 small spines on outer edge. A few females were found in Galle Harbour and also off Karativo Island in the Gulf of Manaar.

The abdomen and 5th natatory legs distinguish this from any other described form. We have peculiar pleasure in naming it after Professor HERDMAN.

Acartia clausi, GIESBR.

A common British species. Occurred at the first 4 stations as far as the Gulf of Suez, and once off Ceylon at the south end of the Cheval Paar.

Acartia longiremis, LILLJ.

Taken at 9 stations, from the English Channel to the Mediterranean off Messina.

Acartia dubia, T. SCOTT.

Found in the Suez Canal and in the Red Sea.

Acartia erythræa, GIESBR.

Well distributed throughout the traverse, occurring at 53 stations, from the Gulf of Suez, throughout the Indian Ocean, and around Ceylon.

Acartia centrura, GIESBR.

Occurred in Gulf of Suez and the Red Sea, and at 6 stations round Ceylon. Previously reported from the Red Sea and Atlantic Ocean.

Acartia negligens, DANA.

Obtained at 38 stations, from Gulf of Suez onwards through the Indian Ocean, and common around Ceylon.

Tortanus gracilis (BRADY).

One record only from about the Gulf of Suez. BRADY records the species from the Philippine Islands.

Tortanus forcipatus (GIESBR.).

Occurred at 3 Ceylon stations only, viz., off Kalpentyn Island, Cheval and Periya paars, and off Pantura, south of Colombo. GIESBRECHT'S specimens were from Amoy, China.

FAMILY: CYCLOPIDÆ.

Thorellia brunnea, BOECK.

Found in washings from sponges, Gulf of Manaar.

Oithona plumifera, Baird.

A common species, recorded from 40 stations almost continuously throughout the seas traversed.

Oithona similis, Claus.

Commencing at the Gulf of Suez, this species occurred at 38 stations; similar in distribution to *O. plumifera*.

Oithona minuta, T. Scott.

This species, first recorded from the Gulf of Guinea, appears to be abundant throughout the Indian Ocean and round Ceylon, occurring at 35 stations.

Oithona rigida, Giesbr.

Occurred in the Red Sea, about Minikoi, and at 18 stations around Ceylon.

Oithona spinifrons, Boeck.

This common British species, closely allied to *O. similis*, occurred in the earlier gatherings, and in the Red Sea and Northern Indian Ocean, to Ceylon.

Oithona nana, Giesbr.

Occurred at 3 stations on the Pearl banks, Ceylon.

Oithona setigera, Dana.

Taken on 4 occasions in the Mediterranean and once in the Suez Canal.

Family: ASCIDICOLIDÆ.

Doropygus normani, Brady.

A few specimens were taken from the branchial sac of a species of *Cynthia* found at the Aripu reef, Gulf of Manaar.

Doropygus pulex, Thorell.

Found attached to the branchial sac of a species of *Molgula*, from the Cheval and Periya paars, Ceylon.

Botryllophilus ruber, Hesse.

Found in washings from sponges, Gulf of Manaar.

Family: HARPACTICIDÆ.

Sunaristes paguri, Hesse.

A few specimens were found in the general washings from Ceylon Invertebrates.

Sunaristes inopinata, n. sp.—Plate III., figs. 1 to 8.

Length, male 1·3 millims.; female 1·5 millims.

Body resembling *S. paguri*, but all the segments broader in proportion to length. Anterior antennæ of female 6-jointed, densely covered on the upper side with plumose setæ and bearing two long club-like appendages, possibly olfactory.

The relative lengths of the joints are as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ \ 6.}{11.\ 7.\ 7.\ 5.\ 4.\ 15.}$

Anterior antennæ of male short and broad, terminating in a curved hook.

Posterior antennæ and mouth organs as in *S. paguri.* Both branches of 1st to 4th pairs of natatory legs 3-jointed, most of the joints having small bundles of fine hairs on the surface or at the sides. Fifth pair as in *S. paguri.*

Abdomen about the same length as the cephalothorax, composed of joints of which the genital segment is the larger one. Furcal rami twice as long as the breadth, tapering to the apex, and each having a stout spine on inner margin. Several specimens were found in the general washings from Ceylon Invertebrates.

Sunaristes longipes, n. sp.—Plate III., figs. 9 to 11.

Length, female 1·5 millims.; male unknown.

Similar in build to the last species but more robust. Anterior antennæ 6-jointed and similar to *S. inopinata*, except in proportional lengths of joints, which are as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ \ 6.}{15.\ 7.\ 3.\ 5.\ 3.\ 19.}$

Abdomen short and robust, about equal in length to the first 3 thoracic segments. First 2 joints are coalescent, the 4th and especially the 5th very small. Furcal rami long and tapering, the length 3 times that of the breadth; each has a spine on both sides. Mouth organs as in *Longipedia*, *Canuella* and *Sunaristes.* Other organs as in last species, with the exception of 4th pair of natatory legs, which (fig. 10) are very narrow, the inner branch being nearly double the length of the outer one.

The length of the furcal rami and the elongated 4th pair of natatory legs serve to distinguish this species from others of the genus. One specimen only, a female, was found in the general washings from Ceylon Invertebrates.

Sunaristes curticaudata, n. sp.—Plate III., figs. 12 to 17.

Length, female, 1·6 millims. Male unknown.

First segment of cephalothorax equal in length to that of the four following segments combined, and much broader. Abdomen 4-jointed, about three-fourths of the length of the cephalothorax. Anterior antennæ 4-jointed, all adorned with plumose setæ, the second joint having also two spines. The proportionate lengths are as follows: $\frac{1.\ \ 2.\ 3.\ 4.}{12.\ 16.\ 5.\ 7.}$

Mouth organs as in *Longipedia*, *Canuella* and *Sunaristes.*

Other organs similar to those of *S. paguri*, with the exception of the inner branch of the 4th natatory legs, which in this species is 2-jointed (fig. 16). Caudal segments short, their length not much exceeding the width; the anterior inner corner of each is marked off by a dividing line. One specimen only was found in the general washings of Ceylon Invertebrates.

The form of the furcal rami is sufficiently diagnostic to distinguish this from other species of the genus. The fact that this species has the inner branch of the fourth pair of legs only 2-jointed may, sometime, necessitate its removal to a new genus.

Longipedia coronata, CLAUS.

Occurred at 2 stations in the Mediterranean and once in the Suez Canal. Usually a littoral species. Found also in washings from Sponges, Gulf of Manaar.

Longipedia minor, T. SCOTT.

A few specimens of this form were obtained in the tow-net off Marichchukaddy.

Canuella perplexa, T. and A. SCOTT.

One specimen was taken between Port Said and Suez.

Ectinosoma atlanticum (BRADY and ROBERTSON).

The most abundant species throughout the collection. Occurred at 66 stations, from the Mediterranean throughout the Red Sea and Indian Ocean and all around Ceylon.

Ectinosoma roseum, DANA.

Hardly less common than *E. atlanticum*. Fifty-nine stations, similarly distributed.

Ectinosoma normani, T. and A. SCOTT.

Ectinosoma propinquum, T. and A. SCOTT.

Both species found in washings from young pearl oysters and in the general washings from Ceylon Invertebrates.

Setella gracilis, DANA.

Occurred at 44 stations fairly continuously, from the Mediterranean to Ceylon.

Miracia efferata, DANA.

Was obtained in the Indian Ocean, twice off Minikoi, and between the Maldives and the Gulf of Manaar.

Miracia minor, T. SCOTT.

Was taken off Gibraltar, and was also found at 2 stations in the northern Indian Ocean. SCOTT'S specimens were taken in the Gulf of Guinea.

Euterpina acutifrons (DANA).

Well distributed throughout the traverse, occurring at 48 stations, from the Mediterranean to Ceylon.

Tachidius littoralis, POPPE.

One specimen was taken in the Gulf of Suez.

Clytemnestra scutellata, DANA.

Occurred at 10 Indian Ocean stations, and 3 round Ceylon, viz., off Pantura to the south of Colombo, at Cheval Paar and west of Periya Paar, Gulf of Manaar.

Clytemnestra rostrata (BRADY).

Found at 8 stations, from the Mediterranean, Gulf of Suez, Red Sea, and the Indian Ocean, and once at Ceylon, near the Muttuvaratu Paar.

Tegastes sphærica (CLAUS).

One specimen of this littoral species was taken between Port Said and Suez.

Tegastes nigrans (T. and A. SCOTT).

A number of specimens were found in washings from Muttuvaratu pearl oysters.

Tegastes imthurni, n. sp.—Plate IV., figs. 1 to 9.

Length, female 0·6 millim. to 0·45 millim.; male unknown.

Cephalothorax composed of 6 segments; the first broadly falciform, and extending ventrally to double the width of the other segments.

Abdomen 4-jointed, the first extending ventrally into a long projection, truncated at end. A large rounded hook from the centre of the 1st segment projects over the posterior ends of the other segments.

Anterior antennæ 6-jointed, the relative lengths being: $\frac{1.\ \ 2.\ 3.\ 4.\ 5.\ 6.}{25.\ 18.\ 9.\ 4.\ 4.\ 4.}$

Posterior antennæ and mouth organs, with the exception of the 2nd maxillipeds, as in *T. sphærica*. In this species the inner concave edge of the chelate hand, instead of being pectinated, has a small funnel-shaped expansion, the upper circular edge being clothed with fine hairs. The inner projecting corner of the hand has, on the upper edge, about 10 short spines arranged in a pectinate manner.

The 1st pair of natatory legs are similar to *T. sphærica*. The 2nd, 3rd, and 4th pairs differ considerably from that species, however, and also from the generic description in BRADY'S Monograph of British Copepoda. In the 2nd and 3rd pairs of *T. imthurni*, and also in *T. donnani*, and in *T. twynami*, the inner branches are composed of 3 joints, while the outer branches have only 2 joints. The 4th pair has the outer branch 3-jointed, and has only 2 joints in the inner branch. The basal joint of the inner branch of this pair is a wide foliaceous expansion with thickened edges. The 5th pair in this and the following 3 species are also different from the type of the genus, and instead of being 2-jointed, are composed of 1 joint only, which, however, is obviously built up of 2 coalesced joints. Fig. 2 represents a smaller form, not differing in details of structure, except in the absence of hook from abdomen.

Several specimens were found in the washings from the Muttuvaratu pearl oysters.

At Professor HERDMAN's suggestion we dedicate this new species to Mr. E. F. IM THURN, the Lieutenant-Governor of Ceylon at the time of the investigations.

Tegastes donnani, n. sp.—Plate IV., figs. 10 to 12.

Length, female, 0·37 millim.; male unknown.

In appearance and structure this species very nearly resembles *T. imthurni*, the 7-jointed anterior antennæ and the 5th natatory legs being the only important points of difference.

Proportionate lengths of antennary joints : $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{26.\ \ 26.\ \ 12.\ \ 22.\ \ 4.\ \ 8.\ \ 7.}$

Four specimens, all females, were found in the Muttuvaratu pearl oyster washings. We name this species after Captain J. DONNAN, C.M.G., formerly Inspector of the Ceylon Pearl Fisheries.

Tegastes twynami, n. sp.—Plate IV., figs. 13 to 16.

Length, female 0·54 millim.; male unknown.

This species also resembles *T. imthurni* in detail, with the exception of the anterior antennæ, the hand of the 2nd maxillipeds, and the 5th natatory legs. The anterior antennæ are only 6-jointed, the proportionate lengths of the joints being as follows : $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.}{13.\ \ 13.\ \ 10.\ \ 8.\ \ 5.\ \ 5.}$

The inner concave edge of the hand in 2nd maxilliped is strongly pectinated and has a round funnel-shaped protuberance with ciliated edge similar to that of *T. imthurni*; the terminal falcate claw is very stout. Fifth pair of natatory legs like those of *T. donnani*, but larger. Two specimens, both females, were found in the washings from the Muttuvaratu pearl oysters.

The cuticle in the foregoing species is covered with minute circular dots, these are also found on the basal joint of the fourth pair of legs, on the fifth pair and in a lesser degree on the chela of the posterior maxillipeds.

We name this species in honour of Sir WILLIAM TWYNAM, who has long been connected with the Ceylon Pearl Fisheries.

Tegastes chalmersi, n. sp.—Plate IV., figs. 17 to 22.

Length, female, 0·3 millim.; male unknown.

A much smaller form than any of the three preceding. Cephalothorax 5-jointed; length and breadth of 1st joint about equal.

Abdomen 3-jointed, the 1st joint being produced as in the other species of the genus, but different from them in having 4 large denticulations on its outer surface.

Anterior antennæ 7-jointed, the proportionate lengths of the joints being as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.}{14.\ 10.\ 6.\ 4.\ 4.\ 4.\ 5.}$

The 2nd maxillipeds differ considerably from those of any of the preceding species. The middle joint is long and narrow, arcuate on one side and flat on the other, with short setæ on one-half of the flat side. The terminal spine is shaped like a scythe and about $\frac{3}{4}$ the length of the middle joint. Natatory legs as in *T. imthurni*, excepting 4th and 5th pairs. In the 4th pair the outer and inner branches are both 3-jointed, and the basal joint of the inner branch is not foliaceous. The 5th legs are less angular than those of the other species, the surface being covered with rows of convolute markings.

Two specimens, both females, were found in the Muttuvaratu pearl oyster washings. The anterior antennæ, the 2nd maxillipeds, and the 4th natatory legs readily distinguish this species from the others of the genus.

This species is named after Dr. A. J. CHALMERS, formerly a Liverpool Student of Science, now Registrar and Professor in the Medical College, Colombo.

Stenhelia brevicornis, n. sp.—Plate V., figs. 1 to 9.

Length, female, 0·9 millim.; male unknown.

Cephalothorax narrow, 5-jointed. Anterior antennæ short, 8-jointed, the relative lengths of the joints being as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.}{18.\ 12.\ 10.\ 8.\ 3.\ 4.\ 6.\ 12.}$ Most of the joints are shorter than the breadth and bear numerous setæ. The 4th joint is produced on upper side, terminating in a long filament.

Posterior antennæ, mouth organs, and 1st to 4th pairs of natatory legs as in *S. ima*. The basal joint of 5th pair is large and triangular, bearing 6 marginal and apical setæ, two of them plumose; second joint long and narrow, tapering towards apex and bearing six setæ, the apical one much longer than the marginal ones. Abdomen 5-jointed; the posterior margin of the 1st joint has a dorsal hook, the margins of the other joints being fringed with fine hairs. Furcal rami about 3 times as long as broad.

Two specimens only, both females, were found in the Muttuvaratu pearl oyster washings. The short, broad-jointed anterior antennæ, the outer joint of the 5th natatory legs, and the long furcal rami are the chief distinguishing features of this species.

Stenhelia gracilicaudata, n. sp.—Plate V., figs. 10 to 15.

Length, female, 0·67 millim.; male unknown.

Cephalothorax 5-jointed, very robust. Anterior antennæ 8-jointed, the proportional lengths of the joints being as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ 5.\ 6.\ 7.\ \ 8.}{14.\ 20.\ 10.\ 11.\ 4.\ 5.\ 3.\ 10.}$ They are well clothed with setæ on the upper side. The 4th joint is produced and terminates in a long narrow filament.

Posterior antennæ and mouth organs as in *S. brevicornis*. Natatory legs in general similar to those of *S. brevicornis*, but the 1st pair differs therefrom in the respective lengths of its joints; the 5th pair is less triangular, the second joint being ovate. Abdomen 5-jointed, about the same length as the cephalothorax, but only half the width, and non-setiferous on posterior edges. Furcal rami about 4 times as long as broad.

One specimen only, a female, was found in the Muttuvaratu pearl oyster washings.

The chief distinguishing features are the anterior antennæ, the 1st and 5th natatory legs, and the long narrow furcal rami.

Stenhelia longicornis, n. sp.—Plate V., figs. 16 to 22.

Length, female, 0·8 millim.; male, 0·6 millim.

Cephalothorax similar to that of *S. brevicornis*. Anterior antennæ 8-jointed, long and narrow, the proportional lengths being: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ 5.\ 6.\ 7.\ 8.}{15.\ 24.\ 12.\ 11.\ 3.\ 4.\ 5.\ 7.}$ The 4th joint terminates in a long narrow filament; the setæ of the various joints as in *S. gracilicaudata*.

Posterior antennæ and mouth organs and 2nd to 4th pairs of natatory legs as in *S. brevicornis*. The 1st pair of legs agrees in form with *S. gracilicaudata*, as also does the 5th pair in the female, with the exception of the spines of the inner joint, which in this species are shorter, more numerous, and mostly plumose. The outer joint has a pellucid circle near the outer edge. Fig. 21 shows the inner branch of the 2nd pair in the male, and fig. 22 the 5th leg of the male, which is much smaller than that of the female.

Abdomen short and broad, the 4th joint having a short tooth on lower edge. The furcal rami are very small, about half as long as broad. A few specimens of each sex were found in the Muttuvaratu pearl oyster washings. The long narrow anterior antennæ, the 5th natatory legs, and the small furcal rami are the distinguishing characters of this species.

Stenhelia perplexa, n. sp.—Plate VI., figs. 1 to 7.

Length, female, 0·6 millim.; male unknown.

Cephalothorax much resembles *S. brevicornis*. Anterior antennæ 8-jointed, the proportional lengths of joints being as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ 5.\ 6.\ 7.\ 8.}{15.\ 17.\ 12.\ 10.\ 3.\ 4.\ 4.\ 8.}$

Posterior antennæ and mouth organs, with the exception of 2nd maxillipeds (fig. 3), as in *S. brevicornis*. Natatory legs all more or less similar to those of *S. longicornis*.

Abdomen broad, the joints mostly quadrate, posterior margins devoid of setæ. Furcal rami short and broad, produced downwards on inner edges; terminal setæ as in *S. longicornis.*

Several females were found in the washings from Muttuvaratu pearl oysters.

This species in many of its characters resembles other members of the genus, without agreeing with any one in all respects. The jointing of the anterior antennæ and the long 2nd maxillipeds are its chief distinguishing features.

Stenhelia dentipes, n. sp.—Plate VI., figs. 8 to 14.

Length, female, 0·56 millim.; male unknown.

Cephalothorax somewhat angular anteriorly, with long narrow pointed rostrum.

The antennæ in the only specimen found were missing, with the exception of the four basal joints on one side. Mouth organs as in *S. brevicornis*, with the exception of 2nd maxillipeds, the middle joint of which is broadly ovate, and the claw curved and slender.

The inner branch of the 1st pair of natatory legs is double the length of the outer branch; 2nd to 4th pairs as in *S. brevicornis.* Inner branch of 5th pair elongated, terminating in a short dagger-like spine; second joint long and gradually narrowing, ending in a small elegant foot-shaped protuberance having 2 apical and 5 lateral setæ. In this respect it somewhat resembles *S. blanchardi*, T. and A. Scott. Abdomen similar to *S. perplexa;* furcal rami twice as long as the width.

Found with the other members of the genus here described in the Muttuvaratu pearl-oyster washings. It can be readily distinguished by its 5th pair of natatory legs.

Stenhelia knoxi, n. sp.—Plate X., figs. 15 to 18.

Length, female 0·67 millim.; male unknown.

Cephalothorax and abdomen each with 5 segments. Anterior antennæ very stout 6-jointed, the proportional lengths being as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.}{12.\ 6.\ 3.\ 14.\ 8.\ 17.}$

Both branches of 1st to 4th pairs of natatory legs 3-jointed; outer branch of 1st pair has long, strong, lateral and terminal spines; 2nd joint of 5th pair ovate.

Three specimens, all females, were found in the Muttuvaratu pearl oyster washings.

We name this species after Robert Knox, who escaped from the King of Kandy to the coast, at the pearl banks, in 1679.

Although the anterior antennæ are only 6-jointed instead of 8, in all other respects the characters agree with those of *Stenhelia*, so we have thought it best to include this species in that genus.

Stenhelia minuta, n. sp.—Plate VI., figs. 21 to 24.

Length, female, 0·5 millim.; male unknown.

This minute species bears a close resemblance to *S. brevicornis*, both in general form and in its mouth organs, posterior antennæ, and 2nd, 3rd, and 4th pairs of natatory legs. Anterior antennæ 8-jointed, the proportional length of the joints being as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.}{10.\ 12.\ 6.\ 10.\ 2.\ 3.\ 4.\ 6.}$

In its 1st pair of natatory legs it resembles *S. longicornis*, the 5th pair being similar to those of *S. gracilicaudata*.

One specimen only, a female, was found in the Muttuvaratu pearl oyster washings. Its minute size, the jointing of the anterior antennæ, and the 1st and 5th natatory legs constituted its chief features.

Parastenhelia, n. gen.

Anterior antennæ 9-jointed. Inner branch of posterior antennæ 3-jointed.

Mandible palp with 2 branches each 1-jointed. Second maxilliped like a grasping hand. First pair of natatory legs has outer branch 3-jointed, inner branch 2-jointed. Inner branches of 2nd, 3rd, and 4th pairs all 3-jointed. Fifth pair foliaceous and 2-jointed. Abdomen in both sexes 5-jointed.

The characters which distinguish this genus from *Stenhelia* are the 9-jointed antennæ and the 2-jointed inner branch in 1st pair of natatory legs.

Parastenhelia hornelli, n. sp.—Plate VII., figs. 1 to 10.

Length, female 1 millim.; male 0·77 millim.

In general appearance, and in the jointing of cephalothorax and abdomen, this species much resembles the members of the genus *Stenhelia*.

Anterior antennæ of female 9-jointed, the proportional lengths of the joints being as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.\ 9.}{21.\ 20.\ 15.\ 12.\ 8.\ 11.\ 4.\ 3.\ 12.}$

The upper surface is plentifully clothed with long setæ. Inner branch of posterior antennæ 3-jointed, the 2 apical joints bearing several plumose spines.

Basal joint of mandible large, with lateral warty protuberance, and 3 rounded teeth at apex. Palp is of pyriform shape, having 3 plumose spines at apex, and laterally has 2 branches, each composed of 1 joint bearing several setæ. Second maxilliped is a grasping hand with ovate middle joint, terminating in a stout claw.

Inner branch of 1st pair of natatory legs 2-jointed, the 1st joint being $1\frac{1}{2}$ times the length of the entire 3-jointed outer branch; terminal joint very small.

Inner branches of 2nd, 3rd, and 4th pairs all 3-jointed in both sexes. Fifth pair foliaceous; basal joint triangular and bearing plumose spines. Second joint in female very long, wide at base and tapering towards apex, the edges having fine hairs, and the apex 6 spines, mostly plumose. Outer branch of male 5th pair half the size of the female and distinctly divided into 3 joints bearing spines, mostly plumose.

Several males and females were found in the washings from young pearl oysters, also in the general washings of dredged material, in deep water off Point de Galle, and in the Muttuvaratu pearl oyster washings. We have pleasure in dedicating this new form to our friend Mr. JAMES HORNELL, who worked with Professor HERDMAN in Ceylon.

The 9-jointed anterior antennæ and the 2-jointed inner branch of 1st pair natatory legs clearly separate this species from the genus *Stenhelia*, with which it in most other points agrees. These characters, together with the 3-jointed inner branch of 2nd pair of natatory legs in the male, as well as the remarkable 5th pair in both sexes, served to distinguish this species from any other genus known to us.

Parastenhelia similis, n. sp.—Plate X., figs. 8 to 14.

Length, female 1 millim.; male unknown.

Has a general resemblance to *P. hornelli*, but differs therefrom in the length of joints of anterior antennæ, in the 2nd maxillipeds, and in the 2nd branch of 5th natatory legs. Anterior antennæ 9-jointed, the proportional lengths of the joints being as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.\ 9.}{10.\ 9.\ 8.\ 7.\ 5.\ 5.\ 4.\ 2.\ 5.}$

Hand of 2nd maxillipeds gracefully curved; the apical claw long and stout. Inner joint of 5th pair of natatory legs long and wide; laterally lined with fine hairs; the terminal spines plumose. Furcal rami about twice as broad as long. Two specimens, both females, were found in the Muttuvaratu pearl oyster washings.

Ameira minor, n. sp.—Plate V., figs. 23 to 29.

Length, female 0·46 millim.; male unknown.

Cephalothorax narrow, 5-jointed. Anterior antennæ 8-jointed, the proportional lengths of the joints being as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.}{5.\ 20\ 12.\ 8.\ 4.\ 5.\ 3.\ 5.}$

The 4th joint terminates with a long narrow filament. Posterior antennæ similar to those of *A. longipes*. Mouth organs as in *A. longiremis*.

Natatory legs, 1st to 4th pairs, somewhat similar to those of *A. longipes*. The 5th pair much resemble those of *A. tenuicornis*.

Abdomen 5-jointed, the posterior edges of all the joints lined with minute hairs. Furcal rami subquadrate, each terminating in 2 thick and 3 thin setæ.

A considerable number of females only were found in the Muttuvaratu pearl-oyster washings. This is a very small species bearing a strong resemblance to the genus *Stenhelia*, but distinctly differing from members of that genus in having the inner branch of the posterior antennæ 1-jointed.

Ameira tenuipes, n. sp.—Plate VI., figs. 15 to 20.

Length, female 0·53 millim.; male unknown.

Cephalothorax 5-jointed. Rostrum short and wedge-shaped. Anterior antennæ profusely setose, 8-jointed, the proportional lengths of the joints being as follows:

$\frac{1.\ \ 2.\ \ 3.\ 4.\ 5.\ 6.\ 7.\ 8.}{20.\ 21.\ 12.\ 8.\ 6.\ 6.\ 3.\ 5.}$ The 4th joint terminates with a long filament. The inner branch of posterior antennæ is 2-jointed, the 2nd joint being very small.

Mouth organs and 2nd, 3rd, and 4th pairs of natatory legs as in *A. minor*. First joint of inner branch of 1st pair of legs as long as entire 3-jointed outer branch; 3rd inner joint long and narrow.

Basal joint of 5th pair of legs triangular, bearing 2 short plumose setæ and 3 plain ones. Outer joint long and narrow, 4 times as long as broad; fringed on both sides with fine hairs, and having 4 terminal setæ and 1 lateral.

One specimen only, a female, was found in the Muttuvaratu pearl oyster washings. Although the inner branch of the posterior antennæ is 2-jointed, we have thought it best to include this species in the genus *Ameira*, with which it agrees in all other particulars. The 1st and 5th natatory legs readily distinguish it from other species.

Ceylonia, n. gen.

Cephalothorax and abdomen each 5-jointed. Anterior antennæ 7-jointed. Inner branch of posterior antennæ 1-jointed. Mandible palp with one small branch. Second maxilliped non-prehensile. Inner branches of 1st to 4th pairs of natatory legs all 2-jointed; outer branches 3-jointed; 5th pair foliaceous.

The genus *Ceylonia* is nearly related to *Mesochra*, and might have been incorporated therewith but for the structural difference in the 1st pair of natatory legs and in the maxillipeds.

Ceylonia aculeata, n. sp.—Plate VII., figs. 11 to 23.

Length, female 1·2 millim; male 1 millim.

Body robust throughout; cephalothorax and abdomen each 5-jointed, the first two abdominal joints imperfectly divided. Rostrum short and blunt.

Anterior antennæ short and stout, thickly setiferous, 7-jointed, a long thick filament protruding from the apex of 4th joint. The proportional lengths of the joints are as follows: $\frac{1.\ \ 2.\ \ 3.\ 4.\ 5.\ 6.\ \ 7.}{16.\ 12.\ 16.\ 9.\ 3.\ 6.\ 11.}$

Outer branch of posterior antennæ 2-jointed, the outer edge and apex of 2nd joint lined with 6 stout spines; inner branch composed of one joint with 2 apical spines.

Biting part of mandible consists of 3 large teeth; palp with small branch, spinous at apex. First maxilliped has terminal claw and two 1-jointed branches with apical plumose setæ. Second maxilliped wedge-shaped, non-prehensile, but with small curved rudimentary claw.

Inner branches of 1st to 4th natatory legs 2-jointed; outer branches 3-jointed. Inner branches of 1st pair only $\frac{2}{3}$ the length of outer branch, both bearing strong spines; a remarkable rod-like projection with hirsute termination extends from the centre of 1st joint of inner branch. The middle joint of outer branch of male

3rd pair of legs bears a long stout aculeate spine. Fifth pair of legs foliaceous; outer joint in female roundly ovate, both clothed with long spinous setæ. In the male 5th pair the joints are coalescent and terminate in dagger-shaped spines and plumose setæ. Furcal rami about $1\frac{1}{2}$ times as long as broad, each bearing a long thick terminal spine and short setæ.

Several females and 2 males were obtained from young pearl oyster washings, and from deep water off Point de Galle. The anterior and posterior antennæ, the mouth organs and the 1st and 5th pairs of natatory legs are clear distinguishing characters of this species.

Laophonte serrata, Claus.

Laophonte inornata, A. Scott.

Both of the above were taken at Cheval Paar, and were also found in general washings of Invertebrates from the pearl oyster beds.

Laophonte hirsuta, n. sp.—Plate VIII., figs. 1 to 8.

Length, female 0·5 millim.; male unknown.

Lateral edges of cephalothorax and abdomen fringed with minute hairs, giving the animal a hirsute appearance. First cephalic segment quadrately shield-shaped, produced postero-laterally, and equalling in size the rest of the cephalothorax and abdomen.

Anterior antennæ 6-jointed, the proportional lengths of the joints being as follows: $\frac{1.\ \ 2.\ \ 3.\ 4.\ 5.\ \ 6.}{13.\ 14.\ 14.\ 4.\ 3.\ 10.}$ The upper side is clothed throughout with short setæ, the protuberance of the 4th joint leading to a long narrow filament.

Posterior antennæ and mouth organs, with the exception of mandible, as in *L. horrida*. Mandible elongated and narrow, the palp being long and slender. Inner branch of 1st pair natatory legs remarkably robust, terminating in a very small joint and a short stout curved claw. Outer branch 2-jointed, the 2 joints not half the length of the 1st inner joint. The outer branch in 2nd, 3rd and 4th pairs is 3-jointed, the inner 2-jointed. The 5th pair have small basal joints and a long narrow second joint armed with plumose setæ. Furcal rami small, subquadrate.

Eleven specimens, all females, were obtained from the Muttuvaratu pearl oyster washings and the general washings of dredged Invertebrates.

The 1st and 5th natatory legs are sufficiently diagnostic of this species.

Laophontella, n. gen.

Body somewhat pyriform, the cephalic segment nearly half the animal's entire length. Anterior antennæ 5-jointed. Posterior antennæ and mouth organs appear to be as in *Laophontodes*. The 1st, 2nd, and 3rd pairs of natatory legs have both inner and outer branches 2-jointed, 4th pair with outer branch 3-jointed, and inner branch with 1 joint only; 5th pair 2-jointed, foliaceous.

Laophontella differs from both *Laophonte* and *Pseudolaophonte* in the absence of claws in the 1st natatory leg; from *Laophontodes* in the inner branch of 4th pair being only 1-jointed.

With only one specimen, however (a female), to judge from, the generic characters may in the future require some revision.

Laophontella typica, n. sp.—Plate VIII., figs. 9 to 16.

Length, female, 0·5 millim.; male unknown.

Cephalic segment long and tumid; produced posteriorly into long acute spines.

Lateral edges of abdomen more or less notched. Anterior antennæ nearly half as broad as long, 5-jointed, profusely setiferous, the proportional lengths of the joints being as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.}{16.\ 8.\ 5.\ 3.\ 4.}$ The 1st joint has two claw-like spines, and the 3rd joint another, of larger size.

Mouth organs similar to those of *Laophontodes*. Branches of 1st pair of natatory legs of equal length; outer branch 3-jointed, as are the outer branches of 2nd, 3rd, and 4th pairs; inner branch 2-jointed, the 1st joint being double the length of the 2nd, both branches terminating in long setæ. Inner branch of 2nd and 3rd legs 2-jointed, and of the 4th 1-jointed, all armed with strong spines. Basal joint of 5th pair small and spinous; outer joint small, bearing 7 spines. One specimen only, a female, was found in the Muttuvaratu pearl oyster washings. The stout rugged anterior antennæ, the notched abdominal segments, and the inner branches of the swimming feet clearly distinguish this species from other genera.

Cletodes linearis (Claus).

Taken in the Suez Canal, and also in various washings of Invertebrates from the Gulf of Manaar.

Tetragoniceps dubia, n. sp.—Plate VIII., figs. 17 to 22.

Length, female, 0·9 millim.; male unknown.

Cephalothorax 5-jointed, the cephalic segment equalling in length the following three combined, and considerably stouter. Rostrum short and blunt. Anterior antennæ 8-jointed, the 1st joint non-setose, but projecting posteriorly into a beak-shaped protuberance. The other joints very setose, the 4th bearing a long narrow filament. The proportional lengths of the joints are $\frac{1.\ \ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.}{37.\ 14.\ 9.\ 6.\ 4.\ 5.\ 5.\ 9.}$

Posterior antennæ and mouth organs generally like those of *T. malleolata*. Inner branches of 1st to 4th pairs of natatory legs 2-jointed, the outer branches 3-jointed. Fifth legs 1-jointed, with partial segmentation, and having 10 setæ. A pyramidal spine projects from the surface. Furcal rami about twice as long as broad.

One specimen only, and that possibly an immature one, was found in the Muttuvaratu pearl oyster washings. It is nearly related to *T. malleolata*, with which we were at first disposed to place it. The 5th feet are, however, very different from, and the furca much shorter than in that species, so that it seems necessary to separate the present form.

Tetragoniceps minor, n. sp.—Plate VIII., figs. 23 to 28.

Length, female, 0·5 millim.; male unknown.

Closely related to *T. bradyi*; differing, however, from that species in the jointing of the anterior antennæ, and in the long narrow furcal rami. Anterior antennæ 8-jointed, the proportional lengths being as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.\ \ 8.}{40.\ 14.\ 8.\ 7.\ 4.\ 3.\ 6.\ 8.}$ A long beak-like hook projects from the 2nd joint, by which it differs from *T. consimilis*.

The posterior antennæ, the mouth organs, and the 5 pairs of natatory legs are much the same as those of *T. bradyi*.

One specimen only was found in Muttuvaratu pearl oyster washings. The beaked 2nd joint of the anterior antennæ sufficiently distinguishes it from others of the genus.

Dactylophusia tisboides (Claus).

This littoral species was taken between Port Said and Suez.

Dactylophusia latipes (T. Scott).

Taken sparingly on the Ceylon pearl banks. Only previous record is Gulf of Guinea.

Dactylophusia dentata, n. sp.—Plate IX., figs. 1 to 10.

Length, female 1·2 millim.; male 0·83 millim.

Cephalothorax robust; cephalic segment about as long as the rest of the thoracic segments combined. Third and fourth segments have remarkably sharp dorsal teeth; abdomen narrow, little more than one-third the length of the cephalothorax; lateral margins of genital segment produced into a large blunt tooth. Anterior antennæ 8-jointed, the proportional lengths being as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.\ \ 8.}{10.\ 11.\ 8.\ 9.\ 3.\ 4.\ 3.\ 4.}$

The prolonged apex of joint 4 bears a long broad filament. Inner branch of posterior antennæ 2-jointed. Mandible palp 2-branched, the primary branch having long terminal setæ. Second maxilliped has an angular hand and terminal claw of about the same length. Both branches of 1st pair of natatory legs 3-jointed; the basal inner joint half as long again as the entire outer branch; the other joints very small.

In the male the 2nd joint of inner branch of 2nd pair is produced into a long pointed dagger-like spine, broad at base. Fifth pair of female 2-jointed, foliaceous, the inner joint ovate; those of the male similar but smaller. Furcal rami subquadrate, about twice as long as broad, a thick chitinous band lining the inner edges.

Ten males and 5 females were found in the Muttuvaratu pearl oyster washings. The dentated thoracic and 1st abdominal segments, the 2nd maxillipeds, the male 2nd natatory legs, and the furcal rami clearly distinguish this species.

Dactylophusia havelocki, n. sp.—Plate IX., figs. 11 to 18.

Length, female 1 millim.; male unknown.

Anterior antennæ short, 8-jointed, the joints short, length and breadth of each nearly equal. Fourth joint bears a long narrow filament, and the proportional lengths of the joints are: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.}{9.\ 8.\ 5.\ 6.\ 3.\ 4.\ 2.\ 6.}$

Mandible palp 2-branched, secondary branch small, distinctly 2-jointed. Hand of 2nd maxilliped rounded on one side, flat on the other; claw slender. Natatory legs similar to *D. dentata;* the inner branch of the 5th pair however is nearly quadrate instead of ovate. Furcal rami nearly twice as broad as long; basal portion of apical spines thick and jointed.

A few specimens, all females, were found in the Muttuvaratu pearl oyster washings. The short anterior antennæ and furca, coupled with the shape of the mandible palp, and the inner joint of the 5th natatory legs, characterize this species.

Dactylophusia hirsuta, n. sp.—Plate IX., figs. 19 to 24.

Length, female 1·2 millim.; male unknown.

All the segments of the abdomen covered with rows of fine short hairs. Anterior antennæ 9-jointed, the 4th joint bearing a long filament.

The proportional lengths of the joints are as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.\ \ 8.\ \ 9.}{14.\ 14.\ 7.\ 10.\ 3.\ 5.\ 4.\ 3.\ 9.}$

Basal joint of 2nd maxilliped has a row of small hairs near apex, and three terminal plumose setæ; hand small; the claw 2-jointed, long and narrow.

Inner branch of 1st pair of natatory legs as in *D. dentata*, but with shorter terminal spines; 5th pair not unlike those of *D. dentata*, but the length and armature of the setæ are distinctly different, and each joint has a pellucid patch on its surface. Furcal rami very short and hirsute.

Three specimens, all females, were found in the Muttuvaratu pearl oyster washings. The 9-jointed anterior antennæ, the hirsute abdomen, 2nd maxillipeds and furca, and the 5th pair of natatory legs serve to distinguish this species.

Dactylophusia ceylonica, n. sp.—Plate IX., figs. 25 to 32.

Length, female 1·3 millim.; male 0·96.

Posterior dorsal edges of thoracic and abdominal segments have each a row of fine hairs. Anterior antennæ 8-jointed, the proportional lengths of the joints being as follows : $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.}{11.\ 11.\ 5.\ 8.\ 3.\ 5.\ 2.\ 6.}$ The 4th joint bears a long thin filament.

First pair of natatory legs of female same as in *D. hirsuta* ; the inner branch in male has a remarkably long stout spine equalling in length the 1st joint, projecting from the 2nd basal joint. The 2-jointed inner branch of 2nd pair in male has 3 thick more or less curved spines at apex of 2nd joint. Outer joint of 5th pair in female about equal in size to the 1st joint. In the male both joints are exceedingly small.

Eighteen females and 13 males were found in the Muttuvaratu pearl oyster washings. The chief distinguishing characters of this species are the inner joints of 1st and 2nd male natatory legs, and the 5th pair in the female.

Dactylophusia hamiltoni, n. sp.—Plate X., figs. 1 to 7.

Length, female 1·1 millim. ; male unknown.

Cephalothorax and abdomen each with 5 segments.

Anterior antennæ 8-jointed, the proportional lengths of the joints being as follows : $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.}{12.\ 12.\ 10.\ 11.\ 3.\ 6.\ 4.\ 7.}$

A long filament springs from the prolongation of the 4th joint. Outer branch of posterior antennæ 3-jointed, a 2-jointed inner branch springing from the basal joint. Second maxillipeds large ; the apical claw strong, blunt at end. Inner joint of 5th pair of natatory legs subquadrate, about twice as long as broad. Abdomen long and slender ; furcal rami quadrate, abont twice as long as broad.

One specimen only, a female, was found in the Muttuvaratu pearl oyster washings. The form of the 2nd maxillipeds, and 5th pair of natatory legs, and the abdomen, are characteristic of this species, which we name after Colonel HAMILTON, a former inspector of the pearl banks.

Dactylophusia robusta, n. sp.—Plate X., figs. 19 to 24.

Length, female 0·64 millim. ; male unknown.

A small but moderately robust species with a very tumid cephalothoracic segment. Anterior antennæ 8-jointed. Joints long and narrow, with the exception of the 5th, which is very small ; the proportional lengths are : $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.\ 7.\ 8.}{14.\ 24.\ 12.\ 20.\ 4.\ 10.\ 7.\ 12.}$

Posterior antennæ, mandible, and maxilla similar to those of *D. gracilicaudata* ; 2nd maxillipeds have the palm straight and the lower side rounded. Outer branches of the 1st natatory legs much shorter than the inner branches. The middle joint of the outer branches longer than either the basal or apical joints ; 2nd, 3rd, and 4th legs resemble those of *D. tisboides*. The 5th pair have a large primary joint and a moderately long and narrow secondary joint. The primary joint is furnished with 5 setæ, and the secondary with 6 setæ. Abdomen 4-jointed, about half as long as the combined lengths of the cephalic and thoracic portions. Furcal rami small, longer than broad.

A few specimens were found in the washings from the Muttuvaratu pearl oysters.

D. robusta differs from other species in the structure of the anterior antennæ, and the 1st and 5th natatory legs.

Dactylophusia laticaudata, n. sp.—Plate XI., figs. 1 to 8.

Length, female 0·6 millim.; male unknown.

A small flat species of a yellow colour, resembling in general appearance *D. flava.* When only recently preserved, the 1st, 2nd, and 3rd thoracic segments present a band of deep brown madder colour; this band eventually disappears in spirit-specimens, and only the general colour remains. Anterior antennæ 6-jointed, short and robust; the proportional lengths are: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.}{13.\ 12.\ 9.\ 8.\ 5.\ 4.}$

Secondary branch of posterior antennæ 2-jointed; basal joint very short; 2nd joint long. Mandible as in *D. tisboides;* palp with 2 nearly equal branches. The lower branch is furnished with 2 strong spines situated in the middle of the external margin. Maxilla and 1st maxilliped resembling those of *D. tisboides.* Second maxilliped long and narrow, both surfaces slightly rounded; terminal claw very strong. Outer branch of 1st natatory legs 3-jointed, very short; inner branch has a long and very wide 1st joint and one small terminal joint; 2nd, 3rd, and 4th legs resembling in general those of the genus; the terminal spines have ring-like markings. The 5th legs have the primary joint large and foliaceous, much longer than broad, with 5 short, stout terminal spines; secondary joint small with 2 strong spines on the outer margin, 2 terminal ringed spines and 1 small spine on the inner distal margin. Abdomen 4-jointed, very wide. Furcal rami small and tumid.

Several specimens of this curious species were found in the Muttuvaratu pearl oyster washings.

Dactylophusia æmula, n. sp.—Plate XI., figs. 9 to 12.

Length, female 0·4 millim.; male unknown.

In general appearance very like *D. laticaudata,* but smaller and less robust. The colouring is the same as in that species.

Anterior antennæ narrow, 7-jointed. The proportional lengths of the joints are as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{13.\ 12.\ 10.\ 11.\ 4.\ 3.\ 6.}$

Posterior antennæ, mandible and palp, maxilla and maxilliped as in *D. laticaudata.* The 1st to 4th natatory legs resemble those of *D. laticaudata,* except that the basal joint of the inner branch of the 1st is less tumid. The 5th legs in this species also have the primary joint large and foliaceous, but proportionally broader than long, and the terminal spines are shorter and less tumid; secondary joint small. Marginal spines, with the exception of the inner sub-terminal one which is very strong, short and slender. Abdomen less tumid than in *D. laticaudata.*

Several specimens, all females, from the same locality as the foregoing species, from which it is distinguished by the structure and proportional lengths of the joints of the anterior antennæ, and by the 1st and 5th legs. The two foregoing species differ in the structure of their appendages, especially in the 1st legs, which have the inner branch only 2-jointed, from the general type of *Dactylophusia*, and may some time require a separate genus.

Dactylophusia platysoma, n. sp.—Plate XI., figs. 13 to 18.

Length, female 0·62 millim.; male unknown.

In general appearance more like a *Porcellidium* than a *Dactylophusia*, and it is only when the appendages are examined that it becomes clear that it is not a *Porcellidium;* neither can it be said to be a typical *Dactylophusia*, though provisionally referred to that genus. Anterior antenna moderately long and slender, 9-jointed; the proportional lengths are : $\frac{1.\ \ 2.\ \ 3.\ 4.\ 5.\ 6.\ 7.\ 8.\ 9.}{13.\ 18.\ 10.\ 9.\ 4.\ 5.\ 2.\ 2.\ 4.}$

Posterior antennæ, mandible and palp, maxilla and 1st maxillipeds nearly as in *D. tisboides;* 2nd maxillipeds elongate, with a strong terminal claw. First natatory legs resembling those of *D. tisboides;* 2nd, 3rd and 4th though generally like those of *Dactylophusia*, are more slender than the corresponding legs of any member of the genus known to us. The 5th feet have the primary joint large and foliaceous. The extremity of the joint is fringed with fine hairs, amongst which are 3 prominent setæ; secondary joint not distinctly separated from the primary one, with rounded margins and furnished with 6 apical setæ. Abdomen very flat, 4-jointed, furcal rami short.

Six females were found in the washings from the Muttuvaratu pearl oysters.

Thalestris mysis, Claus.

Found in the Gulf of Suez and again at Cheval Paar, Ceylon.

Pseudothalestris imbricata, Brady—Plate XI., figs. 19 to 24.

This species was described from a single specimen (a male) in the Report on the "Challenger" Copepoda by Professor Brady. No further specimens seem to have been discovered until now. In the present collection a single female was found in washings from the Muttuvaratu pearl oysters, which from its general resemblance in structural detail we have concluded is the female of *P. imbricata.*

Length, female 0·65 millim.

In general agreement with the recently described species of this genus, it is more like a small *Westwoodia* than a *Thalestris.* The outer branches of the 1st natatory legs are very small and distinctly 2-jointed. Anterior antennæ 6-jointed; proportional lengths as follows : $\frac{1.\ \ 2.\ \ 2.\ 4.\ 5.\ 6.}{9.\ 12.\ 21.\ 4.\ 7.\ 7.}$

Posterior antennæ, mandible, maxilla and maxillipeds similar to those figured by Brady. Natatory legs 1 to 4 also similar. The 5th legs have a large primary joint and a small secondary joint each furnished with a number of hairs.

Furcal rami extremely short, much broader than long.

Harpacticus chelifer (Müller).

A common littoral British species. It occurred only once, in a tow-net gathering from Marichchukaddi, Ceylon.

Peltidium ovale, n. sp.—Plate XIII., figs. 1 to 6.

Length, female 1·6 millim. ; male unknown.

Body ovate, cephalothorax and abdomen not clearly separated. Anterior antennæ short, 6-jointed, the proportional lengths of joints being as follows : $\frac{1.\ \ 2.\ \ 3.\ 4.\ 5.\ 6.}{13.\ 16.\ 10.\ 6.\ 2.\ 6.}$ Most of the joints are densely setiferous, the 3rd and 4th also bearing a long filament.

Posterior antennæ and mouth organs as in *P. purpureum*. Outer branch of 1st pair of natatory legs 2-jointed, with marginal hairs on both sides; inner branch 3-jointed, half as long again as the outer, the middle joint about twice the length of the 1st, and the 3rd joint very small, having at the apex two narrow curved claws. In the 2nd, 3rd, and 4th pair, both branches are 3-jointed, the outer branch armed on outer side with lateral aculeate plumose spines; the inner side and inner branch both bearing plumose setæ. The 5th pair of legs 2-jointed, the basal joint very small and produced on each side; the outer joint long and stout, with terminal aculeate spines.

Three females only were found in the Muttuvaratu pearl oyster washings and in the general washings of Invertebrates. This and the 4 following species all clearly agree with Philippi's original description of the genus except as to the anterior antennæ, which he gives as 9-jointed, whereas our 5 new species are 6- and 7-jointed. Seeing that Philippi knew of only one species, *P. purpureum*, we think the generic character should be altered to read—6- to 9-jointed, to admit these new forms.

The rounded forehead and the 5th pair of natatory legs sufficiently distinguish this species from the others.

Peltidium angulatum, n. sp.—Plate XIII., figs. 7 to 11.

Length, 1·2 millim. ; male unknown.

Body angular, with large anterior protuberance or rostrum. Anterior antennæ 7-jointed, the proportional lengths being as follows : $\frac{1.\ \ 2.\ 3.\ 4.\ 5.\ 6.\ 7.}{16.\ 14.\ 9.\ 6.\ 2.\ 2.\ 5.}$

First pair of natatory legs shorter and stouter than those of *P. ovale*; the basal joint of outer branch bears 2 small elongated processes in place of spines. Basal joint of 5th pair produced on one side into a long linear projection with apical spine; outer joint elongated, narrowing towards apex, armed with strong plain and plumose spines. Two specimens, both females, were found in the Muttuvaratu pearl oyster washings. It differs from *P. ovale* in the anterior antennæ, the 5th pair of legs, and particularly in the arrangement of the chitinous bands or reticulations of the carapace.

Peltidium speciosum, n. sp.—Plate XIII., figs. 12 to 17.

Length, female 1·1 millim.; male unknown.

Body resembles *P. angulatum* in shape, but is differently reticulated, the chitinous bands being thicker. Anterior antennæ stout, 7-jointed, the filaments and setæ as in the two previous species; the proportional sizes are: $\frac{1.\ \ 2.\ \ 3.\ 4.\ 5.\ 6.\ 7.}{22.\ 22.\ 14.\ 6.\ 3.\ 3.\ 6.}$

First pair of natatory legs very robust. In other respects they and the other pairs agree with *P. angulatum*. Fig. 17 represents a smaller form with thinner bands. A number of specimens, all females, were found in the Muttuvaratu pearl oyster washings. The jointing of the anterior antennæ, and the robustness of the 1st pair of natatory legs, serve to distinguish this species.

Peltidium serratum, n. sp.—Plate XIII., figs. 18 to 22.

Length, female 1·6 millim.; male unknown.

Body robust, rostrum broad, with 4 indentations on anterior surface; margins of all the cephalothoracic segments serrated. Anterior antennæ 6-jointed, the proportional lengths of the joints being as follows: $\frac{1.\ \ 2.\ \ 3.\ 4.\ 5.\ 6.}{20.\ 20.\ 14.\ 4.\ 4.\ 7.}$

Outer branch of 1st pair of natatory legs robust. Fifth pair foliaceous, 1-jointed, with a long spear-shaped plumose apical spine and several lateral spines, some of them plumose; anteriorly drawn out into a curved protuberance with terminal spine representing a rudimentary basal joint.

Three specimens, all females, were found in the bottom tow-net at Chilavaturai, Ceylon. The character of the reticulation on the carapace and the remarkable 5th natatory legs clearly distinguish this species from others.

Peltidium perplexum, n. sp.—Plate XIII., figs. 23 to 27.

Length, female 1·1 millim.; male unknown.

Body and character of reticulation resemble *P. speciosum*. Anterior antennæ 7-jointed, the proportional lengths of joints being as follows: $\frac{1.\ \ 2.\ 3.\ 4.\ 5.\ 6.\ 7.}{23.\ 16.\ 9.\ 6.\ 4.\ 3.\ 7.}$

Natatory legs similar to those of *P. angulatum*.

Two specimens, both females, were found in the Muttuvaratu pearl oyster washings. This differs from other species chiefly in the proportional lengths of joints of anterior antennæ. Cleve has formed a genus *Reticulina* for the species *R. aurivillii*, which is certainly a *Peltidium*, but it is not sufficiently well figured to enable us to compare it with any of the foregoing species.

Ilyopsyllus affinis, T. Scott.

Appeared once between Port Said and Suez, and again in the Gulf of Manaar, also at Kodramallai, north of Karativo, and $2\frac{3}{4}$ miles south-south-west of Chilavaturai.

Porcellidium fimbriatum, Claus—Plate XII., figs. 1 to 10.

Length, female 0·7 millim.

Anterior antennæ 6-jointed; proportional lengths of joints: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.}{12.\ 13.\ 10.\ 6.\ 5.\ 2.}$

A few specimens, all females, of this species, which appear to be identical with Claus' *P. fimbriatum*, were found in the washings from the Muttuvaratu pearl oysters. The chief points that distinguish this species from the others are the 5th feet, the abdomen, and the furcal rami.

Porcellidium brevicaudatum, n. sp.—Plate XII., figs. 11 to 14.

Length, female 0·67 millim.

Anterior antennæ 6-jointed, as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.}{13.\ 17.\ 12.\ 8.\ 4.\ 2.}$

This species is easily distinguished from the others by its smooth carapace and ciliated margins, the large 5th feet, the short abdomen, and the furcal rami.

Six specimens, all females, were obtained from the Muttuvaratu pearl oyster washings and from the general washings of Ceylon Invertebrates.

Porcellidium acuticaudatum, n. sp.—Plate XII., figs. 15 to 18.

Length, female 0·6 millim.

Anterior antennæ 6-jointed; proportional lengths as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.}{11.\ 11.\ 8.\ 6.\ 4.\ 3.}$

The chief features of this species are its moderately large 5th feet with rounded apex, the small abdomen produced laterally on each side, and the acutely pointed apex of the furcal rami.

Three females of this distinct species were found in the washings from the Muttuvaratu pearl oysters.

Porcellidium ravanæ, n. sp.—Plate XII., figs. 19 to 22.

Length, female 0·6 millim.

Anterior antennæ 6-jointed; proportional lengths as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.}{10.\ 18.\ 13.\ 8.\ 5.\ 3.}$

The distinguishing characters of this *Porcellidium* are the moderately wide 5th feet, which taper off to an acute point, the small abdomen, the posterior angles of which are not so much prolonged as in *P. acuticaudatum*, and the obliquely rounded external margin of the furcal rami. Three females of this species were found in the washings from the Muttuvaratu pearl oysters.

Idya furcata (Baird).

A common British littoral species. Occurred at 7 stations from the English Channel through the Mediterranean and Gulf of Suez to the Red Sea.

Idya longicornis, T. Scott.

Found in the general washings from Ceylon Invertebrates. Previously known only from British waters.

Pseudanthessius gracilis, Claus—Plate XIV., figs. 19 to 23.

One specimen was found in the general washings of the Ceylon Invertebrata obtained about the pearl banks. We give some additional figures of this species.

Pseudanthessius maximus, n. sp.—Plate XIV., figs. 1 to 11.

Length, female 3·5 millims.; male 2·7 millims.

Cephalothorax 6-jointed, the lateral spaces between the joints giving it a coarsely pinnatifid appearance. Abdomen of female 4-jointed, male 5-jointed, the 1st segment in the male being much longer and wider than any of the others.

Anterior antennæ 7-jointed, each joint bearing several short spinous setæ, and the proportional lengths being as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{15.\ 32.\ 7.\ \ 9.\ \ 9.\ \ 7.\ \ 6.}$

Posterior antennæ 4-jointed, the 3rd joint much the smallest; the 4th bears a stout blunt hooked spine. Mandible is produced apically into a long recurved spine with toothed edges, also a smaller toothed spine, and toothed edge. The palp is short, armed with three apical spines and a lateral one. First maxilliped has a stout basal joint, with an outer joint extended into 2 curved hairy spines. Second maxilliped of female has an oval middle joint terminating in a short claw; that of the male is a strong grasping hand, the terminal claw long and stout.

First pair of natatory legs has both branches 3-jointed, the outer one armed with serrated lanceolate spines; both branches have numerous plumose setæ. Fourth pair 2-branched; the outer one 3-jointed, armed with short ovate serrated spines, the inner branch consists of 1 long joint gradually widening to the apex; the lateral posterior edges are produced into spines, between which are 2 terminal plumose setæ. The 5th pair consist each of a long curved joint with 3 terminal plumose spines. Furcal rami about 3 times as long as broad, slightly tapering to apex.

Several males and females were taken by surface tow-net in Galle harbour.

This species is easily distinguished by its large size, by the mandible and posterior antennæ, and by the 4th and 5th pair of natatory legs.

Pseudanthessius chelifer, n. sp.—Plate XIV., figs. 12 to 18.

Length, female 1 millim.; male unknown.

Cephalothorax 6-jointed, ovate. Abdomen 4-jointed, the 1st joint swollen and rounded anteriorly, narrowing to base. Anterior antennæ 7-jointed, the proportional lengths of the joints being as follows: $\frac{1. \quad 2. \quad 3. \quad 4. \quad 5. \quad 6. \quad 7.}{16. \quad 24. \quad 8. \quad 21. \quad 16. \quad 12. \quad 12.}$

Posterior antennæ 3-jointed, the apical joint having 3 long terminal spines and a long broad curved terminal claw dentated on upper side. Mandible small, anteriorly extended into a serrated spine; palp large, having 3 terminal spines. The 1st maxilliped narrow, ending in a denticulate spine and a smaller lateral spine. The 2nd maxilliped consists of a long narrow curved joint having 2 small lateral spines and 3 terminal spines. Inner branch of 4th pair of natatory legs consists of one small narrow joint with terminal spine. Furcal rami about 3 times as long as broad.

Several specimens, all females, were found about the pearl banks. A very distinct species, readily recognized by its posterior antennæ, the 2nd maxilliped and the 4th pair of natatory legs.

Pseudanthessius concinnus, n.sp.—Plate XIV., figs. 24 to 30.

Length, female 0·85 millim.; male unknown.

Cephalothorax ovate, similar to *P. gracilis*, but considerably smaller. Abdomen 5-jointed. Anterior antennæ 7-jointed, the proportional lengths of the joints being as follows: $\frac{1. \quad 2. \quad 3. \quad 4. \quad 5. \quad 6. \quad 7.}{10. \quad 24. \quad 8. \quad 16. \quad 16. \quad 12. \quad 7.}$

Posterior antennæ nearly as in *P. gracilis*. Mandibles consist of a curved joint, tumid in centre, with narrow, blunt termination. First maxilliped 1-jointed, long, narrow towards apex, with strong lateral and terminal spines. Second maxilliped 2-jointed, the first joint rather longer than broad; terminal joint very small with 2 strong apical spines. Both branches of 1st pair of natatory legs 3-jointed; inner branch of 4th pair 1-jointed with truncate base terminating in large serrated lanceolate spine and one plain spine; outer branch 3-jointed, having serrated lanceolate spines. Furcal rami long and narrow.

One specimen only, a female, was found in the general washings from Ceylon Invertebrata.

The mouth organs, the inner branch of 4th pair of natatory legs and the furcal rami are the distinguishing features of this species.

Pseudanthessius liber (Brady and Robertson).

Found amongst the general washings of Invertebrates from the pearl oyster beds.

Lichomolgus minor, A. Scott.

Found at 2 stations only, and far apart, viz., between Port Said and Suez, and amongst the washings of young pearl oysters, Ceylon.

Lichomolgus gracilis, n. sp.—Plate XV., figs. 1 to 9.

Length, male 0·7 millim.; female 1 millim.

Cephalothorax (female) ovate, 6-jointed, abdomen 3-jointed, the 1st considerably longer and wider than the combined succeeding 2 joints. First joint of male abdomen quadrate; more than 4 times the size of the 2nd joint.

Anterior antennæ (female) 7-jointed, the proportional lengths of the joints being as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{17.\ 25.\ 9.\ 11.\ 12.\ 7.\ 5.}$

Posterior antennæ 3-jointed, the apical joint terminating in a strong curved claw, and having 3 small lateral spines. Mandible has an angular quadrate base, and is pectinated along upper edge; palp short, with 3 spines.

First maxilliped has outer joint triangular, sharp and wedge-shaped, and has a serrated curved lateral spine arising from centre; outer joint of 2nd maxilliped (female) very small, with stout apical spines; in the male it is a grasping hand with long curved claw. Inner branch of 4th pair of natatory legs 2-jointed. Furcal rami divergent, about 4 times as long as broad.

Several males and females were found in the general washings of dredged Invertebrates. The mouth organs, posterior antennæ, and furcal rami sufficiently distinguish this species.

Lichomolgus ieversi, n. sp.—Plate XV., figs. 10 to 17.

Length, male 0·96; female 1·06.

Cephalothorax 6-jointed; cephalic segment subquadrate; abdomen 4-jointed, the genital segment smaller than in the other species of the genus. Anterior antennæ 7-jointed, the proportional lengths of the joints as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{16.\ 25.\ 8.\ 17.\ 17.\ 12.\ 5.}$

Posterior antennæ 3-jointed; the middle joint small; apical joint longer than the combined 1st and 2nd; with four terminal curved spines, two of which are moderately stout. Mandibles long and narrow, coming to a fine point, edges hairy. Terminal joint of 1st maxilliped drawn out, forming a fine ciliated stylet; there is also one lateral spine; 2nd maxilliped (female) 3-jointed, with very short terminal spine; 2nd maxilliped of male forms a chelate hand with very long rounded claw. Inner branch of 4th pair of natatory legs 2-jointed, the outer branch equals 3 of the inner and has truncated apex; outer branch has 5 lanceolate spines. Furcal rami very long and nearly parallel.

About 20 females and 4 males were found in the Muttuvaratu pearl oyster washings and in the Invertebrata washings. The mouth organs, antennal joints, and the furca are the chief distinguishing features of this species, which is named in honour of Mr. R. W. Ievers, Government Agent of the Northern Province of Ceylon, where the pearl banks are situated.

Lichomolgus buddhensis, n. sp.—Plate XV., figs. 18 to 24.

Length, female 1 millim.; male unknown.

Cephalothorax broadly ovate, about 4 times as long as the abdomen, which is 3-jointed; the genital segment being about 4 times the size of the 2 combined succeeding joints; it is much swollen in the middle. Anterior antennæ 7-jointed, the proportional lengths of the joints being as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{17.\ 31.\ 7.\ 15.\ 14.\ 13.\ 10.}$

Mandible and palp short. Maxillipeds and natatory legs similar to *P. ieversi*. Furca quadrate, very small.

Several specimens, all females, were found in the general washings of dredged Invertebrates. The very short abdomen and furca are quite characteristic of this species—named in honour of the celebrated home of Buddhism from which it came.

Lichomolgus lankensis, n. sp.—Plate XV., figs. 25, 26.

Length, female 1·0 millim.; male unknown.

Cephalothorax ovate. Abdomen 3-jointed; genital segment about as long as the combined two succeeding joints and furca. Anterior antennæ 7-jointed, the proportional lengths being as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{22.\ 29.\ 10.\ 14.\ 10.\ 7.\ 5.}$

Posterior antennæ, mouth organs, and natatory legs as in *L. gracilis*.

Three specimens, all females, were found in the general washings of dredged Invertebrates. Its general form, and the comparative shortness of the anterior antennæ and furca, distinguish this species from others of the genus.

Lichomolgus simplex, n. sp.—Plate XV., figs. 27 to 34.

Length, female 0·88 millim.; male 0·8 millim.

Cephalothorax 6-jointed, abdomen (female) 4-jointed, male abdomen 5-jointed, genital segment double in size that of the female; anterior antennæ 6-jointed, the proportional lengths being as follows: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.}{13.\ 22.\ 8.\ 22.\ 18.\ 18.}$

Posterior antennæ 3-jointed, the middle one very short; terminal joint 3 times the length of the second, with 2 apical spines. Mandible constricted in centre; outer portion somewhat quadrate, with ciliated edges bearing 2 small corner filaments and a plumose spine. Maxillipeds similar to *L. buddhensis*, but stouter. Natatory legs as in *L. gracilis*.

Furcal rami about 3 times as long as broad. A few specimens of each sex were found in the washings from sponges dredged in the Gulf of Manaar. The general shape of the animal and of the abdomen and furca and the jointing of the anterior antennæ serve to distinguish this species.

Lichomolgus elegans, n. sp.—Plate XVI., figs. 8 to 13.

Length, female 1·5 millim. ; male unknown.

Cephalothorax 6-jointed. Abdomen 4-jointed, the genital segment being longer than the 3 succeeding joints combined, and having a wedge-shaped notch near the centre on each side. Anterior antennæ 7-jointed, the proportional lengths being as follows : $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{11.\ 32.\ 4.\ 11.\ 9.\ 7.\ 4.}$

Posterior antennæ 3-jointed, the first joint rather longer and nearly double the width of each of the succeeding joints. The third joint bears a strong apical claw. Maxillipeds resemble *L. buddhensis*, but are stouter. Inner branch of 4th pair of natatory legs 2-jointed, the outer joint being about double the length of the inner. Furcal rami very short, about as broad as long.

One specimen only, a female, was found in the general washings from dredged Invertebrates. The notched abdominal genital segment is the most striking characteristic of this species.

Lichomolgus robustus, n. sp.—Plate XVI., figs. 14 to 20.

Length, female 1·1 millim. ; male unknown.

Cephalothorax robust, ovate, 6-jointed. Abdomen 4-jointed; the genital segment about as long as the combined 2 succeeding joints. Anterior antennæ 7-jointed, the proportional lengths being as follows : $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{15.\ 32.\ 5.\ 11.\ 8.\ 8.\ 5.}$

Posterior antennæ similar to *L. simplex*, but more robust. Mandible stylet serrated on outer edge. Maxillipeds and natatory legs like *L. buddhensis*. Furca about half as long again as broad.

One specimen only, a female, was found in the general washings from dredged Invertebrata. In many points there is a great resemblance between this species and *L. buddhensis;* but in the jointing of the cephalothorax, and more particularly of the abdomen, and in the small size of the 5th natatory legs in this species, the difference is so considerable that we are justified in separating them.

Lichomolgus gigas, n. sp.—Plate XVI., figs. 21 to 26.

Length, female 2 millims. ; male 1·4 millims.

Cephalothorax ovate, 6-jointed. Abdomen, female 4-jointed; male 5-jointed. Anterior antennæ long and slender, 7-jointed; the proportional lengths being as follows : $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{12.\ 32.\ 4.\ 16.\ 12.\ 9.\ 7.}$

Posterior antennæ, mouth organs, and natatory legs and furca nearly resemble *L. simplex*.

One of each sex were found in the general washings of dredged Invertebrata.

The large size and the jointing of the slender anterior antennæ sufficiently distinguish this species.

Lichomolgus dentipes, n. sp.—Plate XVI., figs. 27 to 30.

Length, female 0·86 millim. ; male unknown.

Cephalothorax broadly ovate, the cephalic segment equal in size to the combined 5 following ; the edges of the 3rd and 4th segments are finely serrated. The 5th segment is very small, with sharply-pointed lateral terminations.

Abdomen very short and stout, hardly $\frac{1}{5}$th the length of cephalothorax ; genital segment as long as the combined 2 following and double the width ; 4th joint the same as 1st. Furcal rami equal in length and breadth.

Anterior antennæ 7-jointed, the proportional lengths being: $\frac{1.\ \ 2.\ 3.\ 4.\ 5.\ 6.\ 7.}{11.\ 26.\ 3.\ 7.\ 4.\ 3.\ 2.}$

Mouth organs as in *Paralichomolgus.* Inner branch of 4th natatory legs 2-jointed, both joints straight and very narrow. The 5th pair have each a large tooth projecting from inner side anteriorly.

Of this very striking species one specimen only, a female, was found in the general washings of dredged Invertebrata. It is easily recognisable by its serrated thoracic edges and by the 4th and 5th natatory legs—the tooth on the latter gives the specific name.

Paralichomolgus, n. gen.

Female ; body composed of 10 segments ; cephalothorax rotund or ovate ; 5-jointed ; genital segment much larger than the others, being the 1st and 2nd segments united.

Anterior antennæ 8-jointed. Posterior antennæ, mouth organs, and natatory legs as in *Lichomolgus.* The difference between this genus and *Lichomolgus* consists in the lateral prolongations of the body segments and in the jointing of the anterior antennæ.

Paralichomolgus curticaudatus, n. sp.—Plate XVI., figs. 1 to 7.

Length, female 1·2 millims. ; male unknown.

Cephalothorax ovate, 5-jointed ; the posterior edges of segments 2 to 4 being pointed. Abdomen very short, about $\frac{1}{5}$th the length of the cephalothorax ; genital segment wider than its length and having on each side posteriorly a rounded lobe ; the other joints very small. Furcal rami very small, almost half spheres. Anterior antennæ 8-jointed, the proportional lengths being as follows : $\frac{1.\ \ 2.\ 3.\ 4.\ \ 5.\ 6.\ 7.\ 8.}{12.\ 35.\ 3.\ 8.\ 13.\ 8.\ 4.\ 3.}$

Posterior antennæ 3-jointed ; the 1st and 2nd joints sub-equal ; the 3rd as long as the combined 1st and 2nd ; terminal claw thick, and obtuse at apex. Mandible and palp as in *Lichomolgus buddhensis.* Maxillipeds similar to *Lichomolgus ieversi,* except that the joints of the 2nd are nearly double the width of the latter. Natatory legs also similar to those of latter species ; the 2 joints of inner branch of the 4th pair, however, being equal in length to the 3-jointed outer branch.

Two specimens, both females, were found in the general washings from the dredged Invertebrata. The short abdomen, the wide joints of 2nd maxillipeds, and the jointing of inner branch of 4th pair of natatory legs readily distinguish this species.

Paralichomolgus longicaudatus, n. sp.—Plate XX., figs. 6 to 8.

Length, female 1·1 millims.; male unknown.

Body sub-rotund; 1st to 3rd joints of cephalothorax are pointed posteriorly and with a tooth on each lateral edge of 2nd and 3rd; 4th joint very small. Abdomen about $\frac{1}{4}$ the length of cephalothorax; genital segment large and tumid; the rest 3 times broader than long. Furcal rami square, very short, with long terminal setæ.

Anterior antennæ 8-jointed, the proportional lengths being: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.\ \ 8.}{16.\ 28.\ 2.\ 9.\ 12.\ 8.\ 4.\ 3.}$

Posterior antennæ, mandible, maxillipeds, and first 3 pairs and 5th pair of natatory legs as in *P. curticaudatus*. The 2-jointed inner branch of 4th pair natatory legs springs from middle of long basal joint at right angles; the 3 joints of outer branch being also at right angles to basal joint.

One specimen only, a female, was found in the general washings from dredged Invertebrata. The general appearance and the 4th pair of natatory legs clearly distinguish this species from the last described.

Hermannella arenicola, Brady.

Found in the general washings of dredged Invertebrata from the pearl banks.

Hermannella robusta, n. sp.—Plate XVII., figs. 1 to 8.

Length of female 1·1 millims.; male unknown.

A very robust species with comparatively short abdomen. Anterior antennæ 7-jointed; proportional lengths of joints: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{16.\ 35.\ 5.\ 16.\ 8.\ 6.\ 4.}$

The posterior antenna has a short stout hook-like spine arising from the 3rd joint. Mandible and maxillipeds have a general resemblance to the corresponding organs in *Lichomolgus*. Both branches of 1st to 4th natatory legs are 3-jointed. The 5th legs are rudimentary. Abdomen with 4 segments; genital segment large and tumid, 4th joint longer than the 3rd; furcal rami about twice as long as broad, and slightly longer than the last abdominal segment.

This species is easily recognised by the robust body and short abdomen, which is less than a fourth of the length of the body, and by the short furca. Three females were found in the washings from Ceylon Invertebrates.

Hermannella serendibica, n. sp.—Plate XVII., figs. 9 to 11.

Length of female, 1·16 millims.; male unknown.

In general appearance more attenuated than *H. robusta*. Anterior antennæ 7-jointed; proportional length of joints: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{8.\ 26.\ 6.\ 12.\ 9.\ 6.\ 4.}$

Posterior antennæ, mandible, maxillipeds and natatory legs similar to those of *H. robusta*. The 5th feet are more developed than in the previous species. Abdomen 4-jointed, rather less than half the length of the body. Genital segment large, much wider posteriorly than in front; 2nd, 3rd and 4th joints subequal in length and each about as long as broad. Furcal rami long and narrow, about 5 times longer than broad and equal to the combined lengths of the 3rd and 4th joints of the abdomen. Three females were found in washings from Gulf of Manaar sponges. This *Hermannella* is easily identified by its attenuated form, long abdomen, with the peculiar swelling of the genital segment, and long furca.

Hersiliodes leggii, n. sp.—Plate XVII., figs. 12 to 21.

Length of male 1·5 millims.; female unknown.

Anterior antennæ 7-jointed; the proportional lengths are: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{11.\ 14.\ 7.\ 20.\ 13.\ 9.\ 12.}$

Posterior antenna 4-jointed, similar to that of other *Hersiliodes*. Mandible strong, with a well-developed biting part. Maxilla more developed than in *Lichomolgus*, and bearing a number of strong apical setæ. The first maxilliped has the terminal joint strongly toothed and also furnished with a setiferous digit. The second maxilliped well developed, in general appearance resembling that of other species of the genus.

Both branches of 1st to 4th natatory legs are 3-jointed. Fifth legs foliaceous, subquadrangular in shape, rather longer than broad, and furnished with 3 dagger-like spines and 1 seta. Abdomen 5-jointed, fully half as long as the body. Furcal rami short, about as broad as long.

One specimen in washings from Gulf of Manaar sponges. This species, which we name after Captain LEGGE, at present Inspector of the pearl banks, is easily recognised from any other member of the genus by the proportional lengths of the joints of the anterior antennæ and by the quadrangular 5th legs.

Hersiliodes tamilensis, n. sp.—Plate XVII., figs. 22 to 25.

Length, female 1·3 millims.; male unknown. In general appearance resembling the previous species. Anterior antennæ 7-jointed; proportional lengths of the joints: $\frac{1.\ \ 2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.\ \ 7.}{10.\ 10.\ 5.\ 15.\ 10.\ 7.\ 11.}$

Posterior antennæ, mandible, maxilla, and 1st maxillipeds nearly as in *H. leggii*. Terminal joint of 2nd maxilliped armed with 2 moderately strong spines and 2 small setæ. Natatory legs 1 to 4 somewhat similar to those of *H. leggii*. Fifth legs long and narrow, about 3 times longer than broad, and armed with 3 dagger-like spines and 1 seta.

Abdomen 5-jointed, fully half as long as the body. Genital segment long and broad, widest near the middle; 2nd joint quadrangular in shape, about half as long as the genital segment; 3rd, 4th, and 5th joints shorter than broad, and in combined length equal to the 2nd joint. Furcal rami short and wide, about as broad as long.

In washings from Muttuvaratu pearl oysters.

The proportional lengths of the joints of the anterior antennæ, and the long and narrow 5th feet, distinguish this species from any of the others.

Hersiliodes dubia, n. sp.—Plate III., figs. 18 to 27.

Length, male 1·8 millims.; female unknown.

Cephalothorax quadrate in form, composed of 5 segments. Anterior antennæ 6-jointed, and all clothed with non-plumose setæ; the proportional lengths are as follows: $\frac{1.\ 2.\ 3.\ 4.\ 5.\ 6.}{8.\ 6.\ 5.\ 3.\ 4.\ 8.}$

Posterior antennæ 4-jointed, the basal joint equalling in size the 3 following.

Mandible with 2 horizontal plumose projections and 2 plumose setæ. Maxilla with 3 terminal spinous setæ, and 4 on the outer side, 2 of them plumose. First maxilliped 2-jointed, the apical joint terminating in a strong curved claw and a plumose spine on each side. Second maxilliped 2-jointed, the basal one with a rounded papilla; the hand angularly curved on outer side, terminating in a long rounded claw bluntly rounded at apex, and having on under side 3 spine-like setæ.

First 4 pairs of natatory legs 2-branched, each having 3 joints with the edges mostly clothed with fine hairs. Fifth pair each consist of a quadrate joint with 3 strong spines and a few hairs and setæ at base. Abdomen rather shorter than the cephalothorax, 5-jointed, the genital segment very large, nearly square, and having hooked posterior lateral terminations.

Furcal rami linear, about 4 times as long as broad, with a small spine on each outer side and terminating in 3 setæ of unequal lengths.

One specimen only, a male, was taken in the Suez Canal.

This species agrees, in most particulars, with Canu's *Hersiliodes.* Canu, however, gives 7 joints in the anterior antennæ, although his careful drawing of *H. pelseneeri* shows only 6 joints. It is evident that the species comprising the genus *Hersiliodes* undergo considerable changes in their various ecdyses, and in the absence of an adult female we can only provisionally place our species in this genus.

Family: ONCEIDÆ.

Oncea venusta, Philippi.

Oncea media, Giesbr.

Oncea minuta, Giesbr.

Oncea mediterranea, Claus.

All the above were generally distributed over the entire voyage. *O. media* was found only once about Ceylon, viz., at Mudalaikuli Paar. *O. mediterranea* occurred twice in Ceylon, viz., at Muttuvaratu Paar and at Talaivillu Paar. *O. venusta* was taken at 10 and *O. minuta* at 5 Ceylon stations.

Oncea subtilis, Giesbr.
Oncea notopus, Giesbr.
Oncea conifera, Giesbr.

Three rarer species. *O. subtilis* occurred at 3 Mediterranean stations; *O. notopus* between Port Said and Suez, and *O. conifera* in the Northern Indian Ocean.

Lubbockia squillimana, Claus.

Occurred at 4 stations in the Gulf of Suez and Red Sea, and once off Minikoi.

Family: CORYCÆIDÆ.

Corycæus venustus, Dana.

Eighteen species of the genus *Corycæus* are included in the collection. *C. venustus* was obtained in fair numbers throughout the entire voyage, occurring at 42 stations.

Corycæus rostratus, Claus.

Occurred at 5 Mediterranean stations.

Corycæus danæ, Giesbr.

Taken at 22 stations, from the Mediterranean onwards.

Corycæus furcifer, Claus.

Taken at 2 Mediterranean stations, twice in the Indian Ocean, and at 5 Ceylon stations.

Corycæus flaccus, Giesbr.

Occurred at 7 Mediterranean stations and once in the Indian Ocean.

Corycæus elongatus, Claus.

Taken once in the Mediterranean, twice in the Red Sea and once in the northern Indian Ocean.

Corycæus speciosus, Dana.

Generally distributed throughout the voyage, and taken at 5 Ceylon stations.

Corycæus lubbockii, Giesbr.

Found at 8 stations, in Mediterranean, Indian Ocean and 4 localities round Ceylon.

Corycæus carinatus, Giesbr.

Occurred 5 times, viz., Mediterranean, Gulf of Suez and Indian Ocean, off Minikoi and south of Cheval Paar, Ceylon.

Corycæus ovalis, Claus.

Taken at 11 stations in the Mediterranean, Red Sea and northern Indian Ocean.

Corycæus obtusus, Dana.

Corycæus gibbulus, Giesbr.

Corycæus longistilis, Dana.

Similar in range of distribution, occurring from Suez to Ceylon at 47, 41 and 16 stations respectively. *C. longistilis* however occurred only once about Ceylon, viz., south of Adam's Bridge, the others being generally represented round the island.

Corycæus concinnus, Dana.

First appeared in the Indian Ocean, where it occurred at 13 stations, and at 5 Ceylon localities.

Corycæus gracilicaudatus, Giesbr.

Similar in range to *C. concinnus*, but it first appeared in the Red Sea.

Corycæus robustus, Giesbr.

Taken once only, in the northern Indian Ocean.

Corycæus tenuis, Giesbr.

Occurred at 3 stations, viz., in the northern Indian Ocean, off Negombo, and at the Cheval Paar pearl banks.

Corycæus longicaudis, Dana.

One specimen was found at Muttuvaratu Paar, Ceylon.

Copilia mirabilis, Dana.

Found in the Mediterranean, Gulf of Suez, Red Sea, at 6 stations in the Indian Ocean, and once at Ceylon, south-east of Cheval Paar.

Sapphirina ovatolanceolata, Dana.

Ten species of the genus *Sapphirina* occur in the collection, the majority being represented at only 1 or 2 localities. *S. ovatolanceolata* was the most widely distributed, and occurred at 12 stations, extending from the Mediterranean to the Red Sea and Indian Ocean as far as Minikoi.

Sapphirina gastrica, Giesbr.

Occurred twice, viz., in the Red Sea, and again from Perim into the Indian Ocean.

Sapphirina ovalis, Dana.

One specimen was taken in the Indian Ocean after leaving Perim, and another south of Adam's Bridge, Ceylon.

Sapphirina nigromaculata, Claus.

Occurred at 6 Indian Ocean stations, and south of Cheval Paar, Ceylon.

Sapphirina metallina, Dana.

Sapphirina salpæ, Claus.

Sapphirina auronitens, Claus.

Sapphirina bicuspidata, Giesbr.

Sapphirina intestinata, Giesbr.

Sapphirina sinuicauda, Brady.

One or two specimens of each of the above were taken in the Indian Ocean, with the exception of *S. sinuicauda*, which was taken at Vankali Paar, Ceylon.

Family: ASTEROCHERIDÆ.

Asterocheres stimulans, Giesbr.

Asterocheres dentatus, Giesbr.

Asterocheres minutus, Claus.

Several specimens belonging to each of the above species were obtained in the general washings from Ceylon Invertebrates and also in washings from sponges collected in the Gulf of Manaar.

Asterocheres manaarensis, n. sp.—Plate XIX., figs. 11 to 20.

Length, female 0·78 millim.; male unknown.

Cephalothorax ovate, 6-jointed, the 5th joint very small. Abdomen 3-jointed; genital segment subquadrate, larger than the two following joints together.

Anterior antennæ 20-jointed, the relative lengths of the joints being as follows:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
12.	3.	2.	2.	2.	2.	2.	3.	2.	5.	7.	7.	7.	7.	8.	9.	13.	4.	7.	4.

The 17th joint has a long filament, the others profusely setose.

Posterior antennæ, maxilla, and maxillipeds similar to *Asteropontius typicus*.

Mandible consists of a long scythe-like spine, without biting teeth, and a 2-jointed palp, the smaller apical joint bearing two terminal plumose setæ.

Both branches of 1st pair of natatory legs 3-jointed; 1st joint of outer branch has a large posterior plumose spine; 3rd and 4th joints of inner branch are toothed on inner side. Inner branch of 4th pair 3-jointed, the apical joint terminating in a large serrated lanceolate spine; the inner side of the joints toothed. The 5th pair each consist of a ciliated oblong joint. Furca short and stout, broader than long. Two specimens, both females, were found in the washings from Gulf of Manaar sponges.

Asterocheres major, n. sp.—Plate XVIII., figs. 21 to 28.

Length, female 1·1 millim.; male 1 millim.

Body nearly circular in outline. Cephalothoracic segment large. Anterior antennæ 20-jointed ; proportional lengths of joints :—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
12.	5.	4.	3.	3.	3.	3.	4.	4.	5.	4.	4.	5.	7.	7.	7.	10.	6.	4.	2.

Posterior antennæ, mandible and palp, maxilla, maxilliped, and natatory legs, 1st to 4th, nearly as in other *Asterocheres.* Fifth feet very narrow, about $3\frac{1}{2}$ times longer than broad, furnished with three apical setæ. Abdomen 3-jointed, about $\frac{1}{2}$ the length of the body, joints of moderate length, genital segment slightly longer than the 2nd joint, last joint about $\frac{3}{5}$ the length of the second. Furca very short, about as broad as long, and only $\frac{1}{4}$ the length of the last abdominal joint. The male is slightly smaller than the female, and has the anterior antenna only 17-jointed. The genital segment of the abdomen is slightly longer than the combined lengths of the next 2 joints.

A number of specimens in washings from material collected off Point de Galle. This species is easily recognised by its circular body and narrow abdomen.

Asterocheres minor, n. sp.—Plate XVIII., figs. 29 to 31.

Length, female 0·8 millim. ; male 0·7 millim.

In general appearance very like *Asterocheres major*, only much smaller.

Anterior antennæ 20-jointed ; proportional lengths of joints :—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
10.	3.	3.	3.	2.	2.	2.	3.	4.	4.	3.	3.	4.	4.	5.	6.	8.	4.	5.	2.

Other appendages similar to *A. major*.

The distinguishing characters of this species are the difference in the proportional lengths of the joints of the anterior antennæ, the different proportional lengths of the abdominal joints and the furca, the latter being about $\frac{1}{2}$ the length of the last abdominal joint.

Several specimens in washings from Gulf of Manaar sponges.

Asteropontius, n. gen.

Cephalothorax roundly ovate, 5-jointed, the cephalic segment larger than the combined lengths of the 4 following segments. Anterior antennæ 18–19-jointed. Abdomen 3-jointed.

Outer branch of posterior antennæ 4-jointed, a small 1-jointed branch springing from the 1st joint. Maxilla 2-branched. Mandible long and narrow ; palp 1-jointed. Maxillipeds and natatory legs, 1st to 5th, as in *Asterocheres.*

Asteropontius typicus, n. sp.—Plate XIX., figs. 1 to 10.

Length, female 0·96 millim. ; male unknown.

Cephalothorax roundly ovate, about twice the length of abdomen ; genital segment as long as the other 2 abdominal joints combined; tumid in centre. Furca very short.

Anterior antennæ 19-jointed, all clothed with short setose spines; the 17th carries a long narrow filament. The proportional lengths of the joints are as follows:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
12.	4.	3.	3.	3.	3.	3.	4.	3.	5.	7.	7.	7.	7.	7.	8.	9.	4.	6.

Mandible long, narrow, with 5 biting teeth at apex; palp 1-jointed, with long terminal plumose setæ. Maxilla 2-branched, the smaller one half the length and half the width of the larger branch, both bearing long terminal plumose setæ. Maxillipeds and 1st to 5th natatory legs as in *Asterocheres;* basal joint of outer branch of 1st pair has a broad lanceolate spine on apex of outer margin.

Several specimens, all females, were found in the washings from Gulf of Manaar sponges, and in the general washings of Invertebrates. The species bears a general resemblance to *Asterocheres*, but the 19-jointed antennæ and the 1-jointed mandible palp separate it therefrom.

Asteropontius attenuatus, n. sp.—Plate XVIII., figs. 11 to 20.

Length, female 0·92 millim.; male unknown.

Body attenuated, very narrow in front. Cephalothoracic segment triangular in outline, nearly twice as long as the combined lengths of the 1st, 2nd, and 3rd thoracic segments. Anterior antennæ 18-jointed, with a large sensory filament on the end of the 17th joint. Proportional lengths of the joints:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
11.	4.	2.	2.	2.	2.	2.	3.	7.	4.	7.	7.	7.	8.	8.	10.	12.	10.

Posterior antennæ, mandible, maxilla, maxillipeds, and 1st to 4th natatory legs nearly as in *Asteropontius typicus.* Fifth feet long and very narrow, about 6 times longer than broad, and furnished with 3 apical setæ. Abdomen 3-jointed. Genital segment longer than the combined length of the next 2 joints. Anterior portion tumid. Furcal rami short, about $2\frac{1}{2}$ times as long as broad, and equal to the length of the last abdominal joint.

Two specimens were found in washings from Ceylon Invertebrates.

This species is easily distinguished from *A. typicus* by its attenuate form and the long narrow 5th feet.

Collocheres giesbrechti, n. sp.—Plate XVIII., figs. 1 to 10.

Length, female 0·67 millim.; male unknown.

Body elongate, sub-ovate; cephalothoracic segment with a rounded forehead and about equal to twice the lengths of the 1st to 3rd thoracic segments combined. Anterior antennæ 20-jointed, with a sensory filament on the end of the 18th joint.

Proportional lengths of the joints:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
12.	3.	3.	3.	3.	3.	4.	3.	4.	3.	4.	7.	5.	7.	7.	8.	8.	9.	5.	9.

Posterior antennæ, mandible and palp, maxilla and maxillipeds and natatory legs nearly as in *C. gracilicauda*. Fifth feet 2-jointed, 2nd joint slightly curved, long and narrow, furnished with 2 sub-apical setæ on the outer margin, one sub-apical seta on the inner margin and one apical seta, on each side of which there is a distinct tooth-like projection of the foot. Abdomen narrow, 4-jointed. Genital segment longer than the combined lengths of the 2nd, 3rd and 4th joints. Furcal rami short and narrow, about $2\frac{1}{2}$ times longer than broad.

Two specimens in the washings from Ceylon Invertebrates.

This species is easily distinguished from the other members of the genus by the lengths of the joints of the anterior antennæ, the shape of the 5th feet and the furca.

We have much pleasure in naming the new *Collocheres* after Dr. GIESBRECHT, whose monograph on the Naples Copepoda belonging to this peculiar family has done much to simplify their study.

Scottocheres elongatus (T. and A. SCOTT).

Scottocheres longifurca, GIESBR.

Both found in washings from Ceylon dredged Invertebrates.

Lepeopsyllus, n. gen.

Body oval, thin and scale-like, composed of 4 segments. Abdomen 3-jointed and completely covered by the last thoracic segment. Furca completely covered or only partly covered by the same segment. The margin of the carapace is thickly lined with papilla-like prolongations, of irregular length, which probably impart strength to this region.

Siphon long, reaching to about the end of the last abdominal joint. Anterior antennæ 13-15-jointed. Outer branch of posterior antennæ 4-jointed; inner branch long and blade-like.

Mandible rudimentary, consisting of a long hair attached to a short slender basal joint; palp 2-jointed, the joints long and of about equal length, the outer one covered with minute hairs. Maxilla consists of 2 separate lobes attached to the ends of a long basal joint. Maxillipeds nearly as in the other Asterocheridæ.

Both branches of 1st to 3rd pairs of natatory legs 3-jointed; outer branch of 4th pair 3-jointed, the inner consisting of a minute knob with one hair; 5th pair each consist of a long curved hairy appendage. Furca divergent, long and narrow.

Lepeopsyllus typicus, n. sp.—Plate XIX., figs. 21 to 29.

Length, female 1·48 millims.; male unknown.

Anterior antennæ 15-jointed, the proportional lengths of the joints being as follows:

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
26.	13.	18.	5.	4.	5.	4.	4.	4.	4.	4.	5.	3.	4.	1.

Joint 12 bears a long fine filament.

The other characters are the same as those of the genus. Furcal rami long and divergent, extending a little beyond the edge of the carapace.

One specimen, a female, was found in the Muttuvaratu pearl oyster washings. This species has a longer and less rounded body than the succeeding one, the only known species for which it could be mistaken. The jointing of the anterior antennæ also serves to distinguish it.

Lepeopsyllus ovalis, n. sp.—Plate XIX., figs. 30 to 33.

Length of female 1·4 millims. ; male unknown.

Carapace more rotund than in *L. typicus* but otherwise very similar. Anterior antennæ 13-jointed, the proportional lengths of the joints being as follows :—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
21.	10.	17.	5.	4.	7.	4.	4.	7.	5.	2.	4.	2.

The other appendages are practically the same as those of *L. typicus*. Furca are entirely covered by the carapace. Two specimens, both females, were found in the general washings from dredged Invertebrates.

Besides the difference in shape of the carapace, the jointing of the anterior antennæ serves to distinguish this species from *L. typicus*.

Doropontius, n. gen.

Body nearly circular ; cephalic and thoracic segments produced laterally into strong points. Abdomen of the female 3-jointed, anterior antennæ 17-jointed. Posterior antennæ as in *Asterocheres manaarensis*. Mandible, maxilla, maxillipeds and 1st–4th pairs of natatory legs as in *Asterocheres*. Fifth pair of natatory legs 2-jointed.

Doropontius denticornis, n. sp.—Plate XX., figs. 1 to 5.

Length, female 0·9 millim. ; male unknown.

The cephalic segment shield-shaped, forming about $\frac{3}{4}$ of the entire animal. Second and 3rd thoracic segments have each an obtuse lateral tooth. Abdomen short; genital segment about twice as broad as long, laterally excavated to form an upper and a lower tooth, the latter rounded posteriorly. The 2nd and 3rd segments together hardly equal in length to the 1st, and about twice as broad as long. Anterior antenna 17-jointed, the proportional lengths of the joints being as follows :—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
19.	6.	13.	5.	5.	1.	5.	6.	6.	7.	7.	7.	8.	10.	3.	6.	2.

The lower margin of the 4th joint is prolonged into a strong pointed tooth, and the 14th joint bears a long filament. Furcal rami quadrate, rather longer than broad.

A few specimens, all females, were found in washings from Gulf of Manaar sponges and in the general washings of Invertebrates. The pointed cephalic and thoracic segments, the anterior antennæ, and the 3-jointed abdomen are the characters which distinguish this genus and species.

Cletopontius, n. gen.

Body broadly ovate, the cephalic segment forming about $\frac{3}{4}$ of the entire body.

Abdomen 3-jointed. Inner branch of posterior antennæ 2-jointed. Mandible stylet-shaped, palp 1-jointed. Maxilla and maxillipeds as in *Asterocheres*. First, 2nd and 3rd pairs of natatory legs 2-branched, both branches 3-jointed; 4th pair composed of 1 branch only.

The characters of this genus do not agree in all respects with any of the known sub-families of the Asterocheridæ, and a new sub-family may therefore be required for its reception.

Cletopontius serratus, n. sp.—Plate XX., figs. 9 to 18.

Length, female 0·8 millim.; male unknown.

Lateral edges of 1st and 2nd thoracic segments bluntly serrated. Abdomen small, the genital segment being about equal in size to 16 of either of the 2 following joints,

Anterior antenna 18-jointed, the proportional lengths of the joints being as follows:—

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
28.	12.	7.	15.	6.	8.	10.	3.	6.	12.	10.	8.	8.	10.	10.	13.	14	3.

The 4th joint is faintly divided into 3, the 16th joint bears a long filament. Inner branch of posterior antenna 2-jointed; the apical joint less than $\frac{1}{2}$ the length of the basal joint.

The other characters as those of genus, which readily distinguish it. A few specimens, all female, were found in the general washings of dredged Invertebrates.

Bradypontius siphonatus, Giesbr.

Found in washings from Ceylon dredged material.

Artotrogus orbicularis, Boeck.

One specimen was in the general washings from Ceylon dredged Invertebrates.

Stephopontius, n. gen.

Body sub-quadrate, a strongly marked dividing line separating the cephalic segment from the thoracic joints; all have rounded margins.

Abdomen of female composed of 1 joint; that of male 3-jointed. Anterior antenna of female 6-jointed; the male antenna is 2-jointed, the apex forming in conjunction with the extremity of the basal joint what appears to be a strong clasping organ.

Posterior antenna 1-branched. Mandible stylet-shaped; palp 1-jointed. Maxilla represented by a stout plumose spine. Maxillipeds as in *Asterocheres*. First pair of natatory legs each composed of two 1-jointed branches, the outer branch very small; 2nd and 3rd pair 2-branched, both 2-jointed; 4th pair 1-branched, having 2 joints. In 5th pair each consists of a lamella.

Stephopontius typicus, n. sp.—Plate XX., figs. 19 to 31.

Length, female 6·7 millims.; male 8 millims.

Second thoracic segment in female has a terminal lateral appendage on each side; this is absent in male, which has a prolongation of the last thoracic segment on each side of the abdomen. The 1-jointed abdomen in female has a small protuberance on each side at the genital opening. Male abdomen 3-jointed, very small.

Anterior antenna of female 6-jointed, the proportional lengths being as follows:—

$$\frac{1.}{13.}\ \frac{2.\ \ 3.\ \ 4.\ \ 5.\ \ 6.}{16.\ \ 8.\ \ 8.\ \ 7.\ \ 16.}$$ The terminal joint bears a long filament.

Posterior antenna 4-jointed, the apical joint bearing a broad spine with wide trifid end. Other characters as in the genus. Furcal rami very small, spherical in male: knob-like in female. A number of specimens, both males and females, of this very striking form were found in the general washings from dredged Invertebrates. Its general appearance, the male anterior antennæ, and the 1st, 2nd and 5th natatory legs prevent its being mistaken for any other known species.

Family: ERGASILIDÆ.

Bomolochus scomberesocis, Kr.

One adult female with 2 larval forms attached to vulva was taken from the gills of *Caranx leptolepis* from Aripu, Ceylon.

Bomolochus unicirrus, Richiardi.

Several specimens, male and female, were found in the gill chambers of *Amphisile scutata*, Linn., from Ceylon.

Family: CALIGIDÆ.

Caligus dakari, Van Beneden.

Several specimens were taken from the mouth of *Arius venosus* caught in Palk Bay, Ceylon.

Caligus diaphanus, Nordmann.

Several were found about the mouth and attached to the dorsal fin of *Therapon puta* from Aripu, Ceylon.

Caligus benedeni, Bassett-Smith.

Found attached to the inner surface of operculum of *Sciæna diacanthus* from Palk Strait, Ceylon.

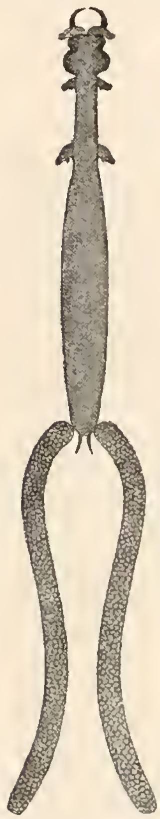

Fig. 1. *Chondracanthus cynoglottidis.*

Lepeophtheirus thompsoni, Baird.

Found associated with *Caligus dakari* in the mouth of *Arius venosus* from Palk Bay, Ceylon.

Family: CHONDRACANTHIDÆ.

Chondracanthus cornutus, Müller.

One only was taken from the gills of *Cynoglossus oligolepis*, from Ceylon.

Chondracanthus cynoglottidis, n. sp.—Text, fig. 1.

Length, female 4·65 millims. (excluding ovisacs); male unknown.

Head rounded, 2-lobed, as wide as the widest part of the body. Body constricted for about $\frac{1}{3}$ of its length, when it expands in width, again narrowing towards the posterior end, and terminating in short strong spines. Anterior antennæ unjointed, about 3 times as long as broad. Posterior antennæ consist of 2 gracefully curved spines. Two pairs of lateral prolongations (rudimentary appendages), having on under side of each a small rounded tubercle, spring from the constricted part of the body. A pair of long wide ovisacs, equalling in length the entire animal, are attached to the posterior end.

Specimens were found attached to the nasal cœcum in *Cynoglossus brachyrhynchus* and *C. brevirostris* by Mr. J. Johnstone, who obtained for us this series of 11 fish-parasites while examining the collection of Ceylon fishes in the Zoological Department of Liverpool University.

Family: LERNÆOPODIDÆ.

Brachiella thynni, Cuv.

Attached to gills of *Chirocentrus dorab*, from Palk Strait.

Brachiella merluccii, Bassett-Smith.

From grooves underneath the head of *Sciæna diacanthus* from Palk Strait.

Anchorella uncinata, Müller.

Found under head in the folds of operculum of *Gazza æquulæformis* from Palk Bay.

EXPLANATION OF PLATES.

PLATE I.

Fig.	1.	*Ridgewayia typica*, n. gen. et n. sp., female, from left side.		× 80.
,,	2.	,, ,,	last thoracic segment, from left side.	× 160.
,,	3.	,, ,,	anterior antenna.	× 123.
,,	4.	,, ,,	posterior antenna.	× 220.
,,	5.	,, ,,	mandible and palp.	× 220.
,,	6.	,, ,,	maxilla.	× 220.
,,	7.	,, ,,	1st maxilliped.	× 220.
,,	8.	,, ,,	2nd ,,	× 220.
,,	9.	,, ,,	1st natatory leg.	× 220.
,,	10.	,, ,,	2nd ,,	× 220.
,,	11.	,, ,,	4th ,,	× 220.
,,	12.	,, ,,	5th ,,	× 220.
,,	13.	,, ,,	abdomen and furca, from above.	× 53.
,,	14.	*Centropages tenuiremis*, n. sp., female, from above.		× 40.
,,	15.	,, ,,	5th pair of natatory legs, female.	× 106.
,,	16.	,, ,,	right anterior antenna, male.	× 53.
,,	17.	,, ,,	5th pair of natatory legs, male.	× 106.
,,	18.	,, ,,	abdomen and furca (male), from above.	× 53.
,,	19.	*Centropages dorsispinatus*, n. sp., female, from above.		× 53.
,,	20.	,, ,,	cephalic segment, from left side.	× 53.
,,	21.	,, ,,	basal joints of anterior antennæ, female.	× 106.
,,	22.	,, ,,	5th natatory leg, female.	× 106.
,,	23.	,, ,,	right anterior antenna, male.	× 53.
,,	24.	,, ,,	5th pair of natatory legs, male.	× 106.
,,	25.	,, ,,	abdomen and furca (male), from above.	× 53.

PLATE II.

Fig.	1.	*Pontella danæ*, var. *ceylonica*, female, from above.		× 32.
,,	2.	,, ,, ,,	rostrum.	× 80.
,,	3.	,, ,, ,,	inner branch of 1st natatory leg.	× 159.
,,	4.	,, ,, ,,	5th pair of natatory legs.	× 80.
,,	5.	,, ,, ,,	abdomen and furca.	× 53.
,,	6.	*Labidocera kroyeri*, var. *gallensis*, male, 5th pair of natatory legs.		× 53.
,,	7.	,, ,, ,,	last thoracic and 1st abdominal segments.	× 53.
,,	8.	,, var. *stylifera*, male, 5th pair of natatory legs.		× 53.
,,	9.	,, ,,	last thoracic and 1st abdominal segments.	× 53.
,,	10.	*Labidocera pectinata*, n. sp., female, from above.		× 40.
,,	11.	,, ,, ,,	rostrum.	× 106.
,,	12.	,, ,, ,,	inner branch of 1st natatory leg.	× 160.
,,	13.	,, ,, ,,	5th pair of natatory legs.	× 106.
,,	14.	,, ,, ,,	abdomen and furca.	× 80.
,,	15.	*Pontellopsis herdmani*, n. sp., female, from above.		× 40.
,,	16.	,, ,, ,,	rostrum.	× 80.

Fig. 17. *Pontellopsis herdmani*, n. sp., female, 5th pair of natatory legs. × 106.
,, 18. *Metacalanus aurivillii*, CLEVE, female, 5th pair of natatory legs. × 552.
,, 19. ,, ,, ,, abdomen and furca. × 552.
,, 20. ,, ,, male, 5th pair of natatory legs. × 159.
,, 21. *Pseudodiaptomus salinus*, GIESBR., female, 5th natatory leg. × 159.
,, 22. ,, ,, male, 5th pair of natatory legs. × 159.
,, 23. ,, ,, ,, abdomen and furca. × 159.
,, 24. *Pseudodiaptomus aurivillii*, CLEVE, female, 5th natatory leg. × 159.
,, 25. ,, ,, male, 5th pair of natatory legs. × 159.
,, 26. ,, ,, ,, abdomen and furca. × 159.

PLATE III.

Fig. 1. *Sunaristes inopinata*, n. sp., female, from left side. × 80.
,, 2. ,, ,, ,, anterior antenna. × 156.
,, 3. ,, ,, ,, 1st natatory leg. × 90.
,, 4. ,, ,, ,, 2nd ,, × 120.
,, 5. ,, ,, ,, 4th ,, × 120.
,, 6. ,, ,, ,, last abdominal segment and furca. × 60.
,, 7. ,, ,, male, apical joints of anterior antenna. × 195.
,, 8. ,, ,, female, 5th natatory leg. × 390.
,, 9. *Sunaristes longipes*, n. sp., female, from left side. × 80.
,, 10. ,, ,, ,, 4th natatory leg. × 120.
,, 11. ,, ,, ,, last abdominal segments and furca. × 60.
,, 12. *Sunaristes curticaudata*, n. sp., female, from left side. × 80.
,, 13. ,, ,, ,, anterior antenna. × 111.
,, 14. ,, ,, ,, 2nd natatory leg. × 120.
,, 15. ,, ,, ,, 3rd ,, × 120.
,, 16. ,, ,, ,, 4th ,, × 120.
,, 17. ,, ,, ,, last abdominal segments and furca. × 90.
,, 18. *Hersiliodes dubia*, n. sp., male, from above. × 45.
,, 19. ,, ,, ,, anterior antenna. × 90.
,, 20. ,, ,, ,, posterior antenna. × 180.
,, 21. ,, ,, ,, mandible. × 260.
,, 22. ,, ,, ,, maxilla. × 260.
,, 23. ,, ,, ,, 1st maxilliped. × 260.
,, 24. ,, ,, ,, 2nd ,, × 90
,, 25. ,, ,, ,, 1st natatory leg. × 120.
,, 26. ,, ,, ,, 4th ,, × 120.
,, 27. ,, ,, ,, 5th ,, × 180.

PLATE IV.

Fig. 1. *Tegastes imthurni*, n. sp., female, from right side. × 106.
,, 2. ,, ,, another female, from left side. × 159.
,, 3. ,, ,, female, anterior antenna. × 195.
,, 4. ,, ,, ,, 2nd maxilliped. × 195.
,, 5. ,, ,, ,, 1st natatory leg. × 136.
,, 6. ,, ,, ,, 2nd ,, × 90.

Fig. 7. *Tegastes imthurni*, n. sp., female, 3rd natatory leg. × 60.

„ 8. „ „ „ 4th „ × 60.

„ 9. „ „ „ 5th „ × 60.

„ 10. *Tegastes donnani*, n. sp., female, from right side. × 159.

„ 11. „ „ „ anterior antenna. × 390.

„ 12. „ „ „ 5th natatory leg. × 90.

„ 13. *Tegastes twynami*, n. sp., female, from right side. × 106.

„ 14. „ „ „ anterior antenna. × 60.

„ 15. „ „ „ 2nd maxilliped. × 260.

„ 16. „ „ „ 5th natatory leg. × 181.

„ 17. *Tegastes chalmersi*, n. sp., female, from left side. × 159.

„ 18. „ „ „ anterior antenna. × 781.

„ 19. „ „ „ 2nd maxilliped. × 320.

„ 20. „ „ „ 1st natatory leg. × 500.

„ 21. „ „ „ 4th „ × 500.

„ 22. „ „ „ 5th „ × 500.

PLATE V.

Fig. 1. *Stenhelia brevicornis*, n. sp., female, from left side. × 106.

„ 2. „ „ „ anterior antenna. × 368.

„ 3. „ „ „ posterior antenna, inner branch. × 276.

„ 4. „ „ „ mandible and palp. × 276.

„ 5. „ „ „ 2nd maxilliped. × 368.

„ 6. „ „ „ 1st natatory leg. × 276.

„ 7. „ „ „ 4th „ × 221.

„ 8. „ „ „ 5th „ × 276.

„ 9. „ „ „ last abdominal segment and furca. × 159.

„ 10. *Stenhelia gracilicaudata*, n. sp., female, from left side. × 159.

„ 11. „ „ „ anterior antenna. × 276.

„ 12. „ „ „ 1st natatory leg. × 276.

„ 13. „ „ „ 4th „ × 276.

„ 14. „ „ „ 5th „ × 276.

„ 15. „ „ „ last abdominal segment and furca. × 159.

„ 16. *Stenhelia longicornis*, n. sp., female, from left side. × 106.

„ 17. „ „ „ anterior antenna. × 221.

„ 18. „ „ „ 1st natatory leg. × 221.

„ 19. „ „ „ 5th „ × 221.

„ 20. „ „ „ last abdominal segment and furca. × 104.

„ 21. „ „ male, 2nd natatory leg, inner branch. × 221.

„ 22. „ „ „ 5th „ „ × 221.

„ 23. *Ameira minor*, n. sp., female, from left side. × 159.

„ 24. „ „ „ anterior antenna. × 335.

„ 25. „ „ „ posterior antenna, inner branch. × 552.

„ 26. „ „ „ mandible and palp. × 552.

„ 27. „ „ „ 1st natatory leg. × 276.

„ 28. „ „ „ 5th „ × 335.

„ 29. „ „ „ last abdominal segment and furca. × 335.

PLATE VI.

Fig. 1. *Stenhelia perplexa*, n. sp., female, from left side. × 159.
,, 2. ,, ,, ,, anterior antenna. × 390.
,, 3. ,, ,, ,, 2nd maxilliped. × 530.
,, 4. ,, ,, ,, 1st natatory leg. × 260.
,, 5. ,, ,, ,, 4th ,, × 260.
,, 6. ,, ,, ,, 5th ,, × 260.
,, 7. ,, ,, ,, last abdominal segment and furca. × 260.
,, 8. *Stenhelia dentipes*, n. sp., female, from left side. × 159.
,, 9. ,, ,, ,, basal joints of anterior antenna. × 260.
,, 10. ,, ,, ,, 2nd maxilliped. × 781.
,, 11. ,, ,, ,, 1st natatory leg. × 390.
,, 12. ,, ,, ,, 4th ,, × 260.
,, 13. ,, ,, ,, 5th ,, × 390.
,, 14. ,, ,, ,, last abdominal segment and furca.
,, 15. *Ameira tenuipes*, n. sp., female, from left side. × 159.
,, 16. ,, ,, ,, anterior antenna. × 390.
,, 17. ,, ,, ,, posterior antenna, inner branch. × 390.
,, 18. ,, ,, ,, mandible and palp. × 390.
,, 19. ,, ,, ,, 1st natatory leg. × 390.
,, 20. ,, ,, ,, 5th ,, × 390.
,, 21. *Stenhelia minuta*, n. sp., female, from left side. × 159.
,, 22. ,, ,, ,, anterior antenna. × 260.
,, 23. ,, ,, ,, 1st natatory leg. × 390.
,, 24. ,, ,, ,, 5th ,, × 390.

PLATE VII.

Fig. 1. *Parastenhelia hornelli*, n. gen. et sp., female, from left side. × 106.
,, 2. ,, ,, ,, anterior antenna. × 260.
,, 3. ,, ,, ,, posterior antenna. × 260.
,, 4. ,, ,, ,, mandible and palp. × 390.
,, 5. ,, ,, ,, 2nd maxilliped. × 390.
,, 6. ,, ,, ,, 1st natatory leg. × 260.
,, 7. ,, ,, ,, 4th ,, × 195.
,, 8. ,, ,, ,, 5th ,, × 195.
,, 9. ,, ,, male, 2nd ,, × 260.
,, 10. ,, ,, ,, 5th ,, × 260.
,, 11. *Ceylonia aculeata*, n gen. et sp., female, from left side. × 106.
,, 12. ,, ,, ,, anterior antenna. × 390.
,, 13. ,, ,, ,, posterior antenna. × 390.
,, 14. ,, ,, ,, mandible and palp. × 390.
,, 15. ,, ,, ,, maxilla. × 260.
,, 16. ,, ,, ,, 1st maxilliped. × 260.
,, 17. ,, ,, ,, 2nd ,, × 780.
,, 18. ,, ,, ,, 1st natatory leg. × 260.
,, 19. ,, ,, ,, 4th ,, × 195.

Fig. 20. *Ceylonia aculeata*, n. gen. et sp., female, 5th natatory leg. × 195.
,, 21. ,, ,, ,, last abdominal segment and furca. × 90.
,, 22. ,, ,, male, 3rd natatory leg. × 195.
,, 23. ,, ,, ,, 5th ,, × 390.

PLATE VIII.

Fig. 1. *Laophonte hirsuta*, n. sp., female, from above. × 106.
,, 2. ,, ,, ,, anterior antenna. × 260.
,, 3. ,, ,, ,, posterior antenna, inner branch. × 395.
,, 4. ,, ,, ,, mandible and palp. × 395.
,, 5. ,, ,, ,, 2nd maxilliped. × 395.
,, 6. ,, ,, ,, 1st natatory leg. × 395.
,, 7. ,, ,, ,, 4th ,, × 395.
,, 8. ,, ,, ,, 5th ,, × 260.
,, 9. *Laophontella typica*, n. gen. et sp., female, from above. × 106.
,, 10. ,, ,, ,, from left side. × 106.
,, 11. ,, ,, ,, anterior antenna. × 395.
,, 12. ,, ,, ,, 2nd maxilliped. × 395.
,, 13. ,, ,, ,, 1st natatory leg. × 260.
,, 14. ,, ,, ,, 2nd ,, × 260.
,, 15. ,, ,, ,, 4th ,, × 260.
,, 16. ,, ,, ,, 5th ,, × 260.
,, 17. *Tetragoniceps dubia*, n. sp., female, from left side. × 106.
,, 18. ,, ,, ,, anterior antenna. × 260.
,, 19. ,, ,, ,, 2nd maxilliped. × 395.
,, 20. ,, ,, ,, 1st natatory leg. × 195.
,, 21. ,, ,, ,, 4th ,, × 195.
,, 22. ,, ,, ,, 5th ,, × 260.
,, 23. *Tetragoniceps minor*, n. sp., female, from left side. × 159.
,, 24. ,, ,, ,, anterior antenna. × 520.
,, 25. ,, ,, ,, 2nd maxilliped. × 780.
,, 26. ,, ,, ,, 1st natatory leg. × 260.
,, 27. ,, ,, ,, 5th ,, × 156.
,, 28. ,, ,, ,, last abdominal segment and furca. × 195.

PLATE IX.

Fig. 1. *Dactylophusia dentata*, n. sp., female, from left side. × 80.
,, 2. ,, ,, ,, anterior antenna. × 221.
,, 3. ,, ,, ,, posterior antenna, inner branch. × 221.
,, 4. ,, ,, ,, mandible palp. × 221.
,, 5. ,, ,, ,, 2nd maxilliped. × 221.
,, 6. ,, ,, ,, 1st natatory leg. × 184.
,, 7. ,, ,, ,, 5th ,, × 221.
,, 8. ,, ,, ,, last abdominal segment and furca. × 221.
,, 9. ,, ,, male, 2nd natatory leg, inner branch. × 221.
,, 10. ,, ,, ,, 5th ,, × 221.

Fig. 11. *Dactylophusia havelocki*, n. sp., female, from left side. × 80.
„ 12. „ „ „ anterior antenna. × 159.
„ 13. „ „ „ posterior antenna, inner branch. × 260.
„ 14. „ „ „ mandible palp. × 260.
„ 15. „ „ „ 2nd maxilliped. × 260.
„ 16. „ „ „ 1st natatory leg. × 195.
„ 17. „ „ „ 5th „ × 130.
„ 18. „ „ „ last abdominal segment and furca. × 130.
„ 19. *Dactylophusia hirsuta*, n. sp., female, from left side. × 80.
„ 20. „ „ „ anterior antenna. × 195.
„ 21. „ „ „ 2nd maxilliped. × 195.
„ 22. „ „ „ 1st natatoıy leg. × 156.
„ 23. „ „ „ 5th „ × 156.
„ 24 „ „ „ last abdominal segment and furca. × 111.
„ 25. *Dactylophusia ceylonica*, n. sp., female, from left side. × 64.
„ 26. „ „ „ anterior antenna. × 156.
„ 27. „ „ „ 2nd maxilliped. × 156.
„ 28. „ „ „ 1st natatory leg. × 156.
„ 29. „ „ „ 5th „ × 98.
„ 30. „ „ male, 1st „ inner branch. × 98.
„ 31. „ „ „ 2nd „ „ × 156.
„ 32. „ „ „ 5th „ „ × 130.

PLATE X.

Fig. 1. *Dactylophusia hamiltoni*, n. sp., female, from left side. × 80.
„ 2. „ „ „ anterior antenna. × 120.
„ 3. „ „ „ posterior „ × 181.
„ 4. „ „ „ 2nd maxilliped. × 260.
„ 5. „ „ „ 1st natatory leg. × 195.
„ 6. „ „ „ 5th „ × 195.
„ 7. „ „ „ last abdominal segment and furca. × 181.
„ 8. *Parastenhelia similis*, n. sp., female, from left side. × 106.
„ 9. „ „ „ anterior antenna. × 260.
„ 10. „ „ „ 2nd maxilliped. × 390.
„ 11. „ „ „ 1st natatory leg. × 260.
„ 12. „ „ „ 4th „ × 195.
„ 13. „ „ „ 5th „ × 260.
„ 14. „ „ „ last abdominal segments and furca. × 260.
„ 15. *Stenhelia knoxi*, n. sp., female, from left side. × 106.
„ 16. „ „ „ anterior antenna. × 390.
„ 17. „ „ „ 1st natatory leg. × 390.
„ 18. „ „ „ 5th „ × 195.
„ 19. *Dactylophusia robusta*, n. sp., female, from left side. × 159.
„ 20. „ „ „ anterior antenna. × 390.
„ 21. „ „ „ 2nd maxilliped. × 390.
„ 22. „ „ „ 1st natatory leg. × 260.
„ 23. „ „ „ 5th „ × 260.
„ 24. „ „ „ last abdominal segments and furca. × 260.

PLATE XI.

Fig. 1. *Dactylophusia laticaudata*, n. sp., female, from above. × 159.
„ 2. „ „ „ anterior antenna. × 260.
„ 3. „ „ „ posterior antenna, inner branch. × 260.
„ 4. „ „ „ mandible palp. × 260.
„ 5. „ „ „ 2nd maxilliped. × 260.
„ 6. „ „ „ 1st natatory leg. × 260.
„ 7. „ „ „ 4th „ × 260.
„ 8. „ „ „ 5th „ × 260.
„ 9. *Dactylophusia æmula*, n. sp., female, from above. × 159.
„ 10. „ „ „ anterior antenna. × 390.
„ 11. „ „ „ 1st natatory leg. × 260.
„ 12. „ „ „ 5th „ × 260.
„ 13. *Dactylophusia platysoma*, n. sp., female, from above. × 106.
„ 14. „ „ „ anterior antenna. × 390.
„ 15. „ „ „ 2nd maxilliped. × 390.
„ 16. „ „ „ 1st natatory leg. × 260.
„ 17. „ „ „ 4th „ × 260.
„ 18. „ „ „ 5th „ × 195.
„ 19. *Pseudothalestris imbricata*, Brady, female, from left side. × 159.
„ 20. „ „ „ anterior antenna. × 390.
„ 21. „ „ „ 2nd maxilliped. × 260.
„ 22. „ „ „ 1st natatory leg. × 195.
„ 23. „ „ „ 5th „ × 195.
„ 24. „ „ „ last abdominal segment and furca. × 395.

PLATE XII.

Fig. 1. *Porcellidium fimbriatum*, Claus, female, from above. × 106.
„ 2. „ „ „ anterior antenna. × 260.
„ 3. „ „ „ posterior antenna, inner branch. × 260.
„ 4. „ „ „ mandible and palp. × 195.
„ 5. „ „ „ 1st maxilliped. × 396.
„ 6. „ „ „ 2nd „ × 396.
„ 7. „ „ „ 1st natatory leg. × 260.
„ 8. „ „ „ 4th „ × 195.
„ 9. „ „ „ 5th „ × 195.
„ 10. „ „ „ abdomen and furca. × 180.
„ 11. *Porcellidium brevicaudatum*, n. sp., female, from above. × 106.
„ 12. „ „ „ anterior antenna. × 260.
„ 13. „ „ „ 5th natatory leg. × 260.
„ 14. „ „ „ abdomen and furca. × 195.
„ 15. *Porcellidium acuticaudatum*, n. sp., female, from above. × 106.
„ 16. „ „ „ anterior antenna. × 260.
„ 17. „ „ „ 5th natatory leg. × 195.
„ 18. „ „ „ abdomen and furca. × 195.
„ 19. *Porcellidium ravanæ*, n. sp., female, from above. × 106.

Fig. 20. *Porcellidium ravanæ*, n. sp., female, anterior antenna. × 260.
,, 21. ,, ,, ,, 5th natatory leg. × 195.
,, 22. ,, ,, ,, abdomen and furca. × 156.

PLATE XIII.

Fig. 1. *Peltidium ovale*, n. sp., female, from above. × 40.
,, 2. ,, ,, ,, anterior antenna. × 195.
,, 3. ,, ,, ,, 2nd maxilliped. × 95.
,, 4. ,, ,, ,, 1st natatory leg. × 95.
,, 5. ,, ,, ,, 4th ,, × 95.
,, 6. ,, ,, ,, 5th ,, × 95.
,, 7. *Peltidium angulatum*, n. sp., female, from above. × 53.
,, 8. ,, ,, ,, anterior antenna. × 195.
,, 9. ,, ,, ,, 2nd maxilliped. × 95.
,, 10. ,, ,, ,, 1st natatory leg. × 95.
,, 11. ,, ,, ,, 5th ,, × 195.
,, 12. *Peltidium speciosum*, n. sp., female, from above. × 53.
,, 13. ,, ,, ,, anterior antenna. × 195.
,, 14. ,, ,, ,, 2nd maxilliped. × 95.
,, 15. ,, ,, ,, 1st natatory leg. × 120.
,, 16. ,, ,, ,, 5th ,, × 195.
,, 17. ,, ,, ,, a smaller form, with thinner bands. × 64
,, 18. *Peltidium serratum*, n. sp., female, from above. × 40.
,, 19. ,, ,, ,, anterior antenna. × 195.
,, 20. ,, ,, ,, 2nd maxilliped. × 95.
,, 21. ,, ,, ,, 1st natatory leg. × 95.
,, 22. ,, ,, ,, 5th ,, × 95.
,, 23. *Peltidium perplexum*, n. sp., female, from above. × 40.
,, 24. ,, ,, ,, anterior antenna. × 156.
,, 25 ,, ,, ,, 2nd maxilliped. × 95.
,, 26. ,, ,, ,, 1st natatory leg. × 95.
,, 27. ,, ,, ,, 5th ,, × 195.

PLATE XIV.

Fig. 1. *Pseudanthessius maximus*, n. sp., female, from above. × 27.
,, 2. ,, ,, ,, anterior antenna. × 90.
,, 3. ,, ,, ,, posterior antenna. × 90.
,, 4. ,, ,, ,, mandible and palp. × 156.
,, 5. ,, ,, ,, 1st maxilliped. × 120.
,, 6. ,, ,, ,, 2nd ,, × 90.
,, 7. ,, ,, ,, 1st natatory leg. × 60.
,, 8. ,, ,, ,, 4th ,, × 90.
,, 9. ,, ,, ,, 5th ,, × 90.
,, 10. ,, ,, male, 2nd maxilliped. × 90.
,, 11. ,, ,, ,, abdomen and furca. × 30.
,, 12. *Pseudanthessius chelifer*, n. sp., female, from above. × 80.
,, 13. ,, ,, ,, anterior antenna. × 260.

Fig. 14. *Pseudanthessius chelifer*, n. sp., female, posterior antenna. × 156.
,, 15. ,, ,, ,, mandible and palp. × 260.
,, 16. ,, ,, ,, 1st maxilliped. × 260.
,, 17. ,, ,, ,, 2nd ,, × 260.
,, 18. ,, ,, ,, 4th natatory leg. × 156.
,, 19. *Pseudanthessius gracilis*, CLAUS, female, from above. × 80.
,, 20. ,, ,, ,, anterior antenna. × 260.
,, 21. ,, ,, ,, posterior ,, × 195.
,, 22. ,, ,, ,, 2nd maxilliped. × 180.
,, 23. ,, ,, ,, 4th natatory leg. × 195.
,, 24. *Pseudanthessius concinnus*, n. sp., female, from above. × 80.
,, 25. ,, ,, ,, anterior antenna. × 260.
,, 26. ,, ,, ,, mandible. × 260.
,, 27. ,, ,, ,, 1st maxilliped. × 395.
,, 28. ,, ,, ,, 2nd ,, × 395.
,, 29. ,, ,, ,, 1st natatory leg. × 195.
,, 30. ,, ,, ,, 4th ,, × 195.

PLATE XV.

Fig. 1. *Lichomolgus gracilis*, n. sp., female, from above. × 80.
,, 2. ,, ,, ,, anterior antenna. × 260.
,, 3. ,, ,, ,, posterior antenna. × 260.
,, 4. ,, ,, ,, mandible and palp. × 395.
,, 5. ,, ,, ,, 1st maxilliped. × 395.
,, 6. ,, ,, ,, 2nd ,, × 260.
,, 7. ,, ,, ,, 4th natatory leg. × 156.
,, 8. ,, ,, male, 2nd maxilliped. × 181.
,, 9. ,, ,, ,, abdomen and furca. × 90.
,, 10. *Lichomolgus ievérsi*, n. sp., female, from above. × 80.
,, 11. ,, ,, ,, anterior antenna. × 260.
,, 12. ,, ,, ,, posterior antenna. × 260.
,, 13. ,, ,, ,, mandible. × 395.
,, 14. ,, ,, ,, 1st maxilliped. × 260.
,, 15. ,, ,, ,, 2nd ,, × 260.
,, 16. ,, ,, ,, 4th natatory leg. × 156.
,, 17. ,, ,, male, 2nd maxilliped. × 180.
,, 18. *Lichomolgus buddhensis*, n. sp., female, from above. × 80.
,, 19. ,, ,, ,, anterior antenna. × 156.
,, 20. ,, ,, ,, posterior antenna. × 78.
,, 21. ,, ,, ,, mandible and palp. × 260.
,, 22. ,, ,, ,, 1st maxilliped. × 260.
,, 23. ,, ,, ,, 2nd ,, × 195.
,, 24. ,, ,, ,, 4th natatory leg. × 156.
,, 25. *Lichomolgus lankensis*, n. sp., female, from above. × 80.
,, 26. ,, ,, ,, anterior antenna. × 260.
,, 27. *Lichomolgus simplex*, n. sp., female, from above. × 80.
,, 28. ,, ,, ,, anterior antenna × 260.
,, 29. ,, ,, ,, posterior antenna. × 195.

Fig. 30. *Lichomolgus simplex*, n. sp., female, mandible. × 260.
,, 31. ,, ,, ,, 1st maxilliped. × 260.
,, 32. ,, ,, ,, 2nd ,, × 260.
,, 33. ,, ,, ,, 4th natatory leg. × 195.
,, 34. ,, ,, male, abdomen and furca. × 90.

PLATE XVI.

Fig. 1. *Paralichomolgus curticaudatus*, n. gen. et sp., female, from above. × 80.
,, 2. ,, ,, ,, anterior antenna. × 195.
,, 3. ,, ,, ,, posterior antenna. × 90.
,, 4. ,, ,, ,, mandible and palp. × 260.
,, 5. ,, ,, ,, 1st maxilliped. × 260.
,, 6. ,, ,, ,, 2nd ,, × 260.
,, 7. ,, ,, ,, 4th natatory leg. × 195.
,, 8. *Lichomolgus elegans*, n. sp., female, from above. × 53.
,, 9. ,, ,, ,, anterior antenna. × 130.
,, 10. ,, ,, ,, posterior antenna. × 120.
,, 11. ,, ,, ,, 1st maxilliped. × 195.
,, 12. ,, ,, ,, 2nd ,, × 195.
,, 13. ,, ,, ,, 4th natatory leg, inner branch. × 90.
,, 14. *Lichomolgus robustus*, n. sp., female, from above. × 80.
,, 15. ,, ,, ,, anterior antenna. × 156.
,, 16. ,, ,, ,, posterior antenna. × 156.
,, 17. ,, ,, ,, mandible. × 260.
,, 18. ,, ,, ,, 1st maxilliped. × 260.
,, 19. ,, ,, ,, 2nd ,, × 260.
,, 20. ,, ,, ,, 4th natatory leg. × 195.
,, 21. *Lichomolgus gigas*, n. sp., female, from above. × 53.
,, 22. ,, ,, ,, anterior antenna. × 98.
,, 23. ,, ,, ,, posterior antenna. × 90.
,, 24. ,, ,, ,, 1st maxilliped. × 260.
,, 25. ,, ,, ,, 4th natatory leg. × 60.
,, 26. ,, ,, male, abdomen and furca. × 45.
,, 27. *Lichomolgus dentipes*, n. sp., female, from above. × 80.
,, 28. ,, ,, ,, anterior antenna. × 98.
,, 29. ,, ,, ,, 4th natatory leg. × 195.
,, 30. ,, ,, ,, 5th ,, × 156.

PLATE XVII.

Fig. 1. *Hermannella robusta*, n. sp., female, from above. × 80.
,, 2. ,, ,, ,, anterior antenna. × 130.
,, 3. ,, ,, ,, posterior antenna. × 156.
,, 4. ,, ,, ,, mandible. × 195.
,, 5. ,, ,, ,, 1st maxilliped. × 195.
,, 6. ,, ,, ,, 2nd ,, × 195.
,, 7. ,, ,, ,, 1st natatory leg. × 156.
,, 8. ,, ,, ,, 4th ,, × 156.

Fig. 9. *Hermannella serendibica*, n. sp., female, from above. × 80.
„ 10. „ „ „ anterior antenna. × 130.
„ 11. „ „ „ posterior antenna. × 156.
„ 12. *Hersiliodes leggii*, n. sp., male, from above. × 54.
„ 13. „ „ „ anterior antenna. × 120.
„ 14. „ „ „ posterior antenna. × 90.
„ 15. „ „ „ mandible. × 260.
„ 16. „ „ „ maxilla. × 195.
„ 17. „ „ „ 1st maxilliped. × 195.
„ 18. „ „ „ 2nd „ × 130.
„ 19. „ „ „ 1st natatory leg. × 90.
„ 20. „ „ „ 4th „ × 130.
„ 21. „ „ „ 5th „ × 111.
„ 22. *Hersiliodes tamilensis*, n. sp., female, from above. × 66.
„ 23. „ „ „ anterior antenna. × 120.
„ 24. „ „ „ 2nd maxilliped. × 120.
„ 25. „ „ „ 5th natatory leg. × 156.

PLATE XVIII.

Fig. 1. *Collocheres giesbrechti*, n. sp., female, from above. × 159.
„ 2. „ „ „ anterior antenna. × 260.
„ 3. „ „ „ posterior antenna. × 260.
„ 4. „ „ „ mandible and palp. × 390.
„ 5. „ „ „ maxilla. × 260.
„ 6. „ „ „ 1st maxilliped. × 390.
„ 7. „ „ „ 2nd „ × 260.
„ 8. „ „ „ 1st natatory leg. × 260.
„ 9. „ „ „ 4th „ × 260.
„ 10. „ „ „ 5th „ × 395.
„ 11. *Asteropontius attenuatus*, n. gen. et sp., female, from above. × 106.
„ 12. „ „ „ anterior antenna. × 195.
„ 13. „ „ „ posterior antenna. × 156.
„ 14. „ „ „ mandible and palp. × 156.
„ 15. „ „ „ maxilla. × 156.
„ 16. „ „ „ 1st maxilliped. × 260.
„ 17. „ „ „ 2nd „ × 260.
„ 18. „ „ „ 1st natatory leg. × 195.
„ 19. „ „ „ 4th „ × 195.
„ 20. „ „ „ 5th „ × 260.
„ 21. *Asterocheres major*, n. sp., female, from above. × 80.
„ 22. „ „ „ anterior antenna. × 156.
„ 23. „ „ „ posterior antenna. × 195.
„ 24. „ „ „ mandible and palp. × 195.
„ 25. „ „ „ maxilla. × 195.
„ 26. „ „ „ 4th natatory leg. × 120.
„ 27. „ „ „ 5th „ × 130.
„ 27*a*. „ „ male, anterior antenna. × 156.
„ 28. „ „ „ abdomen and furca. × 80.

Fig. 29. *Asterocheres minor*, n. sp., female, from above. × 80.
,, 30. ,, ,, ,, anterior antenna. × 195.
,, 31. ,, ,, male, abdomen and furca. × 80.

PLATE XIX.

Fig. 1. *Asteropontius typicus*, n. sp., female, from above. × 80.
,, 2. ,, ,, ,, anterior antenna. × 195.
,, 3. ,, ,, ,, posterior antenna. × 195.
,, 4. ,, ,, ,, mandible and palp. × 195.
,, 5. ,, ,, ,, maxilla. × 390.
,, 6. ,, ,, ,, 1st maxilliped. × 195.
,, 7. ,, ,, ,, 2nd ,, × 195.
,, 8. ,, ,, ,, 1st natatory leg. × 195.
,, 9. ,, ,, ,, 4th ,, × 195.
,, 10. ,, ,, ,, 5th ,, × 195.
,, 11. *Asterocheres manaarensis*, n. sp., female, from above. × 106.
,, 12. ,, ,, ,, anterior antenna. × 195.
,, 13. ,, ,, ,, posterior ,, × 195.
,, 14. ,, ,, ,, mandible and palp. × 195.
,, 15. ,, ,, ,, maxilla. × 195.
,, 16. ,, ,, ,, 1st maxilliped. × 195.
,, 17. ,, ,, ,, 2nd ,, × 195.
,, 18. ,, ,, ,, 1st natatory leg. × 195.
,, 19. ,, ,, ,, 4th ,, inner branch. × 195.
,, 20. ,, ,, ,, 5th ,, × 195.
,, 21. *Lepeopsyllus typicus*, n. gen. et sp., female, from above. × 53.
,, 22. ,, ,, ,, anterior antenna. × 195.
,, 23. ,, ,, ,, posterior ,, × 156.
,, 24. ,, ,, ,, mandible and palp. × 156.
,, 25. ,, ,, ,, maxilla. × 260.
,, 26. ,, ,, ,, 1st maxilliped. × 90.
,, 27. ,, ,, ,, 2nd ,, × 90.
,, 28. ,, ,, ,, 1st natatory leg. × 111.
,, 29. ,, ,, ,, 4th ,, × 111.
,, 30. *Lepeopsyllus ovalis*, n. sp., female, from above. × 53.
,, 31. ,, ,, ,, anterior antenna. × 195.
,, 32. ,, ,, ,, 4th natatory leg. × 111.
,, 33. ,, ,, ,, 5th ,, × 195.

PLATE XX.

Fig. 1. *Doropontius denticornis*, n. gen. et sp., female, from above. × 80.
,, 2. ,, ,, ,, anterior antenna. × 195.
,, 3. ,, ,, ,, 1st maxilliped. × 90.
,, 4. ,, ,, ,, 2nd ,, × 90.
,, 5. ,, ,, ,, 1st natatory leg. × 195.
,, 6. *Paralichomolgus longicaudatus*, n. sp., female, from above. × 106.
,, 7. ,, ,, ,, anterior antenna. × 195.
,, 8. ,, ,, ,, 4th natatory leg. × 195.

Fig. 9. *Cletopontius serratus*, n. gen. et sp., female, from above. × 80.
„ 10. „ „ „ anterior antenna. × 260.
„ 11. „ „ „ posterior antenna. × 260.
„ 12. „ „ „ mandible and palp. × 195.
„ 13. „ „ „ maxilla. × 195.
„ 14. „ „ „ 1st maxilliped. × 195.
„ 15. „ „ „ 1st natatory leg. × 195.
„ 16. „ „ „ 3rd „ × 195.
„ 17. „ „ „ 4th „ × 390.
„ 18. „ „ „ 5th „ × 260.
„ 19. *Stephopontius typicus*, n. gen. et sp., female, from above. × 80.
„ 20. „ „ male „ × 80.
„ 21. „ „ female, anterior antenna. × 520.
„ 22. „ „ male „ × 195.
„ 23. „ „ female, posterior antenna. × 260.
„ 24. „ „ „ mandible and palp. × 260.
„ 25. „ „ „ maxilla. × 395.
„ 26. „ „ „ 1st maxilliped. × 195.
„ 27. „ „ „ 2nd „ × 195.
„ 28. „ „ „ 1st natatory leg. × 395.
„ 29. „ „ „ 2nd „ × 260.
„ 30. „ „ „ 4th „ × 260.
„ 31. „ „ „ 5th „ × 156.

It is with deep sorrow that I have to record the sudden death of my friend and fellow-worker, the senior author of this Report, just as his last sheets were passing through the press, and too late for any change to be made elsewhere in this volume. Mr. Isaac Thompson's many scientific friends, who have known and appreciated his work on the Copepoda, will share the feelings of regret which Mr. Andrew Scott, the joint-author, and I desire to express that this Report should have proved to be his last piece of scientific work.

W. A. H.

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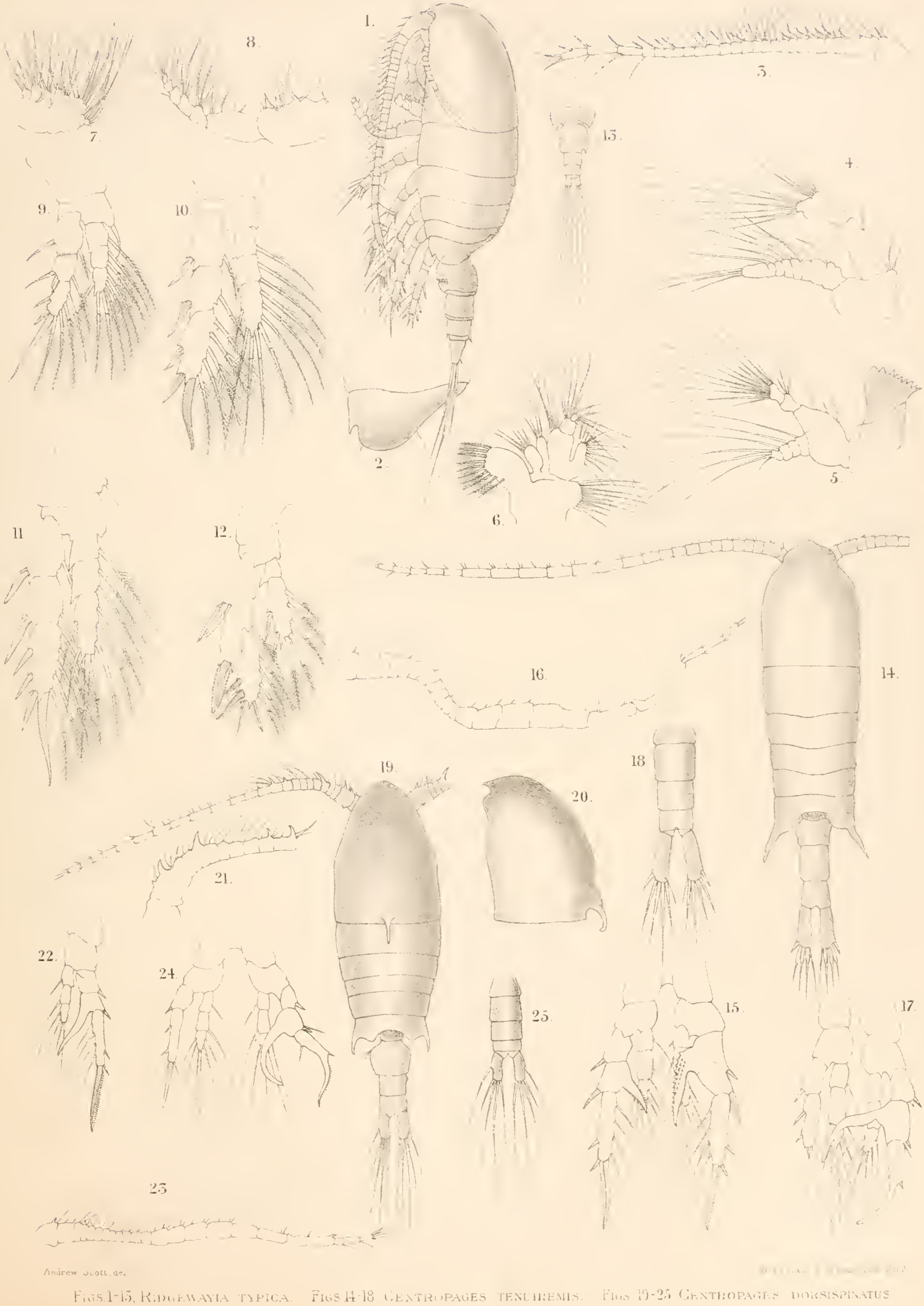
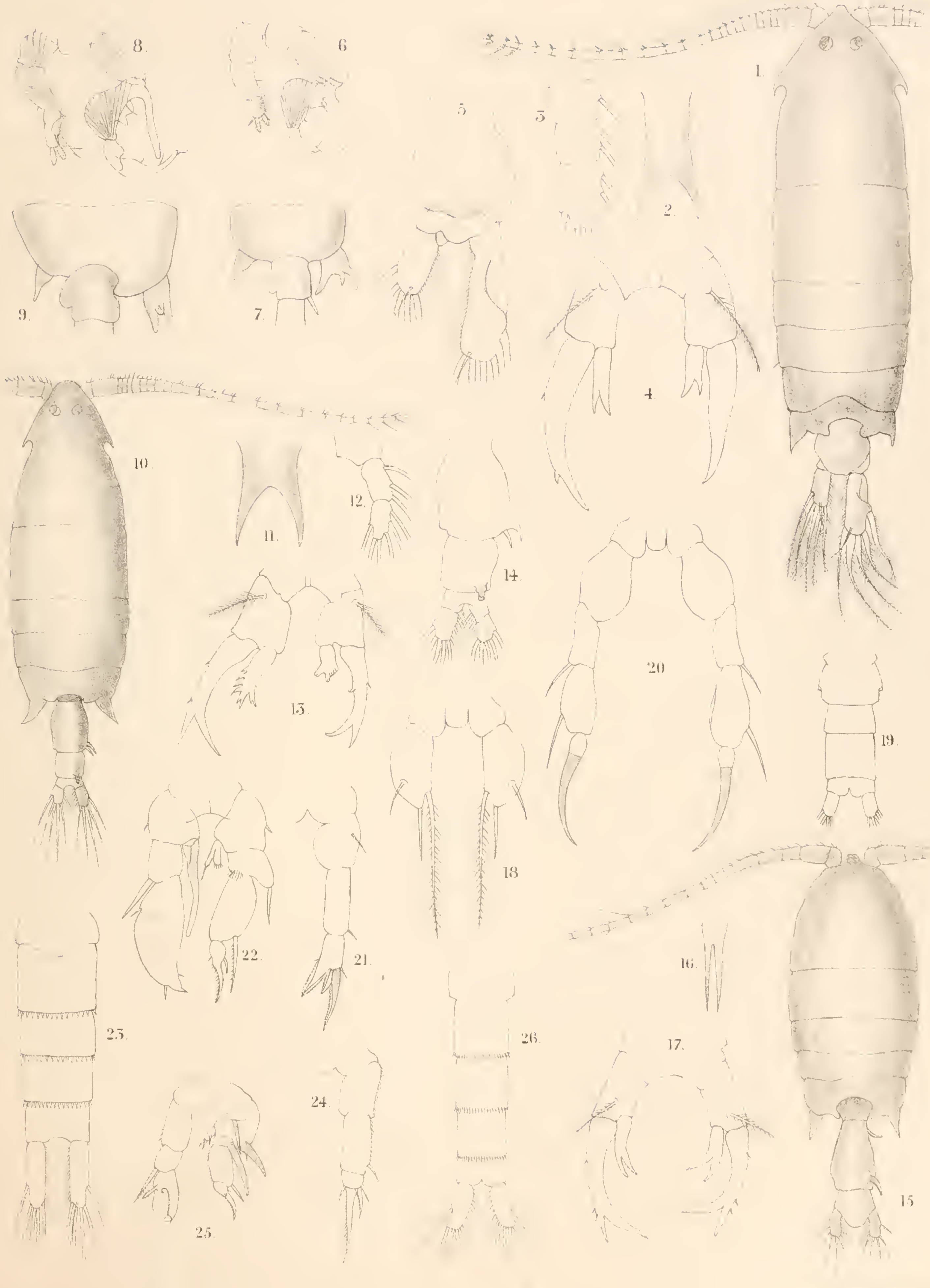


Andrew Scott, del.

Figs. 1-13, Ridgewayia typica. Figs 14-18 Centropages tenuiremis. Figs 19-25 Centropages dorsispinatus



Andrew Scott del.

Figs 1-5 Pontella danæ, *var. Ceylonica* Figs. 6 7. Labidocera kroyeri *var. Gallensis*
Figs 8.9. Labidocera kroyeri, *var. Stylifera*. Figs. 10-14. Labidocera pectinata Figs 15-17. Pontellopsis herdmani
Figs. 18-20. Metacalanus aurivillii, *Cleve*. Figs 21-23 Pseudodiaptomus salinus, *Giesb* Figs 24-26 Pseudodiaptomus aurivillii *Cleve*

Andrew Scott, del.

M'Farlane & Erskine Lith. Edin.

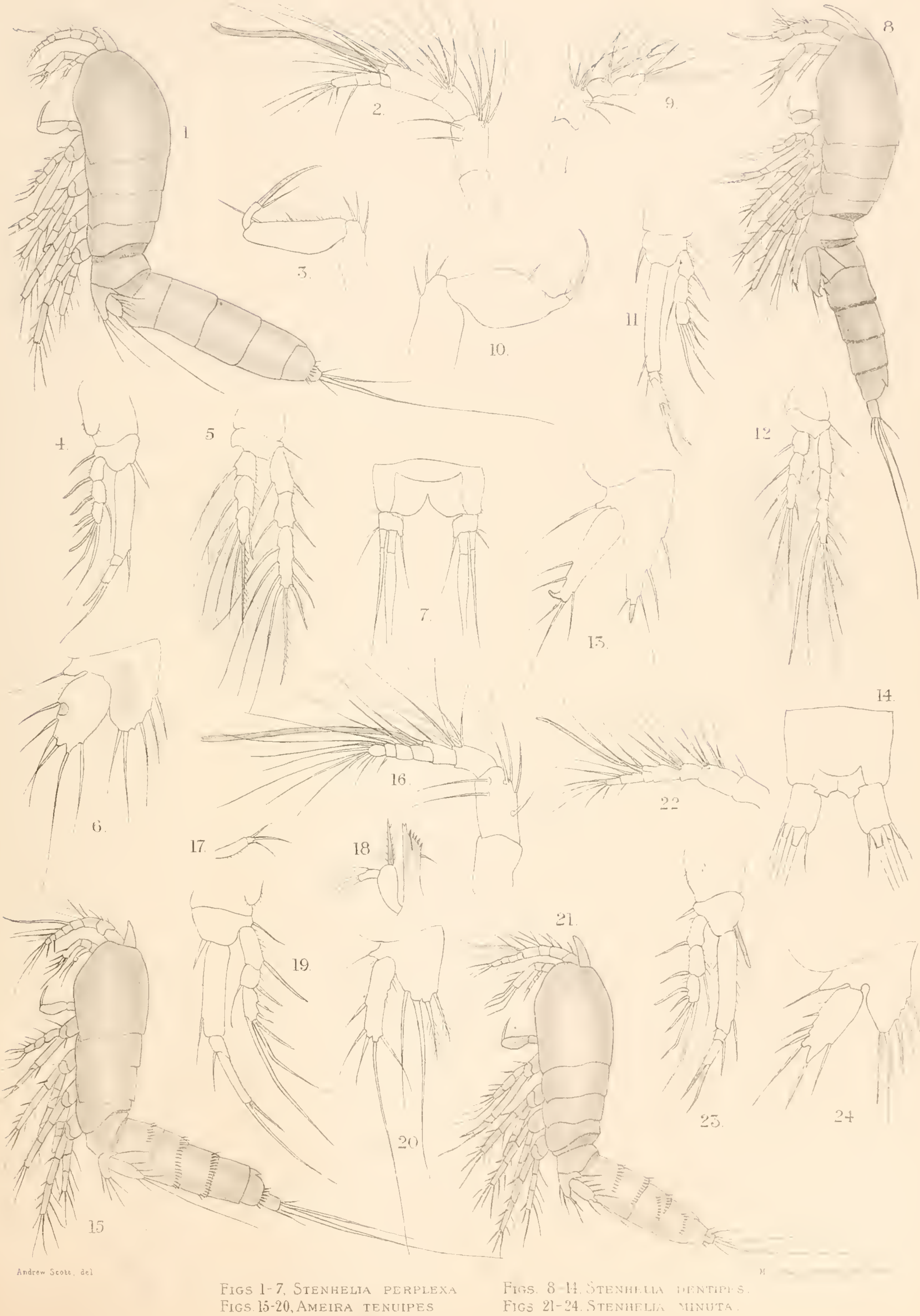
FIGS 1-8, SUNARISTES INOPINATA FIGS 9-11, SUNARISTES LONGIPES

FIGS 12-17, SUNARISTES CURTICAUDATA FIGS. 18-27, HERSILIODES DUBIA

Figs. 1-9, Tegastes imthurni. Figs. 10-12, Tegastes donnani.
Figs. 13-16, Tegastes twynami. Figs. 17-22, Tegastes chalmersi.

Andrew Scott, del.

Figs 1-9, *Stenhelia brevicornis*. Figs. 10-15 *Stenhelia gracilicaudata*
Figs 16-22, *Stenhelia longicornis* Figs. 23-29, *Ameira minor*



Andrew Scott, del.

FIGS 1-7, STENHELIA PERPLEXA. FIGS. 8-14, STENHELIA DENTIPES.
FIGS. 15-20, AMEIRA TENUIPES. FIGS 21-24. STENHELIA MINUTA.

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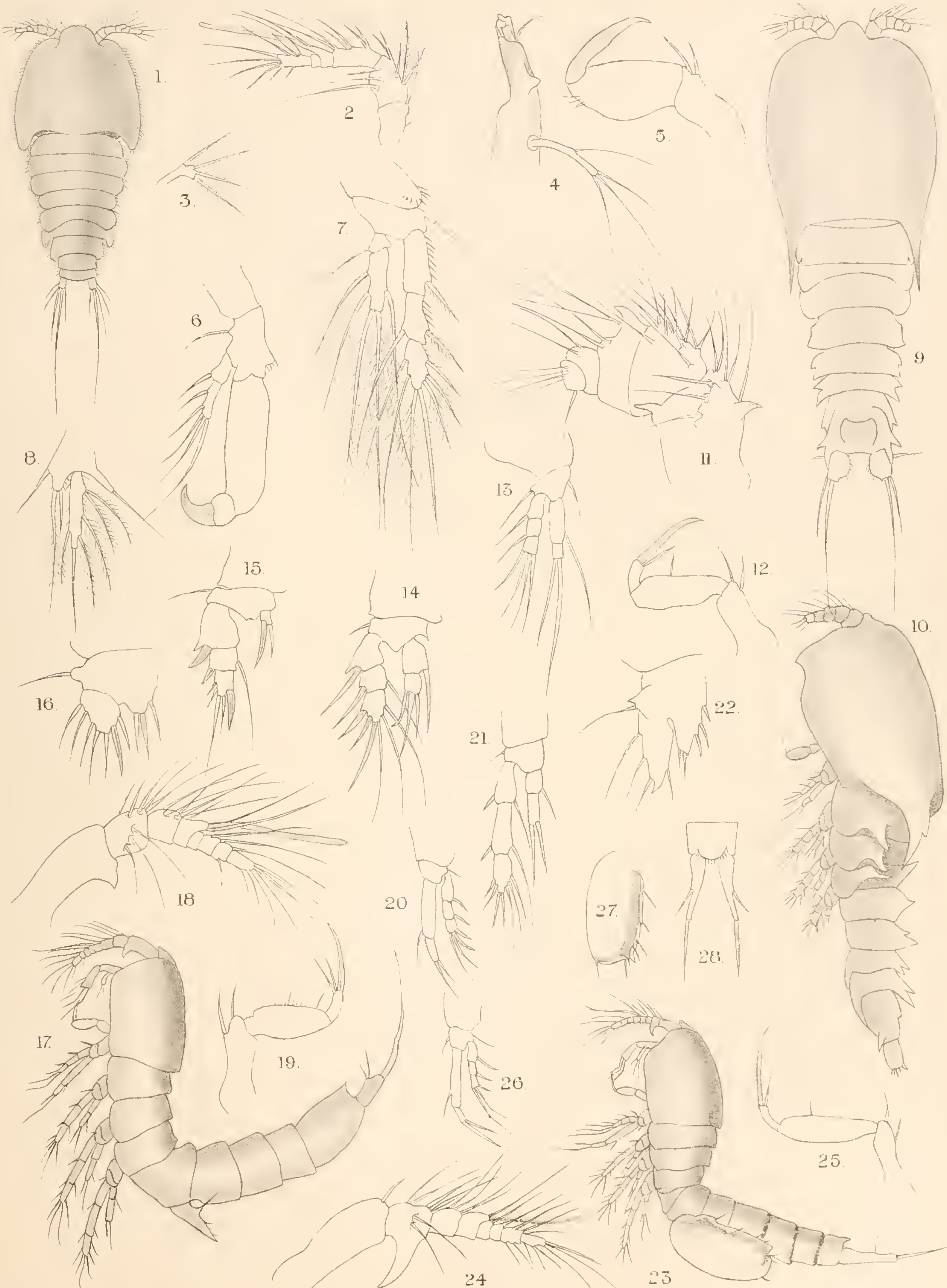
Figs 1-10. Parastenhelia hornelli Figs. 11-23. Ceylonia aculeata.



Andrew Scott del.   M'Farlane & Erskine Lith Edin^r

FIGS 1-8, LAOPHONTE HIRSUTA. FIGS 9-16, LAOPHONTELLA TYPICA

FIGS 17-22, TETRAGONICEPS DUBIA FIGS 23-28, TETRAGONICEPS MINOR.

Andrew Scott, del.

Figs 1-10, Dactylophusia dentata
Figs. 19-24, Dactylophusia hirsuta

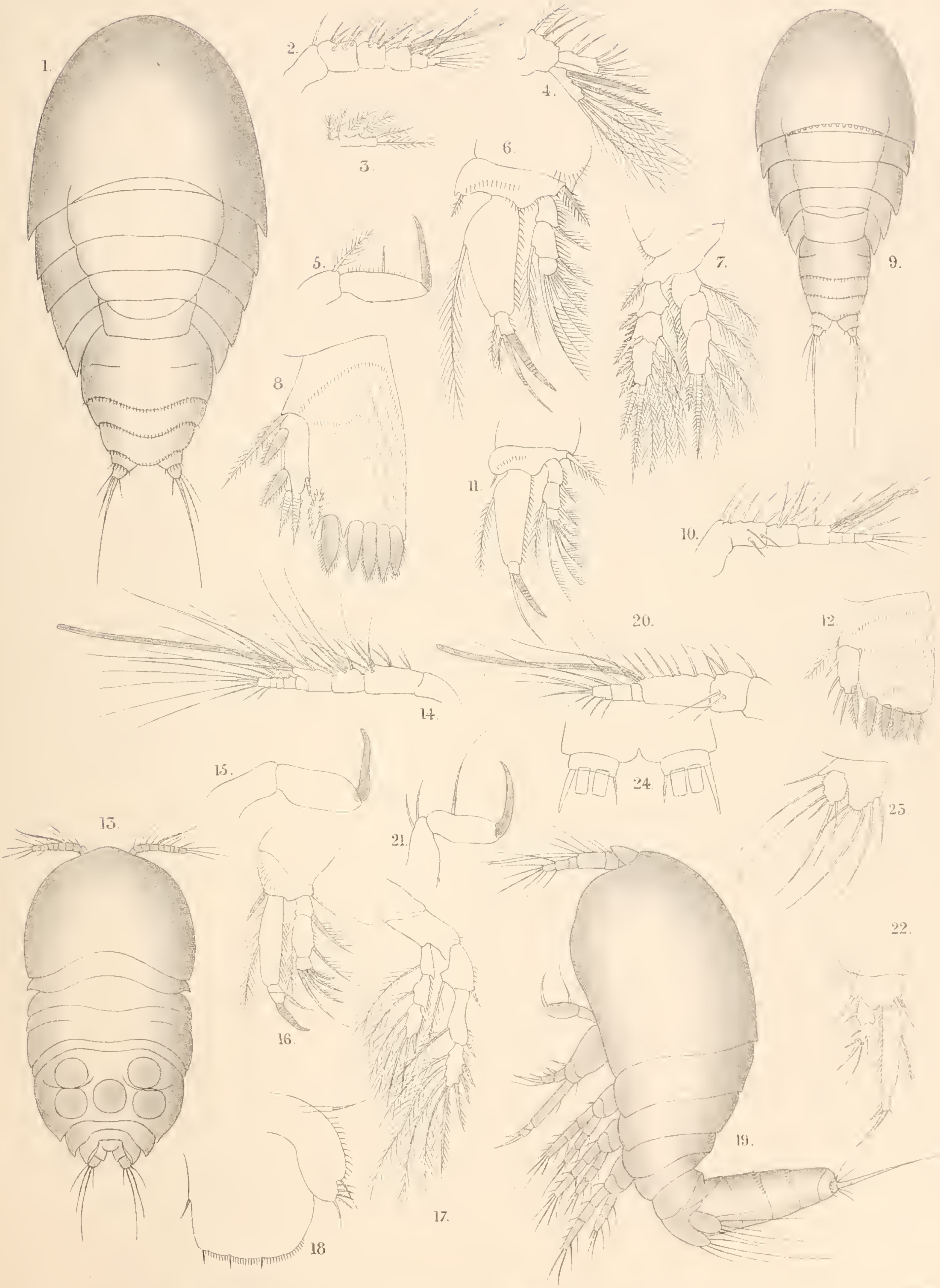
Figs 11-18, Dactylophusia havelocki.
Figs 25-32, Dactylophusia ceylonica

Irew Scott, del.

M'Farlane & Erskine Lith Edin.

Figs 1-7, Dactylophusia hamiltoni. Figs. 8-14, Parastenhelia similis

Figs 15-18, Stenhelia knoxi. Figs. 19-24, Dactylophusia robusta



Andrew Scott, del.

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Figs 1-8, Dactylophusia laticaudata

Figs. 13-18 Dactylophusia platysoma.

Figs 9-12 Dactylophusia æmula.

Figs. 19-24, Pseudothalestris imbricata, *Brady.*

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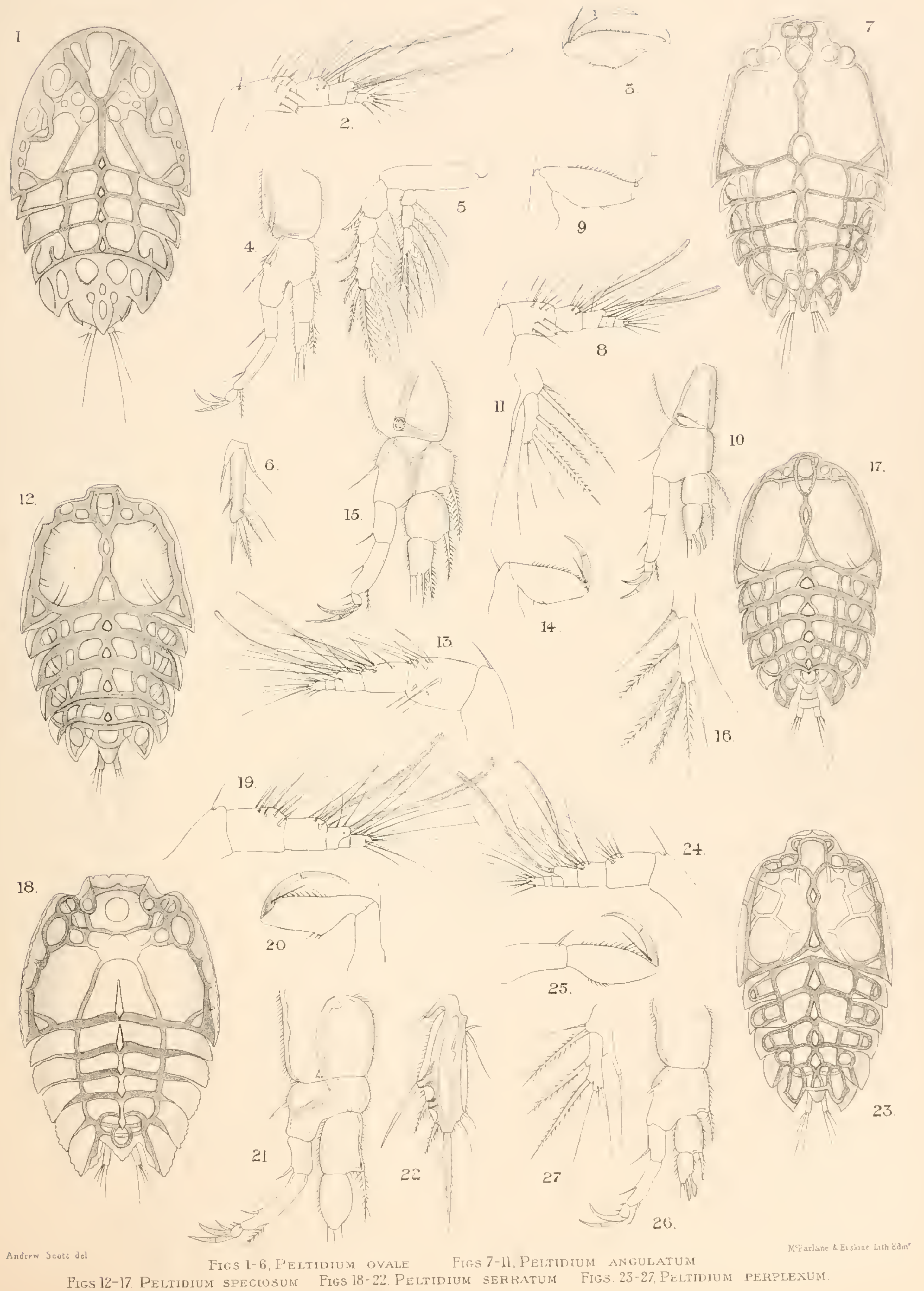
Figs. 1-10, Porcellidium fimbriatum, Claus. Figs. 11-14, Porcellidium brevicaudatum.
Figs. 15-18, Porcellidium acuticaudatum. Figs. 19-22, Porcellidium ravanæ.



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FIGS 1-6, PELTIDIUM OVALE FIGS 7-11, PELTIDIUM ANGULATUM
FIGS 12-17. PELTIDIUM SPECIOSUM FIGS 18-22. PELTIDIUM SERRATUM FIGS. 23-27, PELTIDIUM PERPLEXUM.

Andrew Scott, del.

Figs. 1-11, Pseudanthessius maximus. Figs. 12-18, Pseudanthessius chelifer.
Figs. 19-23, Pseudanthessius gracilis, Claus. Figs 24-30, Pseudanthessius concinnus.

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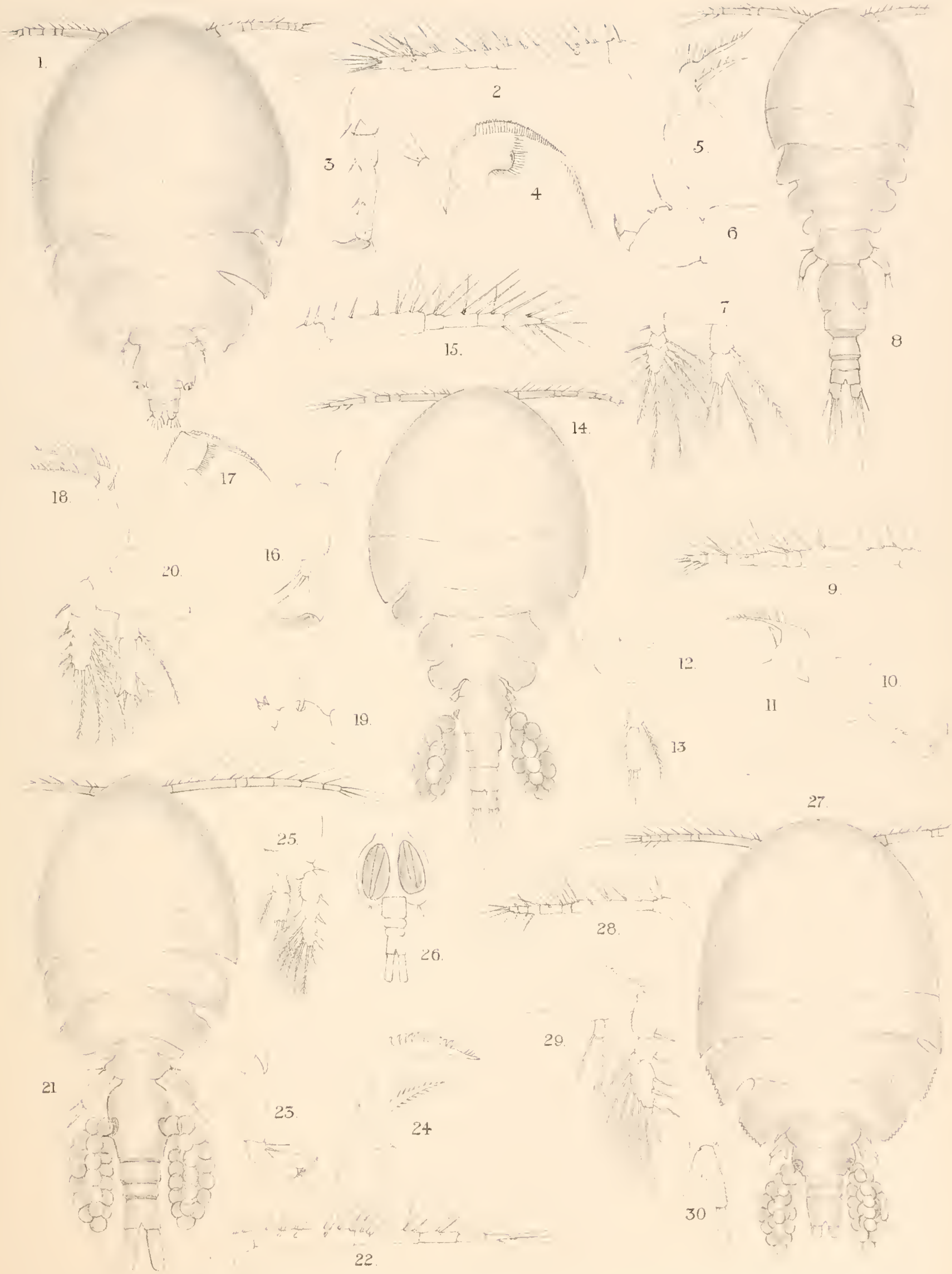
FIGS 1-9 LICHOMOLGUS GRACILIS. FIGS. 10-17, LICHOMOLGUS IEVERSI.
FIGS. 18-24, LICHOMOLGUS BUDDHENSIS. FIGS. 25, 26, LICHOMOLGUS LANKENSIS. FIGS. 27-34, LICHOMOLGUS SIMPLEX.



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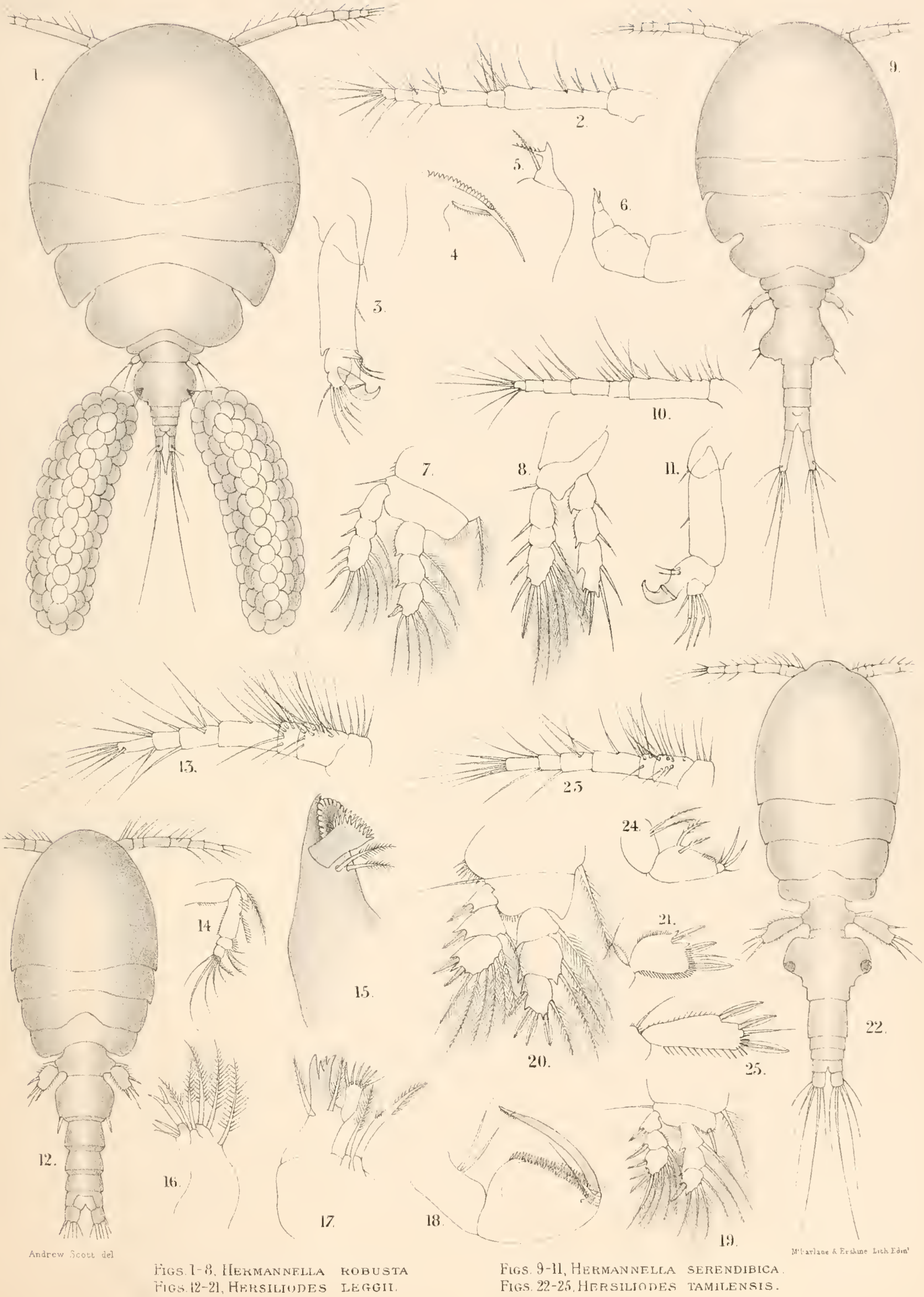
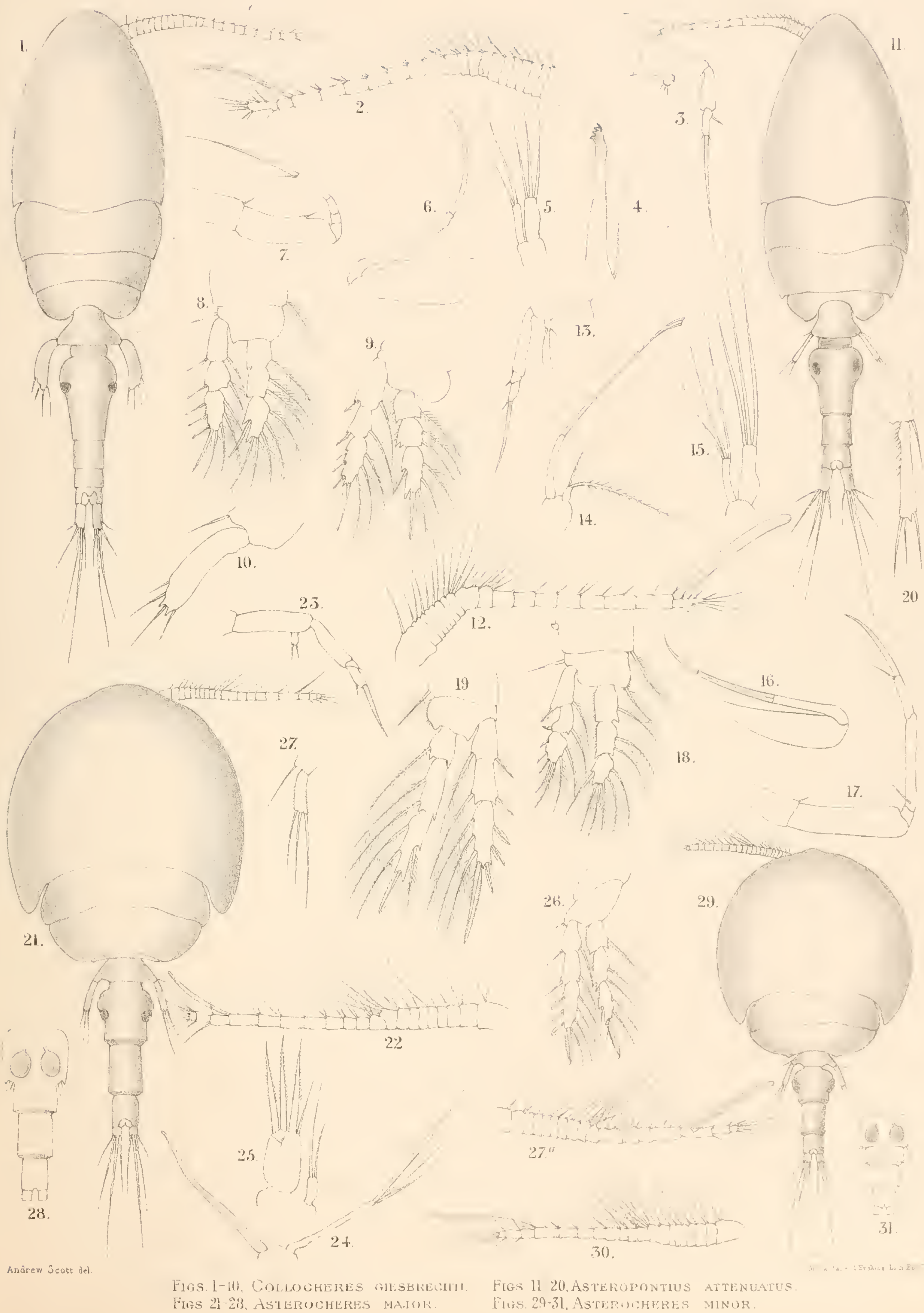
FIGS 1-7, PARALICHOMOLGUS CURTICAUDATUS. FIGS. 8-13, LICHOMOLGUS ELEGANS.
FIGS. 14-20, LICHOMOLGUS ROBUSTUS FIGS. 21-26 LICHOMOLGUS GIGAS FIGS 27-30 LICHOMOLGUS DENTIPES



FIGS. 1-8, HERMANNELLA ROBUSTA.
FIGS. 12-21, HERSILIODES LEGGII.
FIGS. 9-11, HERMANNELLA SERENDIBICA.
FIGS. 22-25, HERSILIODES TAMILENSIS.



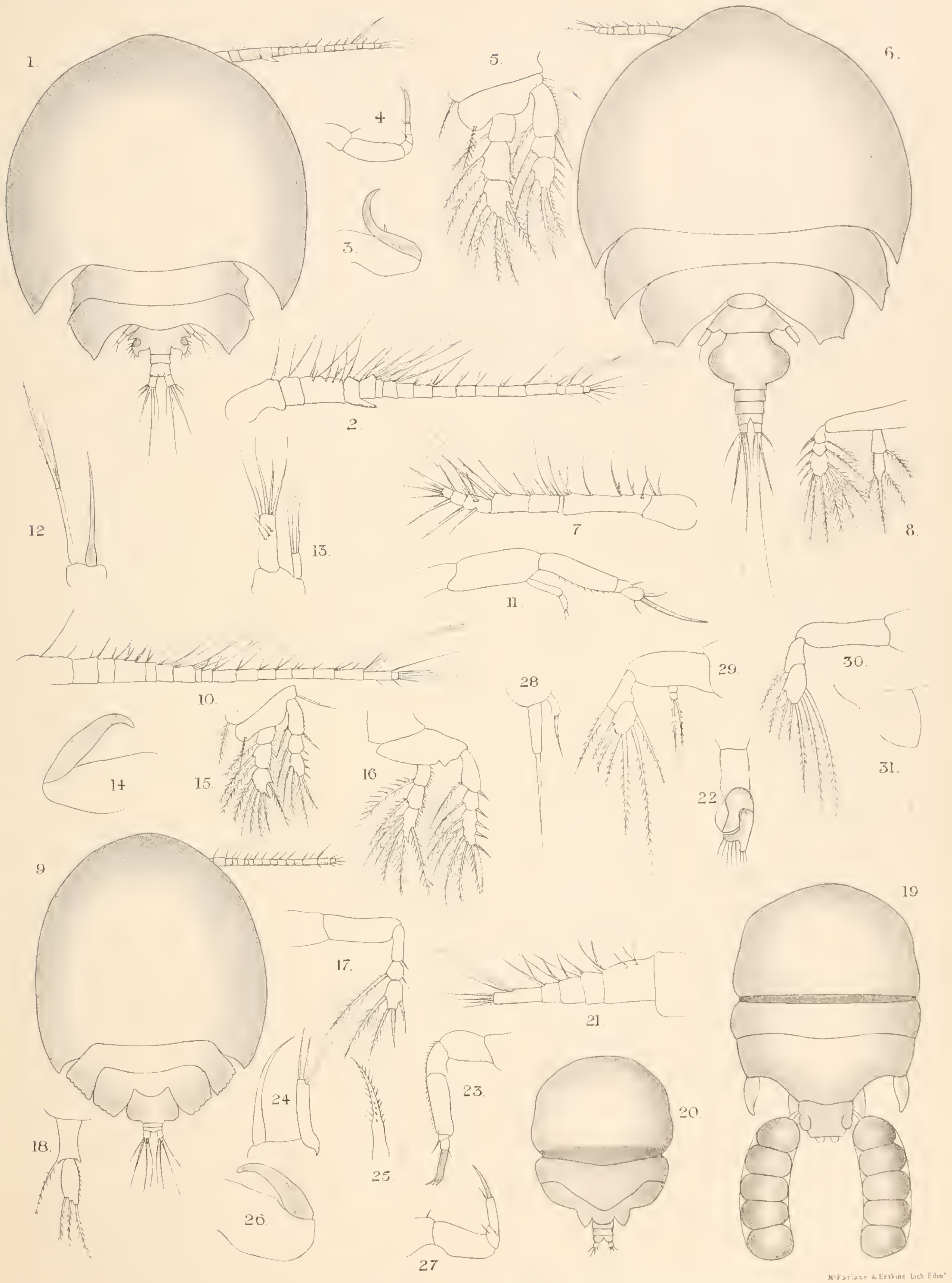
Andrew Scott del.

Figs. 1–10, Collocheres giesbrechti. Figs 11–20, Asteropontius attenuatus.
Figs 21–28, Asterocheres major. Figs. 29–31, Asterocheres minor.

Andrew Scott, del.

M Farlane & Erskine Lith Edin

Figs. 1-10, Asteropontius typicus.
Figs. 11-20, Asterocheres manaarensis.
Figs. 21-29, Lepeopsyllus typicus.
Figs. 30-33, Lepeopsyllus ovalis.



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Figs. 1-5, Doropontius denticornis.
Figs. 9-18, Cletopontius serratus.
Figs. 6-8, Paralichomolgus longicaudatus.
Figs. 19-31, Stephopontius typicus.

1076

REPORT

TO THE GOVERNMENT OF CEYLON

ON THE

PEARL OYSTER FISHERIES

OF THE

GULF OF MANAAR,

BY

W. A. HERDMAN, D.Sc., F.R.S., P.L.S.,
Professor of Natural History in the University of Liverpool.

WITH SUPPLEMENTARY REPORTS

UPON THE

MARINE BIOLOGY OF CEYLON,

BY OTHER NATURALISTS.

PART II.

PUBLISHED AT THE REQUEST OF THE
COLONIAL GOVERNMENT
BY
THE ROYAL SOCIETY.

LONDON:
1904.

1077

CONTENTS OF PART II.

PEARL OYSTER REPORT.

SUPPLEMENTARY REPORTS.

PREFACE.

Part I. of this work was issued in November, 1903, and contained the following sections :—

(a) In the Pearl Oyster Report proper : (1) the Introduction ; (2) the Narrative ; (3) the Description of the Pearl Banks ; (4) Observations on the Sea ; and (5) Observations and Experiments on the Life-History and Habits of the Pearl Oyster ;

(b) In the series of Supplementary Reports : I., the Sea-bottoms ; II., the Marine Algæ ; III., the Gephyrea ; IV., the Polyplacophora ; V., the Holothurioidea ; VI., the Cephalochorda ; and VII., the Copepoda.

Along with that volume, I submitted to the Government of Ceylon a type-written section* dealing with practical recommendations as to the conduct of the inspections and fisheries, and as to the best means of conserving and exploiting the pearl banks. These recommendations, when revised and added to if necessary, as the result of further observation and experiments, will be given as the final section of the last volume of this Report.

In January, 1904, Mr. James Hornell was appointed Marine Biologist to the Ceylon Government, and soon after the further duties of Inspector of the Pearl Banks were added to his office. Facilities have now been given to him for carrying out the work, both experimental and executive, recommended in this Report, and he is at the present time engaged in testing the effects, under different conditions, of lifting oysters (both young and old) in bulk, by means of dredges. The transplantation of young oysters will also engage his attention, and the first results of his labours will probably be available for use before this Report is concluded.

In the present Part II., after a discussion of the past history of the principal "paars," Mr. Hornell and I give our account of the Anatomy of the Pearl Oyster, and that is followed by a notable section on the Parasites, contributed by Mr. Shipley and Mr. Hornell.

The Entozoa of the Pearl Oyster are of practical importance from two points of view : (1) because of their effect as parasites when present in sufficient numbers to

* This has since been printed by the Government of Ceylon as a 'Sessional Paper,' Colombo, 1904.

cause lesions in the body, and (2) because some of them provide the centres ot stimulation which give rise to pearl-production. The last is by far the more important, and at an early period of our work in Ceylon it engaged the attention of Mr. HORNELL and myself.

On the Cheval Paar, in March, 1902, we satisfied ourselves that the "orient" pearl, free in the tissues of the pearl oyster, is deposited around a cyst containing a Cestode larva, and preliminary notices to this effect were published in my Royal Institution lecture of March 27, 1903,* and at the Southport meeting of the British Association in September, 1903.

The Cestode larvæ were found in several stages, and the later ones, at least, clearly belonged to the genus *Tetrarhynchus*. Mr. HORNELL then found later Tetrarhynchid larvæ in the bodies of File fishes (*Balistes*) which, we were able to show, sometimes devour the pearl oysters. Finally, Mr. HORNELL'S discovery at Trincomalee in November, 1903, of an adult *Tetrarhynchus* in the intestine of a Sting-ray (*Tæniura melanospilos*, BLKR.), which had freshly-swallowed *Balistes* in its stomach, led us to suppose that the Cestode which passed its youngest stage in the pearl oyster became transferred as a later larva to the File-fish and attained maturity in the Sting-ray. This view was expressed tentatively in the Introduction to Part I. and more definitely in a letter to 'Nature' of November, 1903. Mr. SHIPLEY, however, who kindly consented to collaborate with Mr. HORNELL in working up these and the other parasites for the joint report which appears in this volume, from a further microscopic examination of the specimens sent home by Mr. HORNELL, has come to the conclusion that these various larvæ differ too much in their minute characters to be placed as stages in the one life-history. He regards them as separate animals, and although it is highly probable that the sequence of hosts—Pearl-oyster, File-fish, Sting-ray—will prove to be very much as was indicated in Part I., still the pearl-producing parasite has apparently not yet been traced through all its stages to the adult condition : further field-work still lies before Mr. HORNELL.

Our original statement that the nucleus in the case of the "orient" pearls is a Cestode larva holds good, and it is interesting to find that this observation has been independently corroborated by M. G. SEURAT, working alone in his laboratory at Rikitea, in the island of Mangareva (Gambier Archipelago). The oyster on which SEURAT worked was a *Meleagrina*, and the Cestode parasite he found is, according to GIARD,† an *Acrobothrium*, or some allied form. It is possible that some of our Ceylon Pearl Oyster parasites may also belong to the genus *Acrobothrium*, although the more advanced ones are certainly Tetrarhynchids.

It is probable that Mr. SHIPLEY and Mr. HORNELL will be able to contribute a further paper on these parasites in the last volume of this Report.

* See also 'Nature' for April 30, vol. LXVII., p. 620.

† 'Comptes Rendus Soc. Biol.,' Paris, Nov. 6, 1903, vol. LV., p. 1222.

The Supplementary Reports in the present Part call for no special remark. I am greatly indebted to my friends the authors for their kindness in helping me to make these contributions to our knowledge of the Biology of the Ceylonese Seas.

Mr. Andrew Scott asks me to state that *Ceylonia*, which was described as a new genus in the Report on the Copepoda (Part I., p. 265), is, he now considers, identical with Claus's genus *Jurinia* ('Die Copepoden-Fauna von Nizza,' 1866). As, however, the name *Jurinia* was pre-occupied when Claus used it, *Ceylonia* must stand as the name of the genus. Our species from the Indian Ocean (*C. aculeata*, Thomp. and Scott) is distinct from Claus's Mediterranean form, which now becomes *Ceylonia armata* (Claus).

The third volume will, so far as can be foreseen, be ready about the end of this year. It will contain Professor Dendy's Report upon the Sponges, part of which is in type, Professor J. Arthur Thomson's Alcyonaria, Mr. E. T. Browne's Medusæ, Mr. G. C. Bourne's Corals, Dr. Edith Pratt's Sarcophytons, Mr. A. Scott's Ostracoda, Mr. Farran's Nudibranchiata, and possibly some other papers on the remaining groups of Crustacea and Mollusca, along with further instalments of the Pearl Oyster Report by Mr. Hornell and myself.

A fourth volume early in 1905, containing accounts of the remaining groups of animals, articles on pearl-formation and on Mr. Hornell's recent inspections and our final Recommendations as to the conservation of the Banks, will, it is hoped, complete the Report.

W. A. HERDMAN.

The University, Liverpool,
July, 1904.

REPORT ON THE PEARL OYSTER FISHERIES OF THE GULF OF MANAAR.—PART II.

HISTORY OF THE PRINCIPAL PEARL BANKS.

It has been shown in the Introduction to Part I. of this Report (p. 4) that the thirty-six fisheries of the nineteenth century took place on nine paars only out of the possible twenty-five to thirty, which is enough in itself to suggest that these banks are of very different values economically. In the section describing the physical features of the pearl banks of the Gulf of Manaar (Part I., p. 99), a classification of the ground was made into :—

(1.) Those paars, such as the Jagerboom, Kallatidel, Aripu, and Anaivelundan, which are at present practically worthless from an economic point of view.

(2.) Some, such as the Periya Paar, which might be used as valuable sources of supply of young brood oysters for transplantation, but cannot be relied upon to yield a fishery.

(3.) Those, such as the great Cheval Paar with its various sub-divisions, the North and South Modragams, the Periya Paar Kerrai, and the Muttuvaratu Paar, which are valuable and reliable grounds upon which most of the successful fisheries of the past century have taken place.

Other paars, such as those lying off Chilaw and Karativo, are less reliable, but may be valuable on occasions; and it must be borne in mind that the whole area is possible paar-ground which might at any time become productive, and consequently the periodic inspections should never be limited to the better known regions. But, as some account has already been given in Part I. of the leading physical and biological features of all the paars, it will suffice now to direct attention to the past history, so far as it can be ascertained, of those that are really of economic importance—especially those which have yielded fisheries and are shown in the accompanying table.

THE CEYLON PEARL FISHERIES from 1801 to 1904 inclusive, showing the Banks that were fished on each occasion. (Compiled from the Government Records at Colombo.)

Cheval Paar.	North Modragam.	South Modragam.	Periya Paar Kerrai.	Periya Paar.	Kondatchi Paar.	Karativo Paar.	Muttuvaratu Paar.	Chilaw Paar.
—	—	—	—	—	1801	—	—	—
—	—	—	—	—	—	—	—	1803
1804	—	—	—	—	—	—	—	—
1806	—	—	—	—	—	—	—	—
1808	—	—	—	—	—	—	—	—
1809	—	—	—	—	—	—	—	—
1814	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1815
1816	—	—	—	—	—	—	—	—
1820	—	—	—	—	—	—	—	—
—	1828	1828	—	—	—	—	—	—
1829	—	—	—	—	—	—	—	—
1830	—	—	—	—	—	—	—	—
1831	—	—	—	—	—	—	—	—
—	—	—	—	—	—	1832‡	—	—
—	—	—	1833†	—	—	—	—	—
—	—	—	1835	—	—	—	—	—
1836	1836*	—	1836	—	—	—	—	—
1837	—	—	—	—	—	—	—	—
1855	—	—	—	—	—	—	—	—
1857	—	—	—	—	—	—	—	—
1858	—	—	—	—	—	—	—	—
1859	1859	—	—	—	—	—	—	—
—	1860	1860	—	—	—	—	—	—
1863	—	—	—	—	—	—	—	—
1874	—	—	—	—	—	—	—	—
1877	1877	—	—	—	—	—	—	—
—	—	—	—	1879	—	—	—	—
1880	—	—	—	—	—	—	—	—
1881	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	1884
1887	1887	—	—	—	—	—	—	—
1888	1888	1888	—	—	—	—	—	—
—	—	—	—	—	—	1889	1889	—
—	—	—	—	—	—	1890	1890	—
—	—	—	—	—	—	1891	1891	—
1903	—	—	1903	—	—	—	—	—
1904	—	—	—	—	—	—	—	—
Totals: 25	7	3	4	1	1	4	3	3

* Captain DONNAN marks this fishery in his MS. chart as South Cheval Paar.
† Captain DONNAN marks this fishery in his MS. chart as North Cheval Paar.
‡ Recorded as "near the Isle of Cardieu, off Karativo Island."

The greatest of these, both in extent and in value, is the Cheval Paar with its outliers, the Periya Paar Kerrai to the north-west and the two Modragams to the south-east. Next in importance is the Muttuvaratu Paar, lying off Karativo Island;

and the others to be considered here, for different reasons, are the Periya Paar, Kondatchi Paar, Karativo Paar, the Dutch Modragam, and the Chilaw group.

The accompanying sketch-map (fig. 1) shows the approximate relative positions of these, the more important paars in the Gulf of Manaar. Charts showing the topography of the region on a larger scale were given in Part I.

Fig. 1. Sketch-map showing the principal pearl-oyster banks in the Gulf of Manaar. C., Chilaw Paar; Ch., Cheval Paar; K., Dutch Modragam and Karativo Paars; M., Modragam Paars; Mu., Muttuvaratu Paar; P., Periya Paar; P.K., Periya Paar Kerrai.

I. CHEVAL PAAR.*

The map published by BALDÆUS in 1672 shows, from the relative positions of prominent features of the shore-line, that the pearl banks then fished off Aripu correspond with the Cheval Paar of the present day. This establishes the permanence of the Cheval Paar in its general position and outline for over two centuries, and we have native records of important pearl banks in that region from much earlier times. No doubt, over-washes of sand have, from time to time, obliterated portions of the oyster-bearing ground, and at other times the scouring action of tides and storms may have extended the area of the hard "paar"; but notwithstanding these vicissitudes, we still have, as in early Sinhalese times, a group of more or less continuous banks

* For an account of the leading physical and biological characters of the Cheval Paar, see Part I., p. 100.

lying off Aripu, in the centre of the bight of Kondatchi, and yielding the most important fisheries now as they did in the days of the Tamil Queen Alliyarasani. The list of the fisheries given on p. 2 shows that the Cheval has given as many fisheries as those of all the other paars together.

There is some uncertainty in regard to the early records of the nineteenth century. The Cheval and Modragam banks are apparently sometimes entered as the Aripu paars or the paars off Aripu; the subdivisions, such as North Cheval, South-East Cheval, &c., have not a uniform nomenclature in the reports of different Inspectors, and the Government records do not agree in all respects with Captain DONNAN'S MSS. and charts to which we have had access. These discrepancies do not affect, however, any important points from which conclusions are drawn in this Report.

RECORD* OF THE CHEVAL PAAR.

Mar., 1802.—Whole Cheval covered with oysters 4 to 5 years old.

Oct., 1802.—Sample of 1668 oysters $5\frac{1}{2}$ to 6 years old lifted.

Mar., 1804.—Fishery (yielded 770,202 rupees).

,, 1805.—Oysters 5 to 6 years old on east side. Sample lifted.

,, 1806.—Fishery (yielded 412,842 rupees).

,, 1808.— ,, ,, 842,577 ,,

,, 1809.— ,, ,, 272,463 ,,

Oct., 1809.—Very few oysters on Aripu Paar and on Cheval, 6 fathoms. On South-east Cheval oysters 6 to 7 years old. On the North, 6 fathoms, 10 to 70 oysters at a dive. On the South, 7 fathoms, young oysters 2 years old. In 6 fathoms, on Koddai Paar (west end of South Cheval), oysters 1 year old. On the south-west, in 9 fathoms, oysters 3 years old.

Nov., 1810.—Oysters 2 to 4 years old of "Koddai" and "Cheval" kind. On South and South-west Cheval abundance of oysters 2 to 4 years old. On the north end, a very small spot, 5 to 6 years old. Sample lifted.

,, 1811.—Oysters 4 to 5 years old on East Cheval. A few 1 year old on the north-east side of the Aripu Paar. Abundant, 3 to 4 years old, on North-east Cheval. On West Cheval abundant oysters of "Kottapakku" variety. Pearls from 943 oysters valued at Rs. 8.93.

Mar., 1813.—On the South-east Cheval oysters 5 to 6 years old, in 6 fathoms, and a great proportion 6 to 7 years old, with many dead shells. The bank measures 2 × 2 miles and should be ready for fishing in Mar., 1814. On the East Cheval abundant oysters 6 years old. On the North-east Cheval, on a bank measuring 2 × 1 miles, abundant oysters 5 and 6 years old and

* Condensed from all the records at our disposal—Inspectors' reports and other papers by Captain DONNAN, Sir WILLIAM TWYNAM, and others, MSS. and charts in the Government Offices at Colombo, and other information obtained by Mr. HORNELL and myself.

some dead shells (supposed to be the same oysters as those found on the Periya Paar Kerrai in 1810).

Oct., 1813.—Samples lifted from Koddai Paar 6 and 7 years old, and from Kottapakku Paar 5, 6, and 7 years old, and from South-east and North-east Cheval 7 years old.

Mar., 1814.—Large fishery (yielded over 1,000,000 rupees to Government).

Oct., 1815.—Very few oysters, 1 year old, on Koddai Paar (centre of Cheval). On Kottapakku Paar (west of Cheval) oysters 6 years old, and some on North-east Cheval; both the latter recommended for fishery.

Mar., 1816.—All oysters dead. No fishery except a few from Kallatidel Paar. [Small fishery on Cheval and Modragam, *fide* VANE.]

,, 1820.—Oysters 4 years old fished (yielded 30,410 rupees).

,, 1821.—Remainder dead.

,, 1826.—Abundant oysters too young for pearls.

Oct., 1826.—5 year old oysters and smaller ones.

Mar., 1829.—Fishery on North-west Cheval (yielded 382,737 rupees).

,, 1830.— ,, South-east ,, ,, 222,564 ,,

Oct., 1830.—Sample lifted.

Mar., 1831.—Fishery on North-west Cheval (yielded 293,366 rupees).

Nov., 1834.—Oysters in 7 fathoms.

Mar., 1835.—Oysters 4 and $4\frac{1}{2}$ years old, recommended for fishing next March. Part of Cheval fished, along with Periya Paar Kerrai.

,, 1836.—Fishery on Central Cheval and Koddai Paar (South Cheval) (yielded over 160,000 rupees).

,, 1837.—Fishery on North Cheval (yielded 106,312 rupees).

Nov., 1840.—Oysters $1\frac{1}{2}$ to 3 years old.

,, 1851.— ,, 1 year old, on South-west Cheval, in a healthy state.

Mar., 1853.—Large bed of oysters on South-west Cheval (2×1 miles). Oysters "4 or 5 years old."

,, 1854.—Oysters on South-west Cheval healthy, but scattered and not very plentiful.

Nov., 1854.—Sample taken up from South-west Cheval and fishery recommended. Younger oysters $1\frac{1}{2}$ to $2\frac{1}{2}$ years old found to the west.

Mar., 1855.—South-west Cheval fished (yielded 109,220 rupees).

,, 1856.—Oysters on northern part remaining from last year said to be $5\frac{1}{2}$ years old. Oysters 3 years old to south.

,, 1857.—North-west Cheval fished (rather too young, over 32,000,000 oysters yielded only 203,633 rupees).

Nov., 1857.—Many dead shells.

Mar., 1858.—North-west Cheval fished (over 16,000,000 oysters yielded 241,200 rupees).

Nov., 1858.—Oysters 6 months old all over Cheval.

Mar., 1859.—North-west Cheval fished (3,000,000 oysters yielded 194,481 rupees). Oysters 2 years old on South-east Cheval. Oysters 1 year old on South-west Cheval.

Nov., 1860.—Abundant oysters 3 years old on South-west Cheval.

,, 1861.—Sample from South-east Cheval taken up and estimated at 5 years. Considered too young to fish next year [!].

Mar., 1862.—Oysters plentiful, but many dead shells to south.

Nov., 1862.—South-east Cheval inspected and sample lifted. Oysters fine and healthy looking and full grown. On the north-east the oysters lie thick and healthy, but are younger than on the south-east.

Mar., 1863.—South-east Cheval fished (over 11,000,000 yielded 510,178 rupees), oysters dying off. Oysters on South-west Cheval. Ground covered with large fishes (Ray) when fishery began.

Oct., 1863.—Sample lifted from South-west Cheval and fishery recommended for March next; many dead shells found. The oysters are of the same brood as those fished in March, 1863. No young oysters on any part of Cheval.

Mar., 1864.—All dead. Possibly some eaten by Rays, but the oysters were old.

Nov., 1865.—Bare of oysters.

Mar., 1866.—No oysters.

,, 1867.—Abundant young oysters (? "false-spat," *fide* HORNELL) attached to weed on grounds fished in 1858, 1859, and 1863, but only weed on fishing grounds of 1864 and 1859.

Dec., 1868.—Weed and oysters gone. No young ones. North and north-east much covered with sand. South-west and south (Koddai Paar) clear of sand, but covered with sponge.

Oct., 1869.—No oysters on usual grounds, but a patch 2 or 3 years old to eastward. Not enough to fish.

Mar., 1870. Oysters still there. 9 patches of young oysters 1 to 3 months old on Cheval. To west nothing but sand and rock.

April, 1871.—Two patches 1 year old on south-west and north-west. A few oysters 4 years old on patch found in 1869.

Mar., 1872.—Bed of oysters 2 to 3 years old from south-west to north-west. None on south-east.

,, 1873.—Oysters in same position as last year. Patch of young oysters a month or two old to extreme north-west.

Dec., 1873.—Oysters have begun to die off. Small fishery recommended for next March. Valuation Rs. 33.33 per thousand. Young oysters to north-west have all disappeared.

Mar., 1874.—North-west Cheval fished (yielded 101,199 rupees). Extensive deposit of young oysters on South-west and South-east Cheval, extending to south part of Modragam.

Mar., 1875.—Large bed of about 10,000,000 healthy oysters, 2 years old, on South-east Cheval. Smaller bed to east, believed to be of same age. On ground fished last year very few oysters and 40 per cent. dead shells.

„ 1876.—On South-east Cheval a few oysters scattered over a large area. Patch to the eastward now joined on. Very few dead shells. On West and North-west Cheval a very large number of small oysters 6 months old. Rock-fish [*Balistes*] eating the oysters.

Nov., 1876.—On South-east Cheval a bed of 3,000,000 oysters and some dead shells. Pearls valued at Rs. 26.70 per thousand. Oysters supposed to be 4 years old. Fishery recommended for next March. Young oysters on West and North-west Cheval still abundant.

Feb., 1877.—Oysters dying out.

Mar., 1877.—Fishery on East and South-east Cheval (yielded 184,591 rupees).

„ 1878.—Large bed, 3 × 1½ miles, of 3-year old oysters, thickly spread and firmly attached. Those on the south half are the oldest and should be fished first. To the south-east a small bed of oysters 9 months old. A small patch left over from fishery on East Cheval seemed healthy, and the pearls were more valuable than last year.

Nov., 1878.—Oysters still abundant, but not grown much.

„ 1879.—Bed of about 66,000,000 oysters 4½ years old, extending about 3 miles north-north-west and south-south-east, including the portions fished in 1831, 1835, 1855, 1857, 1858, 1859, 1874, and that which failed in 1864. These oysters seem to require another year. They are mixed with younger ones, probably from the patch found in 1878 to the south-east, which had disappeared. On the South-east Cheval 1 square mile was covered with oysters 3 months old, firmly attached. Samples from the south-east of the bed of older oysters were valued at Rs. 9.39 per thousand, and those from the north-west at Rs. 6.43. The south-east portion of this bed is recommended for fishing, as there are so many oysters.

Mar., 1880.—Fishery on North-west Cheval (over 35,000,000 oysters yielded only 200,152 rupees).

Dec., 1880.—On the North-west Cheval an extensive bed of 58,000,000 oysters 5½ years old. Valuation Rs. 21.37 per thousand. Immense numbers of young oysters, 3 months old, on bed fished last season, but the young oysters on the south-east, referred to in report of 1879, are dying off.

Mar., 1881.—Splendid fishery on North-west Cheval Paar (27,000,000 oysters yielded 599,533 rupees), but in lifting sample in February before the fishery the oysters were found to have thinned 40 per cent. since November.

Mar., 1882.—No oysters on banks off Aripu.

,, 1883.—No oysters.

,, 1884.—Oysters about 3 months old on East and West Cheval.

,, 1885.—East and West Cheval covered with a most extensive deposit of young oysters 18 months old. Shoals of Rays were seen, but have apparently done no damage.

,, 1886.—Large beds on east and west flourishing. Oysters $2\frac{1}{2}$ years old. On the east 202,000,000 and on the west 79,000,000. Loss since last inspection probably due to overcrowding. No damage seems due to Rays.

,, 1887.—Oysters $3\frac{1}{2}$ years old—healthy. On east side 195,000,000. On west side 38,000,000 and dead shells apparently destroyed by Rays. North-east Cheval fished (yielded 292,430 rupees).

Nov., 1887.—Extensive beds of oysters, 4 years old, all over. On west side the old oysters are covered with young ones 3 months old.

Feb., 1888.—Nearly all the old oysters gone from the bank. Possibly caused by currents. But found and fished to the east of the East Cheval (22,000,000 oysters yielded 804,247 rupees). West side stocked with young oysters.

Nov., 1888.—A few old oysters on the east. Young about 15 months old on west. Many dead shells.

,, 1889.—On the West Cheval a thick deposit of young oysters 3 months old. Those found in the same place in November, 1888, are all gone. None on the East Cheval.

,, 1890.—Four patches of oysters 15 months old on west and south.

Mar., 1892.—Bank bare of oysters.

,, 1893.—West side well stocked with oysters, 6 months old, in detached patches. A few small patches on north-east.

,, 1894.—Bare of oysters.

,, 1895.— ,, ,,

,, 1896.—Small patch of oysters, 6 months old, on north-west.

,, 1897.—Bare of oysters.

,, 1898.—A few small patches of oysters, 3 to 6 months old, on south-east.

,, 1899.—The few patches of young oysters found last year on East Cheval have entirely disappeared.

,, 1900.—Very extensive bed of oysters, 3 to 9 months old, on West Cheval 3 small patches of similar oysters on east side.

,, 1901.—Three detached beds on West Cheval. 2 detached beds, $1\frac{1}{2}$ to 2 years old, on East Cheval.

Oct., 1901.—Oysters in abundance, $1\frac{1}{2}$ to 3 years old, on both East and West Chevals, also spat up to 4 months old on North-east Cheval.

Mar., 1902.—Both old (3 years) and young (3 to 6 months) oysters on both East and West Chevals, and also some in the Central area.

Nov., 1902.—Both old (over 3 years) and young (6 to 18 months) oysters abundant on both East and West Chevals. Samples taken.

Mar., 1903.—Fishery on East Cheval (about 46,000,000 oysters, including Periya Paar Kerrai, yielded over 800,000 rupees).

Feb., 1904.—Mr. HORNELL estimated there were 35,000,000 of $4\frac{1}{2}$-year old oysters on the West Cheval. Also many young, about $2\frac{1}{2}$ years old.

Mar., 1904.—Fishery on West Cheval (over 41,000,000 oysters yielded over 1,000,000 rupees).

On looking over this record, although it is obvious that it is incomplete, that some gaps (*e.g.*, 1840 to 1851) occur, that some oysters are mentioned whose first appearance was not noted and others whose fate is not known, still it is possible, in most cases, to trace the history of events and to follow particular broods from year to year. One cannot but feel doubtful as to the accuracy of some of the ages assigned, especially in the case of the earlier records. If the oysters estimated at 5 to 6 years old in March, 1805, were those fished a year later, they must then have been unusually aged. Captain DONNAN considers that most oysters when fished are not more than 5 years old, and I am inclined to agree with him. If the 1805 oysters were really upwards of 5 years, a very serious risk was run in leaving them unfished; and the same remark applies in regard to the oysters estimated at 6 to 7 years in March, 1813, and fished in 1814. It is probable, looking through these and other records, that many beds of oysters have been lost in the past through delay in fishing. Inspectors and Administrators are no doubt tempted to wait by the thought that the older the oysters are the more valuable will be their pearls. An additional year of growth no doubt increases the value greatly, but the chances of death in that final year are also greatly increased. On the whole I am of opinion that 5-year old oysters should never be left unfished. It will be noticed that the reputed 6-year old oysters of October, 1815, apparently died that winter, that the 4-year old oysters of March, 1820, were dead before the following year, that oysters probably 4 years old in December, 1873, had begun to die off, that oysters supposed to be 4 years old in November, 1876, were dying 3 months later, and that the oysters fished on South-East Cheval in March, 1863 (which according to the estimate were 7 years! but I suspect this to be a mistake and that they were not more than 5 years) were dying off, while those of the same brood from the South-west Cheval were found to be all dead in March, 1864. I think it probable that these oysters of the 1863 fishery were those found "6 months old all over Cheval" in November, 1858, and were therefore about 5 years old when fished. If I am right in this estimate, then the "5 years" entered under November, 1861, must be a mistake for 3 years, and in that case the absurdity of the remark "considered too young to fish next year" disappears.

Considering the large number of broods of oysters that have succeeded one another on the Cheval Paar, the catastrophes have been singularly few, and this is important testimony to the reliability and relative safety of this region as a rearing ground, provided it is kept supplied with the necessary young oysters. Omitting those batches which probably died off from being left too long unfished, the only evidence we have of catastrophic disappearances is as follows :—

(1.) Young oysters attached to weed in March, 1867, gone in December, 1868. (Probably due to overwash of sand; but the young spat when attached to weed must always be very uncertain, and may simply have drifted out of the area when the weed rotted or was detached by the next monsoon. Mr. HORNELL has suggested that these were "false spat"—*Avicula vexillum.*)

(2.) The 2 to 3-year old oysters which were greatly diminished in number between March, 1875, and March, 1876. (Probably eaten by carnivorous fishes, such as *Balistes.*)

(3.) The extensive beds of oysters 4 years old in November, 1887, which had nearly all gone in February, but which are said to have been found further to the east during the fishery. (This was no doubt due to currents during the north-east monsoon,* as suggested by Sir WILLIAM TWYNAM.)

(4.) A few patches of small oysters found on East Cheval in 1898 had disappeared in 1899. (Small patches may easily be missed; or the ravages of a few *Trygon*-rays or a shoal of *Balistes* may so far reduce the patch that it is no longer recognisable by a few chance dives. I think it unlikely that muddy water caused by floods in the four rivers of the adjoining coast could, as suggested by Sir W. TWYNAM, produce a serious effect so far out at sea. The winter of 1898–9 was, however, an exceptional one, with heavy rains and strong currents.)

* This is corroborated by Captain DONNAN, who has kindly read the proofs of this section of the Report for me, and who writes (July 22nd, 1904): "I have no doubt whatever that a strong south-south-east current was the cause of the loss of the splendid bed of oysters on the Cheval in 1888. I noticed when I visited the bank in February to lift a sample and buoy off the bank, that the pieces of rock brought up by the divers were covered with byssus, and the divers said no shells, broken or whole, were to be found. I therefore concluded that the oysters must have been swept away by a current. I then asked the man in charge of the "Active," which was on the paar from November as a guard boat, if he had noticed any current after I left the banks in November, and he said, yes, in December when at anchor on the bank he found the current so strong to the south that he was afraid the guard-boat would drag her anchor, and he let go a second anchor—he estimated the current to be running at 4 knots and said it lasted a week. During my inspection of the bank in February, the divers brought up a *Pinna* shell with a number of old oysters on it, and so to try the effect of a current, I had the shell towed alongside the tug "Active," going at a speed of 4 knots. After about an hour's towing, and finding that none of the oysters had dropped off the shell, I had the speed increased to about 5 or 5½ knots, and in about half an hour's time all the oysters had dropped off, leaving their byssus on the *Pinna*; so after that experiment I had no doubt about a current being the cause of the loss of oysters from the Cheval."

None of these cases of disappearance ot oysters present any special difficulty or remain in mystery. All can be accounted for by natural causes which we know to be at work.

As the Cheval Paar is then, under most circumstances, so reliable as a rearing ground, it is important to consider the adequacy of the supply of spat. On looking over the history, we find that there is either direct record or indirect evidence of at least 26 fresh broods of oysters having arisen during the nineteenth century, as follows :—

Spat of 1801 (?).—Fished 1806.
,, 1805 or 1806.—(?) Fished 1809.
,, 1807.—Sampled 1811.
,, 1808.—Fished 1814.
,, 1810.—Fished 1816.
,, 1816.—Died 1821.
,, 1824 or 1825.—Fished 1829, 1830, and 1831.
,, 1831.—Fished 1835, 1836, and 1837.
,, 1838.—No record between 1840 and 1851.
,, 1850.—Fished 1855.
,, 1852.—Fished 1857 and 1858.
,, 1853.—Fished 1859.
,, 1858.—Fished 1863 ; remainder dead 1864.
,, 1867.—Spat on weed disappeared next year.
,, 1870.—Fished 1874.
,, 1873.—Fished 1877.
,, 1875.—Fished 1880 and 1881.
,, 1877.—(?) Fished also in 1881.
,, 1879. } Young oysters which died off.
,, 1880. }
,, 1883.—Fished 1887 and 1888.
,, 1887.—Young oysters which died off.
,, 1889.—No record of these.
,, 1892.—No record of these.
,, 1898.—Young oysters which died off.
,, 1899.—Fished 1903 and 1904.
[,, 1901.—Not yet fished.]

That 26 deposits of spat should have produced 25 fisheries must be considered a good record, and a strong testimony to the economic value and reliability of the bank. Several of the broods, such as that of 1899, have produced more than one fishery; and, on the other hand, some few broods evidently died off at an early age or have remained unrecorded. Although there have been so many fisheries, 25 in a century, and although it takes 4 or 5 years of oyster growth to produce a fishery, still it must not be supposed that the whole of the ground was almost continuously occupied by these successive broods of oysters. The area is so large and varied, and so small a space covered with spat is sufficient to produce later on a fishery, which itself may occupy only a small portion of the paar (see fig. 3), that there must often have been wide extents of ground uncovered. There is room on the Cheval Paar for many beds of oysters of several different ages to flourish simultaneously. It is probably a very rare occurrence for the whole region to be naturally covered by oysters young or old, and it is this that affords a valuable opportunity for artificial operations. If young oysters can be obtained from other less reliable paars, the rearing ground of the Cheval ought never in the future to be left unoccupied. As soon as possible after an area has been cleared by a fishery, it ought to be re-stocked by young oysters transplanted from the Periya or other outlying paars, so as to keep up, if possible, a constant series of broods coming to maturity in succession.

Fig. 2. Proposed culture areas recommended for the Cheval Paar and Periya Paar Kerrai.

In the following table the fisheries, since the beginning of the nineteenth century, have been assigned to their respective subdivisions of the Cheval, and it must be remembered that each of these is an area of at most perhaps a couple of square miles, capable of containing many millions of oysters and of yielding a profitable fishery. Yet several, if not most of these subdivisions, have lain either wholly or in part vacant in most years, and therefore, profitable as the Cheval Paar has been, there can be little doubt but that by such a system of cultivation as was outlined in Part I. of this Report, and will be elaborated in detail in the Final Recommendations, it could be rendered more profitable still. The diagram (fig. 2), planned by Mr. Hornell, shows the relative positions and names of the subdivisions referred to. These we would propose as culture areas, nearly all of which might be extended and improved by—

(1) Dredging up and removing injurious and competing organisms, and

(2) Laying down suitable clean hard materials such as broken tiles and stone, dead coral and shells as culch, to give a foothold to the oysters.

TABLE OF THE SUBDIVISIONS OF THE CHEVAL PAAR WHICH HAVE YIELDED FISHERIES.

The Nomenclature of the Subdivisions is that given in fig. 2.

		Totals.
Region undefined	1804, 1806, 1808, 1809, 1814, 1816, 1820	7
North Cheval	1833, 1835, 1887, 1903	4
North-east Cheval. . . .	1887, 1888, 1903	3
Mid East Cheval	1837, 1888, 1903	3
South-east Cheval. . . .	1877, 1888, 1903	3
South Cheval	1829, 1830, 1836, 1837, 1858, 1863, 1877, 1888	8
South-west Cheval . . .	1855, 1863, 1888, 1904	4
Mid West Cheval	1831, 1835, 1859, 1874, 1880, 1888, 1904	7
North-west Cheval . . .	1833, 1835, 1881, 1888, 1904	5
North Central Cheval . .	1833, 1835, 1857	3
Central Cheval.	1835, 1836, 1857, 1859, 1888	5
South Central Cheval . .	—	Nil

The localities of a number of the earlier fisheries of the Nineteenth Century (1828 to 1863) on the Cheval Paar and its extensions to north and south, the Periya Paar Kerrai and two Modragams, are shown on fig. 3. The exact positions of the fisheries before this time are not known with certainty. The next fishery after these dates (that of 1874) will be shown in a separate diagram, and a series of still later fisheries and inspections showing the distribution of oysters over the Cheval area will be discussed below. It will be noted from this diagram (fig. 3) how irregular and comparatively small the areas covered by a fishery usually are; and how wide extents of the paar may be left unoccupied by oysters. It is also clear from this figure that fisheries, and therefore beds of oysters, are by no means limited by the conventional

U-shaped outline of the Cheval Paar. The central embayment has evidently been sometimes occupied by oysters in the past just as it was when we dredged across it in February and in March, 1902. The position of the Periya Paar Kerrai as a northern extension of the East Cheval, and the practical continuity of the Modragams with the south central region are evident from both the plan of the ground and the distribution of the fisheries.

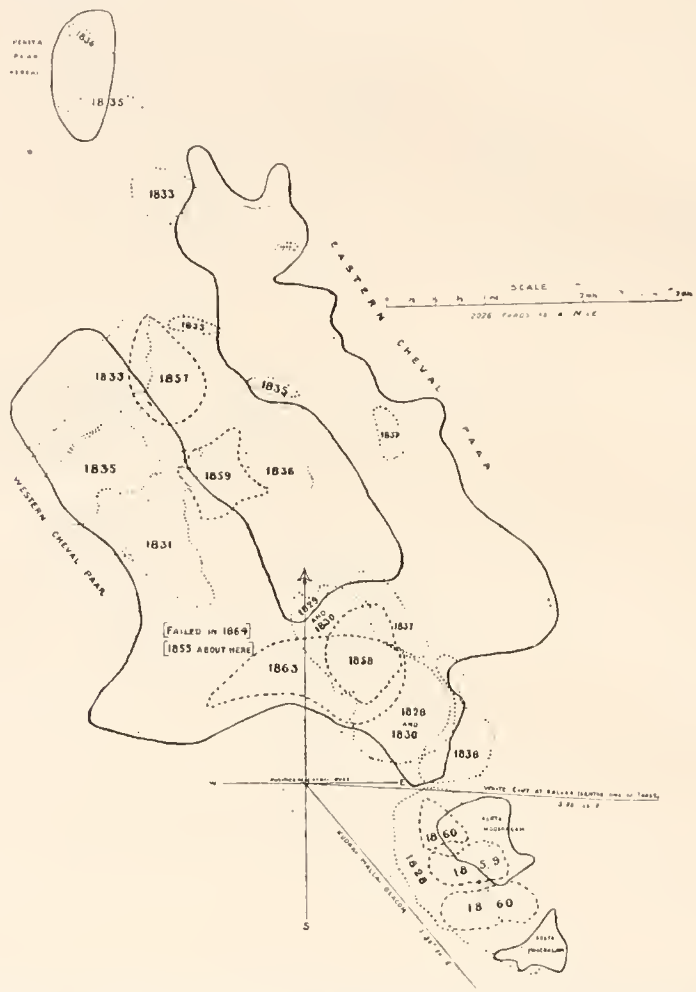


Fig. 3. Plan of the pearl fisheries, from 1828 to 1863, on the Cheval Paar, the Modragams, and the Periya Paar Kerrai.

The next fishery after 1863 is that of 1874, which took place on the North-west Cheval Paar, and as we have very complete records and charts showing the history of this bed of oysters, from the time when it was deposited as spat onwards to the fishery, these have been combined to form the diagram (fig. 4). This shows, by different lines, the condition during the five years 1870 to 1874, and may be taken as an example of the normal uneventful development of a small bed of oysters. It shows what are probably very usual features, viz. :—(1) that small isolated patches of spat either disappear (as in the case of those marked 1, 4, and 6) or expand and join (as in the case of 2, 3, and 5) to form eventually a continuous bed; (2) that if all goes well, as the oysters grow older they increase, for a time, their area of distribution, *e.g.*, we have the two beds of 1871 joining and expanding to form the much larger area of 1872, which again increases somewhat in 1873; (3) after a time, however, the oysters, now over 3 years old, begin to die off, and shrinkage of the bed

Fig. 4. History of one generation of pearl oysters on the West Cheval Paar—from the fall of "spat" in 1870 to the fishery of 1874.

takes place, so that the area fished in 1874 is considerably smaller than that occupied in 1873 or in 1872, and is no larger than the two beds of young oysters present in 1871. In accounting for such changes in the position and the extent of the bed, it is necessary to bear in mind (1) the very considerable powers of locomotion, especially of the young oyster, and (2) the damage done to a bed by both animate and inanimate foes. These have already been discussed in Part I. of this Report.

In order to illustrate more fully the irregular distribution of the oysters on the ground, the large areas that may remain unoccupied on a paar and the changes that take place during the development of a deposit of spat into a fishable bed of oysters, we shall now give a series of diagrams compiled from the MS. notes and plans of the periodic inspections deposited in the Master Attendant's Office at Colombo. They deal with the last 20 years, from March, 1884, and show (figs. 5 and 6) an extensive bed of young oysters which yielded fisheries in 1887 and 1888, various scattered deposits of young oysters (figs. 7 and 8) which apparently came to nothing, and finally (figs. 9 to 14) the detailed history of the extensive bed of young oysters which was first seen on the Western and Southern Cheval in March, 1900, afterwards spread on to the East, and eventually gave rise to the two recent very important fisheries, on the East Cheval in 1903 and on the West in 1904. Although these last oysters must all have been of much the same age, those on the East Cheval, and especially on the North-east, seem to have grown larger and looked older than the others. They were the first to be fished. Figs. 11 to 14 also show the rise and growth of the young oysters, now between 2 and 3 years old, which will probably provide a fishery in 1905 or 1906. In addition to the areas shown on the Eastern Cheval, they also occupy considerable parts of the South, Central, and Western. There are, as yet, no younger oysters in the district.

The first set of diagrams (figs. 5–8) shows the condition of the Cheval Paar at the inspections from March, 1884, to March, 1893. The continuous thick line represents the outline of the paar in each case. In fig. 5 the dotted area represents the part covered with oysters about 3 months old in March, 1884, and the area enclosed by a broken line shows the position of these same oysters in March, 1885. The shrinkage seen in the south-west corner becomes more marked in the following year.

In fig. 6 the dotted area is that occupied by $2\frac{1}{2}$-year old oysters in March, 1886, and the broken line shows the distribution of the same oysters in March, 1887 (then $3\frac{1}{2}$ years old). The oysters now formed two distinct beds, corresponding roughly with the East and West Cheval. These oysters were fished in March, 1887, and March, 1888, and, although so young, yielded a good return.

In fig. 7 the dotted areas on the Western Cheval represent two patches of young oysters, and that on the Eastern Cheval some scattered mature ones in November, 1888 (left over from the fishery in March): the broken line encloses an area covered with oysters 3 months old in November, 1889, while the four black patches show the parts covered with oysters 15 months old in November, 1890. None of these survived to March, 1892, when the bank was found quite bare of pearl oysters.

In fig. 8 the black areas show the extent of ground covered by young oysters, 6 to 9 months old, in March 1893. These scattered deposits came to nothing, as the bank was found to be bare of oysters at the inspections of 1894 and 1895.

The following six diagrams (figs. 9 to 14) show the distribution of oysters on the Cheval Paar during the period March, 1896, to April, 1903, as shown by the periodic inspections and the fishery of 1903. The conventional outline of the bank is shown as a continuous thick line. In fig. 9 the area with oblique lines was covered with oysters 6 months old in March, 1896, the small black areas were occupied with oysters 3 to 6 months old in March, 1898, and the areas enclosed by a dotted line (including an extent of about 5800 acres, occupying the greater part of the West and South Cheval) indicate young oysters at the inspection of March, 1900. These must have appeared as spat after the inspection of 1899, and are of interest as giving rise to the very important fisheries of 1903 and 1904. The bank was bare of oysters at the inspections of 1894, 1895, 1897, and 1899.

In fig. 10 the black areas show the distribution of oysters from $1\frac{1}{4}$ to $1\frac{3}{4}$ years old at the inspection of March, 1901, the dotted circles in this and subsequent figures showing the areas which were surveyed.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Figs. 5 to 8. Diagrams showing the distribution of oysters on the Cheval Paar at the inspections from March, 1884, to March, 1903. Scale about half an inch to one nautical mile.

Figs. 9 to 14, on p. 19, show a similar series of diagrams for the period March, 1896, to the end of the recent fishery in 1903.

Figs. 11, 12, 13, and 14 represent the condition of the paar at the inspections of March, 1902, November, 1902, February, 1903, and immediately after the fishery of 1903 respectively, the black areas showing the distribution of the same oysters as those shown in fig. 10, and the dotted areas showing the distribution of a new brood of young oysters, 3 to 6 months old, in March, 1902, and their condition at subsequent inspections. In fig. 13 the obliquely shaded areas represent continuations of the black areas outside the parts actually surveyed, which were only discovered by the divers at the fishery. In figs. 12, 13, and 14 the parts outside the dotted circles were not inspected. The Western Cheval was still covered with the oysters which have just been fished in March, 1904.

Fig. 14 is of interest as showing the very considerable area covered by fishable oysters (estimated at 22,000,000) which the divers had failed to clear in the fishery of 1903.

The history of the recent fishery (April, 1904) shows the reliable character of the Cheval Paar. Mr. Hornell, in February, found the three western beds of oysters in practically the same positions they occupied when we surveyed them with Captain Donnan in March, 1902. It is therefore only under some exceptional circumstances that any catastrophe happens to a bed of oysters on the Cheval.

The general conclusions we arrive at in regard to this ground are :—

1. That the Cheval Paar provides most favourable conditions for future fisheries, provided there be a sufficient deposit of spat.
2. That such deposits of spat are unfortunately of comparatively rare occurrence, and this accounts for most of the blank years in the history of the fisheries.
3. That consequently the need arises for transplanting young oysters from elsewhere on a large scale if such blank years on the Cheval Paar are to be avoided.

Consider, for example, the position of affairs at present and in the immediate future. The recent fishery (1904) has probably cleared the Cheval Paar of all fishable oysters, except what may still remain on the East Cheval from the fishery of 1903. The next oysters to come on are those on the West and parts of the South Cheval, which are now in their third year, and which will, if all goes well, yield a fishery in 1905 and, perhaps, also in 1906. There are no younger oysters in the Cheval district. There has been no fall of spat this year as yet, and the next possible time when it might occur will be about December. Taking the most favourable estimate, such oysters would not be fishable until March, 1908, but it may very possibly be that no deposit of spat will take place this year, and that consequently future fisheries, if left to unaided nature, may be still further delayed. There are, however, now plenty of oysters about 6 months old on the Periya Paar. They cover an area of about 10 square miles, and are probably sufficient to stock the Cheval Paar several times over. The past history of the Periya Paar justifies us in saying that there is

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

practically no chance of these young oysters coming to maturity where they are. If these are transplanted to the Cheval banks at the earliest opportunity and in sufficient quantities—for such work to be successful must be done on a large scale—they ought to be in their fourth year by March, 1907, and would probably yield fisheries then and in 1908. Our aim should be to have a constant succession of broods maturing on the Cheval, so as to give a continuous series of fisheries, and if sufficient spat does not fall naturally, these broods must be brought from elsewhere.

II. MODRAGAM PAARS (NORTH AND SOUTH).

Fig. 3, on p. 14, shows the close relation between the two little Modragam paars and the great Cheval region. An account of the leading physical and biological characters will be found in Part I., p. 105. The fishery record is as follows :—

1804.—Fished along with the Cheval Paar.
Oct., 1804.—Oysters 5 years old on a bank of small extent.
Mar., 1805.—Small bed of oysters 6 years old. Sample of 1987 oysters lifted. To the south of the bank was found a patch of "Kottapakku" oysters, 3 to 4 years old, and another patch of same age and kind to the north-east. Also a patch of Cheval oysters, 3 to 4 years old.
1806.—Fished along with the Cheval Paar.
1808.— ,, ,, ,, ,, ,,
1809.— ,, ,, ,, ,, ,,
Nov., 1811.—Only a few oysters.
Mar., 1813.—Very few young oysters.
1814.—Fished along with the Cheval Paar.
1816.— ,, ,, ,, ,, ,,
,, 1820.—Oysters 7 years old. Fished along with the Cheval Paar.
,, 1826.—"Great quantity of large oysters."
,, 1827.—"Plenty old oysters in 5 fathoms."
,, 1828.—South-east Modragam fished (yielded 305,234 rupees).
,, 1836.—Fished (6,000,000 oysters yielded 58,624 rupees).
,, 1856.—Oysters in great abundance on west of Modragam, 1 to 8 years old.
Nov., 1856.—Great abundance of oysters, mostly 4 years old.
Mar., 1857.—Oysters in abundance in large clusters, 3 to 5 years old.
Nov., 1858.—Sample of 12,000 lifted.
Mar., 1859.—North paar fished; oysters probably 4 to $4\frac{1}{2}$ years old (over 6,000,000 yielded 287,678 rupees).
,, 1860.—Remainder on north, 5 years old (800,000 oysters yielded 87,269 rupees), and younger ones, 4 years old, on south fished (nearly 3,000,000 oysters yielded 279,547 rupees).

Nov., 1860.—Oysters 8 to 12 months old.

,, 1861.—No oysters on the south-east portion. On the south and on the northern edge, abundance of healthy oysters, 2 to 3 years old. On the North Modragam, healthy oysters $5\frac{1}{2}$ years old.

Mar., 1862.—Oysters 3 to 4 years old, very healthy and abundant, covering 1 square mile; thickest on south part. Should be fishable in 1863.

Nov., 1862.—Millions of oysters 2 to $2\frac{1}{2}$ years old.

1863.—Oysters have totally disappeared. [Probably eaten by Rays.]

Mar., 1864.—No young oysters.

,, 1867.—No oysters.

,, 1868.—To the west and south-west of the bank there is much weed covered with young oysters.

Nov., 1868.—No oysters.

,, 1869.— ,,

Mar., 1870.— ,,

,, 1871.— ,,

,, 1872.—On South-east Modragam a small patch, 9 to 12 months old.

,, 1873.—Oysters have disappeared.

,, 1875.—Two beds of oysters, 2 years old, healthy and numerous on the north and south paars.

,, 1876.—The south bed almost disappeared and the north bed thinned. No dead shells.

Nov., 1876.—200,000 oysters fishable in March, 1877.

Mar., 1877.—North Modragam fished (yielded 4420 rupees).

Nov., 1879.—No oysters.

Mar., 1883.— ,,

,, 1885.—Oysters plentiful, 18 months old; Rays feeding on them.

,, 1886.—Two separate beds, 25,000,000 on north, 14,000,000 on south, oysters $2\frac{1}{2}$ years old; on the south bed mixed with some a year younger. Apparently no loss from Rays yet.

,, 1887.—Serious loss of oysters; north fished at once (yielded 103,664 rupees); south contained too many young oysters mixed with the old.

Nov., 1887.—Some oysters remaining.

Feb., 1888.—3,000,000 on north; 2,000,000 on south, mixed with some 1 year younger. Both banks fished, along with Cheval Paar.

Nov., 1888.—Very few old; no young.

,, 1889.—None.

Mar., 1893.—No oysters.

,, 1899.— ,,

,, 1900.—Small patch of young oysters.

,, 1901.—Two insignificant patches.

Mar., 1902.—North covered with young oysters; south has one bed of young and some of 3 years old.

April, 1903.—Some oysters present in clusters on the sand, and singly adhering to rock.

Mar., 1904.—Large quantities of $2\frac{1}{2}$-year-old oysters on both banks.

It is obvious, in looking over such a record as the above, that it is an incomplete history, and that, in the absence of certain data, we are unable to re-construct a perfect picture of the sequence of events. Still certain beds of oysters can be traced in successive years as follows:—

No doubt the 5 and 6-year old oysters recorded in 1804 and 1805 were those fished in 1806; and the spots of 3 to 4 years old found in 1805 were those fished in 1808 and 1809. But it remains doubtful when the oysters fished in 1814 made their appearance. Those fished in 1816 are very probably the young oysters noted in 1813; and it may be remarked that what may seem comparatively few when young, and small, and closely packed, will, if they live and spread out, be sufficiently numerous when large to form a respectable fishery. It may have been some of these same oysters that formed the 7-year old fishery of 1820. We have no data in regard to the oysters fished in 1828 and in 1836, and after that comes a gap of 20 years during which there are no records. During 1856 and 1857 oysters of all ages were apparently found in abundance, although, in the absence of any history, it may be permissible to doubt whether any were really 8 years old. It is also curious that the older oysters found during these two years and the following one were not fished. In November, 1858, a sample of 12,000 was lifted, and the oysters on the north bank, then estimated at 4 to $4\frac{1}{2}$ years old, were fished to the number of over 6,000,000. The following year what were left on the north bank, amounting to under 800,000 oysters, were fished along with nearly 3,000,000 younger ones from the South-east Modragam. The latter are referred to as 3 years old, but, judging from the high price obtained, it seems unlikely that they were so young.

Young oysters were found on the bank the following November, and again in November, 1861; and in March, 1862, the prospects for a fishery the following year were good. In November younger oysters were also seen "in millions," but in 1863 the oysters had "totally disappeared." This catastrophe occurred during the north-east monsoon, so it was probably not due to any exceptional disturbance of the ground, and from the remarks made by Twynam and Donnan in their Fishery Inspection Report of November, 1863, to the effect that the appearance of the shells brought up showed that they had been destroyed by some animals preying on them, it is very probable that the loss of this bed of oysters was due to an incursion of Rays. Sir W. Twynam thinks, however, that they were also injured by the heavy floods of 1862–63.

From this time there is a blank till 1875, when beds of 2-year-old oysters were found, which yielded the small fishery on the North Modragam in 1877. In 1868, and again in 1872, quite young oysters were seen in the neighbourhood of the Modragams, but these came to nothing. Deposits of spat on weeds must always, in the nature of things, be of very uncertain value. A little extra wind or current in a particular week may drift the weeds with their precious burden on to unsuitable ground or out of the pearl-bank district.

Even if the weeds remain till they rot or the young oysters leave them, the exact nature of the bottom, and the presence of culch or suitable hard objects, may determine whether the spat will be overwhelmed in shifting sand or will start a fresh bed of oysters. No special causes, then, are required to account for the disappearance of weed and spat in its younger stages.

After the fishery of 1877 comes an interval of 10 years, the next fishery being in 1887. That must not be taken as implying that during that time the ground was in any way changed in its nature or unsuitable for oyster growth. Two things are necessary for a successful bed of oysters: first, the suitable ground, and, secondly, a supply of spat; and if an area has been fished out, as the North Modragam was in 1877, and no other adult oysters are present in the neighbourhood, it is easy to understand that no spat will be forthcoming, and that suitable ground may, if left to unaided nature, lie unoccupied for a series of years until, through some accident of winds and tides, or the slow migration of parent oysters, a deposit of spat is again brought into the region. This must have happened in the Modragams in the summer or autumn of 1883, as in March, 1885, oysters 18 months old were found plentiful, but being devastated by Rays. They were still fairly abundant the following year, but in 1887 the loss of oysters was becoming so serious that the north bank was fished at once and yielded nearly 9,000,000, which brought in over 100,000 rupees. In the following year, 1888, the few millions that remained on both banks were fished. On this as on several other occasions difficulties, delay, and loss of oysters were caused by the mixture of fishable old with much younger ones. This is, perhaps, inseparable from the method of fishing by means of native divers, but it is probable that if the oysters were dredged up in bulk, old and young together, from a steamer, most of the young could be separated rapidly by hand on board and thrown back before leaving the "paar" without excessive work, undue delay, or much sacrifice of the young oysters. The prospects of a fishery next year are good.

III. PERIYA PAAR KERRAI.

The relation of this small northern paar to the great Cheval district is seen in fig. 3, on p. 14, and its leading physical and biological characters will be found noted in Part I. at p. 108. The fishery record is as follows:—

Mar., 1802.—Oysters 4 to 5 years old.

Oct., 1802.— ,, $4\frac{1}{2}$ to $5\frac{1}{2}$ years old, many dead shells.

Mar., 1804.—Fishery.

Mar., 1805.—Dead shells.
Oct., 1809.—Young oysters, 2 years old.
Nov., 1810.—Abundant oysters, $1\frac{1}{2}$ to 3 years.
,, 1811.—Oysters present.
Mar., 1813.— ,, 2 to 3 years old.
Nov., 1815.— ,, 6 and $6\frac{1}{2}$ years old—to be fished.
,, 1816.— ,, all dead—no fishery.
,, 1820.— ,, 4 years old.
,, 1821.— ,, dead.
Oct., 1828.—Small patch of good oysters.
Mar., 1832.—Oysters present.
,, 1833.—Fishery (yielded 320,896 rupees).
,, 1835.— ,, (16,000,000 oysters yielded 403,460 rupees).
,, 1836.— ,, (3,000,000 ,, 40,158 ,,
,, 1870.—Two patches of young oysters.
,, 1871.—No oysters.
,, 1876.— ,,
,, 1886.—Two small patches, 3 to 6 months old.
Nov., 1887.—Small patch of oysters about 2 years old.
Mar., 1893.—No oysters.
,, 1899.— ,,
,, 1901.—On south-west 7,000,000 oysters 1 to 2 years old.
,, 1902.—Many oysters about 3 years old.
,, 1903.—Fishery (1,500,000 oysters yielded 32,861 rupees).
,, 1904.—Oysters left last year now gone.

This bank, as might be expected from a northerly extension of the North-east Cheval, although of small size is quite a profitable and reliable paar. It has yielded 5 fisheries that are recorded and one at least, that of 1815–1816, has evidently been lost through the oysters being left too long unfished.

Those of 1820, again, should probably have been fished that year. During the 100 years of our record we have evidence of at least 8 deposits of spat on this bank, but there may well have been more, as this little paar did not until recently receive such close attention as its gigantic neighbour, the Cheval. The patch of hard bottom forming the paar appears to vary considerably in extent and shape from time to time, as the diagram (fig. 15) shows. The variations are, no doubt, due to movements of the sand, and any losses of oysters that have occurred are probably due to that cause or to the incursions of large Rays (Trygonidæ). In March, 1902, we found 3-year-old oysters in quantities which Captain Donnan estimated at over 21,000,000.

In November, 1902, the fishable oysters were estimated at 8,000,000, and in February, 1903, Captain Legge put the figure at a little under 7,000,000.

At the actual fishery, a month later, only 1,473,297 oysters were lifted, but this small number was due in part, at least, to the fact that the great depth (9 fathoms as compared with 6 fathoms on the Cheval) caused the collapse of several divers and discouraged the others, so that it was found impracticable to work longer on the bank. The marked decrease in the number of oysters during 1902 was undoubtedly due to large Rays. Mr. HORNELL found samples of crushed oysters and many broken shells and characteristically comminuted fragments, which he has sent to me, and which I agree are the result of the action of the tooth plates of large Elasmobranchs such as *Trygon uarnak* and its allies.

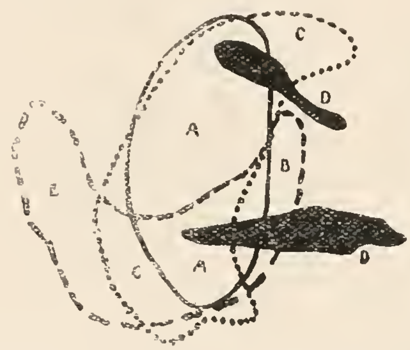


Fig. 15. Plan of the Periya Paar Kerrai. The whole line surrounding A shows the area as inspected in 1882, the dashed line round B shows the paar in 1884, the dotted line round C shows the condition in 1886, while the two black patches indicate the parts fished in 1835 and 1836.

IV. KONDATCHI PAAR.

This is a part of the Cheval group, and evidently forms an extension of the southern end of the East Cheval. Although only one fishery is recorded from this paar, that of 1801, oysters have several times been fished or traced extending to the eastward from the southern part of the Cheval paar in the direction of the Kondatchi. Consequently it is quite possible that a bed might mature and a fishery might take place on this just as on any other part of the Cheval region.

No detailed record of the history is necessary, but it may be added that when we examined this bank in March, 1902, it had about 5,750,000 oysters. These were much reduced in November, 1902, and had nearly all gone by March, 1903, and it seems probable that the destruction in this case may be due to the great numbers of large Star-fishes, and especially of *Pentaceros*, present on the bank.

V. PERIYA PAAR.

This lies outside the other paars in the Cheval district, about 18 miles from land and close to the top of the bank that runs steeply down into deep water. An account of the leading physical and biological features was given in Part I., at pp. 76 and 110. The remarkable fishery record is as follows :—

Mar., 1813.—Oysters 2 years old, in clusters, sticking to small detached rocks.
Nov., 1863.—Young oysters, 6 months old, on piece of ground 3 × 2 miles.
Mar., 1864.—Oysters about 12 months old appearing to be same as last year, but 2 miles further west.

Mar., 1878.—On the Kottapakku paar, where oysters were found in 1802 (extension of Periya to south-east), found 3,500,000 oysters, but there were 13 per cent. dead shells. They were of the "Kottapakku" variety.

Nov., 1878.—Oysters dying on Kottapakku Paar. Pearls valued at Rs. 17.29 per 1000. Small fishery suggested for March.

Mar., 1879.—Bank fished (yielded 95,694 rupees).

Feb., 1880.—Abundance of young oysters.

Mar., 1882.—No oysters on the bank.

April, 1883.—Neighbourhood of ground fished in 1879 thickly covered with young oysters 6 to 9 months old.

Mar., 1884.—Oysters still on bank, mixed with others 3 months old.

,, 1885.—Older oysters gone and very few of the younger remaining.

,, 1886.—No oysters on the bank.

Nov., 1887.—Abundance of young oysters 2 to 3 months old.

,, 1888.—Oysters of last year gone and new lot come, 3 to 6 months old.

,, 1889.—Oysters of last year gone; a few patches present, 3 months old.

Mar., 1892.—No oysters on bank.

,, 1893.—Abundance of oysters 6 months old.

,, 1894.—No oysters on bank.

,, 1895.— ,, ,, ,,

,, 1896.—Abundance of young oysters 3 to 6 months old.

,, 1897.—No oysters present.

,, 1898.— ,, ,, ,,

,, 1899.—Abundance of oysters 3 to 6 months old.

,, 1900.—Abundance of oysters 3 to 6 months old; none of last year's remaining.

,, 1901.—Oysters present, 12 to 18 months old, but not so numerous as in preceding year.

,, 1902.—Young oysters very abundant, 2 to 3 months old. Only a few patches of older oysters (2 to $2\frac{1}{2}$ years) remaining.

Nov., 1902.—All the oysters gone.

April, 1903.—Some oyster spat seen on Sargassum weed.

Mar., 1904.—Bank of 5 × 2 miles covered with young oysters (3 months old) from end to end.

This is an extraordinary history. In 100 years there has only been one small fishery, that of 1879, and yet the Periya Paar probably receives more deposits of spat than any of the other banks. Since 1880 the bank has been naturally re-stocked with young oysters at least 12 times without yielding a fishery. The destruction and the reproduction are both, in this case, on an enormous scale. As this bank was dealt with fully in the Narrative (p. 76) in Part I., I need only say here (1) that the destruction of the successive broods of young oysters seems to be due to the configuration of the ground and its exposure to the south-west monsoon, and (2) that the constant production of fresh spat renders possible the transplantation of young pearl-oysters in enormous quantities from the Periya Paar to other safer grounds further inshore, such as parts of the Cheval district.

VI. DUTCH MODRAGAM PAAR.

This paar, notwithstanding its name, lies at a considerable distance from the better known North and South Modragams. It is about 10 miles to the south-west, and on the other hand is only about a mile to the north of Karativo Paar. It clearly belongs to the Karativo and Muttuvaratu group rather than to the Cheval and Modragam series of paars. It has been described in Part I., at p. 111.

This is a disappointing but at the same time a promising bank. It has apparently not yielded a fishery in British times, and yet it has, on various occasions, been found covered with oysters both young and old (over 3 years). It has a rough hard bottom, suitable for affording good attachment, and it evidently receives deposits of spat, *e.g.*, one in the summer of 1899 and one in the summer of 1902. Consequently, notwithstanding its poor record in the past, I see no reason why it should not at any time yield fisheries like those of the neighbouring Karativo and Muttuvaratu Paars.

It is only of the last few years that we have detailed records; but these, as given below, will serve as a sample to indicate the nature and prospects of the bank.

Recent History of the Dutch Modragam Paar.

April, 1899.—No oysters.

Mar., 1900.—386 acres covered with young oysters 3 to 12 months old (*fide* Donnan).

,, 1901.—Two small detached beds of oysters from $1\frac{1}{2}$ to 2 years old, 1,750,000, rapidly disappearing since last year; about 51 acres of ground covered by these oysters (*fide* Donnan).

April, 1902.—A small bed of 387,500 square yards (= 80 acres) bearing oysters of 2 to $2\frac{1}{2}$ years old (*fide* Donnan).

Nov., 1902.—Oysters were present which, though apparently not over 2 years old, must have been $2\frac{1}{2}$ to 3 years of age. They were mixed with quantities of young, from 6 to 8 months old.

Feb., 1903.—At the place where Mr. Hornell made an examination in a diving dress, very many pearl oysters lay thickly spread on the bottom, very similar in appearance and size to those of Muttuvaratu; age apparently $3\frac{1}{2}$ years, with considerable numbers of younger and smaller ones.

Mar., 1904.—Oysters plentiful ; apparently the majority are not more than 2 to $2\frac{1}{2}$ years old. These represent the young spat which was noted as abundant in November, 1902 ; their growth has been at the expense of the older ones that were present in 1902, and which have been smothered or killed out by the competition of the more vigorous and numerous young.

VII. KARATIVO PAAR.

A short account of the characters of this paar will be found at p. 113 in Part I. Its fishery record is as follows :—

Nov., 1829.—Oysters 5 years old.

Mar., 1832.—Fishery (yielded 45,810 rupees).

1863.—Found nothing.

Mar., 1864.—A few oysters 12 months old ; do not look healthy.

,, 1867.—Only a few scattered oysters.

,, 1868.—To the south-west, weed covered with young oysters.

,, 1870.—Patches of weed covered with young oysters.

,, 1871.—No oysters.

,, 1875.— ,,

,, 1882.— ,,

,, 1883.— ,,

,, 1886.—4,000,000 oysters, 18 months old, on the fishing ground of 1832 ; 1,500,000, 3 years old, thinly spread, and 8 per cent. dead.

May, 1887.—Oysters apparently all gone from fishing ground of 1832 ; young oysters present, not enough for fishing.

Nov., 1889.—3,000,000 of the oysters found in 1886 ; small fishery held at once.

Mar., 1890.—Some fished with fishery at Muttuvaratu.

Nov., 1890.—Most of the oysters had died out.

Mar., 1891.—Remaining oysters (200,243) fished with fishery at Muttuvaratu.

,, 1893.—No oysters.

,, 1899.— ,,

Mar., 1900.—Bare of oysters.

,, 1901.—" A fairly large bed of oysters (234 acres) of from 6 to 12 months old"—number estimated* 30,000,000.

April, 1902.—25,330,000 oysters, from $1\frac{1}{2}$ to 2 years old, occupied a bank having an estimated area of 1,570,850 square yards (= 324 acres).

Nov., 1902.—Not inspected.

Mar., 1903.—Mr. Hornell's inspection by means of diving apparatus showed that the oysters present in April, 1902, had practically all disappeared.

,, 1904.—Old oysters all gone. Some younger (2 years old) have appeared.

* But little importance can be attached to numerical estimates of oysters at this age, and Mr. Hornell advises that such estimates should not be made use of except in the case of banks of mature oysters.

If we include "the paar near the Isle of Cardieu, off Karativo Island," as recorded in 1832, we have four fisheries in all—the other three being of more recent date (1889–91). A great gap, however, exists in the records—from 1832 to 1863—so it is possible that this, like the neighbouring Muttuvaratu Paar, was lost sight of or neglected for some time.

It is evident that spat has appeared on the bank from time to time—three times between 1864 and 1870—and in all probability the area is as good for rearing as the Muttuvaratu Paar, and as likely to yield fisheries. I attach no importance to spat "on weed" disappearing. At that stage it is too uncertain and too much at the mercy of the winds and waves to be regarded as more than a *possible* source of supply. Besides if the weed be carried away from one paar it may drift on to another, and so is not necessarily lost, although it may be lost sight of.

The oysters fished in November, 1889, must have been those that were 18 months old in 1886, and if so, the observation of May, 1887, that the oysters were gone from the fishing ground of 1832 must have been erroneous, unless it be that the oysters shifted their ground, were temporarily lost, and were found again in 1889.

A large deposit of young oysters must have appeared in the summer and autumn of 1900. It was surveyed in March, 1901, and again in April, 1902, when it occupied a still larger area. This increase in area may have been due to spreading of the oysters, or more likely to differences in the areas examined at the two inspections. It is seldom that successive inspection areas closely agree in position—it being practically impossible to place the inspection vessel on the same bearings at successive inspections.

In the following spring, however, Mr. Hornell's inspection showed that these oysters had nearly all gone, and in March, 1904, the bank was practically bare again. If there is no mistake in the locality, and the oysters have not been shifted to some adjoining ground, this is a disappointing case of a bed which ought to have yielded a good fishery, failing after it seemed to be well established. This paar, it must be remembered, is just on the edge of the deep water, exposed to currents, and therefore in a somewhat precarious condition. The loss of these oysters was very probably due to monsoon currents in the summer and autumn of 1902.

VIII. MUTTUVARATU PAAR.

An account of the leading physical and biological characters of this important bank was given in Part I., at p. 114. The fishery record is as follows:—

Dec., 1820.—Oysters, 1 year old, on rock—very thick.
Mar., 1826.—Quantities of large oysters.
,, 1827.—Plenty of old oysters.

* * * * * * *

,, 1886.—27,000,000 oysters 18 months old.

Nov., 1887.—49,000,000 3-year-old oysters firm on rocky ground.

Dec., 1888.—Oysters have not suffered. Sample lifted 4 years old—fishery recommended.

Mar., 1889.—39,000,000 oysters fished. Oysters were young (yielded 498,377 rupees)—small thick "Kottapakku" variety.

Nov., 1889.—Still a large number (30,000,000).

Mar., 1890.—Over 33,000,000 oysters fished (yielded over 300,000 rupees)—much mixed in size; plenty of small pearls.

Nov., 1890.—Oysters still there in quantity.

Mar., 1891.—Over 44,000,000 oysters fished (yielded over 900,000 rupees)—much mixed, but for the most part full-grown, rich in pearl; rapidly dying off—many putrid and of offensive smell when brought to the Kottus.

,, 1893.—No oysters.

,, 1895.— ,,

,, 1896.—127 dives showed oysters 3 to 6 months old. 499 dives were unproductive—bare rock.

,, 1897.—260 dives gave bare rock; 410 showed the presence of young oysters, about 1 year old, estimated at 72,000,000.

,, 1898.—Oysters, 2 to 2½ years old, reported from 278 dives; 429 reported bare rock.

,, 1899.—The bank is again practically clear of oysters. All but total disappearance. Probably due to ravages of large Rays.

,, 1900.—Abundance of young 3 to 9 months old.

,, 1901.—Abundance of young 18 months old; 178,000,000. Large area on north-west side of southern portion has been completely cleared since last year.

,, 1902.—Oysters still present in enormous abundance; 277,000,000.

Nov., 1902.—Considerable reduction in number, and appearance stunted; many yellow individuals present.

Mar., 1903.—Still very numerous, about 125 to the square yard in places.

,, 1904.—Some old still remain, but dying off rapidly. Considerable numbers of younger ones, about 1 year old, now present.

The history of the Muttuvaratu Paar is interesting because of the great gap from 1827 to 1886, during the greater part of which period the bank had apparently been lost sight of. In 1820, 1826, and 1827 there are entries of quantities of old oysters on the rocky bottom,* but there are no records of a fishery until after Captain DONNAN

* Captain DONNAN, however, writes to me that he thinks it probable that these early inspections were on HAMILTON'S Muttuvaratu Paar, which lies between 2 and 3 miles to the north-east of the true Muttuvaratu; in which case we have no record of the true paar from the time of the Portuguese until DONNAN re-discovered it in 1860 or 1861.

re-discovered* the bank about 1860, and watched it carefully after his appointment as Inspector in 1863. And yet there is reason to believe that it was known to the natives, and that there may have been native fisheries there in early times, extending even to the period of the Portuguese occupation. JOHANN JACOB SAAR (1662), in describing the capture of Manaar by the Dutch, referred to one important pearl bank at 3 miles' and another at 10 miles' distance from Manaar. These miles, being Dutch, are from $3\frac{1}{2}$ to 4 times as long as English, and consequently these two banks were respectively from 10 to 12 and from 36 to 40 miles to the south—distances which correspond with the positions of the Cheval and Muttuvaratu paars. The Muttuvaratu Paar is 3 miles in length and covers the ground between 36 and 39 miles from Manaar. It is unlikely that so much importance should have been attached to this bank by the Portuguese and the Dutch unless it had yielded fisheries.

When Captain DONNAN inspected the bank in 1886, it had what was estimated at 27,000,000 of oysters in their second year. There must have been many more. When inspected in November, 1887, a still larger estimate was made (still much under the mark), and this excellent bed of oysters yielded eventually the three very profitable fisheries of 1889, 1890, and 1891, during which in all about 117,000,000 of

* The story of this discovery is so interesting that I add it here in Captain DONNAN'S own words. He told it to me on the pearl banks in 1902, and I have now got him to write it out, and I quote from his letter of July 11th, 1904:—"My first visit to the Muttuvaratu Paar was, as far as I can remember, in November, 1860, or in March, 1861. I was then in command of the s.s. 'Pearl,' and was on a visit to the pearl banks under the direction of Captain PRITCHARD, Master Attendant at Colombo and then Acting Superintendent of the Pearl Fishery. PRITCHARD gave the chart of the banks to me and told me to anchor on each bank according to the bearings, but on getting on the chart bearings of the banks off Karativo I found we were off the bank of soundings, and that the chart was unreliable. I therefore suggested to PRITCHARD that I should go down south of Dutch Bay again and start afresh, steering north and keeping in 8 fathoms water, and stopping every quarter of a mile or so and sending down a diver. PRITCHARD thought that was a good idea and told me to carry it out, which I did. After a great many stops and dives of 'Chippie Illai' (no oysters) at last the diver reported oysters, so I anchored and sent out the boats to inspect, the result being a find of a bed of full-grown oysters mostly all dead and very few found alive. This bank would no doubt have yielded a good fishery if it had been discovered a year sooner. I made a note of the position of the bank, and when I became Inspector of Pearl Banks I determined to visit that spot every two or three years, as I imagined that the spot where oysters had matured would be a likely spot for them to come on again, but it was not until 1886 that I was rewarded for my perseverance by finding a large bank of young oysters which yielded three fisheries in succession.

"When the oysters were approaching maturity, I looked up STEUART'S book to see if he had any record of a bank in that neighbourhood, and I found that in the Dutch time a native of Calpantine had given information of a bank, named Muttwartu Paar, some 8 miles north-west of Calpantine Flagstaff. There was no information as to the position of the flagstaff, but I imagined that the bank referred to might possibly be the one I had discovered. I thereupon consulted the Adigar of Manaar as to the meaning of the word Muttwartu, and he replied that the proper name must be Muttuvaratu Paar, which means the bank where the pearls come, so I then decided that the bank I had discovered should bear that name.

"It is, I think, very probable that my Muttuvaratu Paar is the same as the one referred to in the Dutch records, and in that case my discovery was only a re-discovery of an old bank that had been lost for ages."

oysters were lifted. These fisheries show well how pearl oysters increase in value as they get old, the last one (1891) when the oysters were rich in pearl being much the most remunerative, and in fact being the only fishery since 1814 that has brought in nearly 1,000,000 of rupees. But the record also shows the risk there is in trying for the enhanced value by delaying the fishery once the oysters are over 5 years of age. In 1891 this bed must have been 6 years old, and they are described as rapidly dying off, many being already dead and putrid.

The next deposit of young oysters on the Muttuvaratu, found in March, 1896 disappeared* in 1898–99 (a winter of exceptionally heavy rains and storms); and a fresh population made its appearance a year later and has been recorded at all the inspections since. In March, 1902, it was estimated by Captain DONNAN at the enormous figure of 277,000,000. This number has probably been greatly reduced since by disease and the ravages of enemies, and it is doubtful whether sufficient will survive to yield a fishery next year when these oysters will be over 5 years of age.

The adult oysters of the Muttuvaratu Paar are of small size and have a peculiarly stunted appearance. They are infested with parasites, and also seem liable to a diseased condition in which the mantle and other tissues become of a yellow colour. In April, 1903, over 11 per cent. of the oysters examined were affected with this disease. The Muttuvaratu, like the Karativo and the Dutch Modragam, seems excellently adapted for the deposit of spat, but less reliable than the Cheval as a rearing ground.

IX. CHILAW PAARS.

There are several paars, large and small, in the neighbourhood of Chilaw, which have been described in Part I. (pp. 117, 118). The following record covers several of these :—

Mar., 1802.—Oysters 5 years old. On Jokkenpiddi, 4½ and 4 years old.

,, 1803.—Jokkenpiddi fished (yielded 163,154 rupees).

Oct., 1804.—Nothing on Jokkenpiddi.

Nov., 1812.—On the Jokkenpiddi Paar, oysters 4 and 5 years old, with young ones attached, estimated to be fished in 1815. On Karkopanni Paar, abundant oysters 2 to 3 years old, and to the north, some of 4 to 5 years. On the Chilaw Paar a small bank of oysters 4, 5, and 6 years old, half of them dead.

Nov., 1814.—On Karkopanni the oysters are thin and scattered, upwards of 6 years old, and there are many dead shells—to be fished in March. On Jokkenpiddi, only dead shells. On the Chilaw Paar nothing but rock and dead shells.

* Captain DONNAN informs me that it was his report on this disappearance which caused Sir E. WALKER, then Acting Governor, to write to the Secretary of State asking for an expert enquiry into the condition of the pearl banks, and so gave rise to the present investigation.

Mar., 1815.—Small fishery on Karkopanni (yielded 5842 rupees).

Dec., 1820.—On the Jokkenpiddi, a few oysters 2 years old. On the Karugugalie Paar a large bed of oysters 1 to $1\frac{1}{2}$ years old.

April, 1871.—No oysters.

,, 1875.—On Jokkenpiddi, a small patch. On Chilaw Paar, a large bed 6 months old.

,, 1876.—Still some oysters; doubtful if they are enough for fishery.

Nov., 1876.—On Chilaw Paar, 500,000 oysters 2 years old. On Jokkenpiddi, 250,000, 3 years old.

April, 1878.—On the south part of the Jokkenpiddi Paar there is a bed of oysters of "Kottapakku" variety, 4 years old. The others seen on Jokkenpiddi in 1876 are nearly all gone. Those on the Chilaw Paar are nearly all gone.

Nov., 1878.—Oysters on Jokkenpiddi all gone.

April, 1882.—On Chilaw and Karkopanni, beds of 2-year-old oysters.

,, 1883.—Last year's oysters still exist and thrive.

,, 1884.—Oysters dying off fast. Small fishery held on Chilaw Paar (yielded 17,153 rupees).

Nov., 1884.—Small fishery off Chilaw, and on Karkopanni.

April, 1885.—Three beds of young oysters 6 months old.

Dec., 1888.—Only one patch found in 1885 remains; oysters very few and scattered.

Nov., 1889.—Not inspected.

April, 1899.—No oysters.

Mar., 1901.— ,,

April, 1902.—Chilaw Paar had a bed of young oysters, 6 to 9 months old, covering about 1,120,000 square yards. Jokkenpiddi had many young oysters 3 months old.

Mar., 1903.—Not inspected.

Mar., 1904.—Oysters over 2 years old still present.

From the early Sinhalese records it seems probable that the banks off Chilaw were much more productive in ancient times than they have been during the last century. Chilaw seems, in fact, to have been formerly as important a fishery centre as Chilavaturai. The Sinhalese poem, 'Kovul Sandésaya,' written about the middle of the fifteenth century, refers to the pearl-lined shore of Chilaw in such a manner as to suggest that this locality was the centre of the Southern, or Sinhalese, pearl fisheries. In Portuguese and Dutch times its fame seems to have been eclipsed by that of the more northerly banks worked from the settlement at Manaar; but as the Chilaw region is still productive, and yielded at least three fisheries in the nineteenth century, it is possible that beds of oysters may have remained undiscovered and unfished. The record shows great gaps—from 1820 to 1871 and again from 1888 to

1899—so that probably the history looks less favourable than the reality may have been.

The fishery in 1803 was on the Jokkenpiddi Paar, and that in 1815 was on the Karkopanni, so that the fishery of 1884 was the only one on the Chilaw Paar proper—all were small fisheries. On the whole the record is uneventful, there have been no great successes and no marked catastrophes. There are no new conclusions to draw, but the banks may still be of value. There seems no reason why a bed of oysters should not mature on occasions, and parts of the Chilaw region will at least serve from time to time to supply a stock of young oysters to the Cheval or other paars that require replenishing.

Pearl fishing fleet at work on the Cheval Paar.

CONCLUSIONS.

This examination of the records of the principal pearl banks has served to emphasise some of the conclusions that were put forward in Part I. of this Report. In tracing the history of the different beds of oysters, in considering how the paars differ from one another and in trying to find the causes of such catastrophes as have occurred, we are brought to see :—

(1.) That man can do comparatively little to mitigate the severity of such influences as tell against the life and prosperity of the pearl oyster. He may possibly, if it be thought wise, to some extent diminish the ravages of certain carnivorous fishes, and he may by dredging the banks improve their condition and remove competing organisms. and also thin out beds that are overcrowded, but he is powerless against the invasion of microscopic parasites and of sand over-washes caused by monsoons, storms and tidal currents;

(2.) That much can be done, however, to preserve and make the best of what oysters we have, by careful inspections, by judicious transplantations and by speedy fisheries undertaken at the right moment.

Inspections should be as accurate, as frequent and as extensive as possible. They should extend beyond the conventional limits of the known paars and aim at exploiting new areas. It must be remembered that the greater part of the shallow shelf that forms the Ceylon side of the Gulf of Manaar out to the 10-fathom or 12-fathom line is potential "paar ground" and that new deposits of spat might be found any day on almost any part of it. It is impossible, of course, to inspect the whole area in detail every year, but it is important that lines of observations should be run across at least the more likely parts, and that could readily be done by means of a series of dredgings from a small steamer. The inspections should give early intelligence as to (*a*) new deposits of young oysters which might possibly require to be transplanted to safer ground, and (*b*) the necessity for a speedy fishery in order to save some threatened bed of adult oysters from being totally lost.

The necessity for transplantation has already been pointed out in Part I. It will suffice now to state that transplanting is the only means by which (*a*) many beds of young oysters can be saved from almost certain destruction, and (*b*) large areas of suitable ground can be supplied with a sufficient oyster population.

The relative efficiency of different methods of transplanting and also of speedy fishing by means of dredges or trawls—to be used in emergencies, when a bed of oysters might be lost if left unfished—are matters upon which Mr. Hornell, as Inspector of the Pearl Banks, is now experimenting, and it is hoped that in our recommendations which will conclude the final Part of this Report we may be able to incorporate results obtained from his present experiences.

Finally, there are prospects of good fisheries both next year and in 1906 on the Modragams and several divisions of the Cheval Paar—possibly also on the Muttuvaratu and the Dutch Modragam in the latter year. The results in 1907 and the immediately succeeding years will, so far as we can now see, depend upon whether large measures of transplantation are adopted without delay.

ANATOMY OF THE PEARL OYSTER.

(*Margaritifera vulgaris*, Schum.).

[With NINE PLATES.]

The Anatomy of the Ceylon Pearl Oyster has never been adequately investigated. L. G. Seurat, in his little book 'L'Huître Perlière,'* gives a short account of the structure of one of the large pearl oysters of the Pacific, *Meleagrina margaritifera*, and makes a few remarks upon the shell and some of the organs of the much smaller Ceylon pearl oyster (then known as *M. fucata*). Several writers on Molluscan morphology have described special points in our animal—or closely related species. For example, Grobben† gives some information as to the heart, Pelseneer‡ as to the branchiæ and nervous system, Ridewood§ discusses the gill structure in *Avicula argentea* and various species of *Meleagrina*, and Thurston|| gives a few figures and a brief description.

The works of Garner, Rawitz, Thiele and Biedermann all contain useful information bearing more or less on our subject. H. L. Jameson¶ has recently written on the identity and distribution of the mother-of-pearl oysters and has determined that the Ceylon form commonly known as *Avicula fucata* is in all probability the *Perlamater vulgaris* of Schumacher, belonging to the modern genus *Margaritifera*, and must therefore be known as *Margaritifera vulgaris*, Schum.

In the following account of the anatomy of the Ceylon pearl oyster, while the aim has been to give a fairly complete description of all parts of the body, those organs have been treated most fully which are of greatest importance in connection with the operations of the pearl fisheries and of the oyster culture. And, as in biological work generally Structure should never, if possible, be dissociated from Function, what information could be given in regard to the uses of the parts has been supplied when discussing the anatomy.

I have included as much as possible from our field-notes in regard to the habits and actions of the living animal as seen in our experimental tanks, since it is a rare event

* 'Encyclopédie Scientifique des Aide-mémoire.' Masson et C[ie], Paris, 1901.

† 'Arbeit. Zool. Instit. Wien,' Band VII., p. 410.

‡ 'Archives de Biologie,' tome XI., p. 198, 1891.

§ 'Phil. Trans.,' B, vol. 195, 1903, p. 147.

|| 'Madras Government Museum Bulletin,' No. I., 1894, p. 18.

¶ 'Proc. Zool. Soc.,' April 16, 1901, p. 372.

for the naturalist to have such an animal as this alive under observation. It will be noticed that certain of our figures—drawn by Mr. HORNELL—are taken from the living animal. Some of the photographs are his, others are my own.

Our pearl oyster and a number of allied "mother-of-pearl" shell-fish belong to the family AVICULIDÆ, which RIDEWOOD has recently shown to be more nearly allied to the PECTINIDÆ (scallops) and SPONDYLIDÆ, in gill structure, than to the OSTREIDÆ (the true oysters). They are therefore placed in the order ELEUTHERORHABDA, characterised by the relative freedom of the gill filaments (see description below), while the OSTREIDÆ and PINNIDÆ are placed in the group EULAMELLIBRANCHIATA. The order Pseudolamellibranchiata, in which the pearl oysters and their allies were formerly placed, has thus been abolished.

The general characters of the AVICULIDÆ (pearl oysters and their allies) are as follows:—

The shell is usually inequivalve, the dorsal margin straight, often very long and forming anterior and posterior wings or "auricles," the lateral teeth of the hinge-line are much prolonged and may be inconspicuous, the minute structure of the shell is "cellular"; the mantle lobes are not fused, siphons are absent; the foot is moderately long, tongue-shaped, with a well-developed byssus gland; the posterior adductor muscle is very large and nearly central, the anterior adductor is usually absent. The gills may or may not fuse in part with the mantle, gill lamellæ plicate and heterorhabdid, with both descending and ascending filaments which are held in position to their neighbours by "ciliated discs" placed at intervals along the filaments.

These and other important points in structure will be more fully described and explained in the pages below and are shown in some of the figures on the plates.

SHELL.

The bivalve shell of the Ceylon pearl oyster, *Margaritifera vulgaris*, SCHUM. (= *Avicula fucata*, GOULD), is inequivalve, the left valve being deeper or more convex externally than the right. Each valve is more or less rounded in outline, with a flattened dorsal edge ending in projecting wings or "auricles" in front and behind (Plate I., figs. 2, 3, 4). The dorso-ventral and antero-posterior diameters are much the same, and in a 4-year old specimen measuring 9·5 centims. in length (dorso-ventrally) the breadth (antero-posterior) is 9 centims. Two shells, both 8·5 centims. long, measured respectively 7 centims. and 8 centims. in breadth. Plate I., fig. 5, shows an unusually narrow form. Other variations in the shape of the shell are shown on the plates—Plate I., fig. 4 is an unusually straight and fig. 6 an unusually oblique form. In handling some thousands and seeing some millions of these shells, as we have done, one cannot but be struck by the great variation in form and markings. Probably some of the supposed species of *Margaritifera* are merely varieties of the Ceylon form.

The shell is very thin, about 1·5 millims. over the greater part of its extent, and is lined by an exceedingly brilliant layer of nacre or mother-of-pearl. The outside of the shell is usually marked by 6 or 8 radial bands of dark red or reddish-brown on a pale yellowish ground. These colours are brightest and best seen in young specimens, as in the older shell they become dulled and obscured on the outside by incrustations and growths (Plate II., fig. 2). They are, however, usually visible even in large specimens on the inside of the valve on the ventral margin (see fig. 1). The outer surface in the young shell is also marked by concentric ridges or projecting imbricating lamellæ, which grow out at intervals to form spatulate or finger-like processes (Plate VII., fig. 14), which may be over 12 millims. in length. These are sometimes seen in the old shell (Plate I., fig. 2). The layer of nacre ends from 10 millims. to 15 millims. back from the free edge of the shell (Plate I., fig. 4), and at that point the shell in a well-grown specimen is about 1 millim. in thickness. From this the shell thickens gradually towards the dorsal edge, reaching an average of 2 millims. at about the point of greatest convexity of the valve.

In thick shells it may be as much as 3 millims. at this point, and an examination of the section shows that this increased thickness is due entirely to the nacre, which may be 2 millims., while the prismatic layer is only 1 millim. Over the greater part of the shell these two layers are of equal thickness, say from 0·5 millim. to 1 millim. each. On the anterior ear of the shell, forming the side of the byssal notch, there is a thickening of the shell up to about 5 millims.; and at the hinge, in the mid-dorsal line, another local increase may reach to 8 millims.

At the ventral edge the shell beyond the lining of nacre gradually decreases in thickness, and in a rapidly growing shell the free edge is flexible and horny in consistence, being composed of periostracum and a thin layer of prismatic shell still imperfectly calcified. Two shells from Kondatchi Paar (17th November, 1902), measuring 7 centims. in length, have this delicate margin, free from nacre, extending up to 2 centims. in width, not including the processes at the edge (Plate I., fig. 3).

On Plate I., figs. 1 and 2 show the contrast between an unusually smooth and an unusually imbricated shell; figs. 3 and 4 show variations in the development of the nacre and the margin, and figs. 5 and 6 marked differences in the shape of the shell. The "auricles" and the byssal notch also vary much in their development, as may be seen from the figures.

The hinge line is a narrow ridge running along the greater part of the straight dorsal edge and in contact with its fellow of the other valve, but not conspicuously cut up into projecting teeth. Much elongated, narrow, ridge-like lateral teeth are present. Outside the middle third of its length is the large black elastic ligament (see Plate I., fig. 4). It may measure in an adult shell about 20 millims. in length and 5 millims. in breadth. The ligament serves to open the shell, and so is antagonistic to the adductor muscle. Alongside the ligament and extending from the hinge line upwards to the umbo (the most prominent point of the valve, placed in front of the ligament near the anterior end of the dorsal edge) is a sloping area of roughened shell, marked with close-placed lines of growth. This area (Plate I., fig. 4) becomes much more extensive, and less vertical in its slope, because of an increased thickening of the hinge, in old shells, and its condition is a good guide to the age after the shell has ceased to grow actively in length and breadth.

The shell is composed of three layers, outer, middle, and inner. The very thin outer layer is the uncalcified, cuticular "periostracum," an extremely delicate horny layer which allows the colour of the layer below to show through, and which becomes worn off in old shells. At the free margin of the shell the periostracum is very thin and transparent, extends beyond the calcareous matter, and is reflected to join the surface of the ectoderm cells of the mantle-edge in the longitudinal groove where it is secreted. The periostracum is seen in several parts of the section represented in Plate VIII., fig. 1, and also as a detached film in the groove on the mantle-edge in Plate VIII., fig. 2, *Per. ostr.*

The middle or "prismatic" layer of the shell shows what CARPENTER called, in *Pinna*, a "cellular" structure being formed of calcareous prisms or columns running transversely to the surface, and appearing as polygons in section (Plate VII., figs. 14 to 18, and Plate VIII., fig. 1).

The carbonate of lime is laid down in an organic matrix of conchiolin, and is found in the adult pearl oyster to be in the form of the mineral aragonite. The prismatic layer is deposited by the mantle epithelium near the free edge, just behind the margin which forms the periostracum; and many such layers of prisms may be formed successively, each new one inside the last, as the shell grows. At the free edge of the shell and on the imbricating ridges these films may separate and stand out as in the section shown on Plate VIII., fig. 1. The red and brown coloration of the shell is in this layer, certain of the prisms being charged with pigment, as shown in fig. 18 on Plate VII. Various stages in the decalcification of the prisms is shown in fig. 19. Complete decalcification reduces a section to a honey-comb-like network of conchiolin (as shown in Plate VII., fig. 17), which is continuous with the very similar organic periostracum lying over it.

The inner layer is the "nacre," formed of numerous delicate lamellæ of the organic matrix conchiolin, and calcareous matter. It is transparent under the microscope, allowing the "cellular" structure of the prismatic layer to show through it clearly (see Plate VII., fig. 15), and is almost structureless, having merely a fine granular appearance (Plate VII., fig. 21) in surface view under a high power. The layers of which it is formed show as a series of very closely placed contour lines (Plate VII., fig. 20). The most conspicuous feature of the nacre is the beautiful iridescence, an interference phenomenon due to the diffraction of light by the irregular free edges of the numerous delicate lamellæ, alternately calcareous and organic, of which the layer is formed. The iridescence in the case of the Ceylon shell is singularly brilliant, but the nacre is too thin to be of much value in the arts.

The markings on the interior of the shell (Plate IV.) consist of :—

(1) The large adductor impression sub-centrally placed and occupying from one-third to one-half the diameter of the shell; and

(2) The pallial line and scars caused by the insertion of the pallial muscles, which are fan-shaped bundles formed of fibres radiating outwards from small insertions placed along the pallial line. These insertion scars vary considerably both in number and in form. Usually there are from 12 to 15 between the umbonal region, where they begin anteriorly, and the antero-ventral end of the adductor, with 3 between the dorsal tip of the latter and the hinge line (see Plate IV., figs. 2 to 6). Besides these, which are distinct scars, there is an extremely narrow and practically continuous insertion band confluent with the posterior and ventral edge of the adductor scar. This band leaves no separate impress upon the nacreous surface of the valve, its scar, like that of the retractor muscle of the same side, being merged with that of the adductor (see Plate IV., fig. 1). Figs. 2 to 6 show five variations in the distribution of the insertion scars of the pallial muscles, while fig. 1 is the typical arrangement of the muscles as seen on removal of the valve.

As to the size of the Ceylon pearl oyster shell at different ages, we believe from our observations on different grounds that there may be very considerable variations according as the conditions are favourable or the reverse. It is difficult to get well-established dates fixing the ages, but the following figures may be useful as giving some indication.*

A pearl oyster in the Master Attendant's Office at Colombo, labelled by Captain DONNAN as being $2\frac{1}{2}$ years old, measures $3 \times 2\frac{3}{4}$ inches.

The average of the oldest pearl oyster from the Muttuvaratu Paar in March, 1902, also considered by Captain DONNAN to be $2\frac{1}{2}$ years old, is $2\frac{1}{4} \times 2$ inches.

A 1-year-old oyster, from the samples in the Master Attendant's Office, measures $2\frac{1}{8} \times 2$ inches.

Some natural-size drawings made by Dr. ONDAATJE many years ago, at Colombo, show the following sizes :—

1-year-old measures	. . . .	2×2 inches.
2 ,, ,, ,,	. . . .	$3 \times 2\frac{3}{4}$,,
3 ,, ,, ,,	. . . .	$3\frac{1}{2} \times 3$,,

Mr. HORNELL is now measuring very large numbers of shells, and is determining more accurately than has yet been done the average growth year by year, and the results of his observations will appear in the final volume.

* See also the measurements and weights given in "Observations and Experiments on the Life-History and Habits of the Pearl Oyster," in Part I. of this Report, p. 136.

GENERAL ANATOMY.

Before describing the different systems of the body in detail, it may be well to refer to a few of the figures on the plates, which give some idea of the general structure and arrangement of the soft parts of the animal inside the shell.

Fig. 3 on Plate II. shows the left side of the animal when one valve of the shell has been removed; the dorsal surface is above and the anterior end to the left. In the centre is seen the single great adductor muscle (white) with the heart and viscera above it, the sickle-shaped gills (dark) curving round the lower central surface of the muscle, and the foot (at the base of the gills) with its byssus fibres projecting anteriorly (to the left). The mouth is above the byssus, and the anus on the ventro-posterior edge of the muscle where the anal funnel can be seen projecting (right-hand side of figure).

The three widely gaping specimens seen in fig. 5, A, B, C, show the adductor muscle in the middle crossing from valve to valve, the gills in the form of two lamellæ on each side and a mantle lobe or pallium lining each valve of the shell. The pigmented mantle-edge, studded with little papillæ or tentacles, is well seen in the left-hand specimen (A).

The diagrammatic dissections shown in figs. 1 and 2 on Plate VI. give the chief systems of the body in their relative positions. Fig. 1 shows mainly the course of the alimentary canal from the mouth (*O*) to the stomach (*St.*) and through the various parts of the intestine to the anus (at *An.f.*). Fig. 2 shows, in addition, the heart (*Au.* and *V.*) and the principal blood-vessels. The lettering of these figures in the Explanation of Plates will supply further information.

Finally, the series of sections through different parts of the body, given in Plate V., show the relations of gills to mantle lobes, of gills to foot, of adductor muscle to viscera, of stomach to liver, of intestine to heart, and so on. They need not be described here in detail, as a full account of each is given in the Explanation of the Plates.

PALLIUM OR MANTLE.

The integument or outer part of the body-wall forms two great lateral flaps, the right and left pallial or mantle lobes which line the valves of the shell and wall-in the pallial cavity—the space, freely open to the water when the shell gapes, into which the foot and the gills project (see the top row of sections on Plate V.). The two pallial lobes are separated anteriorly, ventrally, and posteriorly, but become continuous dorsally underneath the hinge-line of the shell. The free edge of the lobes is thickened, pigmented, and fringed with short branched tentacles (see Plate III., figs. 6 to 10). This pallial edge of the mantle is attached some little distance inside the margin of the shell, and the nacre stops short where the mantle is attached (see Plate II., fig. 6, where the mantle has been drawn back at one point to show the nacre), and that is the point to which the mantle is retracted in preserved specimens, leaving the non-nacreous part of the valve exposed (see also text-fig. 1, where the pigmented mantle edge is drawn up on the left side of the figure to show the nacre).

The mantle has the same general structure as in other better-known Lamellibranchs, such as the European oyster, *Ostrea edulis*. It is composed mainly of connective-tissue traversed by muscular bundles and numerous blood spaces, and covered on both

Fig. 1. Dissection of pearl oyster from the right side, showing the stomach and digestive gland, the gills, foot and byssus, pigmented pallial margin, and a cyst-pearl *in situ* at the top left-hand corner; natural size, from a photograph by Mr. HORNELL.

outer and inner faces by a layer of epithelial cells, the ectoderm (Plate VIII., fig. 2). The epithelium on the outer surface, next to the nacreous layer of the shell, is secretory, while on the inner free surface, facing the pallial cavity, the ectoderm is ciliated (Plate VIII., fig. 2, *i.ep.*). The centre and dorsal part of each pallial lobe is adherent to the rest of the body and thus envelops the viscera (Plate V., fig. 10, *Pall.*), while the ventral and marginal parts hang down freely like a flap or curtain, so as to form the side walls of the pallial cavity (see various sections on Plate V.).

Further details of the minute structure of the mantle are seen in fig. 2 on Plate VIII. The marginal and velar processes, the deep periostracal groove, the blood spaces, the glands, the muscles, and the nerves are all evident. The character of the epithelium in different parts is shown in the more highly magnified side figures:—A. shows the tall epithelium which secretes the prismatic layer; B. is the much lower general surface which deposits nacre; C. shows the ciliated internal surface; D. and E. the side and end of the marginal groove, with glands and high epithelium for the secretion of the periostracum.

Each pallial lobe may be divided into three parts, a central, a distal or muscular, and the marginal mantle-edge. The central pallial area extends from the mid-dorsal line to the pallial line (Plate IV., fig. 1), where the shell is marked with muscle scars. This part of the pallial lobe is perforated by the insertions of the adductor (*Add.*), the retractor (*Ret.*), the levator (*Lev.p.*, *Lev.a.*), and the pallial muscles. In a healthy condition of the living pearl oyster, the tissues of this part of the mantle are soft and mucoid in consistence, and opalescent white in colour. After hardening in alcohol this tissue becomes brittle, and has a semi-prismatic fracture which is very characteristic. All varieties of pearls—cyst, ampullar, and muscle pearls—may form within its substance. Text-fig. 1, p. 43, shows a cyst-pearl *in situ* close to the dorsal extremity of the adductor muscle.

The distal or muscular area is translucent, and is capable of considerable contraction by its muscles, and distention by the influx of blood into the large sinuses it contains. It is formed of a thick layer of loose connective-tissue traversed by nerves and blood-spaces, and by the radiating fan-like bundles of the pallial muscles (Plate VI., figs. 1 and 14, *Ret.Pall.*). This region is highly sensitive and irritable, and so contractile that we found it difficult to introduce even minute foreign bodies between the mantle-lobe and the shell in our experiments on artificial pearl-production.

The marginal region or mantle-edge is chiefly a muscular thickening which ends in two thin membranous folds with pigmented papillate edges (Plate II., figs. 3, 5, A, and text-fig. 1). The outer of these, bearing digitate papillæ, is in the same plane as the inner surface of the shell and forms the true pallial edge (Plate V., fig. 1, *Mg.Pall.*). The inner, which bears flattened palmate papillæ, and may be called the pallial veil or velum, projects inwards at right angles from the mantle-edge (Plate V., fig. 1, *Vel.*), so that the veil of the one pallial lobe stretches towards that of the other (Plate II., fig. 5, A). In life the free edges of the two veils are usually in contact along the median line of the body, except at two spots where they gape. One of these, the inhalent aperture, is somewhere about the middle of the ventral surface; while the other, the exhalent, is at the posterior end, opposite the opening of the anal funnel and supra-branchial chamber. The former is not a permanently localised or specialised opening, its position and its size and shape vary considerably from time to time, so that any part of the ventral edge may form temporarily the inhalent gap through which the main in-flowing current passes. The exhalent aperture, on the contrary, is definitely localised and specialised. In outline it is broadly ovoid or almost circular (Plate III., fig. 10). Its broad rounded lower (ventral) margin is immediately dorsal to the pallial fold, an inwardly directed gutter-like fold of the velar margin that meets the tip of the ctenidium (see Plate VI., figs. 1, 2, &c., *Pall.f.*).

In 3 to 4-year old oysters the velum has a breadth of fully $\frac{1}{4}$ inch on the ventral aspect where it is most fully developed. Here, too, the marginal processes are largest, and are of two kinds, long and short, several of the latter usually alternating with the singly placed longer (Plate III., fig. 6). Diversity of form in the larger ones is great, no two being quite alike, but most of them are doubly trifid, the summit of the papilla being first divided into 3 stout branches, each of which again divides into 3 digitate twigs; occasionally a twin process is seen (fig. 7). The extremities of the twigs bear minute (? sensory) processes formed of groups of epithelial cells.

In a healthy expanded oyster, where the papillate edges of the velum meet, these large papillæ interdigitate (Plate III., fig. 10). The short papillæ, which are placed between, are simpler, and digitate in form.

Along the posterior edge of the body, *i.e.*, from the pallial fold upwards to the posterior end of the hinge, the larger papillæ of the veil become greatly reduced in size and simpler in form until, in the region of the posterior "auricle" of the shell, they approach in character those of the pallial margin. The same reduction in size is also seen in the velar processes within the anterior auricle.

The pallial margin consists of a conspicuously pigmented papillate free inner edge and an outer fold, which is continuous with, and is covered by, the film of periostracum which folds over the free edge of the valve (Plate VIII., fig. 2, *Mg.Pall.* and *Per.Ostr.*). The whole of the free margin is drawn out into very delicate and very sensitive elongate digitate processes of two sizes, long and short (Plate III., fig. 8). In young specimens, 1 year old, the tips of the longer papillæ bear asymmetrically disposed secondary projections, sometimes simple, sometimes very abbreviated. In older individuals—2 years old and upwards—these longer papillæ become further elongated and conspicuously fimbriated (Plate III., fig. 9). They can be seen, when alive, swaying and bending gracefully about as if the tip were a tactile organ on watch, feeling first in one direction, then in another. These finger-like processes are especially well developed in the region of the exhalent aperture—some, a full $\frac{1}{4}$ inch in length, projecting even beyond the velar papillæ, which latter are here turned outwards in the same plane as the mantle lobe. The long processes stand singly, separated from one another by from 2 to 11 short and usually simple digitate papillæ closely set (Plate III., fig. 8). The appearance of the surface of a papilla in section is shown in Plate VIII., fig. 2, at *Mg.Pall.*

The Ciliated Pallial Path.—The whole of the inner surface of the pallial lobes is ciliated, but, at the ventral truncate edge of the labial palps, a specially marked ciliated path begins which, curving at once outwards and downwards, passes to the base of the velum, parallel with which it runs until it reaches the anterior wall of the pallial fold, where it passes over the velar edge by means of a slight folding of the latter (*Pall.f.*, Plate VI., fig. 14). The cilia of this pathway are in continuous action from before backwards, by which means the unsuitable particles collected by the gills and sent forward to and rejected by the palps are conveyed away and passed out from this pallial fold (Plate VI., figs. 1, 15, &c., *Pall.f.*).

When coming under the influence of the strong excurrent flow from the gills, the smaller particles are frequently propelled to a considerable distance from the oyster—a provision to ensure that they do not again become a source of annoyance and loss of energy to the animal. This provision for thus disposing of unsuitable particles is especially useful when the water is disturbed and laden with sand or mud. Under such circumstances the oyster feeds slowly, rejecting nearly everything that comes. When, as happened sometimes in our tanks at the Galle Marine Laboratory, the in-flowing water was laden with decaying vegetable *débris* in great quantity, or when mud was present, the palps accumulated the particles till they had enough to form a small bolus. This while forming was revolved constantly by the palpar surfaces. When large enough, a twist seemed to be given to it whereby it passed from the palps to the anterior end of the pallial ciliated path, along which it advanced rapidly, and was shot out in a few seconds. In the course of a few hours it has been noticed, when the tank water remained still, that a conical pile of ejecta more than $\frac{1}{4}$ inch high accumulated on the ground just behind the oyster (Plate VI., fig. 14, *Pel.*).

Pigmentation.—The free pallial margin together with the velum is in most cases deeply pigmented (Plate II., figs. 3, 6), usually in black, grey, and shades of yellows and browns, mostly chestnut brown, though orange is also frequent. The pigmentation is usually in the form of large alternate blotches which give a certain appearance of regularity to the colouring; but the exact pattern varies much. It is noticeable, however, that there is considerable difference in the degree of pigmentation in oysters from quite shallow water and in those from depths of 6 to 10 fathoms. The latter have the colouring mainly confined to the velum and the pallial margin, whereas in the former the pigment may extend widely over the general inner face of the mantle. We find that orange and chestnut tints are much more frequent amongst the pearl oysters of Trincomalee Harbour, which live in shallows averaging from 6 to 18 inches at low tide, than amongst those from the deeper banks in the Gulf of Manaar. The gills also are more frequently and more extensively pigmented at Trincomalee than amongst individuals from deeper water.

THE FOOT AND BYSSAL ORGAN.

The Foot is a highly mobile tongue-shaped organ capable of great elongation and contraction. It arises from the anterior region of the visceral mass nearly midway between the mouth and the intestinal lobe and has the anterior extremities of the branchiæ flanking it on either side (Plate VI., fig. 1). The greater part of its bulk is composed of networks of muscle fibres running in various directions, thus ensuring a wide range of movement, and is so extensively penetrated by blood spaces that the organ is highly cavernous. When these spaces are rendered turgid through an influx of blood, the foot becomes erected and is then quite three times as long as in the completely contracted, non-turgid state. In the latter condition it has the form of a slender elongated cone tapering gently from a wide base to a pointed apex (Plate III., fig. 13). The dorsal and ventral surfaces are clearly distinguishable, the former convex in section; the latter, which is grooved longitudinally, is also convex in section when in a state of contraction (Plate III., fig. 21). It becomes flattened in the distal third when the organ is extended (fig. 20). In oysters of 2 years of age and upwards the dorsal surface and the sides of the foot are usually so thickly covered with dark chestnut pigment speckles as to appear quite brown. The speckles become less numerous on the lower parts of the sides as they approach the prominent white edges of the ventral or pedal groove, while the floor of the locomotor or anterior part of the pedal groove is usually pigmented similarly to the exposed part of the foot. Occasionally the pigment is purplish-brown, dark drab, or even dark orange.

The foot in 3-year-old oysters is capable of extension to over $1\frac{1}{2}$ inches when fully turgid; in contraction the length is $\frac{1}{2}$ inch or even less. In an older oyster it may be extended to over 2 inches. Oysters 6 to 9 months old can extend the foot to a length of 1 inch, contracting it to about $\frac{1}{3}$ of an inch.

A deep pouch-like pit, the byssus gland or organ, is lodged at the proximal end of the foot upon the ventral aspect. The wide mouth of the pit (Plate III, figs. 13, 14, 15, 22, &c.) is a little way anterior to the junction of the foot with the visceral mass, while the pouch itself penetrates deeply backwards and slightly downwards into the central portion of the visceral mass (Plate VI., fig. 2). The axis of the mouth of the byssal gland coincides with the longitudinal axis of the foot. The byssal gland lodges the common "root" of a bundle of stout, laterally-flattened, bronze-green fibres, the byssus, which by means of a discoid attachment at the distal extremity of each fibre anchors the pearl oysters to rocks and other objects (Plate III., figs. 16, 22, 22, 23). The anterior edge of the mouth of the byssal gland passes into a groove, the pedal groove, extending medially along the whole of the remaining length of the ventral surface of the foot (Plate III., fig. 20, and Plate VIII., figs. 3 and 4).

The pedal groove comprises two regions functionally distinct, a distal or locomotor and a proximal or secretory. Both are, indeed, lined with a layer of secreting glands, but while this layer is of great thickness in the proximal region, in the distal it is thin, and the secretion is of a different character (Plate VIII., figs. 3, 4). When the foot is contracted, the edges of all parts of the pedal groove are approximated.

The hinder or secretory part of the groove has two regions, an anterior part which is cup-shaped when in use, and a hinder which is nearly always tubular through the approximation of the lips of the groove. The anterior cup-shaped part is about mid-way between the base and the tip of the foot, and may be termed the "disc-pit." The tubular byssal groove connects this with the byssal gland. Figs. 3 and 4, on Plate VIII., represent the structure of the foot as seen in transverse section; both show the numerous muscle bundles, longitudinal, circular, and oblique; fig. 3 has the open locomotor pedal groove ventrally, and fig. 4 the closed byssal groove which becomes an open canal further out.

Functions of the Foot.—The functions of the foot are threefold: the distal ventral surface subserves locomotion; the median and posterior parts effect attachment by means of the secretion of the byssal fibres; lastly, on account of the general mobility of the organ, and probably its sensory nature, the tip is of great use in cleaning the gills and mantle from intrusive particles that cannot otherwise be got rid of.

Locomotion.—As has been explained in this Report, Part I., the pearl oyster is capable of travelling short distances when it is freed from the byssal cable which attaches it to some foreign body. When separated either by the byssus being wrenched away, as may happen in diving operations or in dredging for transplantation, or by its own action in sloughing the root of the byssus, it soon, under favourable conditions, extends the foot as far beyond the shell as possible and begins to travel. The tip of the foot circles round, bending first in one direction and then in another, till it meets a body suitable for crawling upon. Then the groove immediately behind the tip opens (see Plate III., figs. 18 and 19) and is flattened against the surface selected, whereupon progression takes place by alternate extension and contraction, as seen in the crawling action of the typical gastropod foot. Only that part of the pedal groove anterior to the disc-pit takes part in the locomotion, an action therefore strictly limited to the distal third of the organ.

Cleansing.—As to the use of the foot in freeing the gills, palps, and mantle from intrusive bodies, it can be seen through the partly open valves of a living oyster that the point is pushed between the gill plates, and over the inner surface of the mantle, gently stroking the surface and insinuating itself into the crevices, thus freeing the parts from any foreign bodies—accumulations of *débris*, &c.—that might cause inconvenience. It is frequently on the move in this manner; when at rest, it lies shortened up, with the tip turned to the left, and tucked downwards between the left gill and the mantle. In one pearl oyster, in which Mr. HORNELL had broken a hole in the umbonal region of the valve, the mantle beneath being also pierced, the foot was seen feeling gently round the edges of the wound and working off particles of dirt that had gathered. The tongue-like tip was passed occasionally *through* the wound in the mantle and projected somewhat, at one time well beyond the hole in the valve. The tip also freed the wound from dirt lying between the mantle and the valve.

Attachment by the Byssus.—When a pearl oyster finds a place to re-attach to, subsequent to sloughing a former byssus, it uses the locomotor region of the tip as a suctorial organ to hold its body in position, while at the same time the disc-cup expands and its edges press against the attachment surface, and the edges of the byssal groove are tightly closed against one another. While in this position, the byssal gland pours forth through the byssal groove a quantity of a fluid secretion which has the property of coagulating and hardening upon contact with sea-water. This secretion sets in a remarkably short time, and usually after the foot has remained pressed to the contact surface for between 3 and 5 minutes, it is withdrawn and then reveals the presence of a pale yellow, elastic strand stretching from the mouth of the byssal gland to the point where it is attached by an oval disc, which is a model of the cavity of the disc-pit. During the withdrawal of the foot the edges of the byssal groove open to permit of the newly-formed byssal fibre passing out. Under favourable conditions this operation is performed again and again, until at last from 50 to 70 fibres are formed, constituting a wonderfully strong cable of attachment. In 3-year-old oysters the byssus is so strong that the twist and wrench necessary to break it off requires a distinct effort. The divers dislike fishing pearl oysters which are attached individually to rocky surfaces, as the effort of wrenching them off reduces the result of the day's work both by taking longer time and also because of the weariness induced by the hardness of the work. After a few days' fishing on a rocky bank the divers' hands become painfully lacerated unless they take the precaution, as many do now, of using roughly made gloves. From the age of 4 to 5 years the strength of the byssus decreases, rendering the older oysters more easy of detachment.

Structure of the Byssus.—On examining a sloughed byssus we find that the individual fibres arise from an ovate, laterally compressed "root" (Plate III., fig. 23; sometimes it is forked with laterally spreading groups of fibres), the surface whereof is corrugated or laminated in correspondence with the parallel folding or grooving, which is characteristic of the inner surface of the walls of the byssal gland (Plate VIII., fig. 5). This mass can be resolved into branched or pennate fibres, the twigs of which penetrate between the lamellæ of the gland and come into close relation with the surrounding muscle bundles. Each byssus fibre, outside the body, is distinctly flattened laterally, and can be readily frayed into a number of longitudinal fibrils. Each terminates distally in an oval disc by which attachment is made to rocks, old oysters, and other suitable bodies. The fibres are of a lustrous deep bronze-green colour, growing paler as they enter the root. When first formed, however, they are pale yellow, gradually becoming of the characteristic green tint in the course of the ensuing 48 hours.

The byssus is markedly elastic and very tough, and the disc is so firmly attached that if sufficient tension is applied either the substance to which the disc adheres gives way or the strands themselves break. It is a most rare occurrence for the "root" to be torn out—a fact that is of the greatest importance in the cultivation by transplantation of the pearl oyster, as otherwise the pearl oysters dredged for transplantation would be so injured during the operation that death would ensue in the majority of cases. As it is, the wrenching off of pearl oysters is found in practice to induce no ill effects. An hour afterwards, under favourable and natural conditions, the pearl oyster begins to slough the root of the ruptured byssus and may, indeed, actually make re-attachment by means of a new byssus within this period.

The approximated ends of the two retractor muscles are attached to the hinder end of the byssal gland (Plate III., fig. 24, *Ret.*). The structure of the byssus gland, as seen in section, is shown in fig. 5 on Plate VIII. It is divided into two halves, placed right and left, and each formed of parallel layers of glands opening into narrow folds, in which the secretion forms long, and in places convoluted, threads. The byssus fibre is a compound structure formed by the union of a number of these threads of secretion. The figure shows a few of the narrow folds from one side only, the glands, the convoluted threads of secretion and the close relation with groups of muscle fibres on the periphery of the organ.

THE MUSCULATURE.

The pearl oyster is monomyary, possessing a single adductor (the posterior), the largest and most important muscle in the body. The other muscles present are:—one pair of retractors of the foot, two pairs of weak pedal levator muscles (superior retractors), the orbicular retractor muscle of the mantle (pallial muscles), the intrinsic muscles of the foot and visceral mass, the branchial bands, and the heart or cardiac muscle (which will be discussed under the vascular system below).

The Adductor Muscle of the shell (*Add.*, Plate VI., fig. 1) stretches transversely across the body from valve to valve. It is a massive bundle, wedge-shaped in section, and slightly curved (Plate II., figs. 3, 4). The narrow end points upwards and lies immediately behind the ventricle of the heart. The terminal part of the rectum runs in the middle line along the posterior surface (Plate VI., fig. 1, *Int.* 3).

As the concavity of the muscle faces upwards and forwards, the wider ventral end, which is rounded, is turned anteriorly. Its anterior margin marks, approximately, the centre of each valve, while the dorsal and posterior apex lies a short distance in front of the posterior sinus in the margin of the shell. Thus, as the lower end of the adductor stretches from side to side in the widest region of the body, the fibres decrease in length as they approach the dorsal and posterior extremity, where the extent of the muscle is less by half than at the anterior and ventral end.

The muscle is not homogeneous; two distinct regions are obvious. The one, a narrow tendinous strip made up of white glistening fibres, forms the posterior border (*Add.'*, Plate VI., fig. 1, and sections on Plate V.); the other, broad and massive, of colourless, semi-translucent fibres, occupies the remainder of the mass. Under the microscope, the fibres of the latter are finer when teased up, and have an appearance which has been described as striation, but is by no means distinct;* those of the former are about two to three times as thick, more fleshy and quite smooth.

The substance of this muscle is permeated with lacunar spaces, penetrating into and among the loosely compacted bundles of fibres. The blood supply is derived from the posterior pallial arteries which arise from the terminal branches of the posterior aorta and pass outwards to the mantle sunk within the substance of the tendinous portion of the adductor (*Art.p.p.*, Plate VII., fig. 4).

The power exerted by the adductor in bringing the two valves together by its contraction is very considerable, and the action is very rapid. Sir WILLIAM TWYNAM

* Very much less obvious than the striation of the corresponding fibres in, for example, *Pecten opercularis*.

relates ('Report on Ceylon Pearl Fisheries,' p. 6, 1900) how at the fishery of 1891, after the oysters had been landed and had lain in heaps in the Kottu for some time, one gaping individual had still strength enough left to snap at and seize a hungry sparrow which incautiously attempted to feed upon it. The oyster held on so tightly that all the efforts of the trapped bird to escape were vain, and the strangely assorted pair are now to be seen in Sir WILLIAM TWYNAM's museum at Jaffna. Similarly, Mr. HORNELL reports that an oyster lying in the Kottu during the last fishery (1903) captured a mouse (now in the possession of the Lieutenant-Governor the Honourable Mr. E. IM THURN); and that he himself saw the foot of that agile animal, an inquisitive mongoose, caught by an oyster which resisted all the efforts made to dislodge it for nearly five minutes.

Although the pearl oyster has not the power of moving rapidly through the water or over the sea-bottom after the fashion of *Lima* and of some species of *Pecten*, by the violent expulsion of water caused by a sudden closure of the valves, still it can eject a jet of water with some force to a distance of 9 to 12 inches, as can be seen when living oysters are watched in shallow vessels of water. This forcible ejection is evidently useful in dislodging any small animals and other particles that may have gained access to the branchial chamber.

The Retractors of the foot are a pair of symmetrically disposed muscles lying in the horizontal plane of the body. They originate (*Ret.*, Plate III., figs. 24, 25) in the walls of the byssal gland and, then diverging, pass backwards in V-like manner, to be inserted, one into the right valve, the other into the left, within the concavity of the adductor scar (compare *Ret.* on Plate IV., fig. 1, with other figures on same plate). Neither retractor impresses a separate scar upon the nacre, the posterior edge of the retractor impression blending indistinguishably with the anterior edge of that of the adductor.

In its anterior portion each retractor is sub-cylindrical, flattening to an oval, in section, at the place of insertion. There is no decussation of the fibres of the two bundles at their junction anteriorly.

The Levators of the foot are four, two anterior and two posterior. Each of the anterior pair (*Lev.a.*, Plate III., fig. 26) has its insertion at the apex or inmost point of the umbonal recess of its respective valve—a point directly dorsal to the mouth region. From this place the fibres pass vertically downwards, on either side of the mouth, spreading laterally, fan-like, as they go. The external lateral fibres eventually blend with the muscular sheath on the sides of the viscero-pedal mass, while the inner or anterior fibres pass into the root of the foot.

The left anterior levator is considerably stronger than its neighbour, a specially strong cord of fibres passing on the inner side to the dorsal aspect of the root of the foot. By the contraction of this cord the foot is drawn over to the left side, which is its normal position when in a state of rest. The explanation of this asymmetrical arrangement is seen in the fact that the left valve is much deeper and consequently more roomy than the right, and so the foot is more easily accommodated on that side of the body (as shown in Plate II., fig. 6).

The posterior pedal levators (*Lev.p.*, Plate III., fig. 26) are two short insignificant bundles which originate high up in the fibres of the anterior levators, exactly on the level of the mouth. Thence their course is backwards and upwards through the visceral mass to an attachment to the valves behind the scar of the corresponding anterior levator, but on a slightly lower plane. The whole course of each posterior levator in an adult oyster is less than one-quarter of an inch—from $\frac{3}{16}''$ to $\frac{1}{4}''$. The contraction of the anterior levators causes the foot to be retracted and raised dorsally; the coincident shortening of the posterior levators introduces a drag towards the rear. No protractor muscles are present, turgescence of the venous pedal spaces effecting, in the main, the protrusion of the foot when muscular relaxation takes place.

The Intrinsic Muscles of the foot and viscera are diffuse rather than in masses. Those of the foot form a muscular enveloping sheath or interlacing net of considerable thickness and complexity. It is formed of several ill-defined layers and scattered bundles, shown in transverse section on Plate VIII., figs. 3 and 4. A number of the internal bundles run in the main longitudinally along the foot, some fibres run circularly, there are groups diverging radially, and in some parts the fibres interlace in various directions.

In the visceral mass proper, small transverse muscle bundles pass from side to side, binding its tissues together and providing a framework, slight though it be, wherein ramify the tubules of the digestive gland and of the gonads. These transverse intrinsic bundles are somewhat spindle-shaped, each end narrowing to a tendinous insertion attached to the fibrous connective-tissue ensheathing the visceral mass.

Of other intrinsic muscles the most important are the branchial, one of which, in the form of a flat band of muscle fibres, runs within each ctenidial axis from end to end, close to the dorsal edge, along with a large nerve. These bands have the effect of retractor muscles, shortening the gills and withdrawing their posterior extremities, an action assisted by other muscle fibres which radiate, fan-like, from a point just in front of the anterior margin of the adductor. There are also muscle bundles running longitudinally down each side of the principal filaments (Plate VIII., fig. 13, *m.b.*).

The Pallial Muscles (*Ret.pall.*, Plate VI., fig. 14) are all retractors, and together constitute the orbicular muscle of the mantle. They are a series of fan-shaped muscles, radiating outwards to the mantle edge from a number (15 to 18) of insertion centres of various sizes, arranged circularly, and which together form the well-marked pallial line of scars that runs parallel with the margin of the shell, upon the inner surface of each valve (Plate IV., figs. 1 to 6). The fibres lie entirely within the layer of loose connective-tissue, that is between the inner and outer epithelial surfaces of the free portion of the mantle. Their ultimate ramifications form an anastomosing network, the branches diverging and reuniting in the complex manner seen in Plate VII., fig. 13. The bundles in some cases surround the branches of the pallial nerves.

With the exception of the heart, and the somewhat indistinct appearance of striation in the larger portion of the adductor, the muscle fibres throughout the body are non-striped.

THE ALIMENTARY CANAL.

As the œsophagus and the stomach, together with two-thirds of the intestine, lie within the viscero-pedal mass (see Plate VI., fig. 1), the surrounding tissues, first those of the superficially placed gonad and then of the more deeply lying digestive gland have to be carefully picked away before the relative positions and the course of the parts can be traced. Hardened material is easier to manipulate than fresh ; and the best method is to kill the animal by immersion in a 5-per cent. aqueous solution of formol, and to keep it therein till the day prior to dissection, when it should be removed from the shell and soaked in several changes of fresh water to remove most of the formol.

Two projecting horizontal lips conceal the aperture of the mouth (*O.*, Plate VI., fig. 1). Each is smooth on both outer and inner surfaces, and is produced laterally at each extremity into a labial palp, the upper lip passing right and left into the right and left dorsal palps, and the lower into the corresponding ventral palps (*Pa.*, in various sections on Plate V.). The palps are smooth on the surfaces turned away from the mouth, but are closely grooved on the opposed faces which bound the entrance to the mouth. The mouth thus guarded lies at the base of the deep cleft formed by the approximation of these lips. It is a large, slit-like depression placed transversely between the anterior levator muscles of the foot. Each of the two corners or angles of the mouth is produced laterally to merge imperceptibly into the palpar gutter that marks the line of junction of the dorsal and ventral palps of that side. In this way a long shallow ciliated gutter leads up to each angle of the mouth from between the palps.

The oral cavity rapidly contracts inwards to the narrower width of the œsophagus (*Oe.*, Plate VI., fig. 1), which is a short, straight, ciliated tube, dorso-ventrally compressed, continued posteriorly along the median line and in the same plane as the mouth. Its hinder end opens into the anterior end of the stomach, slightly below the level of the roof.

The form of the stomach (*St.*, Plate VI., fig. 1) is ovoid, the long axis lying horizontally, with the narrow end directed anteriorly and slightly upwards. It is unsymmetrically placed, encroaching greatly upon the left portion of the visceral mass—so much so that three-fourths of its capacious chamber lies to the left of the median plane. Except at the extreme left, and for a small space on the roof, it is enveloped by the digestive gland.

Folds and depressions diversify the walls and floor of the stomach and break them up into definite areas. The most conspicuous is a slightly projecting vertical fold which arises from the posterior wall and from the hinder part of the floor, marking out the hinder or cardiac moiety of the stomach into a right and a left chamber. This postero-ventral fold (*P.v.f.*, Plate VI., fig. 7) dies away before reaching the roof, which, in marked contrast to the rugose floor, is smooth and unbroken, except for a small but well-marked median depression or pit at the junction of the anterior with the median third. The wide bipartite opening into the intestine and intestinal cæcum (*Int.ap.*, Plate VI., fig. 7) marks the hinder end of the floor of the left chamber, which may therefore be named the intestinal or pyloric chamber. In size it slightly exceeds the right or cæcal chamber, the former being appreciably deeper, and being as wide as it is deep, whereas the height of the latter is twice as great as its breadth (Plate VI., fig. 4). Anterior to where the postero-ventral fold dies away midway along the floor, a peculiar flattened and obliquely sloping plate (*Pl.d.*, Plate VI., fig. 7), facing backwards, upwards, and to the right, occupies a sub-central position; and branching channels radiate forwards on its surface, connected possibly with the distribution of the digestive fluid. To the right of this area, which may be named the dendritic plate, is a ridge with accompanying furrow, running forwards and upwards to the antero-lateral bile-duct, while to the left is a shallow, wide pre-intestinal depression (*P.i.dep.*, Plate VI., fig. 7). A deep, rugose, sub-œsophageal pit (*S.œ.p.*) is well marked anterior to the dendritic plate, and high up on the right lateral wall the postero-lateral furrow leads from the postero-lateral duct towards the intestinal aperture. On the left side, a stout antero-lateral fold lies between the pre-intestinal depression and the sub-œsophageal pit.

The digestive gland, or "liver" (*D.gl.*, Plate VI., fig. 1), as already noted, surrounds the stomach except at small areas upon the extreme dorsal and right lateral aspects. Under healthy conditions it is of large size and of a characteristic deep sage-green colour. It is made up of dense clusters of secreting alveoli (Plate IX., fig. 3), which open into ductules and thence into the larger ducts, which lead into the stomach. There are eleven of these terminal ducts, namely :—

a. The *antero-lateral duct* (*D.a.l.*, Plate VI., fig. 6), opening high up on the right side, and posterior to the right of the sub-œsophageal pit.

b. The *postero-lateral duct* (*D.p.l.*, fig. 6), opening at the same level and on the same side, within the posterior third of the stomach. Several large ductules open at its very end (as is the case with *a* and several of the others), and, as the latter is wide, some of these tributary apertures are visible from within the stomach. This duct ramifies within the upper and posterior region of the digestive gland.

c. The *postero-ventral duct* (*D.p.v.*, fig. 7) opens in the floor of the posterior third, also upon the right side. It comes from the posterior and ventral parts of the gland.

d. Anterior to the last named are the *three sub-central ducts* (*D.s.c.*, fig. 7), the inmost one being of large size.

e. *Two pre-intestinal ducts* open within the pre-intestinal depression and drain the left ventral portion of the gland.

f. Below the œsophageal aperture the openings of three small *sub-œsophageal ducts* (*D.s.œ.*, fig. 7) can be readily made out, bringing the secretion of the anterior and lower portion of the glandular organ.

To see the openings of these ducts, divide the stomach horizontally along the mid-lateral plane and syringe out the contents. Then *a* and *b* will be seen upon the right side of the roof (see fig. 6), the remainder upon the ventral half (fig. 7). The course of the larger ducts can also be traced for some distance by picking away the glandular tissue around the stomach (see also figs. 8 and 9).

Lining the greater portion of the gastric cavity, dipping into depressions and rising over the folds, a gelatinous layer (corresponding to the "flèche tricuspide" of some other molluscs) invests the epithelial lining. It is colourless and transparent; and in section is seen, under the microscope, to be a cuticular laminated structure in close relation with the underlying epithelium. In freshly caught, healthy individuals, the distal end of the crystalline style is invariably seen protruding into the stomach from the circular and larger anterior portion of the intestinal aperture.

The intestine may be divided into three sections of approximately equal length, namely: (*a*) The descending portion; (*b*) the ascending portion; and (*c*) the rectum (see Plate VI., fig. 1).

(*a*) The first or descending section of the intestine (*Int.* 1) passes ventrally, with a slight inclination to the rear, into and through the posterior part of the visceral mass, which is here composed of the tubules of the gonad. Its course then lies behind the base of the byssal gland and between the converging bundles of the two pedal retractor muscles. At this point it changes its direction and curves forwards and downwards to the prominent antero-ventral corner of the visceral mass which marks the point of its junction with the ascending branch (*Int.*, 2).

A longitudinal fold projects inwards from the anterior and one from the posterior wall of the descending intestine. As these folds are *vis-à-vis* and to one side of the median axis of the tube, they divide it into two unequal longitudinal chambers, or rather gutters, that to the left being the larger (Plate VI., fig. 10, *a*). The two folds are low and little prominent for a short distance from the stomach; little by little they reach further across the cavity till in the middle and lower thirds their apices broaden and close together, so as to form two distinct tubes. The broader of the two is circular in section at all points; the smaller, except at the beginning, is irregular in sectional outline and appears rather as a narrow and deep gutter along the side of the broad cylindrical left portion (Plate VI., fig. 10, *b*).

The narrow tube usually contains a train of partially digested food matter, while under healthy conditions the larger cavity is completely filled with a clear gelatinous solid cylinder, the crystalline style, a gently tapering, pliant and slightly elastic rod. The right-hand tube, in spite of its insignificant diameter, is the true intestine, the wider left being the sheath of the crystalline style, which here, as in *Ostrea*, *Pecten*, *Cardium* and *Mya*, is imperfectly separated from the anterior portion of intestine, with which it communicates by a longitudinal cleft. The function of the crystalline style is still doubtful. Among more modern views, while Möbius, Haseloff, and Hazay have argued that it represents a reserve food supply, Barrois, Pelseneer, and others believe it to function as a lubricant to obviate the danger of sharp fragments, taken in with the food, causing damage to the delicate lining of the intestine. The upper end of the style certainly projects into the stomach, and as it wastes, the hinder part is continuously being pushed upwards to compensate for the loss. According to Barrois, sand and shell fragments are invested by the viscous waste of the style, and so made bolus-like are moved along the intestine more freely and without inflicting injury upon the walls.

Margaritifera vulgaris is, however, capable of exercising a certain degree of selection in feeding, and sand grains are seldom seen in any numbers within the alimentary canal. And yet the crystalline style is always present in healthy individuals containing a fair amount of food material in the intestine, as, for example, all the individuals examined in Trincomalee harbour in October, 1902, and upon the Pearl Banks during the 1903 fishery. But out of 43 oysters examined at Galle during June, July, and August, while in a state of semi-starvation, having been kept for ten days and upwards in water containing little suitable food matter, five only showed a crystalline style. The alimentary canal of the whole number contained an extremely small amount of food, and the visceral mass was notably shrunken.

Still it must be remembered that small sand grains and sharp-pointed sponge-spicules and diatoms are here and there to be met with in the stomach contents, and in these cases the suggested gelatinous investment by the style would be useful. Moreover, the cohesion of particles into a bolus capable of traversing the intestine more readily, brought about by the investment, would, no doubt, also be useful.

A valvular folding of the intestinal ridges gives entrance to the ascending region of the intestine (*Int.*, 2, Plate VI., fig. 1), which, however, before turning on an upward course, curves backwards along the base of the visceral mass to the left of and parallel with the lower or forwardly directed portion of the descending intestine. At the posterior extremity of the ventral surface of the visceral mass the two intestinal divisions intersect, the ascending section crossing to the right. The intestinal loop (*Int.lp.*, Plate VI., fig. 3) thus formed in the floor of the visceral mass is the visceral loop. From the point of intersection the ascending intestine turns sharply upwards, running parallel with and closely adjacent to the upper part of the descending intestine, the course of the latter lying a little forward and to the left. The portion of the ascending intestine forming the second limb of the visceral loop is small in diameter and somewhat compressed. The anterior fold of the descending intestine is continued into it as a somewhat undulating and irregular dorsal ridge dying off midway along.

At the point where this division of the intestine assumes a dorsal course, an increase takes place in the diameter, concurrent with the appearance of a great longitudinal fold, the *typhlosole* (Plate VI., figs. 3 and 11, *Ty.*) projecting inwards. At its start, this typhlosole projects from the anterior wall, but almost at once curves over to the posterior side of the tube, thence running vertically upwards without further change of course. Longitudinal and somewhat oblique furrows channel the surface, and as it expands greatly above the line of attachment to the intestinal wall, its bulk largely fills the cavity of the intestine. In transverse section, the lumen is seen to be reduced to an attenuate long-horned crescent (Plate VI., fig. 5). As it approaches the level of the floor of the stomach, the typhlosole thins down rapidly to a low ridge, and the intestine itself then curves posteriorly in the direction of the heart (Plate VI., fig. 1). This change in direction and thinning down of the typhlosole indicate the commencement of the rectum (*Int.*3, Plate VI., fig. 1), which is not marked by any other definite sign.

From the right-angled curve made by the intestine posterior to the stomach, the rectum runs posteriorly, through the upper part of the pericardium. Beyond this it begins to curve ventrally, and passes round the posterior aspect of the adductor muscle in the median line, ending in an erectile ear-like process bearing the anus (Plate VI., fig. 1), and situated opposite the exhalent orifice of the mantle.

The rectal typhlosole, though well-marked as a semi-cylindrical ridge (Plate VI., fig. 12, *Ty.*), never rises much above the semi-diameter of the tube. It runs along the intestinal floor while in the cardiac region, and when the rectum courses behind the adductor muscle it becomes a median fold on the anterior wall.

Where the first portion of the rectum passes through the narrow upper part of the pericardium, it has the ventricle attached to its lower surface (Plate VI., fig. 1) with an anterior aorta running forwards and upwards to the left, and a posterior aorta passing backwards posteriorly and ventrally to pursue a course parallel with the rectum (see also Plate VII., fig. 2). From the point where it passes from the cardiac region, the rectum and the accompanying aorta are overlaid with a considerable thickness of spongy lacunar tissue (Plate IX., fig. 6). The bulk thus attained renders the course of this division of the intestine conspicuous as a massive semi-cylindrical vertical ridge descending the posterior surface of the adductor in the median line. This rectal ridge (*R.r.*, Plate VI., fig. 15) is frequently pigmented with splashes of black and opaque white pigments—occasionally it is suffused more or less extensively with orange. Figs. 6 and 7 on Plate IX. show the range in height and shape of the rectal ridge, and fig. 8 gives the character of the tall ciliated epithelium of the rectum.

The anal process (*An.f.*, Plate VI., fig. 3) is a comparatively large, slightly curved, erectile, ear-shaped organ facing ventrally. It stands out at right angles to the last section of the rectum, and the tip is directed posteriorly, while the margins tend to be somewhat in-curved. The anal aperture (*an.*) is situated at the base, on the ventral aspect. Fæcal matter is expelled periodically in string-like masses, which, caught up by the steady exhalent current, are swept out through the mantle orifice and carried some little distance clear of the animal (Plate VI., fig. 14, *Pel.*).

The form of the anal process is likely to prove of diagnostic importance in the characterization of species when a revision of the genus *Margaritifera* and allied forms is undertaken upon the basis of a study of the soft parts. The variations in the shells of *M. vulgaris*, which our plates exhibit, show that such characters alone are insufficient for an accurate differentiation of some species.

The one living *M. margaritifera*, LINN. ("Black-lip"), which we had an opportunity of examining in Ceylon had an anal process wholly different from that of *M. vulgaris*, being pinnatifid palmate, with five lobes (Plate III., fig. 5).

In a third species, small and much flattened, which appears to be closely related to the Shark's Bay shell, this process is simple, as in *M. vulgaris*, but is broader in proportion, and with a rounded obtuse free termination, whereas in the latter it is longer and more lanceolate, with an acuminate tip (see Plate III., figs. 1 and 3). But probable variations in the soft parts must also be considered.

The histology of the wall of the alimentary canal is shown in figs. 8, 9, and 10, on Plate IX. The tube is lined by ciliated columnar epithelium throughout, and presents no features that call for special detailed description. The columnar cells on some parts of the wall are enormously taller than on other parts (see fig. 9), so as to form great pads projecting into the lumen. The ciliated epithelium of the stomach is continued for some distance along the larger ducts of the digestive gland (fig. 2).

The cæca of the digestive gland are seen cut in various directions in figs. 1 and 2 on Plate IX. In a transverse section the exterior of the cæcum is circular, but the lumen is frequently quadrangular (fig. 4) because of the unequal size of the gland cells. The organ agrees in detailed structure (see Plate IX., figs. 1 to 4) with that of other better-known Lamellibranchs, such as the common oyster.

THE BRANCHIÆ.

Between the slightly opened valves of a living pearl oyster the four sickle-shaped branchiæ or gills, delicately fluted and usually more or less edged and dappled with shades of grey and drab, are easily seen (Plate II., fig. 5). The free edges curve outwards from the base of the foot (Plate II., figs. 3 and 4), and, keeping a little inside of and parallel with the mantle edge, extend to a point just ventral to the exhalent orifice, where they narrow to a well-defined combined tip (fig. 3).

Of these four gills, two belong to each side of the body (*Br.*, Plate V., fig. 3), and each such lateral pair (Plate VIII., fig. 6) constitutes morphologically one ctenidium —so that one fold or "gill" is a hemi-ctenidium. The ctenidium consists of a vascular basis or axis upon which are inserted at right angles along its whole length two rows of long delicate branchial filaments, hollow outgrowths of the axis. As the axis extends from the ventral border of the palps anteriorly along the front edge of the visceral mass, nephridium and adductor muscle, and curves round ventrally and posteriorly to a point opposite the anus, with its convexity first forwards and then downwards, it follows that these branchial filaments must be directed in the upper or oral region forwards, and in the lower or ventral downwards—in all cases towards the nearest margin of the valve.

The outwardly directed parallel filaments of each series are folded upon themselves, so that they become deeply V-shaped. The folding in each case is away from the common centre or axis, the external filament turning outwards and the internal inwards. Consequently, each branchial plate, formed of the doubled filaments, consists of two lamellæ—the direct and the reflected—which enclose between them a narrow inter-lamellar space (see Plate V., fig. 4)—where the outer lamella of the external hemi-ctenidium is the reflected, and the inner (that which is attached to the vascular axis) is the direct—the converse being the case with the internal hemi-ctenidium where the outer lamella is the direct one: the two direct lamellæ face one another.

Immediately behind the visceral mass the edges of the reflected lamellæ of the inner gills (*a.g.f.*, Plate VIII., fig. 7) of the two sides join loosely in the middle line, so as to show in a transverse section the form of two capital W's, imperfectly joined, thus—WW (Plate V., fig. 9, *Br.*). The free outer edge also adheres somewhat, under normal conditions, to the adjacent mantle by a thickened rim; but both the median and the lateral concrescing surfaces are readily separated with a little pressure, and it can scarcely be said that there is permanent fusion.

Histological examination of these places shows that the union is by means of very long and perfect ciliary junctions (Plate VIII., figs. 8, 9, 10), closely resembling in the appearance both of cells and cilia the ciliated discs of the filaments. At the extreme ventral edge of the median junction of the inner gills there is a very narrow but quite definite organic connection (Plate VIII., fig. 9, *org.*) which must be ruptured when the gills are pressed apart. At these ciliated junctions the epithelial cells are cubical or low columnar, with a distinct seam or margin from which the very regular stiff cilia project (figs. 9 and 10).

The common base (*ct.a.*, Plate VIII., fig. 6) of each ctenidium is a vascular attached ridge reaching from the anterior end of the gills, overlapped slightly by the bases of the palps, to a point near the anterior end of the adductor, thence running as a free axis to the posterior or distal extremity. It is seen in both conditions in sections on Plate V., attached in fig. 4 and free in fig. 9. Within the axis lie two great blood-vessels, the afferent and the efferent branchials. The former (*Br.aff.*, Plate VIII., fig. 8), which conducts the blood from the venous sinuses to the gills for purification, lies internal and dorsal to the latter (in Plate VIII., fig. 8, it appears as a tube above the efferent vessel, *Br.eff.*).

Hollow outgrowths, the inter-lamellar junctions, containing branches from the afferent vessels, convey blood from the axial trunk to the base of the reflected lamella. Thence the blood enters certain of the individual filaments, flowing outwards to the free margin, where it passes over into the direct filaments and so returns inwards to the branchial axis, where it joins the efferent vessel by openings along each side. The branchial afferent vessels and the band-shaped inter-lamellar junctions (Plate VIII., figs. 8 and 12) are comparatively few, and each serves a group of 10 or 12 of the reflected filaments. On the other hand, each direct filament has its own aperture into the efferent vessel.

The filaments composing a lamella are not placed in one plane. On the contrary, the lamella is pleated or plicated regularly at right angles to its base, so as to have alternating shallow channels and rounded ridges (Plate VIII., fig. 12). The number of filaments constituting a plica varies from 10 to 12. The transverse section of the gills given in fig. 12 on Plate VIII. shows how the ridges are formed by the plication of the filaments. At the bottom of each channel there is a specially large and modified filament (Plate VIII., figs. 12 and 13, *p.f.*) with a great development of skeletal chitin and some muscle bundles. These are known as the principal filaments, and they have the inter-lamellar junctions attached to them and alone receive afferent branchial vessels. The aërated blood passes from the gills by the ordinary filaments.

Neighbouring filaments are joined by continuous organic union mainly at the lower and the upper ends of the reflected filaments, where there are longitudinally-running blood vessels. Elsewhere the filaments are joined chiefly by the interlocking stiff cilia of the large ciliated discs which occur at intervals (Plate VIII., fig. 11, *c.d.*) throughout their length. In many places, however, groups of two or three or more filaments (see figs. 16, 17) are united by true organic junctions which occur alongside the ciliated discs, as Ridewood* suggested might possibly be the case. Fig. 16 shows four filaments united, I have found several examples of six, and in one specimen the whole twelve filaments of a plica were joined by continuous tissue. The concrescence is not always at the internal edge of the filaments, but may be about the middle, and in one case I found two unions between two neighbouring filaments leaving an ovate ciliated gap. But all such examples of true organic union are comparatively few and exceptional, and we certainly do not have in this gill the continuous solid inter-filamentar junctions which are found in the less simple gills of the Eulamellibranchiata (such as *Venus*, *Cardium*, *Mya* and *Anodonta*).

The frequency and arrangement of the ciliated discs is seen in fig. 11, representing a longitudinal section along several adjacent filaments, and a transverse section at the level of these junctions is seen in fig. 16. The epithelial cells bearing these special stiff cilia project beyond the general surface, and are of cubical or low columnar form.

The gill of the pearl oyster is thus what Pelseneer termed "Pseudolamellibranch," the lamellæ being plicated and connected by inter-lamellar vascular junctions, while the individual filaments are mainly united by the interlocking of the ciliated discs.

In transverse section the filament has a bluntly wedge-shaped outline, the narrower end being internal. The structure of an ordinary filament, where free from junctions,

* 'Phil. Trans.,' vol. 195, B, p. 155.

and more highly magnified, is shown in fig. 14. The epithelium on the surface is ectoderm, and this varies in height in certain parts, and is ciliated along special tracts, the chief of which are the frontal and the lateral (Plate VIII., figs. 13, 14). Underneath the epithelium of the gill filament is a thin layer of connective-tissue strengthened by chitinous thickenings. These skeletal thickenings take on a special development in the principal filament lying in the angle between two ridges (Plate VIII., fig. 13). Connective-tissue septa do not occur in the interior of the ordinary filaments, but at the level of the ciliated junctions the modified filaments which bear the discs may have their lumen largely obliterated by an unusual development of connective-tissue (fig. 15). Further details can be seen in the figures.

Apart from the special action of modified cilia in forming an interlocking junction, the normal function of the ordinary cilia on the branchiæ is to create the all-important current of water which enters the pallial chamber and passes over and through the branchial lamellæ, so as (1) to aërate the blood flowing in the filaments, and (2) to convey food particles to the mouth. The respiratory current is apparently due to the normal rhythmic lashing of the cilia on the large cells at the edges of the filaments; while the collection or rejection of particles in the water seems to be the result ot special action stimulated apparently by the irritation. Particles arrested by the branchial filter are caught up by the nearest cilia, which by local reversed lashing carry them outwards to the free ventral edge of the lamella. Here they are guided by the cilia of a pathway running along the branchial margin and are propelled forwards and upwards to the anterior end of the gill, where they come under the influence of the palps, to be accepted as food or rejected and conveyed to the exterior by the pallial ciliated band. On Plate VI., fig. 13 shows the ciliated paths, upon and between the gills, by which particles can approach the palpal gutters (*b.*) leading to the mouth (*a.*); and fig. 14 shows the track (*Pall.cil.b.*) along the mantle edge by which excreta pass to the exterior at the pallial fold (*Pall.f.*).

THE VASCULAR SYSTEM.

In common with all typical Lamellibranchs, *Margaritifera vulgaris* has a circulatory system consisting of a heart and a series of arteries, whence by means of irregular ill-defined spaces, the lacunæ, between and among the tissues and organs the blood flows into larger and usually well-defined thin-walled cavities, the venous sinuses. The bulk of the blood then circulates through the gills prior to being returned to the heart, but a portion passes direct from certain sinuses in the mantle. Of these vessels the arteries alone have definitely cellular walls, those of the sinuses being of connective-tissue.

The heart is contained in a thin-walled transparent sac, the pericardium (*Per.*, Plate VII., fig. 2), occupying nearly all of the posterior region of the body, the space bounded in front by the posterior limit of the viscero-pedal mass and behind by the upper part of the adductor. While in front the pericardium is in contact wholly with the viscero-pedal mass, its floor is formed of the wide median communication between the right and left nephridia; posteriorly the pericardial wall is entirely free and coincident with the body-wall and forms the anterior and dorsal boundary of the adductor embayment of the supra-branchial chamber, and laterally its walls are also partially free.

Dorsally the walls gradually approach, and close to the apex are perforated by the rectum; so narrowed, however, is the portion of the pericardium above the latter that it appears in sagittal sections rather as a tubular connection uniting the lateral portions of the main pericardial chamber—the supra-rectal pericardial arch (*Per.ar.*, Plate VII., fig. 1). This part of the wall is separated from the dorsal or hinge portion of the body-wall only by some loose connective-tissue.

Anteriorly there arises on either side from each ventral corner a wide sleeve-shaped prolongation directed forwards, so that the two appear to clasp the viscero-pedal mass. These are the two reno-pericardial canals (*Rn.per.*, Plate VII., fig. 1) each of which opens anteriorly by a horizontal slit (*Rn.per.'*, Plate VII., fig. 8) into one of the nephridia close to the external renal orifice.

The heart largely fills the pericardial space and is clearly distinguished through the thin pericardial wall. It consists of a dorsally situated median ventricle (*v.*, figs. 1 and 2) and two lateral auricles (*au.*, fig. 1)—dark-walled and symmetric—lying ventral to the ventricle. The auricles are liver-coloured bodies with puckered walls, roughly triangular in form when viewed from behind. The apex of each is attached separately to its respective corner of the base of the ventricle. The two are connected medially by the junction of their inner corners, while thin sheets or partitions of connective-tissue anchor their bases to the floor of the pericardium immediately over the inter-nephridial passage. The walls are largely thickened by the presence of numerous accessory excretory glands—the pericardial glands—to which is due also their distinctive dark-brown hue (see p. 65 below for details of these glands).

An efferent blood-vessel from the gills enters each auricle at the outer angle of the base. The auricular cavities inter-communicate through the basal junction and are reduced in capacity by inward projections of the walls.

The lips of the auriculo-ventricular apertures project inwards and form simple yet effective valves preventing the reflux of blood into the auricles during the ventricular systole. The ventricle is elongated, of a pale yellowish-white tint; the walls are thick and muscular, and the cavity is further reduced by numerous muscular trabeculæ crossing in various directions. As Grobben first pointed out, this ventricle does not surround the rectum, as is so usual in Lamellibranchs, but its dorsal extremity is intimately fused with the lower surface of the rectum. The muscle fibres in the wall of the heart are distinctly striated (Plate IX., fig. 12).

Anteriorly and posteriorly the dorsal ends of the ventricle pass into the anterior and posterior aortæ respectively. The latter (*Ao.p.*, Plate VII., fig. 2), the smaller of the two, passes backwards into the tissue surrounding the exposed part of the rectum and runs therein parallel with the latter to a point slightly above the anus (about $\frac{1}{8}$ inch in $2\frac{1}{2}$-year-old specimens). Here it changes its course, turning forwards into the hinder tendinous portion of the adductor muscle and immediately divides into two branches (Plate VII., figs. 4 and 5). One of these turns to the right, passing through the muscle parallel to and a little beneath its surface. Just before reaching the insertion of the muscle it turns abruptly at right angles and passes into the mantle—as the right posterior pallial artery (*Art.p.p.*, Plate VII., figs. 4 and 5). Its neighbour on the left—the left posterior pallial artery (*Art.p.p.'*)—passes under the rectum and into the tendinous part of the adductor, emerging and entering the left mantle lobe in a similar manner to the right branch.

Each of these arteries after entering the mantle runs forward along its junction with the adductor till opposite the paired pallial sense organ (*S.o.*, Plate VII., fig. 5). Curving forwards each then runs out to the inwardly projecting tongue of the mantle edge opposite the posterior gill tips. Here an anterior and a posterior branch are given off which run forwards and backwards respectively within the thickened pallial margin, parallel to and just beneath the pallial gutter.

The anterior branch meets a similar branch from the anterior pallial artery, the two so fused being the common pallial artery (Plate VI., fig. 2, *Art.c.p.*).

The anterior aorta (*Ao.A.*, Plate VI., fig. 2) passes forwards from the heart, above and to the left of the rectum, and then bends to the right and runs above and to the right of the stomach and œsophagus.

Of the many branches given off by this arterial trunk, by far the most important and largest is the first, the unpaired visceral artery (*Art.vis.*, Plate VI., fig. 2). This branches off immediately after the dorsal aorta crosses the rectum. It is rather wider than the continuation of the aorta. Turning ventrally, it penetrates the central portion of the viscero-pedal mass, crossing in its course to the left of the descending intestine and then giving off branches into the gonad and to the intestines.

Returning to the dorsal aorta, we find it supplying numerous arteries to right and left—and downwards—the chief of these being the hepato-pedal artery (*Art.h.p.*, Plate VI, fig. 2), given off just above the junction of the œsophagus with the stomach. Then branches are given off to the right and left labial palps, and beyond the mouth the aorta ends in two diverging branches—the right and left anterior pallial arteries (*Art.a.p.*), which pass ventrally within the mantle edge to fuse with the posterior pallial arteries as the common pallial artery (*Art.c.p.*).

The hepato-pedal artery, like the visceral, passes downwards to supply the viscero-pedal mass. Level with the floor of the stomach it bifurcates, the anterior branch going forwards to the foot as the pedal artery, the posterior branch—the hepatic artery—turning back to traverse the digestive gland. From the pedal a branch goes forwards and bifurcates to form twigs going right and left to the palps.

The blood stream, carried by the ultimate ramifications of the arteries, passes into the lacunæ—irregular spaces between the tissues—whence it drains into larger cavities, the venous sinuses, which conduct directly to the heart (from the mantle) or indirectly by the intermediation of the gills.

The blood is colourless, and contains nucleated corpuscles, which are shown in some of the figures of the blood spaces in the gills (Plate VIII., figs. 11, 13).

THE EXCRETORY SYSTEM.

The renal excretory system consists of the paired nephridia and possibly of the numerous small pericardial glands projecting from the walls of the auricles. The nephridia consist of two large symmetrical pouch-like sacs lying one on either side of the hinder half of the viscero-pedal mass. Each opens into the pericardium by a wide duct and to the exterior by a minute pore, and they intercommunicate by a wide channel beneath the auricles. In outline each is roughly triangular, the apex passing into the channel under the auricles, while the elongated base looks outwards and forwards, coinciding with the base of the anterior third of the gill of that side, and thus conforming to the inclination of the gill.

The outer wall of the nephridium (*Neph.*, Plate VII., fig. 8) is thin and membranous; it is fused with the body-wall, as is also the most anterior portion of the inner wall, namely, that strip extending from the base of the gill to the viscero-pedal mass; from this line it runs back, overlying and in contact with the hinder part of the gonad, gradually narrowing as it approaches the auricle.

The external renal aperture (*Rn.o.*, Plate VII., fig. 8) is a minute oval opening furnished with a sphincter muscle. It opens immediately below the genital aperture, within an inconspicuous lipped slit, the urino-genital vestibule (Plate VII., figs. 10 and 12), placed at the junction of the inner plate of the inner gill with the visceral mass, at a point about mid-way between the ventral border of the latter and the base of the foot.

Each nephridium consists of a glandular and of a non-glandular portion. By separating the right and left ctenidia and reflecting each, the glandular region (*Neph.'*, Plate V., fig. 4) is seen as a narrow, elongated, coloured strip—yellow, or pale brown, or even dark dull red—bordering the anterior part of the inner base of each gill. It consists of spongy tissue, occupying the anterior angle formed by the meeting of the inner and outer walls of the organ, and the secretion passes from the cavernous chambers of the glandular region directly into the spacious cavity of the main or non-glandular portion. The spongy renal tissue shows, when magnified, branching tubes and septa formed of irregularly cubical cells much vacuolated and with very distinct nuclei (Plate IX., fig. 15).

The passage (*Np.con.*, Plate VII., fig. 8) connecting the right and left nephridia lies beneath the auricles. It is a wide tunnel with thin membranous walls, bounded behind by the lower part of the pericardium, while in front its wall lies against the visceral mass, and below it fuses with the body-wall and so forms part of the roof of the adductor embayment of the supra-branchial chamber.

The reno-pericardial tubes (*Rn.per.*, Plate VII., fig. 8) are a pair of wide lateral prolongations of the pre-cardiac part of the pericardium, thin-walled and membranous, and directed forwards. Each gradually narrows towards the anterior end, where it opens into the non-glandular part of the nephridium of its own side. The aperture is a curved slit, with the concavity facing towards the ventral aspect (*Rn.per.'*). It has but one lip, the tube opening at a very acute angle. It is situated upon the inner wall of the nephridium, immediately to the rear of the external renal aperture. Usually, but not invariably, a small area around is rendered conspicuous by flecks of brown pigment.

Compared with the total bulk of the body, the size of the nephridial system is small, especially when we bear in mind the comparatively great size of this organ in some other Lamellibranchs, such as *Anodonta* and *Cardium*. There are, however, also the accessory pericardial glands, described by GROBBEN,* possessing an excretory function, situated on the walls of the auricles and on the neighbouring part of the pericardial wall; and it is the dark-brown colouring of these glands which renders the auricles most conspicuous objects in the dissection of the pearl oyster (see Plate VI., fig. 1). These glandular outgrowths increase largely the secretory area, as the auricular walls are thrown into numerous pouches, which are of a spongy structure, with deep folds of the inner surface dipping down into the blood stream. The epithelium shows large cubical, rounded or ovate cells packed with concretions and granules (Plate IX., fig. 13). The lower or auricular end of the pericardium is also glandular, and has its epithelium thrown into folds formed of granular vacuolated cells (Plate IX., fig. 14) of the same character as those of the nephridium. The secretion from all these pericardial glands passes by the wide reno-pericardial ducts into the nephridia, and thence gains the exterior by the renal aperture.

THE NERVOUS SYSTEM AND SENSE ORGANS.

The nervous system of the pearl oyster is of the ordinary Lamellibranch character, and is very similar to that of *Mytilus edulis*, the common mussel. The bi-laterally symmetrical central nervous system has 3 pairs of ganglia: (1) the cerebral ganglia at the sides of the œsophagus (Plate VI., fig. 15, *Cer.g.*), (2) the pedals conjoined to form a single ganglion (fig. 16, *Ped.g.*) at the base of the foot, and (3) a pair of large visceral or parieto-splanchnic ganglia (fig. 15, *Par.sp.g.*) lying upon the anterior surface of the adductor. These are connected as follows:—

Stout paired nerves, the cerebro-visceral connectives (*C.v.con.*), link the cerebral with the parieto-splanchnic ganglia (fig. 15), while a pair of similar cords—cerebro-pedal connectives (*C.p.con.*)—joins the cerebral with the pedal nerve mass (fig. 16).

* 'Arbeit. Zool. Instit. Wien,' Bd. VII., 1888.

The cerebral ganglia are pre-oral or supra-œsophageal in position, and a nerve cord or commissure, passing over the œsophagus, connects the two cerebral ganglia; while a single stout transverse cord—the visceral commissure—joins the two parieto-splanchnic ganglia (fig. 18).

The cerebro-visceral connectives surpass all the other commissural nerves in length. Taking their rise at the posterior end of the cerebral ganglion, each passes backwards and downwards, buried within the visceral mass, till it emerges opposite the upper angle of the base of the foot. Then it passes ventrally, overlaid by the renal sinus, whose course it follows till, entering the tissue at the base ot the gills, it turns slightly forwards—still passing ventrally—and ends in its respective parieto-splanchnic ganglion (fig. 15).

In addition to the supra-œsophageal cerebral commissures and to the connectives passing to the pedal and parieto-splanchnic ganglia respectively, the cerebral ganglion of each side gives off anteriorly a stout nerve—the anterior common pallial. This passes forwards, bifurcating almost immediately. The outer branch (the external pallial nerve) courses along the pallial edge, meeting and anastomosing with the corresponding external pallial branch of the posterior common pallial trunk. The labial palps and the otocysts are also innervated from the cerebral ganglia.

The cerebro-pedal connectives arise from the posterior and outer sides of the cerebral ganglia, and run downwards within the visceral mass and just behind the levator muscles of the foot to the pedal ganglion. They lie close together in their course, and about midway each gives off a nerve, passing posteriorly into the visceral mass.

The double nature of the pedal mass is distinctly seen in sections (Plate IX., figs. 16 and 16A). Three principal nerves arise from the pedal ganglion to innervate the foot and byssal gland (Plate VI., fig. 16). One, the dorsal (or superior) pedal nerve, given off from the upper anterior part, passes along the dorsal region of the foot to the tip of this organ, throwing off twigs as it goes. Its terminal portion innervates the locomotor or crawling portion of the foot. The second, the ventral (or inferior) pedal nerve, arises immediately below the last described, passes forwards and downwards and supplies the byssal groove and disc-pit. The byssal nerve is the third offshoot from the pedal ganglion; it comes away from the ventral end and passes direct to the byssal gland, dividing into numerous branches.

Each of the visceral or parieto-splanchnic ganglia receives from above the stout cerebro-visceral connective, the two ganglia being themselves united by a single transverse visceral commissure. In addition to these connecting nerves, each ganglion gives off two stout distributory nerves (Plate VI., fig. 18)—an anterior lateral (the branchial, *n.br.*) and a posterior (the pallial, *n.pal.*). Each branchial nerve leaves the ganglion at the anterior lateral corner, turns down at once into the base of the gills, and then passes backwards to the posterior tips following the course of the afferent vessel. The posterior common pallial nerves emerge from the posterior end of the visceral ganglia; from the base of each a stout nerve (fig. 18, *n.s.o.*) passes straight back, parallel with its neighbour and midway between the median line and the margin of the adductor, till it reaches the pigmented pallial sense organ of its respective side—a little anterior to the anus.

After giving off the last-named nerves, the common pallial trunk passes backwards and outwards, bifurcating almost immediately; the external branch, the larger, is the external pallial nerve and straightway bends outwards and passes into the mantle; the inner branch pursues a more median course, but in turn it soon divides. The outer of the resultant nerves becomes the median pallial nerve; the inner the internal pallial nerve, the latter being the weakest of these three pallial trunks. By the ramifying of these three nerves in the muscular and marginal regions of the mantle, and by their anastomoses with a corresponding series of inner, outer, and median branches given off by the anterior common pallial trunks from the cerebral ganglion, a complex network of nerves termed the pallial plexus is formed. A somewhat similar arrangement of the pallial arteries is found—the marginal pallial artery having, like these pallial nerves, a double origin.

In the case of the nerves, we find the external pallial, as indicated by the name, passes directly to the margin along which it runs, branching as it goes; the median takes a parallel but more internal course, and anastomoses freely with its fellow outside, while the third or inner branch passes forwards along the line of insertion of the pallial retractors, branches being given off which meet and anastomose with others from the median. On tracing these three nerves forwards we find that they join the corresponding series arising from the anterior common pallial trunk.

Sense-Organs.

Specialized sense-organs are few and of low type in the pearl oyster, the only structures that can come under this head being the otocysts, the osphradia, and the pallial or abdominal organs of Thiele. The latter are a pair of slightly asymmetrical laterally compressed tubercles lying upon the ventral surface of the adductor muscle, one on either side, a little anterior to the anus. In each the long axis lies transverse to the greater axis of the body. Dark pigment renders them conspicuous, and the one to the right is distinctly the larger. It is also situated slightly further back than its neighbour. In sections these sensory papillæ are seen to be covered with epithelium which contains specialized sense-cells. Plate IX., fig. 17A, shows the tip of one of these sensory papillæ. They are innervated by a special nerve from the visceral ganglion, possibly derived from the cerebral, close to the posterior pallial nerve (Plate VI., fig. 17, *n.s.o.*). The function of these organs is probably olfactory or of such a (?) tactile nature as to test the quality of the water passing over the gills, or to be stimulated by particles it contains.

The otocyst, at the pedal mass, has numerous otoconia, and is supplied from the cerebral ganglion. The osphradium is an area bounded by a well-marked projection close to the parieto-splanchnic ganglion at the origin of the branchial nerve. It has a small ganglionic mass lying at its base (Plate IX., fig. 18), and its nerve is cerebral in origin.

There are probably sensory cells in the ciliated epithelium on the grooved and corrugated oral surfaces of the labial palps (Plate IX., fig. 11); but the sense of touch seems to be localized chiefly in the margin of the mantle, and more especially in the filiform and digitate processes of the velum. These latter are extremely sensitive to touch, and the longer processes of the anterior and of the ventral margin have compound digitate apices; it is upon these multiple terminations (Plate IX., figs. 19, 20) that the chief sensory epithelial cells are disposed. The long processes of the posterior part of the mantle edge are of a different form. They are cylindrical filiform organs beset on all sides with short spinulate branches towards the tip (Plate III., fig. 9). Those on the margin of the temporary exhalent aperture are notably developed, and in life sway and sinuously bend in snake-like motion unceasingly. In sections they show a delicate columnar epithelium which is no doubt sensory.

Little can be said definitely regarding the sense of sight, although we have some evidence of the function being performed to a certain extent. Thus from the observations described in Part I., it is clear that there is a marked sensibility to light and shadow—a sensibility which may be termed dermatoptic, as it resides in the surface layer of certain regions. When the tanks were well lighted during the day, the shadow of a hand passing over was frequently followed by the immediate closing of the oyster's valves, and conversely after dusk they showed a similar but more accentuated re-action when stimulated by a bright light. Especially is this the case when surprised during a promenade, when having slipped their byssal cables they crawl along in search of a new resting place. At such times, or when forming new byssal threads, they appear extremely sensitive; they cease operations immediately and remain passive, with valves closed, as long as the irritation is continued. This photoscopic or dermatoptic sensibility can be located only in the soft parts turned towards the light—the edges of the mantle and the surface of the foot, when the latter is protruded—and there we invariably find patches of more or less deeply pigmented epithelial cells.

THE REPRODUCTIVE ORGANS.

The sexes are separate in *Margaritifera vulgaris*, and, as is shown by the experiments detailed on p. 125 in Part I., remain the same from season to season, *i.e.*, each individual is permanently either male or female throughout life.

The gonads (*Go.*, Plate VI., fig. 1) are paired but asymmetrical. The pair together forms a thick envelope covering the stomach, liver and first two sections of the intestine, and thus constitutes the greater part of the outside of the proximal portion of the viscero-pedal mass (Plate IX., fig. 1). Yet although the gonads envelop the viscera of this region, they do not hide the byssal gland, which, lying excentrically, comes in contact with the body-wall on the right; and when the viscero-pedal mass is viewed from this aspect (Plate VI., fig. 2), the byssal gland is seen as a broad band reaching from the base of the foot backwards to the right retractor muscle. This band has the appearance of dividing the right gonad into a dorsal larger part and a ventral smaller (Plate VI., fig. 15), a division more apparent than real, as the two parts are continuous to the left of the byssal gland. No portion of the reproductive glands extends into the foot proper, or into the mantle as in the case of *Mytilus*.

When mature, the male and the female gonads are practically indistinguishable from one another to the naked eye. Both are usually pale creamy yellow in colour; the male, in some cases, rather paler than the female. The male, too, is rather less bulky than the female; this, however, is no guide to the sex, as the bulk will in that case approximate to that of a partially developed female.

The gonads, testes or ovaries as the case may be, consist of branched tubuli, whereon cluster myriads of saccate cæca, the alveoli (Plate IX., figs. 21, 22). In these arise, by proliferation from the germinal epithelium of the walls, spermatozoa or ova, according to the sex. The accumulated ripened products filling these alveoli and tubuli are then passed on into three trunks, which converge into a single main vessel just within the external genital aperture (Plate VII., fig. 11). This opens immediately dorsal to the renal aperture of the same side, and, indeed, the vestibule into which they both open is really a deep cleft whereof the V-shaped bottom merges imperceptibly into the primary genital duct.

The spermatozoa (Plate IX., fig. 22A) are excessively minute and of the typical form. The head is comparatively large, clear, and highly refractile, ovate in outline; while the long flagellum, proceeding from its more rounded end, is from nine to twelve times the length of the head.

The ovarian ova (Plate IX., fig. 21), measuring 16 μ by 8 μ, are more or less polygonal in form, by reason of mutual pressure, while within the alveoli and tubuli of the female gonad; but when shed they become of a laterally compressed pyriform, or ovate, shape. The former is most characteristic—the narrow short stalk marking what was originally the place of attachment to the germinal epithelium. When fertilization takes place, the stalk functions as a micropyle. The vitelline membrane enclosing the coarsely-granular vitellus is thin. The nucleus is large, oval in outline, very clear, and but lightly granular, in length and in breadth exceeding the half length and the half breadth of the entire ovum. A nucleolus is also present, very conspicuously situated within the nucleus, close to its periphery. The more detailed characters of the ovum and the fertilization and early embryology will be discussed in a future Part of the Report in connection with the Life-History of the Pearl Oyster.

EXPLANATION OF PLATES.

List of Reference Letters.

Add., adductor muscle.
Add.', peripheral portion of *Add.*
Add.'', central portion.
Add.''', adductor impression.
An. or *a.*, anus.
An.f., anal funnel.
Ao.a., anterior aorta.
Ao.p., posterior aorta.
Art.a.p., anterior pallial artery.
Art.c.p., common pallial artery.
Art.h.p., hepato-pedal artery.
Art.p.p., right posterior pallial artery.
Art.p.p.', left " "
Art.vis., visceral artery.
Au., auricles.
B.c., blood corpuscles.
Br., branchiæ.
Br.aff., common afferent branchial vessel.
Br.eff., " efferent "
Br.int., internal branchia.
By., byssus.
By.d.p., byssus disc-pit.
By.p., byssal pouch.
By.p.', pleated surface of byssal gland.
By.p.gl., glands forming byssus.
By.r., root of byssus.
By.s., byssal sinus.
By.t., byssal tube, or groove.
C.c., granular cells with concretions.
C.d., ciliated disc.
Cer.g., cerebral ganglion.
C.p.con., cerebro-pedal connective.
Ct., ctenidium.
Ct.a., ctenidial axis.
C.v.con., cerebro-visceral connective.
D.a.l., antero-lateral hepatic duct.
D.gl., digestive gland.
D.p.i., pre-intestinal duct.
D.p.l., postero-lateral duct.
D.p.v., postero-ventral duct.
D.s.c., sub-central duct.
D.s.œ., sub-œsophageal duct.
Exc.o., excurrent orifice.
F., foot.
F.by.p., folds of byssal gland.
Fib.ret., fibres of retractor muscle.
G.f., gill filament.
Go., gonad.
Go.', external aperture of gonad.
I.l.j., inter-lamellar junction.
Int.ap., intestinal aperture in stomach.
Int.lp., intestinal loop.
Int. 1, descending intestine.
Int. 2, ascending "
Int. 3, rectum.
Lev.a., anterior levator muscles.
Lev.p., posterior "
Lig., ligament.
M.b., muscle bundle.
Mg.pall., pallial margin.
Mg.vel., edge of velum.
My., muscular tissue.
N., or *n.*, nerve.
N.br., branchial nerve.
Neph., sac of nephridium.
Neph.', glandular portion of nephridium.
N.pal., pallial nerves.
Np.con., channel between nephridia.
N.s.o., nerve to pallial sense organ.
O., mouth.
Oe., œsophagus.
Org., organic connection in branchiæ.
Os., osphradium.
Pa., labial palps.
Pa.d., dorsal palp.
Pall.', centre of pallial lobe.
Pall.'', muscular region of mantle.
Pall.cil.b., pallial ciliary band.
Pall.f., pallial fold (opposite tips of branchiæ).
Par.sp.g., parieto-splanchnic ganglia.
Pa.v., ventral palp.
Ped.g., pedal ganglion.
Ped.loc., locomotor part of foot.
Per., pericardium.
Per.ar., supra-rectal pericardial arch.
Per.ostr., periostracum of shell.
P.f., principal filament in gills.
P.i.dep., pre-intestinal depression.
Pl.d., dendritic plate of stomach.
Pr.dig., digitate process of valve.

Pris., prismatic layer of shell.
P.v.f., postero-ventral fold of stomach.
Ret., pedal retractor muscle.
Ret.', impression of retractor muscle.
Ret.ins., insertion of retractor muscle.
Ret.pall., pallial retractor muscle.
Rn.o., renal orifice.
Rn.per., reno-pericardial canal.
Rn.per.', aperture of last.
Rn.s., renal sinus.
R.r., rectal ridge.
Sn.add.lat., lateral adductor sinus.
Sn.m., median sinus.
Sn.tr., transverse sinus.
S.o., pallial sense organ.
S.œ.p., sub-œsophageal pit.
St., stomach.
St. 1, intestinal or pyloric chamber of stomach.
St. 2, right or cæcal chamber of stomach.
Ty., typhlosole.
V., ventricle.
Vel., velum of mantle.
Vel.pr., velar processes.
V.l., visceral lobe.
V.m., visceral mass.

PLATE I.

Fig. 1. Right valve of a specimen of the Ceylon pearl oyster (*Margaritifera vulgaris*) from Kondatchi Paar, showing an unusually smooth and rounded form; nat. size. This seems very similar to the "Shark's Bay shell," described by JAMESON as *M. carchariarum.*

,, 2. Right valve of another specimen of the same species brought up in the same haul from Kondatchi Paar, to illustrate variation in the shell; nat. size.

,, 3. Inside of right valve of an unusually wide specimen from Kondatchi Paar, showing a broad margin devoid of nacre and very large auricles; nat. size.

,, 4. Inside of left valve of a more normal shell, from Cheval Paar, showing well-developed nacre and a group of small pearls near the anterior auricle; nat. size.

,, 5. Outside of left valve of an unusually straight and narrow specimen, from Cheval Paar, the surface covered with Polyzoa and other organisms; nat. size.

,, 6. Outside of left valve of an unusually oblique specimen from Cheval Paar, the surface largely covered with adhering organisms; nat. size.

(Figs. 1 and 2 from drawings by Mr. J. HORNELL; figs. 3 to 6 from photographs by W. A. H.)

PLATE II.

Figs. 1 and 2 show photographs (W. A. H.) of the inside and outside of the valve of a normally developed pearl oyster, showing form, markings and nacre; slightly reduced.

Fig. 3. From a photograph (J. H.) of the animal after removal of the left valve, showing foot and byssus, mantle, gills, adductor muscle, &c.; nat. size.

,, 4. From a photograph (J. H.) of pearl oysters from (A) Muttuvaratu Paar and (B) East Cheval Paar, of the same age (3 years to $3\frac{1}{2}$ years) to show the marked difference in growth; nat. size.

,, 5. From a photograph (J. H.) of three pearl oysters seen edgeways, to show adductor muscle and mantle lobes; nat. size.

,, 6. From a photograph (J. H.) of a pearl oyster with the right valve removed and dissected to show the adductor muscle, foot, &c.; nat. size.

PLATE III.

Figs. 1 to 5 show differences in the soft parts of three species of "pearl oysters."

Fig. 1. Anal funnel of *Margaritifera* sp. (?)—a small, flat, dark brown species, A in ventral and B in lateral view; enlarged; *a.*, anus.

,, 2. Ventral part of visceral mass of same species from the side; nat. size.

,, 3. Anal funnel of *M. vulgaris* (SCHUM.), A in ventral and B in lateral view; enlarged; *a.*, anus.

Fig. 4. Ventral part of visceral mass of same species, from the side, showing the visceral lobe (*v.l.*) more prominent and more distinctly separated than in fig. 2; nat. size.

,, 5. Palmate anal funnel of *M. margaritifera* (Linn.); enlarged.

,, 6. Marginal processes from ventral part of velum; *s.h.*, sensory tufts on tips of branches.

,, 7. Similar processes from another individual.

,, 8. Simpler processes of the pallial edge—typical forms.

,, 9. Some variations in the longer processes of the pallial edge; *a*, from near exhalent orifice; *b*, *c*, *d*, common forms; *e*, bifurcate form, unusual—all these processes × 4.

,, 10. Semi-diagrammatic view of posterior aspect of living pearl oyster, showing the usual circular appearance of exhalent orifice; enlarged; *My.pall.*, edge of mantle lobe; *Pall.f.*, pallial fold; *Vel.pr.*, velar processes interdigitating.

,, 11. An abnormal anal funnel, the tip being bifurcate (compare fig. 3, A); enlarged.

,, 12. An abnormal foot (from South-east Cheval), the tip being bifurcate. The lateral branch is non-functional, its groove having no connection with the byssal gutter and pit (compare fig. 18).

,, 13. Dissection showing foot (ventral surface) lying at rest within the mantle cavity; three byssal fibres are present; nat. size.

,, 14. Lateral view of the foot at rest; nat. size.

,, 15. Foot extended in the act of secreting a new byssal fibre; the locomotor region and the byssal disc-pit are pressed against the rock *a*; *By.p.*, byssus pore.

,, 16. Foot retracted from rock to reveal the new byssal fibre; *By.d.p.*, the disc-pit in which the attachment disc of the fibre was moulded—the lips have partially closed.

,, 17. Diagram showing the relative positions of the parts during and after the secretion of a byssal fibre.

,, 18. Ventral surface of foot when, the old byssus having been cast off, the animal is crawling with tip of foot searching for a new place of attachment.

,, 19. The same as seen through a glass plate over which the animal is crawling by means of its flattened locomotor region; *By.p.*, byssus pore; *By.d.p.*, byssus disc-pit; *By.t.*, byssus groove; *Ped.loc.*, distal locomotor region.

,, 20. The same when attached by byssus, and elongated for the purpose of forming a fourth byssal fibre (compare with fig. 15).

,, 21. Semi-diagrammatic transverse sections through foot; *a* and *b*, through the distal locomotor region; *c* and *d*, through the proximal secretory region; *x*, locomotor surface; *By.t.*, byssal groove; the shaded part is secretory, the unshaded part mainly muscular (compare figs. 3 and 4 on Plate VIII.). All these figures of foot are about natural size.

,, 22. Sagittal section through foot and byssal organ; *By.*, byssus; *By.p.'*, pleated surface of byssal gland; *By.p.gl.*, glandular tissue of byssal gland; *By.t*, byssal groove; *My.*, muscular tissue of foot; *Ped.loc.*, locomotor distal third of foot.

,, 23. The byssus: A, an entire byssus which was sloughed off by the oyster, showing the numerous fibres uniting in a common root lodged in the byssal pouch; B, one side of root of same byssus enlarged; C, reverse side of same root, showing furrows and ridges in dendritic form moulded in the pleated surface of the byssal gland—the two sides of the root diverge in some cases to form two separate masses of rootlets; D, distal end of byssal fibre, showing the disc of attachment, *a*.

,, 24. Antero-ventral view of visceral mass, looking towards pericardium to show relative positions of the retractor and adductor muscles; nat. size.

,, 25. Dissection from right side to show the course of the retractor muscle from its origin (*Ret.*) in the shell to its insertion (*Or.*) at the base of the foot. The visceral mass is shaded dark. The right mantle lobe is cut away along line *a*; nat. size.

,, 26. Dissection to show the course of the anterior (*Lev.a.*) and the posterior (*Lev.p.*) levator muscles, and the manner of their attachment to the base of the foot (F.).

PLATE IV.

Fig. 1. Outer surface of the mantle, as seen from left side on removal of valve, to show the number and arrangement of the insertions of the pallial muscles; nat. size. *Add.*, adductor muscle; *Ret.*, retractor muscle; *Lev.a.* and *Lev.p.*, anterior and posterior levators.

Figs. 2 to 6. Drawings of the interior of five pearl-oyster valves to show the variations in the arrangement and number of the scars produced by the insertion of the pallial muscles; nat. size. *Lev.a.* and *Lev.p.* indicate the scars of the anterior and posterior levators of the foot.

PLATE V.

Showing a series of sections across the body at different levels; slightly enlarged. D, dorsal; V, ventral; R, right, and L, left side of body.

Figs. 1 to 8. Vertical transverse sections in series from before backwards.

Fig. 1. Through œsophagus (*Oe.*); anterior end of byssal pouch (*By.p.*); palps (*Pa.*); anterior and posterior levator muscles (*Lev.a.*, *Lev.p.*); gonad (*Go.*); mantle lobe (*Pall.'*, *Pall.''*); pallial edge (*Mg.Pall.*); and velum (*Vel.*).

,, 2. Through anterior part of stomach (*St.*), parallel with last, showing also digestive gland (*D.gl.*) and hepato-pedal artery (*Art.h.p.*).

,, 3. Parallel with last, through lower part of byssal pouch with byssus-root (*By.r.*); antero-dorsal tip of nephridial sac (*Neph.*); end of intestinal loop (*Int.lp.*); and obliquely through branchiæ (*Br.*).

,, 4. A little posterior to last, showing postero-ventral hepatic duct opening into stomach (*St.*); glandular part of nephridium (*Neph.'*); sections through intestinal loop (*Int.lp.*); and anterior ends of the two retractors (*Ret.*) joining on posterior wall of byssal gland.

,, 5. Through posterior end of stomach (*St.*), showing intestine (*Int.* 1) leaving stomach, the two retractor muscles (*Ret.*) converging towards byssal pouch; nephridial sacs (*Neph.*) at their widest; Adductor muscle (*Add.'*), &c.

,, 6. In vertical plane immediately behind stomach, along ascending intestine (*Int.* 2), two portions of adductor (*Add.'* and *Add.''*); visceral artery (*Art. vis.*) descending through gonad, &c.

,, 7. Through the auricles (*Au.*) and posterior end of visceral mass with rectum (*Int.* 3); insertion of retractors (*Ret.*); pericardium (*Per.*); median venous sinus (*Sn.m.*); and lateral adductor sinuses (*Sn.add.lat.'*).

,, 8. Through ventricle (*V.*) and rectum (*Int.* 3), upper and posterior part of auricles (*Au.*), pericardial arch (*Per.ar.*), anterior aorta (*Ao.a.*), branches of median sinus (*Sn.m.'*), &c.

,, 9. Oblique dorso-ventral section through middle of visceral mass, adductor muscle, &c., as before.

Figs. 10 to 14. Horizontal sections at different levels, working downwards.

Fig. 10. At level of stomach (*St.*), showing anterior levators (*Lev.a.*) in transverse section, palps (*Pa.*), supra-cardial part of rectum (*Int.* 3), pericardial arch (*Per.ar.*), and an arrow entering anterior aorta cut obliquely.

,, 11. At level of ventricle (*V.*) and dorsal part of foot (*F.*), showing 3 sections of the intestine (*Int.* 1, 2, 3), palps (*Pa.*), &c.

,, 12. At level of auricles (*Au.*), showing auriculo-ventricular apertures, rectal ridge (*R.r.*) on posterior face of adductor, &c.

,, 13. Through middle of foot, showing origin of retractors (*Ret.*), inter-auricular communication, &c.

,, 14 Through byssal gland and root of byssus (*By.r.*), showing course of retractor muscles to insertion (*Ret.ins.*), &c.

PLATE VI.

Fig. 1. General anatomy of the pearl oyster as seen in sagittal section. The alimentary canal is slightly diagrammatic, as the limbs of the visceral loop do not lie in one plane, and neither the descending nor the ascending parts of the intestine are exactly in the median plane, and consequently would not occur in the one section. The size is that of a $2\frac{1}{2}$-year-old oyster. For the explanation of the reference letters, see list on p. 70.

" 2. Dissection (semi-diagrammatic in parts) in same position as last figure, to show the principal arteries, see explanation of reference letters on p. 70.

" 3. Dissection of the alimentary canal; nat. size.

" 4. Transverse vertical section through dorsal part of visceral mass, passing through posterior part of stomach to show the two parts separated by the postero-ventral fold (*P.v.f.*) and the intestinal aperature (*Int.ap.*); enlarged.

" 5. Horizontal section through visceral mass at base of the byssal gland, showing the retractor muscle fibres (*Fib.ret.*) inserted into the wall of the folded byssal gland (*F.by.p.*); *Go.*, gonad; *Art.*, arteries; *Int.* 1 and 2, descending and ascending parts of intestine; enlarged.

" 6. Stomach bisected horizontally; roof viewed from below, to show the opening of the œsophagus (*œ.*) and ducts; enlarged. Stomach wall in solid black.

" 7. Floor of same stomach viewed from above, to show dendritic plate (*Pl.d.*) and the various openings; enlarged.

" 8. Diagrammatic longitudinal vertical section of the stomach to the right of the median line, to show ducts entering; enlarged.

" 9. Diagrammatic longitudinal vertical section of the stomach to the left of the median line, to show ducts entering; enlarged.

" 10. Outline of cavity of first or descending part of intestine: *a*, cæcum of crystalline style; *b*, intestinal cavity proper; enlarged.

" 11. Portion of second or ascending part of intestine, opened to show the typhlosole (*Ty.*); enlarged.

" 12. Transverse section through rectal ridge, on posterior surface of adductor muscle, to show rectum (*a*) with its typhlosole (*Ty.*); *c*, loose connective tissue; *b*, posterior aorta (see also Plate IX., figs. 6 and 7); enlarged.

" 13. Diagram to show the ciliated paths leading from the gills by the palpar gutters (*b*) to the mouth (*a*); *d*, channel between base of external gill and mantle; *e*, at junction of external with internal gills; *f*, at junction of internal gills; *h*, along crest of external gill; *i*, along crest of internal gill. The paths diverge, converge, and join as shown.

" 14. Dissection to show the course of the ciliated track (*Pall.cil.b.'*) from labial palp (*Pa.*) along base of velum to pallial fold (*Pall.f.*), opposite posterior tips of gills. *Ret.pall.*, pallial retractor muscles; *Pel.*, particles ejected; nat. size.

" 15. Dissection from the right side, with right pallial lobe and right ctenidium removed, in order to show the course of the cerebro-visceral connective (*C.v.con.*); nat. size.

" 16. Diagram of the pedal ganglion (*Ped.g.*) and its connections and nerves; nat. size.

" 17. Posterior surface of adductor muscle (*Add.*), showing the parieto-splanchnic ganglia (*Par.sp.g.*) and their nerves; *n.br.*, branchial nerve; *n.pal.*, pallial nerves; *n.s.o.*, nerve to sense-organ (*S.o.*); nat. size.

" 18. Ventral aspect of adductor muscle and visceral mass (*v.m.*), to show the nerves given off by the parieto-splanchnic ganglia; nat. size. Lettering as in last figure.

PLATE VII.

Fig. 1. Diagram of the heart and pericardium, seen from behind; enlarged.

" 2. The same from right side. Lettering for both figures:—

Au., auricle; *V.*, ventricle; *Per.*, pericardium; *Rn.per.*, reno-pericardial canal; *Np.con.*, channel connecting nephridia; *Per.ar.*, pericardial arch; *Int.* 3, rectum; *Ao.a.*, anterior aorta; *Ao.p.*, posterior aorta.

Fig. 3. Dissection of dorsal surface of visceral mass, seen from above, enlarged; to show branches of anterior aorta (*Ao.a.*).

„ 4. Semi-diagrammatic vertical section through rectal ridge and adductor muscle, to show posterior aorta (*Ao.p.*) branching into right and left posterior pallial arteries (*art.p.p.*); enlarged.

„ 5. Course of the posterior pallial arteries from their origin in the posterior aorta close to the anal funnel (*An.f.*) out to the pallial margin; nat. size.

„ 6. Plan of the venous sinuses on the ventral and posterior aspects of the adductor muscle; enlarged. For lettering see p. 70.

„ 7. Plan of the same from the dorsal aspect, enlarged; showing especially the main and branch branchial afferent vessels (*Br.aff.*) to the gills. *Rn.s.*, renal sinus.

„ 8. Diagrammatic representation of the nephridial system and its relations to the pericardium. The arrows show the reno-pericardial canal (*Rn.per.'*) and the external renal aperture (*Rn.o.*).

„ 9. Enlarged view of the external renal aperture (*Rn.o.*) and of the reno-pericardial opening (*Rn.per.'*).

„ 10. Opening of the urino-genital vestibule at the junction of base of ctenidium (*ct.*) with the wall of the visceral mass (*v.m.*); enlarged.

„ 11. Transverse section through the urino-genital opening, showing the emergence of the genital duct; enlarged.

„ 12. More enlarged view of the urino-genital opening; *a.*, genital aperture.

„ 13. Anastomosis of the muscle fibres of the pallial muscles. × 40.

„ 14. A thin process from the growing margin of the shell, to show the "cellular" structure of the conchiolin in which the calcareous matter is laid down. × 40.

„ 15. Margin of the shell showing the same structure. × 40.

„ 16. Some prisms from a thick section of the prismatic layer. × 50.

„ 17. Part of a section of the prismatic layer decalcified to show the conchiolin framework. × 100.

„ 18. Part of a section of the prismatic layer showing the ends of the prisms and the distribution of pigment, × 50. A. shows one prism more magnified containing granular pigment.

„ 19. A, B, C, stages in the decalcification of prisms, × 100; D, the conchiolin framework; E, part of conchiolin more highly magnified to show layers of deposition.

„ 20. The nacre in surface view showing contour lines, × 300; A, more enlarged.

„ 21. Another part showing the granular appearance sometimes seen. × 300.

„ 22. Decalcified nacre, looking like a very much crumpled and folded membrane. × 300.

PLATE VIII.

Fig. 1. Section through the margin of decalcified shell to show the successively formed layers of prismatic material separating at the free edge. × 50.

„ 2. Section of the mantle lobe showing the marginal and velar processes. × 50.

A, B, C, D and E show the character of the epithelium, &c., at the points indicated, more highly magnified. × 500.

„ 3. Transverse section of the foot in the distal locomotor part. × 50.

„ 4. „ „ „ „ region of the byssal groove. × 50.

„ 5. Transverse section of part of the byssus gland, showing the secretion lying in the lamellar ducts. × 50.

„ 6. Dissection of posterior part of left ctenidium (the outer and inner gills of the left side). × 2.

„ 7. Diagrammatic transverse section across the two ctenidia, to show the median ciliated junction (*M.c.j.*) between the two inner gills and the lateral ciliated junctions (*L.c.j.*) between the outer gills and the mantle lobe. × 2.

Fig. 8. Transverse section through the left mantle lobe and both ctenidia, to show their relations and the extent of the median (*M.c.j.*) and lateral (*L.c.j.*) ciliated junctions. × 15.

,, 9. The median ciliated junction between the inner lamellæ of the inner gills; *org.*, slight organic connection. × 400.

,, 10. The lateral ciliated junction between the outer lamella of the outer gill (*g.f.*) and the mantle lobe (*Pall.*) × 400.

,, 11. Longitudinal section along the gill filaments, to show the ciliated discs (*c.d.*). × 50.

,, 12. Horizontal section across the two ctenidia (four "gills," *o.g.* and *i.g.*), to show the plication, the interlamellar junctions (*i.l.j.*), and the principal filaments (*p.f.*). × 50.

,, 13. Small part of such a horizontal section more highly magnified, to show a principal filament (*p.f.*), several ordinary filaments (*g.f.*), and an interlamellar junction (*i.l.j.*). × 400.

,, 14. An ordinary gill filament in transverse section, to show cilia, &c. × 500.

,, 15. Transverse section of a filament at the level of a ciliated disc (*c.d.*). × 500.

,, 16. Section showing filaments joined by organic union at the level of the ciliated discs. *a* is an ordinary filament free; *b* is a filament with a ciliated junction; *c*, *d*, *e* show ciliated and organic junctions together; *f* shows a ciliated junction alone. × 400.

,, 17. Another group of two filaments showing organic union. × 400.

PLATE IX.

Fig. 1. Section through visceral mass, to show stomach (*St.*), cæca and ducts of digestive gland (*D.gl.*), gonad (*Go.*), &c. *P.* shows an encysted Cestode larva. × 20.

,, 2. Another section of the stomach and digestive gland more highly magnified. × 50.

,, 3. Duct of digestive gland terminating in cæca. × 50.

,, 4. Transverse section of cæcum of digestive gland. × 400.

,, 5. Transverse section of pallial muscle bundle enclosing branch of pallial nerve (*n.*). × 400.

,, 6. Transverse section of rectal ridge (*R.r.*), showing rectum (*Int.*3), posterior aorta (*Ao.p.*), and loose connective-tissue. × 50.

,, 7. Section across another part of rectal ridge further back. × 50.

,, 8. Part of transverse section of rectum more highly magnified, to show epithelium. × 400.

,, 9. Part of wall of stomach highly magnified, to show epithelium. × 400.

,, 10. Transverse section of intestine near the loop, to show irregular typhlosole. × 50.

,, 11. Section across labial palps. × 50.

,, 12. Part of wall of heart, to show striped muscle fibres of the ventricle. × 400.

,, 13. Part of wall of auricle, to show gland cells. × 400.

,, 14. Section through ventral end of pericardium, to show pericardial glands. × 50. A, a part more highly magnified. × 400.

,, 15. Section from glandular part of nephridium, to show renal cells. × 400.

,, 16. Transverse section of pedal ganglionic mass. × 50.

,, 16A. Another section showing junction of cerebro-pedal connectives. × 50.

,, 17. Pallial sense-organ. × 50. A, the apex more highly magnified. × 400.

,, 18. Section showing parieto-splanchnic ganglion and osphradium. × 50.

,, 19. Sensory papilla on pallial tentacle. × 500.

,, 20. Tip of velar papilla. × 500.

,, 21. Section through female gonad, to show developing ova. × 400.

,, 22. Section through male gonad, to show tubules filled with developing spermatozoa. × 100. A, part of a cæcum more highly magnified. × 400.

Fig. 1.

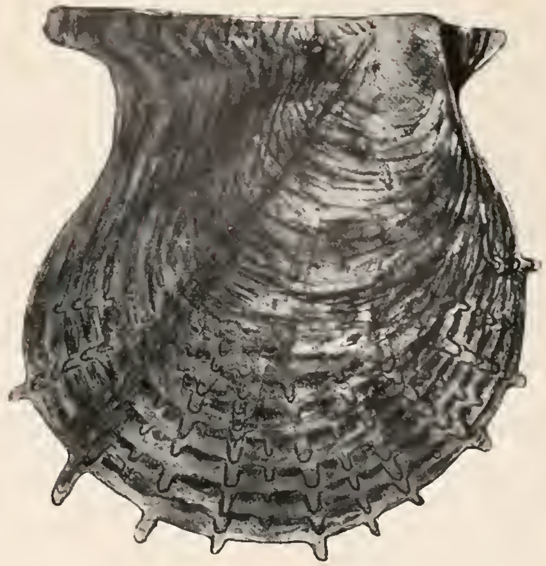


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

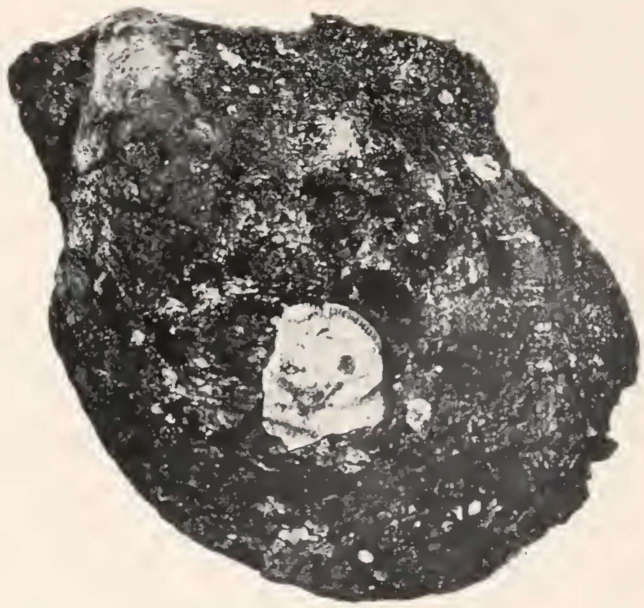


Fig. 6.

Variations in Shell Form.

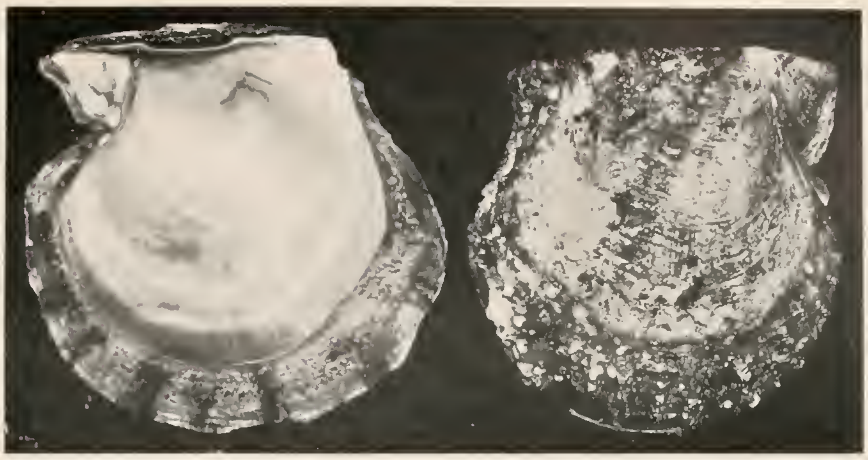


Fig. 1. Fig. 2

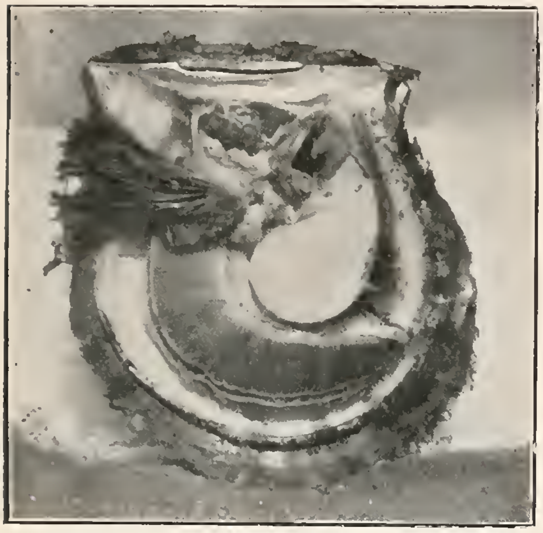


Fig. 3.

A. B.

Fig. 4.

A. B. C.

Fig. 5.

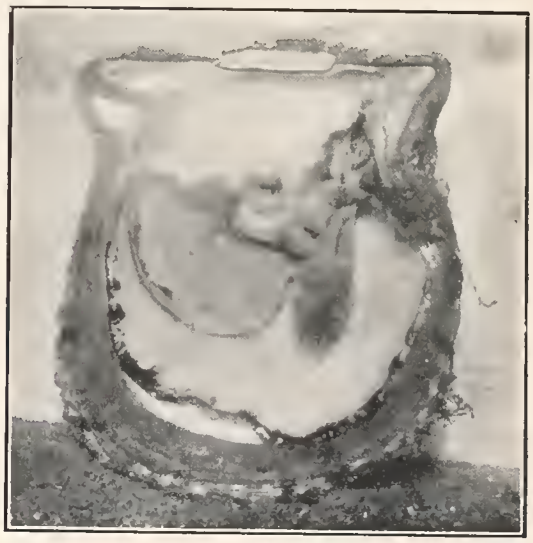
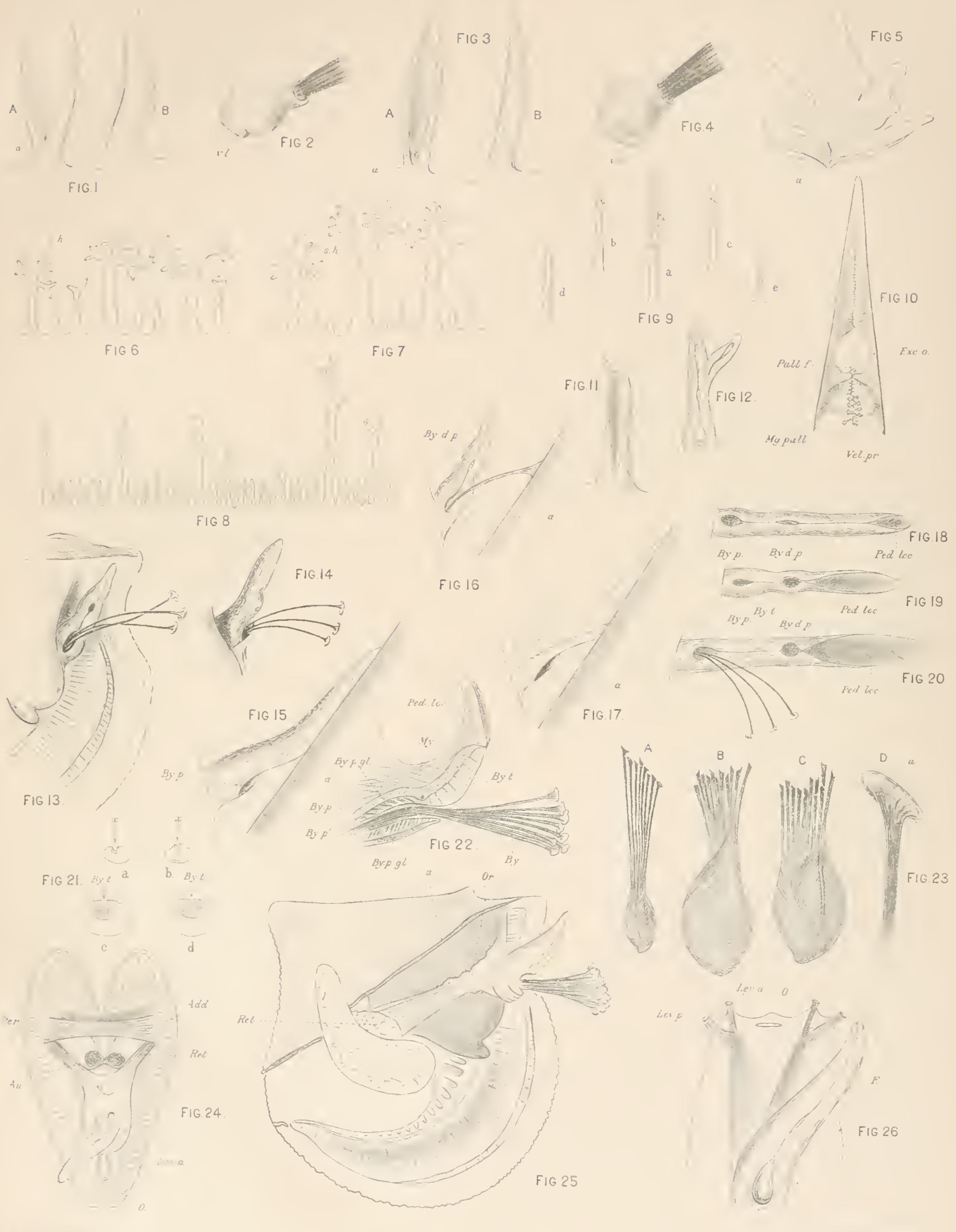


Fig. 6.

Shell and Animal.



MANTLE, FOOT AND BYSSUS.

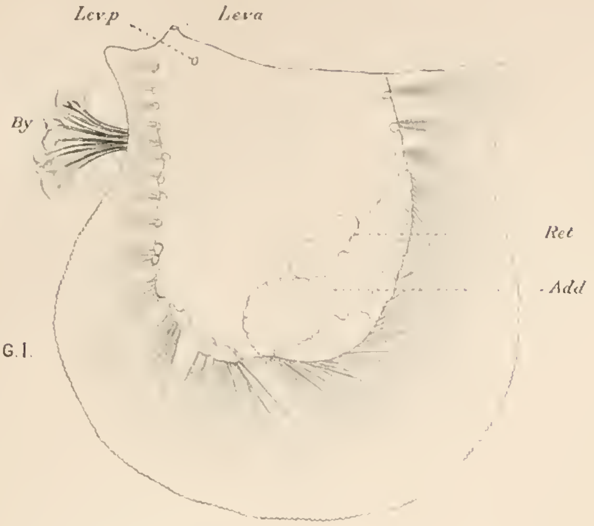


FIG.1.

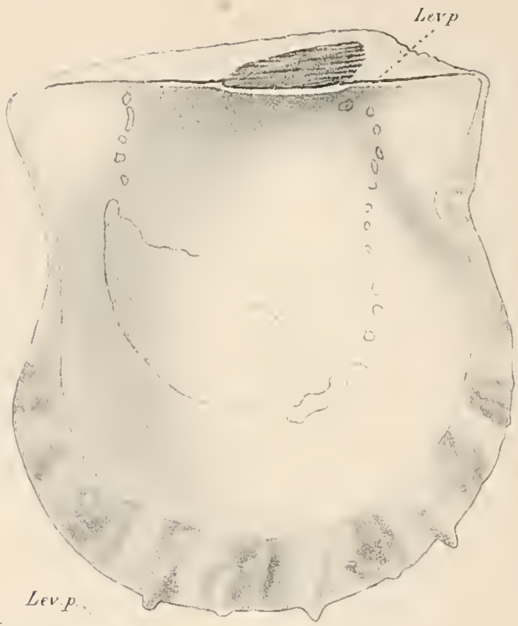


FIG.2

FIG.3.

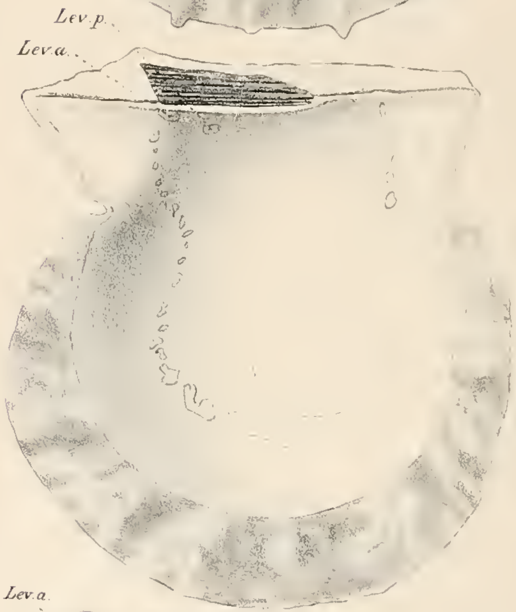


FIG.4.

FIG 5.

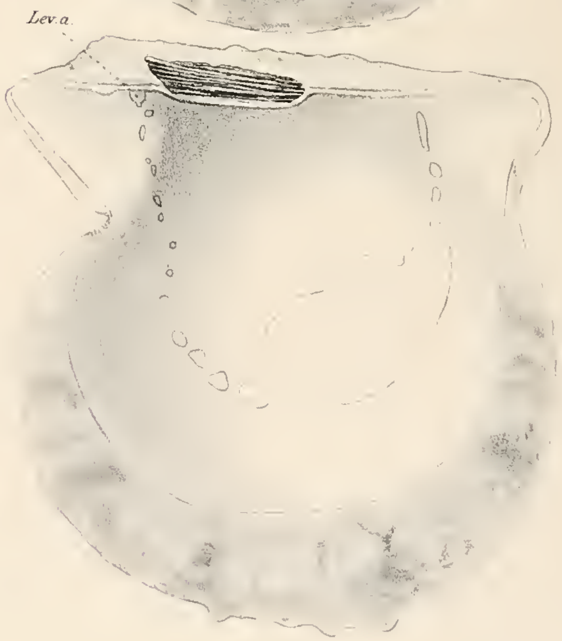


FIG.6

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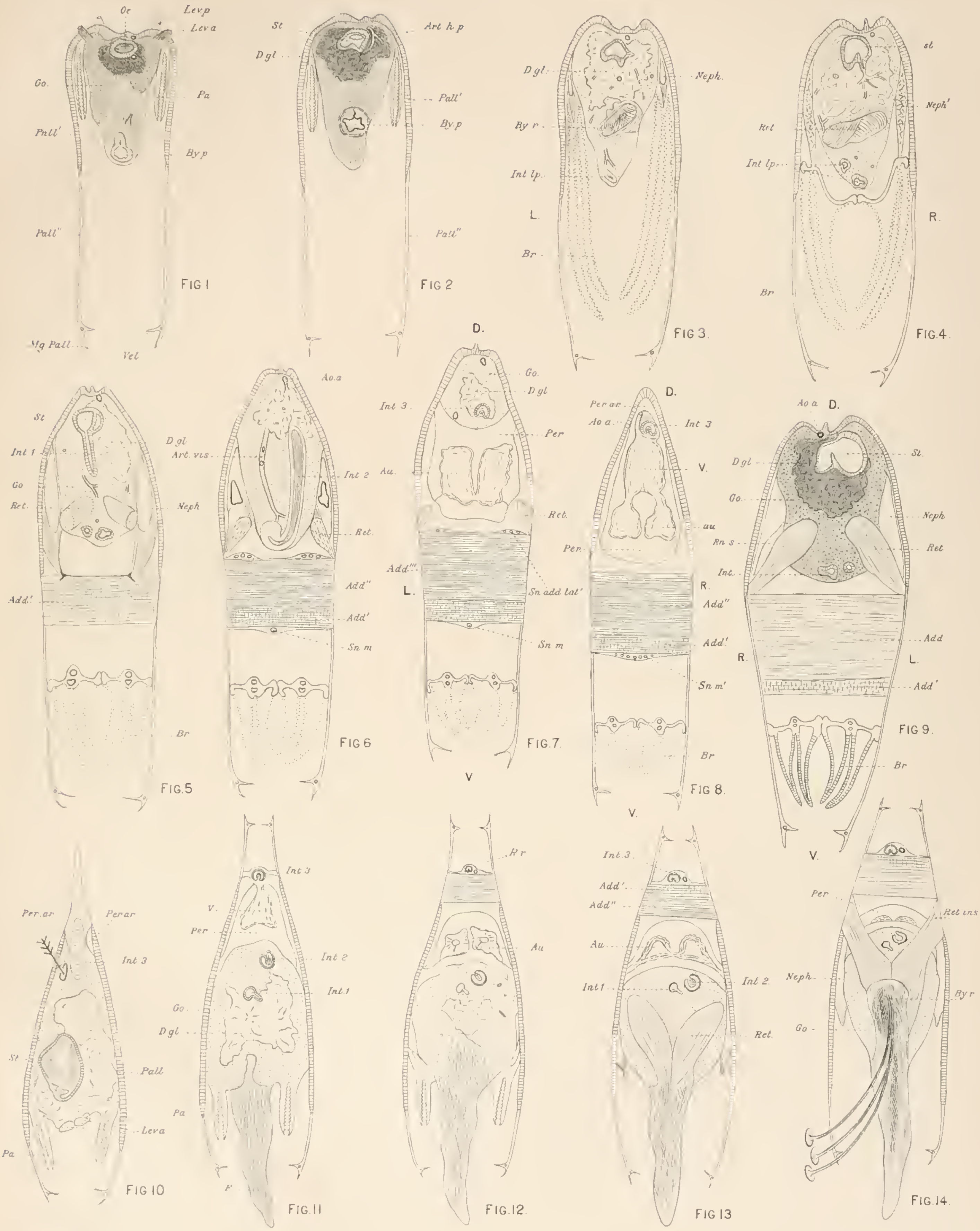
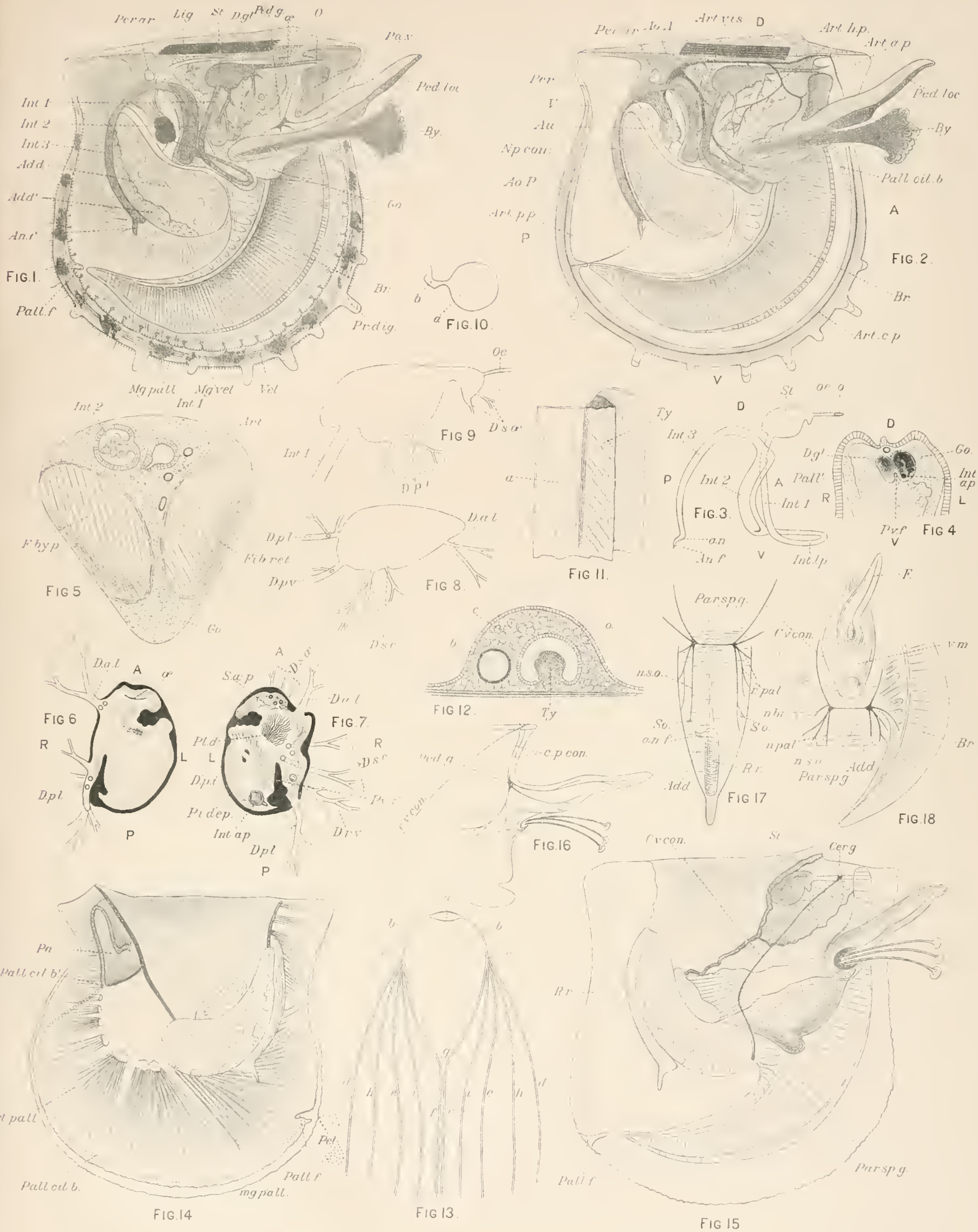
MUSCLE INSERTIONS



SECTIONS ACROSS THE BODY.



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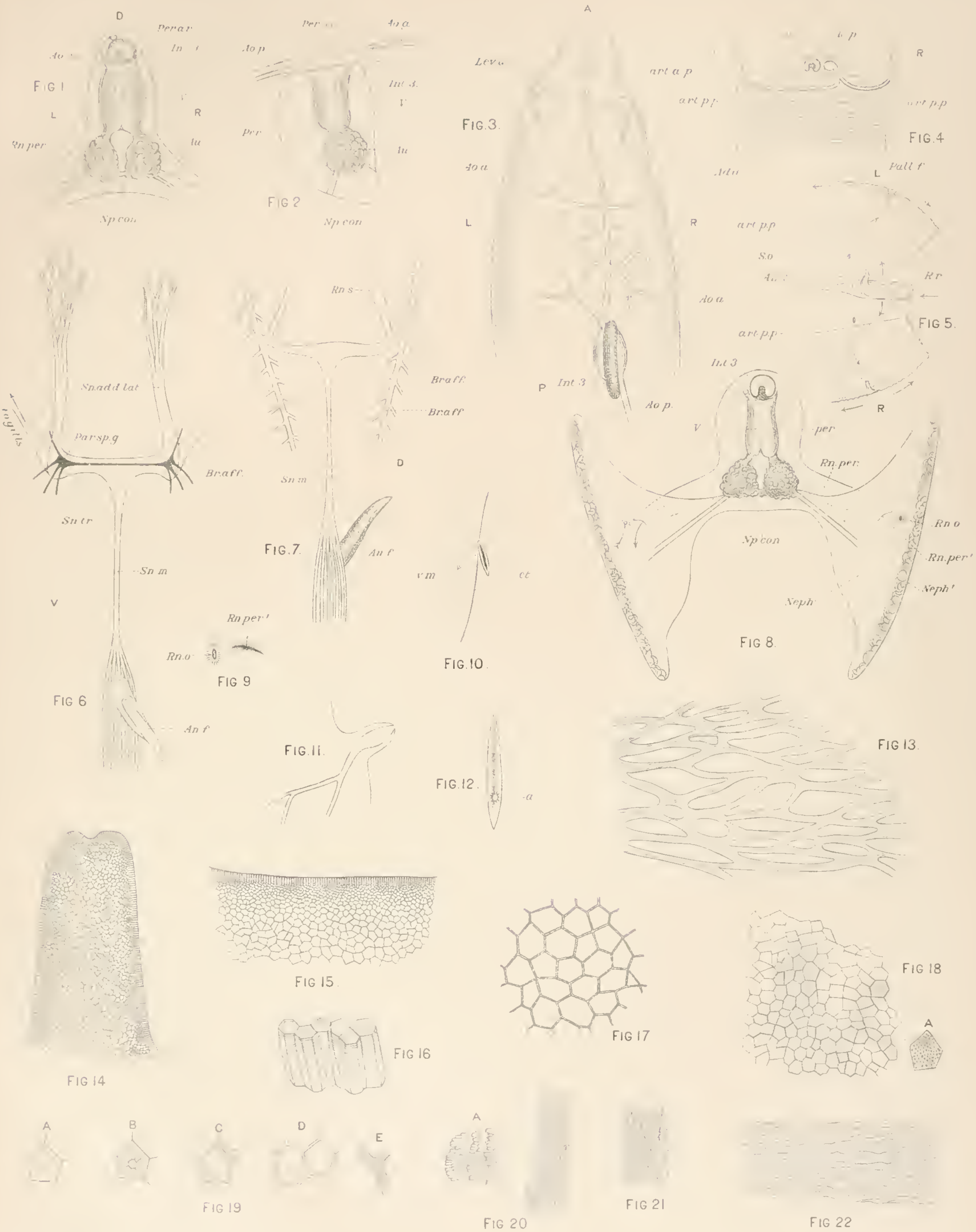
E. Wilson, Cambridge.

ALIMENTARY CANAL, NERVES &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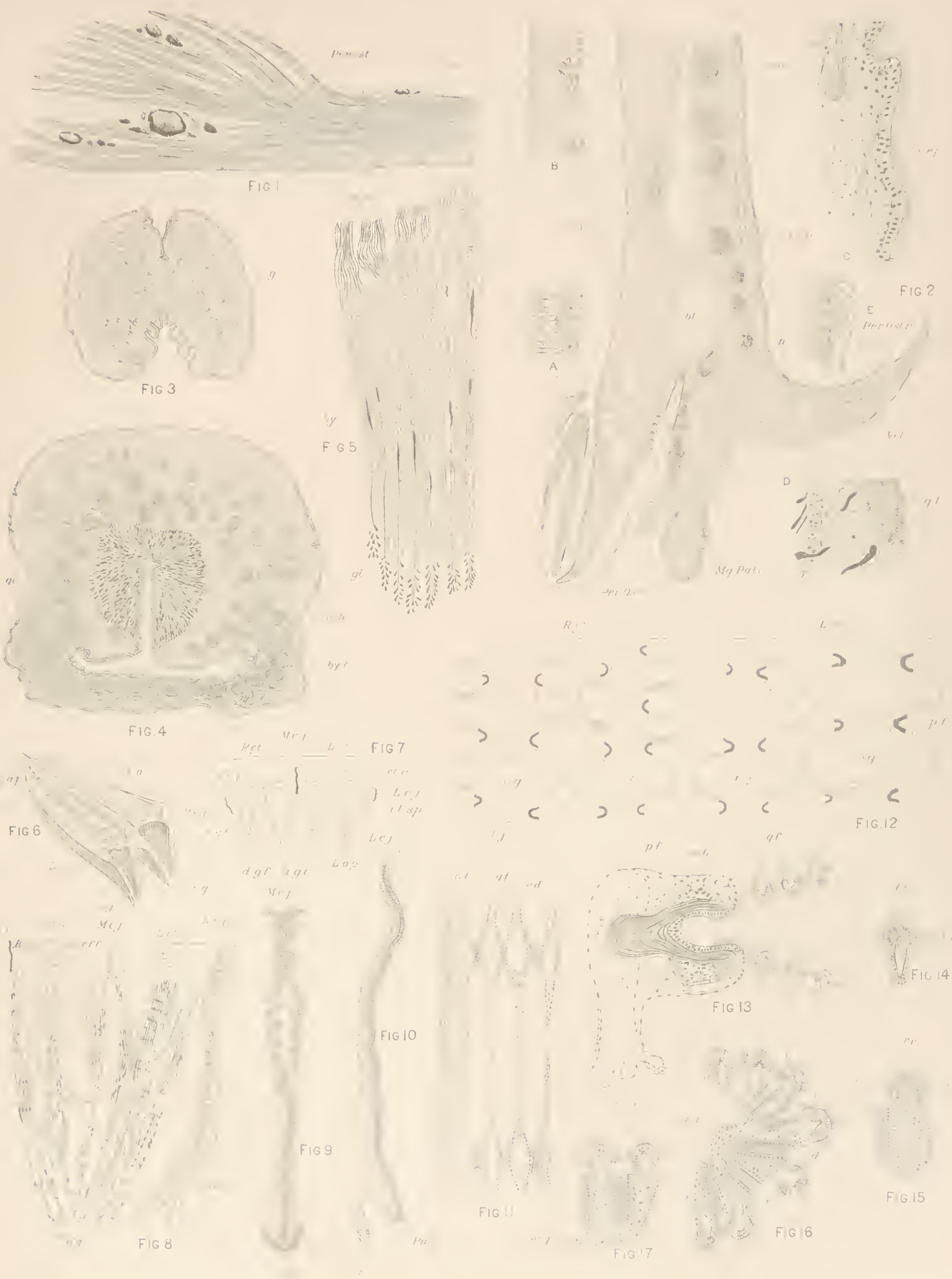
FIG 1
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FIG 16
FIG 17

THE PARASITES OF THE PEARL OYSTER.

BY

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AND

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[WITH FOUR PLATES.]

INTRODUCTION.

THE history of the formation of pearls in European mussels around the Cercaria of Trematodes is recorded in the papers of GARNER (1871), GIARD (1897), DUBOIS (1901) and others, and it has recently been re-told in more detail by Dr. H. LYSTER JAMESON.* The main part of Dr. JAMESON'S own observation was directed to the *Leucithodendrium* (*Distomum*) *somateriæ* (LEVINSEN) of the eider-duck (*Somateria mollissima*, LINN.) and of a scoter (*Oedemia nigra*, L.), the sporocyst of which he states is found in *Tapes decussatus*, GMEL., and in the cockle, *Cardium edule*, L., whilst the tailless Cercaria infests the mussel, *Mytilus edulis*, and is the centre round which the small lustreless pearls of that mollusc are formed. It has been pointed out since that two points are still left in an unsettled condition by JAMESON'S paper, viz. (1) the exact mode of origin of the epithelial sac around the parasite which secretes the pearl, and (2) the supposed transference of the parasite from the cockle to the mussel.

With regard to the history of the relationship of internal parasites to the pearls formed in the Ceylon pearl oyster, *Margaritifera vulgaris*, SCHUM.—not a true oyster but a member of the AVICULIDÆ, and so allied to the mussel, *Mytilus edulis*—we quote two short paragraphs from Professor HERDMAN'S Introduction to the first volume of this Report:—

> "To Dr. KELAART (1857 to 1859) belongs the honour of having first connected the formation of pearls in the Ceylon oyster with the presence of vermean parasites. It is true that Filippi, seven years before, in 1852, showed that the Trematode *Distomum duplicatum* was the cause of pearl formation in the fresh-water mussel *Anodonta*, and KÜCHENMEISTER (1856), MÖBIUS (1857),

* 'P. Zool. Soc.,' London, 1902, p. 140.

and others extended the discovery to other pearl-producing oysters, and to other parasites; but it is possible that KELAART knew nothing of these papers, and that he made his discovery in regard to the Ceylon oysters quite independently. He (and the Swiss Zoologist, HUMBERT, who was with him at a pearl fishery) found '*in addition to the Filaria and Circaria, three other parasitical worms infesting the viscera and other parts of the pearl oyster. We both agree that these worms play an important part in the formation of pearls; and it may yet be found possible to infect oysters in other beds with these worms, and thus increase the quantity of these gems.*' Thus we have KELAART, in 1859, definitely stating the possibility, in the case of the Ceylon pearl oyster, of infecting other beds with the larvæ of the pearl-producing Platyhelminthian parasites in order to increase the quantity of pearls.

"THURSTON, in 1894, confirmed KELAART'S observation, finding in the tissues and also in the alimentary canal of the Ceylon oyster, '*larvæ of some Platyhelminthian* (*flat worm*).' He figures ('Madras Mus. Bull.,' I., Plate II., fig. 1) a section showing two of the parasites encysted between the alimentary canal and generative tubes. Here the matter rested so far as the Ceylon pearl oyster was concerned."

KELAART'S work has been till recently somewhat neglected, and we therefore give in a note* the whole paragraph which deals with parasites from his last Report.†

The large number of oysters dissected during the fifteen months of Dr. HERDMAN'S and Mr. HORNELL'S expedition enable us now to furnish what is probably a fairly exhaustive list of the Entozoa of the pearl oyster, seven in number. They comprise one Cestode (*Tetrarhynchus unionifactor*, n. sp.), three Trematodes (*Muttua margaritiferæ*, n. sp., *Musalia herdmani*, n. sp., *Aspidogaster margaritiferæ*, n. sp.) and three Nematodes, *Ascaris meleagrinæ*, n. sp., *Cheiracanthus uncinatus*, and an unidentified species of *Oxyuris*.

* "I have not in this paper detailed some very interesting discoveries made since my last Report, on the Anatomy and Physiology of the Pearl Oyster, believing that they are better fitted for a treatise on the subject than to be embodied in a Report to the Ceylon Government, which must necessarily be written in popular form. However, as this Report may, like the preceding ones, fall into the hands of scientific men, I shall merely mention here that Monsieur HUMBERT, a Swiss zoologist, has, by his own microscopic observations at the last pearl fishery, corroborated all I have stated about the ovaria or genital glands and their contents; and that he has discovered, in addition to the Filaria and Circaria, three other parasitical worms infesting the viscera and other parts of the pearl oyster. We both agree that these worms play an important part in the formation of pearls; and it may yet be found possible to infect oysters in other beds with these worms, and thus increase the quantity of these gems. The nucleus of an American pearl, drawn by MÖBIUS, is nearly of the same form as the Circaria found in the pearl oysters of Ceylon. It will be curious to ascertain if the oysters in the Tinnevelly banks have the same species of worms as those found in the oysters on the banks at Arripo."

† Reprinted in the 'Proceedings of the Madras Government Revenue Department,' 17th February, 1864.

The ectoparasites of the pearl oyster consist principally of shell-boring animals which tunnel more or less extensively into the nacreous portion of the valves. Of these, the only one whose depredations are of economic importance is the boring sponge *Cliona margaritiferæ*, DENDY. The other two, the Polychæte worm *Leucodore* sp., and the Lamellibranch mollusc *Lithodomus* sp. (date-shell), are never so numerous as to constitute a serious danger to the oyster population of the pearl banks.

I. CESTODES OF THE PEARL OYSTER.

I. CESTODE LARVÆ IN THE PEARL OYSTER, *Margaritifera vulgaris*, SCHUM.

The cestode larvæ of the pearl oyster pass through several stages in the tissues of the host, that is if they escape being entombed within the centre of a pearl. Economically these unpleasant little creatures are of supreme importance to the Ceylon pearl fishery, as their presence in the oyster causes the formation of the finest quality of pearl and those with the highest lustre.

These larvæ first attracted attention during the second cruise* of the "Lady Havelock," on March 6th, 1902, and the following days, when numbers of the early globular stage were dissected out from the livers of oysters dredged from the West Cheval Paar. Subsequently, during the investigation carried out at the Galle Biological Laboratory, a second and more advanced stage of a *Tetrarhynchus* larva was found in the same animal. Details of the morphology and histology were then worked out, and the relationship which the larvæ bear to pearl formation was investigated.

It is usual for a *Tetrarhynchus* to enter its first host as an embryo enclosed in an egg-shell. As VAULLEGEARD† says, "L'œuf doit être avalé par un animal marin ; il ne se développe que si cet être lui fournit un milieu convenable, mais les Tetrarhynques paraissent peu tenir à une espèce ;" the drawings made by one of us (Plate I., fig. 1) of a free-swimming larva taken in the plankton at the north end of the Muttuvaratu Paar seems to point to the fact that the embryo of the pearl-forming parasites may leave the egg-shell before entering their first host, and this must be so if the organisms in question are truly the young of the *Tetrarhynchus;* this point, however, requires corroboration.

The earlier and more globular-shaped of the two stages met with in the pearl oyster is by far the more numerous, as may naturally be expected. It accounts for all save one per cent. of the total cases found. The liver, the gills (Plate I., figs. 3 and 4), and the connective tissue of the mantle (Plate I., fig. 2) are the organs chiefly favoured ; the muscles are practically free, while the gonads yield comparatively few.

* See "Narrative," this Report, Part I., p. 70.

† 'Mem. Soc. Normandie,' XIX., 1897 to 1899, p. 353.

In the liver and in the base of the gills they usually reach the greatest size; in the gill-filaments, where they occasionally abound, they seldom attain other than minute dimensions. Each is enveloped in a tough, elastic, and fibrous capsule of spherical form, derived from the adjacent connective-tissue cells (Plate I., figs. 5, 6, and 8). The capsules of those found in the liver and gill-bases are specially thick and strong, and slightly opalescent. In extreme cases the fibrous capsule has a thickness equal to fully half the diameter of the enclosed parasite (Plate I., fig. 5 *a*, and fig. 8 *a* and *b*).

The minute larvæ encapsuled in the gill-filaments—and these are easy of observation because of the transparency of the capsule membrane (Plate I., figs. 5 and 8)—may be seen occasionally to rotate slowly within their prison. The body is subglobular and remains so, even after considerable increase in size. The oldest larvæ however tend gradually to assume an elongated cylindrical form, with a pointed protrusible head, a denticulated collar, and a long oval body, foreshadowing the change to the rarer second or hooded larval phase (Plate I., figs. 12 and 13).

The larva in this stage closely resembles one of those figured in a paper by Professor GIARD on "L'Origine Parasitaire des Perles."* It was observed by Monsieur SEURAT, who not unnaturally mistook it for *Amphistoma*.

In the globular stage, whether minute or comparatively large, the structure differs but in details. Thus the body consists of two regions, an anterior, the smaller, and a large bladder-like posterior division. The former measures approximately but one-third of the total diameter. Viewed *en face*, this region has the appearance of a broad convexly-annular sucker, with a wide central orifice, wherefrom protrudes slightly the rounded summit of a low eminence (Plate I., fig. 9).

The saccate hinder portion of the body is thin-walled and filled with granular contents wherein rounded refractile corpuscles lie scattered abundantly, especially in the peripheral layer (Plate I., figs. 12 and 13). Under slight pressure, as first seen, it exhibited a striking resemblance to a tiny Trematode, or it might be mistaken for a large Gregarine.

When freed from its investing membranes, the larva progresses slowly by means of the alternate elongation and contraction of the body, the low central anterior eminence assisting by protrusion and retraction. The anterior region is clear and slightly tinged with yellow; the hinder is colourless and granular.

The cephalic "sucker" is in reality a head-sheath, the low median eminence within being a proboscis-like head rudiment, the scolex-rudiment (Plate I., fig. 6). When the latter is retracted—the normal condition when at rest within the cyst capsule—it lies sunk within the sheath, separated from it by a deep and narrow encircling groove. Under the influence of slight pressure, the head is seen (Plate I., fig. 11) to be shot out in the form of a blunt cone, the head groove being temporarily obliterated. The muscular walls of this cephalic apparatus, sheath as well as head,

* 'C. R. Soc. Biol.,' LV., 1903, p. 1222.

are highly developed, and consist of two series, one running longitudinally, the other in a circular manner.

The cuticle of the head and its groove is smooth ; that of the sheath is ornamented with a multitude of closely set minute shagreen-like points, resembling in shape denticles from the skin of *Scyllium* ; the central point having a tiny basal projection on either side (Plate I., figs. 10 and 11, Plate II., fig. 18).

The hinder portion of this larva is the morphological equivalent of the "bladder" of the Cysticercus stage of *Tænia*, differing however in that the contents, in lieu of being fluid, are composed of a loose connective-tissue parenchyma, in which are distributed the rounded refractile bodies already referred to. These effervesce upon the application of acid, and by this test, taken together with the similarity in appearance, they are shown to be calcareous corpuscles identical with those so widely met with among the Cestoda.

Ensheathing the body parenchyma are two muscular layers of similar arrangement to those of the head, but of extremely feeble development. These in turn are overlaid by a cuticle of peculiar appearance. In the parenchyma ramify the tubules of the vascular system.

The connective-tissue framework of the cortical region of the parenchyma is rather denser than it is in the centre. In the former, accumulating at the periphery, lie the majority of the calcareous corpuscles. Of these, while some are nearly spherical, the greater number are slightly reniform, or else obscurely compound, double, or even roughly trifoliate, shallow depressions marking some out into two or even three distinct areas (Plate II., figs. 16 and 17). With pressure, they can be broken into irregular sharp-edged fragments, just as a glass ball shatters under a blow.

The traces of a distinct and fine capsule around many of the corpuscles, which can be detected in the living tissue, is probably the remains of the cells in which the concretions arise (Plate II., fig. 17).

A closely woven network of anastomosing tubules of exceeding delicacy, suffused with the palest of pink tints, is also to be seen in the cortical parenchyma. Such represents a generalised and rudimentary excretory system which becomes specialized in succeeding stages (Plate I., fig. 12).

In the peripheral region just under the cuticle are occasionally to be made out large clear-walled cells filled with colourless transparent globules; probably these are the "bladder-cells" which ooze through the cuticular tubules under pressure.

When a living larva is examined microscopically, the body behind the denticulated hinder portion of the head-sheath shows a distinct appearance of being clothed in a densely ciliated envelope. So distinct is the appearance, that time after time references to the "ciliated surface" of these larvæ appear in the earlier notes made on the steamer "Lady Havelock." Never however were these cilia seen in motion, and this suspicious circumstance led to a more minute scrutiny, which revealed that the appearance is due to an optical illusion. In reality the apparently ciliated layer is an extremely delicate semi-mucilaginous external cuticular layer—the *epicuticle* as we may perhaps term it—deriving its deceptive appearance of ciliation from numerous closely-set vertical tubuli (Plate I., fig. 15). Underlying this is the thin true cuticle, perforated with pores corresponding in position and continuous with the tubules of the epicuticle. In consistence it is elastic, firm, and strong.

When one of these larvæ is being examined alive under pressure, after some time, as activity and vitality decrease, the epicuticle begins to disintegrate, delicate bladder-like cells filled with clear, colourless, oil-like globules ooze through the tubules from the sub-cuticular tissues, the mucilaginous epicuticle disappears concurrently, apparently dissolving, so that after the lapse of a few minutes the larva shows but the merest traces of this investment. The body appears then to be bounded externally by the firm and very thin true cuticle, a multitude of free thin-walled sacs full of oil-globules clustering cloud-like around the larva (Plate I., fig. 15).

In the elongated Balanoglossus-like older individuals belonging to this first larval stage, the head rudiment becomes longer and more proboscis-like; its bulk increases more rapidly than its sheath, which tends to assume a collar-like form (Plate I., figs. 12 and 13). At this stage, movements become more active, and the larva, facilitated by its more vermean form, crawls restlessly about when freed from its capsule. Histologically, the tissues show no further differentiation.

The larvæ we have described correspond so closely with the figures of those found by Monsieur SEURAT given in Professor GIARD'S article mentioned above, that we think there is little doubt that they are at least generically the same. Professor GIARD identifies these as belonging to the family Monobothria of VAN BENEDEN'S Order Pseudophyllidea. If Professor GIARD'S identification be correct, then our larvæ also belong to this family. We have, however, found a larval stage of an undoubted *Tetrarhynchus* living in the pearl oyster, and it is not impossible, though it seems improbable, that this stage is but a later one of such of the larvæ described above as escape entombment in a pearl.

This second stage, or larval *Tetrarhynchus*, shows a great advance on the larva described above. In length it measures from 4·5 millims. to 5·5 millims., and has a sagittate outline. The body, covered with a sculptured cuticle, is sub-cylindrical, decreasing slightly in diameter at the extreme posterior extremity (Plate II., fig. 19).

The anterior end is sub-conical, furnished laterally with two hood-like lappets, which are laid back ear-like, one on either side, when the creature is quiescent. They function as organs both of progression and of adhesion. Two muscular cup-shaped depressions occur in each, constituting two pairs of simple suckers (Plate II., fig. 22). When at rest, these suckers are not apparent; but as the lappets sweep forwards, either as swimming or locomotor organs, or as organs of prehension and attachment, the pits or suckers become conspicuous and comparatively deep. The lappets are extremely mobile, changing form continuously.

The short caudal region, slightly less in diameter than the rest of the body, terminates bluntly and is armed over the posterior moiety with stiff cilia-like hairs (Plate II., fig. 20).

The internal structure of the body is obscured by the massing of innumerable calcareous corpuscles in the cortical region. No details of the excretory system could be made out, save the presence of the main longitudinal trunks, and of a well developed terminal contractile vesicle opening to the exterior at the posterior extremity (Plate II., figs. 19 and 20), and a few loops in the head (Plate II., fig. 21).

Conspicuous within the second quarter of the body lie the four great proboscis-sacs. Each proboscis passes forwards to its point of emergence between the cephalic suckers (Plate II., fig. 22). One of their hooks is shown in Plate II., fig. 23.

The cuticle possesses a certain surface ornamentation, consisting of tiny mammillations or tubercles, irregularly disposed (Plate II., fig. 20), except upon the caudal portion, where the markings assume a meandering Greek pattern of graceful and intricate curves. The latter are possibly the expression of a post-mortem shrinkage, they were not observed in all cases, and are exaggerated in our figure.

II. Cestodes in the File or Trigger Fishes.

In looking for the second host of the pearl oyster parasites, it was natural to examine the species of *Balistes*, the Trigger or File fishes. It has been asserted, and also contradicted, that these fishes feed largely on pearl oysters and other molluscs. We have, however, confirmed the truth of the statement, having on many occasions found pearl oyster shells in the stomachs of *Balistes* taken on the banks. The presence in the body of both *B. mitis* and *B. stellatus* of numerous Tetrarhynchid cysts led to the hope that a further stage in the life history of the parasite upon which jewellers are so greatly dependent had been discovered. A more minute examination however, renders the connexion between the parasites of the pearl oyster and those of the file fish a doubtful one.

We have found so far in the *Balistes* two *Tetrarhynchi* belonging in our opinion to two distinct species, and these we have named *Tetrarhynchus balistidis* and *T. pinnæ* respectively. The latter is ensheathed in a large bladder-like vesicle, four or five times the length of the scolex, and perhaps twice as broad, the whole somewhat resembling a Lima-bean. The other form, *T. balistidis*, is also ensheathed in a vesicle. but of somewhat different form ; it has, for instance, little space between the inner and outer wall, and is simply a double membrane closely applied to the head of the scolex. It does not arise from the extreme end of the scolex, and so envelop the whole scolex, but it arises a little way behind the head and is folded forward as a woman might turn a short cape over her head. The result is that in this second form the scolex projects behind the vesicle (Plate II., fig. 24), whilst in the first the vesicle projects behind the scolex (Plate II., figs. 31 and 32).

Macerated specimens and sections show that the teeth of these two *Tetrarhynchi* are very different in shape, size and number. In *T. balistidis* the teeth are few in number, slightly curved or hooked, with a well pronounced broad base (Plate II., figs. 33 and 35). Seen in optical section, there are but two teeth visible in a transverse row, and probably each transverse ring of teeth consists of but four to six of these structures (Plate II., fig. 34). The teeth of *T. pinnæ* are, on the other hand, exceptionally numerous. They arise in two hemicircles, and the centre of each hemicircle lies posterior to the free ends. The right and left hemicircles alternate, as is seen in Plate II., fig. 37. The teeth are so numerous that the oblique \\// shape in which they are arranged is not evident when the teeth are themselves examined. Then only a forest of fine blades is seen like the clashing swords of an army acclaiming an Emperor, but if the lens be focussed on to the bases from which the teeth originate the orderly arrangement, as of soldiers drawn up in rank, becomes apparent. The teeth of this form differ from the stout teeth of *T. balistidis* not only in their number, but in their size and shape. They are smaller and far more delicate in outline, and are shaped like a Malay kriss (Plate II., fig. 36). At the proximal end is a small haft or handle, which probably represents the portion embedded in the flesh.

T. balistidis occurs encysted in the liver, and beneath the peritoneum of the spotted file or trigger fishes (*Balistes stellatus* and *B. mitis*). Its length is about 12 millims. to 13 millims., and its breadth 1·5 millims. to 2 millims. It consists of a rounded triangular head and an elongated, melon-seed-shaped body. The head is enveloped in a protective sheath—like an amnion—but remaining open at a median pore (Plate II., fig. 24). The hooked introverts and their muscular sheathes are all confined to the head, and are enveloped in the sheath. Traces of the bothria or suckers are visible. The body is quite free from the sheath and in no part surrounded by it. Both body and head are crowded with calcareous corpuscles.

What we take to be a later stage of *T. balistidis* also occurs beneath the peritoneum of *Balistes mitis* and *B. stellatus*. This stage is represented by the squarish head of a *Tetrarhynchus* with the introverts protruding and the bothria well marked (Plate II., fig. 25). This form has thrown off its body and its amnion, in fact the whole vesicle has disappeared. It shows distinct signs of 4 bothria, such as exist in *Tetrarhynchus bisulcatus*, LINTON. The introverts and their muscular sacs lie one on either side of the level of the bothria. The small papilla or protuberance at the posterior end indicates the beginning of the body or string of proglottides of the adult.

We have thus in *Balistes mitis* and *B. stellatus* in all probability two stages of the species *T. balistidis*.

T. pinnæ lies in more definite cysts formed by the pathological growth of the tissues of its host, and from which they can be easily shelled. The cysts are elongated oval or sausage-shaped, whitish or brownish-yellow in colour, and some

10 millims. to 15 millims. in length (Plate II., figs. 28, 29, and 30). The larva with the cyst is covered by a thin cuticle, beneath which lie some poorly developed circular and longitudinal muscular fibres (Plate II., fig. 38). The body of the vesicle is very fluid, consisting of a highly vacuolated parenchyma. In the parenchymatous cells numerous oil drops and calcareous bodies lie.

Finally we have a very small *Tetrarhynchus* found amongst the spiral valves of the intestine of a sting-ray, *Tæniura melanospilos*, BLKR., kindly identified for us by Mr. G. A. BOULENGER of the British Museum (Plate IV., figs. 67, 70, 71, and 72). In the stomach of this fish, known locally as the "Pulli-thirikkai," two entire and quite unmutilated *Balistes* were found. Dr. VON LINSTOW has kindly furnished us with a diagnosis of this *Tetrarhynchus*, which he has named *T. minimus*, and this we subjoin in the systematic part dealing with the Cestoda (p. 89).

Amongst the specimens of *Tetrarhynchus minimus* found in the *Tæniura* was a single example of *Polypocephalus*, a genus established by BRAUN* for some specimens he described from the stomach of *Rhinobatis granulatus*, CUV.

We have now dealt with the following forms :—

A. In the pearl oyster, *Margaritifera vulgaris*, SCHUM.—

(i.) Small Cestode larvæ in various tissues, some of these form the nuclei of pearls. These correspond very closely with the larvæ found by Monsieur SEURAT, and identified by Professor GIARD as belonging to the family Monobothria.

(ii.) Older larvæ, of the genus *Tetrarhynchus*, in more than one stage, the most mature and the most abundant of which have no sign or trace of a vesicle, the introverts protruded and probably functional, the muscular sacs of the introverts reaching back to the middle of the body, a well developed excretory system with a terminal pore, the posterior end of the body spinous, with sinuous markings, and the rest of the body covered with low warts (Plate II., fig. 20).

B. In the file or trigger fishes, *Balistes mitis*, *B. undulatus*, and *B. stellatus*—

(iii.) *Tetrarhynchus balistidis*, n. sp., whose head is closely enveloped in a vesicle which does not enclose the body, the teeth on the introvert are large and few in number, 4 to 6 in a horizontal ring (Plate II., fig. 24); a later stage of this form, like it encysted in the sub-peritoneal tissue, is represented by a squarish head with 4 bothria (Plate II., figs. 25 and 26). This stage has quite freed itself from vesicle and "body," but is provided posteriorly with a papilla or protuberance, from which the proglottides will probably arise.

(iv.) *Tetrarhynchus pinnæ*, n. sp., enveloped in a large vesicle swollen with

* 'Arbeit. Inst. Würtzburg,' IV., 1877–78, p. 297.

aqueous parenchyma. The vesicle covers the whole head and such body as exists, and in relation to the scolex recalls the Cysticercus stage of *Tænia*. The oval cysts lie embedded in the sub-peritoneal tissues. The introverts of this form have enormous numbers of weak hooks which arise from shaped bases. There are but 2 bothria (Plate II., figs. 28, 29, 30, 31, 32, 36, 37, 38).

(v.) *Tetrarhynchus minimus*, v. LINS., from the spiral valve of the intestine of *Tæniura melanospilos*, BLKR., a fish which eats *Balistes* (Plate IV., figs. 67, 70, 71, 72).

C. In the sea—

(vi.) A planarian-like larva, which in the structure of its calcareous corpuscles and its cuticle recalls the embryonic forms described above.

What is the relationship of these six forms?

To begin with the last, the planarian-like larva found swimming by lateral undulations—for it is unciliated—certainly resembles the youngest forms found in the pearl oyster. The indications of the invaginated head and the presence of calcareous corpuscles strengthen the resemblance. On the other hand, we as yet know of no other Tetrarhynchid which has a free-swimming larva. *Tetrarhynchi* make their way into their first host as embryos still encased in egg-shells. The Bothriocephalidæ have however free-swimming larvæ, but these swim by cilia. On the whole, we think it probable that this larva is the first stage in the life-history of the pearl-forming organism, but until it has been observed to enter the *Margaritifera vulgaris*, and until a more minute examination by sections proves the precise nature of the larva, it would be unwise to be dogmatic.

The young larvæ within the oyster have a two-fold fate, (i) either they become the nuclei around which their own sarcophagus is secreted, or—but this is most improbable—(ii) they may grow into the older *Tetrarhynchus* larvæ. The first have no further interest for their race. They perish but to form "pearls of great price" for which men risk their lives, and, as dried-up mummies set in a costly sheath, they serve to deck the crowns of kings and the necks of fair women. Had Cleopatra, when she dissolved her Orient pearl in vinegar, examined the residue with a lens instead of drinking it, she would doubtless have found a shrivelled, dried-up particle, the mummy of a tape-worm larva, around which the pearl had been deposited.

The *Tetrarhynchi* found in the pearl oyster seem to lack but reproductive organs to be adults. The following features in these forms are of importance in considering their alleged relationship with the encysted forms found in the *Balistes*:—the presence of the 2 lappets, each sheltering 2 bothria; the absence of any kind of vesicle; the position of the muscular sheaths into which the introverts can be withdrawn, the posterior end of these lies about half-way along the body; the warty markings on the skin; and the ciliated posterior end of the body.

None of these features are reproduced in either of the *Tetrarhynchi* encysted in the tissues of the *Balistes*. The more advanced larvæ from the pearl oyster have arrived at a later stage in development than the larvæ found in the *Balistes*, and, unlike them, seem to belong to that group of the Tetrarhynchidæ which form no vesicle. The teeth on the introvert differ in all respects from those of the *Tetrarhynchi* of the *Balistes* and from another *Tetrarhynchus* sp. found in *Trygon walga*. Those of the two species from the *Balistes* differ in nearly every detail. It would be rash to make a dogmatic statement as to the future fate of the *Tetrarhynchus* of the pearl oyster. The trigger or file fishes (*Balistes*), known to the Tamil fishermen as the Kilathi, have by our own observation been proved guilty of feeding largely on pearl oysters. Fragments of pearl oysters are frequently found in their stomachs, and altogether they seem to be the most likely host for the further development of the oyster parasite. We do not, however, think that it is at present clear that they are the second or final host.

Like the pearl oysters, the infested file fishes are by no means confined to the oyster banks in the Gulf of Manaar. Our Ceylon Expedition took them at Trincomalee and again at Galle; at the latter place one was taken so infested with young *Tetrarhynchi* that the mass of their cysts equalled in bulk the whole of the stomach and intestine. A second point is that the form with the large vesicle, *T. pinnæ*, was also found in the tissues of a large *Pinna* sp., a mollusc more widely distributed around Ceylon than *Margaritifera vulgaris*.

The nature of the teeth and their arrangement in *T. minimus* argues against any relationship between the pearl oyster parasite and the small *Tetrarhynchus* found in *Tæniura melanospilos*, and this want of relationship is corroborated by its very minute size. At present the final host of the pearl-forming Cestode does not seem to be *Tæniura melanospilos*. Still the adult *Tetrarhynchi* live almost exclusively in the alimentary canal of Elasmobranchs. Other members of this order which were found in the neighbourhood of the pearl fisheries were *Pteroplatea micrura*, Bl. and Schn., and *Trygon walga*, Müll. and Heull, *T. uarnak* (Forsk.) and *T. sephen* (Forsk.). The last two species were taken by Thurston in the Gulf of Manaar. Day also records *T. marginatus*, Blyth, *T. bleekeri*, Blyth, *T. hennettri*, Müll. and Heull, *T. kuhlii*, Müll. and Heull, *T. lumbricata*, Bl. and Schn., *T. zugei*, Müll. and Heull, from the Indian and Indo-Malayan seas. Probably one of these is the host of the final stages of the two Tetrarhynchid metacestoid larvæ found in the *Balistes*, which they certainly eat, and possibly also of the pearl-forming larvæ of the *Margaritifera vulgaris*. Linton* has described a number of *Tetrarhynchi* from various species of *Trygon*. These are *Tetrarhynchus* (*Rhynchobothrium*) *hispidus*, *T.* (*Rh.*) *longispinis*, *T.* (*Rh.*) *tenuispinis*, and *T.* (*Rh.*) *wagneri*, *T. tenuis*,† and *T. robustus*

* 'U.S. Commission of Fish and Fisheries. Commissioner's Report,' Part XV., 1887. Washington, 1891.

† The *T. lintoni* of Vaullegeard.

from *Trygon centrura*. DIESING* has also described *T.* (*Rh.*) *rubromaculatus* from *Trygon pastinaca*, and *T.* (*Rh.*) *heteromerus* from *Trygon brucco*, but the Trygons from the seas around Ceylon have yet to be investigated for their Cestode parasites. None of these *Tetrarhynchi* hitherto described from Trygons sufficiently resemble the forms described in this Memoir to warrant any claim to relationship.

SYSTEMATIC DESCRIPTION.

The following is an attempt to draw up the systematic characters of the three Tetrarhynchids described above, but it must not be forgotten that these characters are taken from larval forms. Although the later stages of the larvæ obviously approximate to the adult condition, the characterisation of a species from a larval form is always open to objection.

Cestodes from Pearl Oyster.

1.—**Tetrarhynchus unionifactor**, n. sp., Plate II., figs. 19 and 20.

Well advanced larva, about 6·5 millims. to 7 millims. in length. Head with two lappets at the bottom of each two bothria. Introverts with teeth spirally arranged, teeth shaped as in figure, uniform in shape and size. Surface of body covered with low warts except the hindermost end, where the last thirtieth of the total body length was ornamented with coiling markings, perhaps post-mortem wrinkling. The posterior half of this region bears stiff cilia. The sacs of the introverts stretch throughout the anterior half of the body. There is no trace of vesicle.

Habitat :—In the tissues of the pearl oyster. *Margaritifera vulgaris*, SCHUM., from the Gulf of Manaar, Ceylon.

Cestodes from File or Trigger Fish.

The three Cestodes hitherto recorded from the genus *Balistes*, and they are all from *Balistes capriscus*, L., are :—

(i.) *Rhynchobothrium paleaceum*, RUD., which in a larval state is found in *Mullus barbatus*, L., and is a synonym of *Tetrabothriorhynchus migratorius*, DIES.† According to VON LINSTOW'S 'Compendium der Helminthologie' this species is figured in OLSSON'S "Entozoa, iakttagna hos Scandinaviska hafsfiskar."‡ In the explanation to the Plate, however, the Cestode is simply called a *Tetrarhynchus* without specific name.

* 'S.-B. Ak. Wien,' XLVIII.

† 'DIESING 'Systema Helminthum,' p. 573, and 'Rev. d. Cephal. Param.,' 'S.-B. Ak. Wien,' XLVIII., p. 294.

‡ 'Lund. Univ. Ars-skr.,' 1886 (IV.), Plate II., figs. 35, 36, 37.

(ii.) *Tetrarhynchus balistes-caprisci*, Wag.* Two figures are given of a *Tetrarhynchus* from *B. capriscus*, but there is no diagnosis of the species, and the figures are hardly sufficient for purposes of precise determination.

(iii.) *Cestoscolex capriscus*, Parona, is mentioned in a list given in 'Res Ligusticæ,' II. "Vermi Parasiti in Animali della Liguria,"† but no description and no figures are given.

From the above brief résumé of the literature of the subject it seems impossible to identify the specimens at our disposal with any of those mentioned by previous writers. We have therefore made a fresh start and described the two species from *Balistes* as new.

2.—**Tetrarhynchus balistidis**, n. sp., Plate II., fig. 24.

Well advanced metacestoid larva, still retaining the body, 12 millims. to 13 millims. in length. Head triangular, enveloped by a closely wrapping vesicle which leaves the body free. Body crowded with calcareous corpuscles. Teeth of introvert few, only 4 or 6 in a transverse row, strongly hooked. Introvert sheathes confined to the head and not entering the body, which, it seems, is after a certain time thrown off (*cf.* fig. 25) with the vesicle. Apparently 4 lappets.

Habitat:—The metacestoid stage or cysticercoid occurs in the sub-peritoneal tissues of *Balistes stellatus* and *B. mitis* from Ceylon.

3.—**Tetrarhynchus pinnæ**, n. sp., Plate II., figs. 31 and 32 and 38.

The advanced larva or metacestoid is enclosed in a large vesicle, which not only covers the head, but the entire body, and is much larger than the body, 1 millim. to 15 millims. long. The teeth on the introvert are very numerous and arranged in oblique lines. Each tooth is slender, very slightly hooked, and is shaped like a Malay kriss. The proboscis sheaths extend nearly to the posterior end of the scolex. Two lappets.

Habitat:—The metacestoid larva lives in cysts in the tissues around the alimentary canal of *Balistes stellatus* and *B. mitis*, the younger larvæ probably in a *Pinna* sp. from Ceylon.

Cestodes from Sting-Ray.

4.—**Tetrarhynchus minimus**, n. sp., von Linstow.—Plate IV.,‡ figs. 67, 70, 71, 72.

Length 3·7 millims., the last proglottis measures 1·6 millims. in length and 0·39 millim. in breadth. The body consists of about 6 proglottides. The scolex or head bears on its anterior third 4 roundish projections directed backwards; these

* 'Acta Ac. German.' XXIV. Suppl. 1854, p. 77, Plate XIV., figs. 179, 180.

† 'Ann. Mus. Geneva,' Ser. II., IV., 1886, p. 486.

‡ Plates III. and IV. have, by mistake, been lettered 3 and 4 in Arabic.

are the proboscis sheathes from which the proboscides are protruded (Plate IV., figs. 71 and 72). The projections bear very minute, closely packed hooks, from their apices the proboscides protrude, and these bear larger hooks at wider intervals. There is a regular gradation in the size of the proboscis hooks which is shown in Plate IV., fig. 67. The part of the proboscis which is retracted is arranged in a wavy fashion. The reproductive pore is lateral on the posterior third of each proglottis, but for the most part, only immature proglottides were present. The ova are thin-shelled, spherical, with a diameter of 0·0039 millim. This is the smallest of all species of *Tetrarhynchus*.

Habitat:—The folds of the spiral valve of the intestine of *Tæniura melanospilos*, Blkr., taken off Ceylon, at Trincomalee.

The very peculiar and regular arrangement of the teeth, and the gradation in their size and shape is a remarkable feature in the *Tetrarhynchus* from the *Tæniura*. These features seem to separate it off both from the *Tetrarhynchi* of the pearl oyster and from those of the file fish, and to bring us to the conclusion that these forms which seemed at first as if they might be stages in one life-history are really independent species, and that our knowledge of the life-cycle of the parasite which causes the formation of pearls is still incomplete.

II. TREMATODES OF THE PEARL OYSTER.

Three species of Trematodes inhabit the pearl oyster, all of them in an immature condition. They all appear to be new species and we have called them *Muttua margaritiferæ*, *Musalia herdmani*, and *Aspidogaster margaritiferæ* respectively.

1.—**Muttua margaritiferæ**, n. gen. and n. sp.—Plate III., figs. 53, 54, 55, 56 and 57.

Minute, 0·9 millim. to 0·75 millim. in length. Lanceolate shape, slightly narrower anteriorly, both ends bluntly rounded. Cuticle covered with minute pointed scales which extend over posterior end. Suckers almost equal in size, the posterior lies behind the middle of the body. No prepharynx. Pharynx medium in size, no œsophagus, the links of the alimentary canal extend to the vesicle of the excretory system, *i.e.*, almost to the posterior end of the body. Excretory vesicle large, transversely placed and somewhat basin shaped, the coils of the excretory tubules are very marked on each side of the pharynx. Genital pore to the right of the posterior sucker. The vagina is plicated, the penis is large. The cercaria stage has two black eye-spots, one on each side of the pharynx. The characters of the species are those of the genus.

Habitat:—The cercaria stage inhabits the pearl oyster, *Margaritifera vulgaris*, Schum. It is usually found in the gills, and is most frequently met with in those oysters which live on a rocky substratum, such as those of the Muttuvaratu Paar.

Of the three Trematodes associated with the pearl oyster, this is the only one found in any abundance; the other two species are so rare that no more than some half-dozen individuals have been met with during the course of the present investigation.

The local distribution of *M. margaritiferæ* is noteworthy. Its Cercariæ swarm in the stunted pearl oysters of the Muttuvaratu Paar; but in those from the Eastern Cheval they are very rare. Rocky ground predominates in the former locality, sand in the latter. As a consequence the molluscan, annelidan and fish constituents of the fauna show considerable divergence, and this, in turn, influences the numbers of the two unknown animals which lodge respectively the sporocyst and the adult form of this Trematode, and thus produces the erratic local distribution noted.

These Cercarian larvæ are usually found in the gills of the pearl oyster; there they occur frequently in considerable numbers. In a fragment of gill-lamella from a Muttuvaratu individual, made up of 12 filaments, as many as 6 of these Trematodes were found. To a much smaller degree they infest the mantle. In the other organs they seldom appear.

Their abundance is strangely variable even in oysters from the same "paar." In those from the Muttuvaratu, the majority contain from 20 to 40 each; occasional individuals are, however, found infested by an extremely limited number, and in a few instances there is a total absence of the parasite. On the other hand, in the large well-grown oysters from the Eastern Cheval, during the past eighteen months it was exceptional to find even a single one.

To give an account of the life-history of the Trematode and to discover the hosts of the other stages in its life-cycle, it will be needful to anchor on the Muttuvaratu Paar for a sufficiently long period to permit of an exhaustive examination of the principal organisms that live there in association with the oysters. A lengthy visit to this particular paar is also required in order to determine whether this Trematode has any importance as a pearl-inducing factor, although, so far as present evidence goes, it is strongly against such a presumption—every one of the dozen cyst-pearls obtained from this bank which have been decalcified has yielded a Cestode larva as nucleus.

The stage of *Muttua margaritiferæ*, which is met with in the pearl oyster, is a quiescent Cercarian form of an advanced character, the alimentary canal and the copulatory organs being fully developed. What appear to be testes are also present, but no trace of ovary was detected.

The larva lies coiled or, rather, doubled upon itself (Plate III., fig. 54) within a thin membranous adventitious capsule. It frequently changes position, rotating slowly within its prison.

When liberated by the rupture of the investing sac, the body is seen to be gracefully lanceolate in outline when viewed from either the dorsal or the ventral aspect. Anteriorly it is somewhat truncate, posteriorly it narrows rapidly, ending in a blunt rounded angle (Plate III., fig. 55). In length it is remarkably uniform, 0·75 millim. to 0·9 millim. covering all the individuals measured.

The two suckers are equal in diameter, that of each equal to one-third of the width of the body at its widest part. The posterior or ventral sucker (*v.s.*) is placed just behind the middle point in the longitudinal axis, its anterior margin approximately coinciding with this point. The muscular structure of the suckers presents no unusual feature.

Transverse rows of minute spines, closely and regularly disposed, beset the cuticle. The points are directed backwards, and as a rule they alternate in position with those of the row in front. The rows encircle the body, and, being arranged with perfect regularity, they impart a distinct appearance of annulation. There are about 150 or more of these encircling rows (Plate III., fig. 57, *c.s.*).

Two black eye-spots are conspicuous, even when the larva is viewed within its capsule (Plate III., figs. 54 and 55, *e*). One lies on either side, close to the junction of the oral sucker with the muscular pharynx. The diameter of each eye is equal to the width of two of the transverse rows of cuticular spines.

A wide aperture in the centre of the oral sucker opens into its capacious funnel-shaped cavity, a chamber continually varying in size. The mouth lies at the base of this funnel, whence a short buccal passage leads directly into the muscular pharynx (*ph.*), elliptical in optical section. There is practically no œsophagus, and the two long tubular digestive cæca (*d.c.*) arise close to the pharynx. Each of these, as it passes backwards, curves outwards till it approaches close to the lateral margin, thereafter pursuing a nearly straight posterior course. The cæca terminate at a point close to the anterior border of the excretory vesicle (*c.v.*). They are never distended with food material, as happens in the case of the succeeding species; little is to be seen save a number of rather large clear globules. All the organs are, indeed, remarkably clear and free from the massing of opaque granules so frequent in many Cercariæ and which is so marked a feature of the species next to be described.

The excretory system consists of two tubular lateral trunks extending the whole length of the body. Anteriorly, in the pharyngeal region, they are much convoluted; posteriorly they empty into a capacious median vesicle which communicates with the exterior by means of a narrow funnel-shaped pore at the hinder end. The excretory vesicle varies considerably in form; sometimes, as when the larva is lying within its capsule, it is broadly ovate, the narrow end directed posteriorly (Plate III., fig. 54, *c.v.*); at other times, when the worm is crawling about after liberation, the vesicle shortens and widens, and appears as a broad transverse chamber, roughly triangular in outline, the base directed forwards (Plate III., fig. 55, *c.v.*). The epithelial cells lining its interior are very conspicuous; they consist of very large cells, markedly convex on the free surface.

Two paired glands, which appear to be the male gonads, are present. They are situated laterally, one on either flank of the ventral sucker. Each is an elongated sac, broader behind than in front, and full of densely packed cells containing numerous clear globule-like bodies. No ovary can be traced.

Both of the copulatory organs are present and well developed. They open side by side to the immediate right of the ventral sucker at about the level of its centre. That of the male consists of a great cylindrical penis-sheath (*p.sh.*) lying, in great part, posterior to the ventral sucker. It contains a well-defined seminal vesicle (*s.v.*) at the posterior end together with the rudiments of the penis itself. The distal portion of the sheath is somewhat narrowed to form a distinct neck.

The female organ, the vagina, lies to the right, alongside and parallel with the penis-sheath. The walls are thrown into a number of circular folds or pleats—wide grooves, concave in section, alternating with sharp-angled encompassing projecting folds—that give it much the appearance of a broadly spindle-shaped Chinese lantern. No trace of uterus can be made out.

The encysted cercariæ of this Trematode resemble those figured and described by JAMESON in some features, but differ from them in other particulars, which indeed exclude it from the sub-family Brachycoelinæ to which *Leucithodendrium* belongs, *e.g.*, the two branches of the alimentary canal extend far beyond the ventral sucker, and indeed reach almost to the hinder end of the body.

It is difficult to establish a new genus upon a form which is not yet adult, but after going through the twelve sub-families into which LOOSS* has split up the Distomidæ we cannot bring our specimens into line with any of them. Some of their characters appear in one sub-family and some in another, but the totality of characters does not appear in any one of them. Owing to the immaturity, several of the chief features of the adult anatomy, such as the disposition of the uterus, could not be made out.

The increasing difficulty of coining names hitherto unoccupied has induced us to fall back on Tamil, and we suggest the name *Muttua* (Muttu means a pearl) for the genus. This will recall the particular paar (Muttuvaratu) where it occurs in the greatest abundance.

2.—**Musalia herdmani**, n. gen. and n. sp.—Plate III., fig. 51, and Plate IV., figs. 58, 59, and 65.

Skin smooth, without denticles. Pharynx rather smaller than oral sucker. Ventral sucker very large and protrusible; its diameter, as compared with that of the oral, is as 7 : 3. Œsophagus very short, a median backward pouch projects between the origin of the two limbs of the alimentary canal. The latter are long and reach back to the end of the body. The reproductive openings lie between the ventral sucker and the oral, but nearer the latter. The testes lie behind the ventral sucker and are inclined at an angle one to another, the ovary lies behind them. Excretory bladder small and triangular.

Habitat:—The larval encysted stage is found in *Margaritifera vulgaris*, SCHUM., encapsuled in the muscles, the mantle, and the foot.

* 'Zool. Jahrb. Syst.,' XII., 1899, p. 522.

This species is exceedingly rare in the pearl oyster. Four individuals only have been found, two from oysters hailing from the Periya Paar Kerrai, and a like number from the Muttuvaratu. Both of the former were found in the muscular pallial region in front of the base of the foot (Plate IV., fig. 65) in separate oysters. Of the others, one lay in the floor of the visceral mass, the other in the posterior ventral region of the mantle.

As in *Muttua margaritiferæ*, the stage met with had the outward form and the rudiments at least of all the organs of the adult individual. The specimens found were, however, not sexually mature, and being in an encysted condition must be considered as a Cercaria. Their length when in a normal non-contracted condition is $\frac{1}{8}$ of an inch (3 millims.). They are of an elongated narrow lanceolate shape, with a ratio of length to breadth of about 6 to 1 (Plate IV., figs. 58 and 59).

The cuticle is perfectly smooth, without denticles or ornamentation of any description.

The suckers are of greatly disproportionate size, the ventral rather more than twice the diameter of the oral (ratio of 7 : 3). The former (*v.s.*) is rendered further conspicuous by being pedunculate, rising boss-like from just behind the centre of the body. The peduncle is rather longer than half the diameter of the sucker (Plate IV., fig. 58). It has a large degree of mobility.

When *in situ*, and also when freed from its capsule, to the naked eye the worm appears of a pale pink tinge; under a low power of the microscope this is resolved into a dark yellow coloration confined to the œsophagus and wide digestive cæca of the alimentary canal. The only other colour present, when viewed by transmitted light, is the black of the narrow excretory trunks.

The mouth is situated at the bottom of the funnel-shaped cavity of the oral sucker (Plate IV., fig. 59, *o.s.*). It opens almost immediately into the short muscular pharynx (*ph.*). A rather wide aperture admits in turn to a peculiar saccate, subglobular œsophagus (*œ.*) which gives off laterally and dorsally a branch on either side. These pass outwards, at right angles, for a short distance, then, turning posteriorly, they are continued as very wide blind sacs, the digestive cæca (*d.c.*) as far as the anterior border of the excretory vesicle (*e.v.*). A great mass of yellow granules distends both œsophagus and digestive cæca, imparting a characteristic deep yellow hue to the digestive system. By reason of their great bulk these organs occupy the major portion of the body of this worm—a condition contrasting notably with the transparent and practically empty state of the alimentary canal in *Muttua margaritiferæ*.

The main trunks of the excretory system (*ex.tr.*) are two narrow tubes, black by reflected light, coursing backwards in sinuous manner from the pharyngeal region, one on either side. Posteriorly they empty into the slender pyriform excretory vesicle (*e.v.*), transparent and contractile. The products of excretion pass to the exterior by a terminal excretory pore (*ex.p.*).

It is probable that this species is protogynous, for while the testes are as yet empty, the ovary is densely packed with granular tissue. In the present resting condition the former organs appear as two paired ovoid sacs, clear, and with no distinguishable contents. They lie immediately posterior to the ventral sucker. Behind the left testis lies the globular ovary, opaque with the mass of its crowded granular contents.

The copulatory organs lie near the anterior end of the body. They open side by side just behind the œsophageal dilatation. The penis-sheath (*p.sh.*) has a nearly median position; the vagina lies a little to the left. The former is cylindrical, showing the rudiment of a seminal vesicle (*s.v.*). The vagina is slightly curved and appears to have glandular walls. The uterus (*ut.*) is barely distinguishable in pressure preparations as a long, transparent coiled tube running from the base of the vagina backwards to connect with the ovary. Vasa deferentia are not to be made out.

In many respects this larval form conforms to the characters of Looss' sub-family PHILOPHTHALMINÆ.* It is a larval form, so that the difference in size is immaterial. More important is the fact that the testes in the new species are, roughly speaking, on a level, not one behind the other, and that they are before, and not behind the ovary, as they are in the Philophthalminæ. The members of this family live, according to Looss, "An geschützten Stellen der Körperoberfläche bei Vögeln."

Until we have succeeded in tracing the life-history of this form, it would be unwise to dogmatize as to its systematic position. We have, however, little doubt that it is a new genus; and we have named it after Musali, the district of which the pearl fishery coast is part. The Adigar of Musali is the native official responsible for all details when a fishery camp is being organized. The present holder of the office, Mr. V. VRASPILLAI, typifies everything that is best in the headman system in vogue in Ceylon.

3. **Aspidogaster margaritiferæ**, n. sp.—Plate IV., figs. 60, 61, 62, 66, 68, 69.

Length in immature specimens 6 millims., colour brown ochre dorsally, but the foot has a beautiful rose-red hue. Four rows of alveoli or suckers on the foot arranged alternately; the number of alveoli is not precisely known, it probably increases with age, but there are something like 20 in the outer rows and 18 in the two median rows. A number of "tube-feet" project from the area between the outer rows and the middle rows and between the two central rows. There are none on the outer side of the outer rows.

Habitat.—Pericardial cavity of *Margaritifera vulgaris*, SCHUM. Taken at the Cheval Paar, Ceylon.

Three specimens of this Trematode, closely related to *Aspidogaster conchicola*, were found within the pericardial chambers of pearl oysters from the south and south-east

* 'Zool. Jahrb. Syst.,' XII., 1899, p. 586.

areas of the Cheval Paar. They were pinkish red to the naked eye, and of comparatively large size, quite ¼ inch (6 millims.) when extended. From its distinctive habitat, we may appropriately apply the name *margaritiferæ* to this species.

The body is composed of two distinct regions, an anterior neck-like portion, slender and cylindrical, bearing oral sucker and mouth at the free extremity, and a posterior stout region which spreads laterally, on the ventral aspect, into a broad, oblong, pedal disc, armed with rows of numerous sucker-pits and short, digitate tube-feet (Plate III., figs. 49 and 50, and Plate IV., figs. 61 and 66). The dorsum is minutely wrinkled or annulated transversely (Plate IV., fig. 62).

The oral suctorial apparatus (*o.s.*) is not of the definite rosette form typical of *Distomum;* it appears as a transverse slit bounded by thin mobile lips. The lips divaricate when about to make adhesion, as in the manner characteristic of an ordinary lipped sucker.

Careful examination during life showed the pedal disc (*p.d.*) to possess a wonderfully complex structure. The surface is excavated into numerous cup-shaped hemispherical pits, associated with which are numbers of small tube feet of remarkable characteristics. Both series are arranged with perfect regularity. The shallow pits or suckers (*s.p.*) are disposed in four longitudinal rows, the individual pits of one row alternating with those of the adjoining, an economy of space which permits the accommodation of the largest possible number of pits (Plate IV., figs. 60 and 61). The mouth of each sucker-pit is simple, bordered by a membranous edge containing muscular elements. When the animal is detached from its hold, the apertures are frequently seen to close by an approximation of the muscular margin. In most cases the edges meet in a tri-radiate manner; in others the lips close upon a single slit, the axis of this being at right angles to the adjacent margin of the pedal disc (Plate IV., fig. 62).

The tube-feet project from the angles between the sucker-pits, forming therefore three double ranks of feet disposed in zig-zag pattern (Plate III., fig. 52, Plate IV., figs. 61, 66, and 68). There are none along the margin of the pedal disc. They are hollow, thin-walled, and tubular, capable of great extension and of complete retraction by inversion, in manner similar to the eversion and retraction of the proboscides of *Tetrarhynchus.* They are hollow erectile organs of the simplest structure, possessing the power of extension in an extraordinary degree. When fully extended, they assume the form of slender cylinders tapering very gradually to an acuminate apex (Plate III., fig. 52, Plate IV., fig. 68). Partially retracted, they exhibit a closely annulated or wrinkled appearance, reminding one of the annulation of an earthworm, the anterior extremity of which they greatly resemble. When drawn in more fully, they show as low truncate pillars or stumps.

The alimentary canal is median and unbranched, ending blindly near the posterior end of the body. The mouth, situated at the base of the oral sucker-slit, leads into a short narrow buccal canal opening into the strongly muscular pharynx (*ph.*) oblong in optical section. Immediately behind this is a thin-walled vesicle representing the œsophagus. From this issues the long unbranched, thick-walled digestive cæcum (*d.c.*).

The excretory system is more highly specialized than in the two Distomids already described. As in them, it consists of a lateral trunk system opening behind into a contractile vesicle. In place, however, of arising in the pharyngeal region and passing backwards direct to the contractile vesicle, each trunk is doubled and consists of a proximal and a distal section. The proximal, which receives numerous branch feeders in its course, arises in the posterior portion of the body, close to the termination of the digestive cæcum. Thence it runs forwards to the anterior end of the pharynx, where it loops and turns upon itself, passing backwards over nearly the same course as it came. As it goes it coils around the primary or proximal portion. Both divisions are richly ciliated, a current is observable passing forwards in the cavity of the proximal limb, towards the hinder end in the other, or the distal limb. Another (third) tube or band is very faintly visible running longitudinally. Possibly it is a sexual duct.

The only specimen which could be spared to the knife was immature. There is a median aperture just between the pharynx and the anterior end of the foot. The penis is well-marked, the testis is single and so is the ovary, both lie in a mass of parenchyma which is separated above from the mass in which the alimentary canal lies, and below from the foot by two sheets of muscles. No vitellaria, uterus, or LAURER'S canal were distinguishable.

A pale smoky yellow tint suffuses the entire body, saving in the tissues lying dorsal to the tube-feet, where a warm brick-red tint is distinctive. The tube-feet appear to be colourless.

When one of these *Aspidogasters* is extracted alive from the pericardium, it exhibits an active and restless disposition, crawling freely about in a watch-glass. Its habit when thus isolated is to attach itself firmly by the suckers of the pedal disc and to wave the long neck-like anterior region from side to side, upwards and downwards, after the manner of a leech scenting or searching for prey, swaying to the extreme right, back almost to the posterior end of the body, then swiftly swinging round it repeats the search upon the left side, then forwards and above (Plate IV., figs. 61 and 69).

The manner of progression resembles that of a leech. Making adhesion over the whole of its ventral sucking disc, the mouth rises from the surface to which it has till now adhered; the neck stretches forwards, lengthening to the utmost, it curves downwards, the lips part, and the oral sucker makes a fresh adhesion (Plate IV., figs. 69). The posterior portion of the body is next drawn forwards, the anterior suckers of the disc remaining fixed the while; then, where the posterior region is well shortened, the whole of the ventral disc is freed and drawn along to the point where the oral sucker is fixed, when the disc re-attaches first at the anterior end and then posteriorly. Thus the animal moves one step forwards and is brought back to the attitude it had at the beginning.

In BRONN'S Trematoda, BRAUN enumerates four species of *Aspidogaster*, viz., *A. conchicola*, v. BAER, *A. limacoides*, DIESING, *A. insignis*, LEDIZ, and *A. macdonaldi*, MONT. In his recent revision of the family Aspidobothridæ, NICKERSON* places the third of these, *A. insignis*, in the genus *Cotylaspis*, thus reducing the number of species of *Aspidogaster* to three. Of these three our species is most clearly allied to *A. macdonaldi*, inasmuch as these two species, and these two species alone, are provided with the remarkable "tentacles" or "tube-feet" which project between the suckers of the foot. It however differs from this species in the following particulars:—(i.) MACDONALD'S specimens were tallowy in colour, while ours are of an ochreous brown with a deep, rose-pink foot; (ii.) MACDONALD'S specimens were $\frac{1}{8}$ inch to $\frac{1}{10}$ inch in length, ours are $\frac{1}{4}$ inch long; (iii.) MACDONALD mentions "cæca" in the intestine of *A. macdonaldi*, ours have a simple alimentary canal, possibly MACDONALD has made a mistake in this respect; (iv.) MACDONALD records some 180 tentacles and some 120 alveoli or suckers, the numbers in our specimens are fewer; (v.) MACDONALD found his specimens "creeping about in the respiratory siphon of a large *Melo*, or melon-shell, in Shark Bay, Western Australia," our specimens occurred in the pericardial chamber of *Margaritifera vulgaris*, SCHUM., on the Cheval Paar, Ceylon.

At the end of his paper NICKERSON raises the question as to whether MACDONALD'S species does not deserve generic rank. If it does it carries our species with it. The chief generic character would be the possession of the tentacles or "tube-feet." At present, and until more specimens have been investigated and until we know more of the life-history, it seems wise to regard these forms as well-marked species of *Aspidogaster*.

III. NEMATODES OF THE PEARL OYSTER, AND OF THE FILE FISH.

The only previous record of a Nematode from the pearl oyster that we have been able to find is in a list by Dr. L. ÖRLEY of the Nematodes in the British Museum,† where the name appears of *Ascaris meleagrina*, KOLLAR, from the pearl oyster. VINCENZ KOLLAR wrote almost exclusively on insects, and we were unable to trace any reference to this Nematode in such of his writings as we have been able to inspect. We therefore applied to Mr. C. D. SHERBORN for help. Together with Professor F. JEFFREY BELL, he very kindly made an inspection of ÖRLEY'S MS.,

* 'Zool. Jahrb. Syst.,' XV., 1901 to 1902, p. 597, NICKERSON makes no mention of *A. vallei*, STORS, described in a Memoir I have not seen, from the œsophagus and stomach of *Thalassochelys caretta* (M. STOSSICH, 'Appunti di Elmintologia').

† 'Ann. Nat. Hist.,' IX., 5th Series, 1882, p. 310.

where the name KOLLAR occurs, but when this was compared with W. BAIRD'S copy of GRAY'S Catalogue, a note in BAIRD'S handwriting was found containing the words *Ascaris meleagrina*, KELAART. There seems little doubt that ÖRLEY miscopied KOLLAR for KELAART. We have not, however, been able to find any diagnosis in the reports of KELAART, or any figure of this animal which would enable us to recognize the species, and so it seems that the name is a *nomen nudum*.

Three species of Nematoda, representing as many genera, *Oxyuris*, *Ascaris*, and *Cheiracanthus*, were found in the pearl oysters on this expedition.

The *Oxyuris* was met with but twice, and both specimens were unfortunately lost. They measured barely $\frac{1}{8}$ inch in length. They were found in the intestine of the pearl oyster. The other two species were found encysted in the tissues of the pearl oyster. These were kindly examined for us by Dr. VON LINSTOW, who identifies one as new. The specimens which reached England, and which were submitted to him, were both larvæ. Dr. VON LINSTOW has been good enough to give us the following descriptions :—

Ascaris meleagrinæ, n. sp.—Plate III., figs. 42 and 43.

The greatest length is 29 millims., the breadth is 0·55 millim. On the anterior end there are 3 lips, of these the dorsal one is round, with 2 large papillæ directed forward ; on the anterior edge a row of small teeth or projections occur, and between the 3 chief lips lie 3 secondary and much less prominent lips. The cuticle is regularly ringed. The œsophagus is $\frac{1}{8\cdot13}$ of the total length, and the conically pointed tail is $\frac{1}{116}$ of the same. A pair of anal glands occurs in the end of the alimentary canal.

Habitat :—The larva in the tissues of the pearl oyster *Margaritifera vulgaris*, SCHUM., the adult in the intestine of the file fishes *Balistes mitis* and *B. stellatus*.

This Ascarid is usually found within the gonad of the pearl oyster, less frequently within the tissues of the mantle, in all cases in an encysted condition. It appeared, in life, transparent and slightly yellowish to the naked eye. Under the microscope, the intestine is seen to be a brownish-yellow tint. The surface of the body is distinctly and closely annulated.

In the pearl oyster, its primary host, this Nematode does not attain sexual maturity, remaining encysted and immature so long as this host lives. The mature stage is reached only after the pearl oyster, happening to be devoured by one of the oyster-eating species of file fishes—usually *Balistes mitis* or *B. stellatus*—suffers digestion within the stomach of the fish. Being thus set free, the Ascarid finds its way into the intestine and attains there eventually a notably larger size than when in its primary host, the pearl oyster.

Statistics and Details.—Out of 24 pearl oysters, 3 to $3\frac{1}{2}$ years old, from the Periya Paar Kerrai, dissected on 7th November, 1902, as many as 10 contained 1 each of this Ascarid. The cysts were lodged chiefly in the gonad in the immediate vicinity of the stomach, most to one or other side, a few above the roof of this organ. One individual was found beneath the mouth in the substance of the labial palps.

Out of a further lot of 16 dissected on 7th November, 1902, and coming from North-east Cheval Paar, 5 contained this species of Nematode. As many as 5 of these worms were found in one individual; 3 were within the gonad, a fourth was contained in a large cyst in the palpar region of the mantle close to the pallial line.

In a second pearl oyster, 2 Nematodes were found in the gonad. A third and fourth each had one encysted in the same region, while in a fifth the Nematode cyst was in the mantle.

On 14th November, 1902, 43 pearl oysters from South-west Cheval yielded but 3 individuals harbouring this parasite, found in each case in the gonad. In another lot, one individual had one of these Ascarids in a cyst in the antero-ventral region of the mantle.

On 5th November, none were found in 30 oysters from South-east Cheval, and on 6th November, none in 15 oysters from the same.

On 11th November, two out of 20 dissected oysters from North-west Cheval yielded each 1 Nematode from the gonad.

On 12 November, 20 oysters from West Cheval gave but one, which contained this parasite. It was encysted within the wall of the stomach.

On 15th and 16th November, none were found in 61 pearl oysters from South-east Cheval.

On the 18th and 20th November, none were yielded by the dissection of 55 individuals from the Dutch Modragam and Muttuvaratu Paars.

On 3rd and 4th February, 1903, 5 individuals out of 83 dissected oysters from South-east Cheval showed 1 Nematode each in the gonad.

On 8th and 13th February, 1903, 3 oysters only were infected out of a lot of 120 dissected from North-east Cheval, in each case the cyst was within the gonad.

Of 15 oysters dissected on 11th February, 1903, from Periya Paar Kerrai, 1 only yielded an Ascarid, found in the usual position.

On 12th February, 1903, 32 oysters from the North Cheval contained no trace of this worm.

Of a total of 534 pearl oysters dissected specially in search for Nematodes, 30 individuals yielded specimens of this species.

The cysts were usually of distinct pyriform outline, flattened laterally. Occasionally the form was irregular.

Cheiracanthus uncinatus, Molin.—Plate III., figs. 41, 44, 45, 46, 47, and 48.

Echinocephalus uncinatus, Molin, 'Denk. Ak. Wien,' XIX., 1861, 2nd Abth., p. 311.

This Nematode was also in a larval state. The specimens averaged 12·8 millims. in length and 0·43 millim. in breadth. The cuticle is swollen. On the thickened head end are 6 rows of about 50 hooks about 0·031 millim. long. The head-lappets are rounded behind and abut on one another in the lateral line. There are 6 lips on the head. The œsophagus is $\frac{1}{45}$ of the entire length, and the conically pointed tail end is $\frac{1}{54}$ of the total length. Four tubes lie beneath the anterior end of the œsophagus; these are 2·05 millims. in length, and, as is characteristic for the genus *Cheiracanthus*, these are shorter than the œsophagus and show externally a layer of spiral muscles. The larvæ were found encysted in the adductor muscle.

The adult of these forms is in all probability the *Cheiracanthus uncinatus*, described and figured by Molin under the name *Echinocephalus uncinatus*. It is found in the alimentary canal of *Trygon pastinaca* and of *Trygon brucco*.

This second Nematode infesting the pearl oyster is a robust species, readily distinguishable at sight from the Ascarid, by its comparative shortness and the subglobular enlargement of the cephalic extremity, which is armed with 6 concentric rings of backwardly-directed spines (Plate III., figs. 41, 44, 45). This globular cephalic inflation is characteristic, but at times it appears in a deflated condition, as shown in Plate III., fig. 45, when the form becomes that of a truncated cone.

To the naked eye it appears when lying in its cyst of a faint pinkish tint, under magnification the alimentary canal is seen to be of a dirty pale-yellow hue. The colourless transparent tissue lining the body wall has a distinct areolar appearance, due to the presence of large saccate cells. The body is smooth, with no trace of annulation.

This Nematode favours exclusively as its habitat the substance of the adductor muscle, lying coiled up therein in an ovoid cyst. Plate III., fig. 47, shows some of the usual regions in the muscle where it is found. Its occurrence is strictly limited to this particular organ, but occasionally it would appear to become freed from its envelope and to leave the muscle, as instances occurred of this species being entombed in the nacreous lining of the shell. In several cases the covering film of nacre obscured scarcely anything of the outer form of the worm's body, the globular head and curved and pointed tail being especially conspicuous.

Later stages have been found by one of us in the trigger fishes *Balistes mitis* and *B. stellatus*, both pearl oyster-eating species, as proved by the presence of the shell fragments in the stomach.

This spinous-headed Nematode is found both in the alimentary canal and in the visceral cavity of *Balistes*. In the latter case, where it is much the more frequently found, it burrows in the peritoneal membranes and adjacent connective-tissue. Judging from this habitat, it would appear to use its spine-armed cephalic extremity as a burrowing organ.

It is most probable that the adult also lives in some species of *Trygon* which are known to feed on file fish, and also on pearl oysters.

Statistics and Details.—In all the cases noted below the Nematode was found in the adductor muscle—one Nematode in each case (Plate III., fig. 47).

Nov. 5th, 1902.	One infested	out	of	30	dissected	from	the	South-west Cheval.
,, 6th ,,	None	,,	,,	15	,,	,,		South-east Cheval.
,, 6th ,,	,,	,,	,,	8	,,	,,		East Cheval.
,, 7th ,,	,,	,,	,,	16	,,	,,		North-east Cheval.
,, 7th ,,	,,	,,	,,	24	,,	,,		Periya Paar Kerrai.
,, 11th ,,	One	,,	,,	20	,,	,,		North-west Cheval.
,, 12th ,,	,,	,,	,,	20	,,	,,		West Cheval.
,, 14th ,,	Two	,,	,,	16	,,	,,		S.W. Cheval.
,, 14th ,,	None	,,	,,	27	,,	,,		,, ,, (another locality).
,, 15th ,,	One	,,	,,	31	,,	,,		South-east Cheval.
,, 16th ,,	Two	,,	,,	30	,,	,,		,, ,,
,, 18th ,,	None	,,	,,	17	,,	,,		Dutch Modragam.
,, 20th ,,	,,	,,	,,	38	,,	,,		Muttuvaratu Paar.
Feb. 3rd, 1903.	One	,,	,,	8	,,	,,		South-east Cheval.
,, 3rd ,,	Fifteen	,,	,,	60	,,	,,		,, ,,
,, 4th ,,	Three	,,	,,	15	,,	,,		,, ,,
,, 8th ,,	Six	,,	,,	70	,,	,,		North-east ,,
,, 11th ,,	One	,,	,,	15	,,	,,		Periya Paar Kerrai.
,, 12th ,,	Three	,,	,,	32	,,	,,		North Cheval.
,, 13th ,,	Four	,,	,,	50	,,	,,		North-east Cheval.

Thus in all 41 individuals had the adductor muscle infested by this Nematode out of a total of 542 pearl oysters dissected specially in search of this parasite. In one of those of February 4th, the worm lay upon the surface of the muscle on the ventral aspect. In only one instance were two Nematodes found in the same muscle—never a greater number.

In the intestine of *Tæniura melanospilos* was found a fragment of a Nematode which was undeterminable, and a number of the species *Ascaris pastinacæ*, Rud., which inhabits also *Trygon pastinaca*, Cuv.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. Planarian-like free-living organism, possibly the larva of a species of Cestode, taken in the plankton on Muttuvaratu Paar, 19th November, 1902. It is most probably of the same species as the encysted larvæ found so abundantly in the pearl oysters of the paar named. Actual length when elongated, 0·37 millim. The rudiment of what may be the proboscis is already apparent. *a–h*, show various specimens in various attitudes; *c.c.*, calcareous corpuscles; *cut.*, the thick mucilaginous cuticular layer; *Pr.*, possible rudiment of a proboscis.

,, 2. Three fragments *a*, *b*, and *c* of the distal or marginal region of the mantle of a pearl oyster, showing Cestode cysts scattered in the intermuscular connective-tissue. Natural size. *Mg.Pall.*, pallial margin; *Mg.vel.*, velar margin; *T.cy.*, Cestode cysts.

,, 3. A Cestode cyst (*cy.*) in an interlamellar junction at the base of a branchia. × 3 diameters.

,, 4. Fragment of a branchia of a pearl oyster showing encysted larval Cestode (*cy.*). × 12 diameters.

,, 5. *a.* Nucleus of a "fine" pearl from the posterior ear region of a Cheval Paar oyster. The proboscis sheath and the central pit within which the proboscis is retracted are clearly shown. *k.* A "fine" pearl, showing distinct resemblance in outer form with the characteristic appearance of a Cestode larva (see fig. 5, *i*), viewed anteriorly; *c*, the same viewed laterally; *d* and *e*, natural size of the same. *i.* Outline of a young Cestode larva for comparison with the preceding. *f.* An elongated pearl, also having resemblance in outline to a Tetrarhynchid larva. *h.* Natural size of same. *l.* A lenticular pearl having an equatorial band of brown prismatic pearl-substance.

,, 6. Section through an encysted larva of about the same shape as that represented in fig. 4. The rostrum or proboscis (*a*) is still retracted in the body.

,, 7. *a* and *b*, two of the later larval stages of the Cestode met with, in encysted condition, in the tissues of the pearl oyster. Compare with fig. 13. × 80 diameters.

,, 8. A. A partially calcified Cestode cyst from the muscular pallial region of a 3-year old oyster from the Muttuvaratu Paar. The larva was dead and slightly changed in outline—partial disintegration having taken place. In colour it was dirty yellow. In the outer layers (*b*) of the cyst capsule a deposit of lime salts had begun. B. Another cyst. *b.* The outer layers of cyst; *c.* Nucleus, obtained by decalcification, of a fine pearl from the muscular pallial region of a pearl oyster from the Cheval Paar. C. Nucleus of another "fine" pearl from the ventral pallial region of a pearl oyster from the same locality as before; *d.* a few calcareous corpuscles seen within the larva as solution brought the character of the nucleus into view. D. The innermost of the membranous laminæ left after solution of the corresponding pearl coats; *c*, a dead Cestode larva forming the actual nucleus; a ball-shaped calcification within the Cestode larva is seen. (Weight 195 milligrs.)

,, 9. Very young Cestode larva extracted from a thick-walled cyst in the mantle of a pearl oyster. × 50 diameters. (NOTE.—The outer layer is *very faintly* seen under a low power, and has an appearance closely resembling ciliation. The distal limit is not so strongly marked as shown here, see fig. 10.) *c.c.*, calcareous corpuscles; *Pr.*, proboscis; *Pr.sh.*, proboscis sheath.

,, 10. Young Cestode larva extracted from a cyst within the mantle of a pearl oyster. It shows the minute denticulation of the proboscis collar. × 25 diameters.

,, 11. The same, seen under slight pressure, whereby the proboscis, *Pr.*, has been evaginated forcibly. *Pr.sh.*, proboscis sheath. × 25 diameters.

Fig. 12. Another larva of the same stage, seen under slighter pressure, and higher magnification. × 40 diameters. The vertically striated mucilaginous cuticle is clearly shown, together with a network of anastomosing vessels. *Cut.*, cuticle; *Ex.p.*, excretory pore.

,, 13. Shows the beginning of the change from a spherical to an elongated form of body. Taken from a cyst from the viscero-pedal mass of the pearl oyster.

,, 14. Portion of same larva seen in optical section at region of proboscis collar, showing a fragment of the anastomosing network of vessels and the large bladder-like cells full of clear globules, lying beneath the dermal layer (semi-diagrammatic). The calcareous corpuscles are omitted for the sake of clearness. *Den.*, denticles; *Par.*, sub-dermal bladder-like cells; *Pr.sh.*, proboscis sheath; *Ves.*, anastomosing vessels.

,, 15. *a.* Optical section of body-wall of a Cestode larva from the pearl oyster, showing the normal appearance. *b.* Final stage, when, under continual pressure, the mucilaginous cuticular layer has disintegrated, its place being taken by one or two layers of the bladder-like cells, which thus come to invest the body of the larva. *c.* The same as *a* under slight pressure; an invasion of the delicate cuticular layer by bladder-like cells full of clear globules is in progress.

PLATE II.

Fig. 16. Forms of the calcareous corpuscles found in the larvæ of *Tetrarhynchus unionifactor.*

,, 17. The same, enclosed in the cells that secrete them.

,, 18. Form of denticles which ornament the proboscis collar of the early larva of *Tetrarhynchus unionifactor.*

,, 19. The oldest larval stage of *Tetrarhynchus unionifactor* met with in the tissues of the pearl oyster. *Arm. cil.*, armature of stiff cilia around excretory pore; *cs.*, one of the two pairs of cephalic suckers; *Ex.o.*, external orifice of excretory system; *Pr.*, protractile proboscides; *Tr.ex.*, lateral trunks of excretory system.

,, 20. Surface view of the posterior extremity of the same individual on an enlarged scale.
a. Shows the warted pattern of the whole surface of the body, except at the extreme posterior extremity, where, as shown (*b*), the surface marking becomes sinuous; other letters as in fig. 19.

,, 21. A loop of the excretory network in the cephalic region of the same individual.

,, 22. Anterior extremity of an individual of the same stage as that depicted in fig. 19 seen under greater magnification. *Pr.sh.*, sheath of proboscis; *Ret.m.*, retractor muscle of proboscis.

,, 23. One of the hooklets from a proboscis.

,, 24. A larval form of *Tetrarhynchus balistidis* from the liver of a *Balistes*, sp. × 16 diameters. *C.c.*, calcareous corpuscles; *Tr.ex.*, excretory trunks. The natural size is shown by the small figure to the right.

,, 25. Sub-spherical larva of *Tetrarhynchus balistidis* found in oval and in rounded cysts beneath the peritoneum of *Balistes*, sp.; *Pr.pro.*, proboscis protruded.

,, 26. A slightly older example of the same.

,, 27. Natural size of a cyst of *T. balistidis* from abdominal cavity of a *Balistes*, sp.

,, 28. Cyst from peritoneum of *Balistes*, nat. size, containing *T. pinnæ.*

,, 29. The larval *T. pinnæ* freed from cyst membrane. Nat. size.

Figs. 30, 31, 32. The same, under higher magnification. *C.c.*, calcareous corpuscles; *Cy. mem.*, cyst membrane; *Pr.ret.*, proboscides retracted; *Sc.*, scolex.

Fig. 33. Teeth of *T. balistidis*, isolated by maceration and highly magnified.

,, 34. Teeth of *T. balistidis in situ* on the introvert.

,, 35. More teeth of *T. balistidis* for comparison with fig. 36.

Fig. 36. A single tooth of *T. pinnæ*.

„ 37. A portion of the introverts of *T. pinnæ*, showing the oblique rows with enormous numbers of weak teeth.

„ 38. A section through the head, cut in two places, and showing the four proboscides and the bladder, with widely separated walls, of *T. pinnæ*, magnified to the same extent as figs. 39 and 40.

„ 39. A section through the head, cut twice, and the bladder of *T. balistidis* showing the four introverts, magnified to the same extent as fig. 38.

„ 40. A section through the same, showing the junction of the head with the inner wall of the bladder.

PLATE III. (3 on Plate).

Fig. 41. Head end of *Cheiracanthus uncinatus*. *gl.*, glands; *int.*, intestine; *l.*, lip; *œ.*, œsophagus.

„ 42. Tail end of *Ascaris meleagrinæ*. *a.gl.*, anal glands; *int.*, intestine.

„ 43. Head of *Ascaris meleagrinæ*, seen from above.

„ 44. Head end of *Cheiracanthus uncinatus*, inflated. × 30.

„ 45. The same collapsed.

„ 46. The whole worm, *Cheiracanthus uncinatus*. × 6.

„ 47. Diagrams showing usual position of *Cheiracanthus uncinatus* within the adductor muscle. Natural size.

„ 48. Posterior extremity of *Cheiracanthus uncinatus*. × 30.

„ 49. Ventro-lateral view of *Aspidogaster margaritiferæ*. In this specimen the tube feet were all retracted. The natural size is shown by the small figure on the right.

„ 50. Side view of the same with extended tube feet. The natural size is shown by the small figure on the right.

„ 51. Views of spirit specimens of *Musalia herdmani*, magnified.

„ 52. Transverse section through the suckers and tube feet of *A. margaritiferæ*, highly magnified.

„ 53. Cercaria of *Muttua margaritiferæ* within its cyst capsule. Extracted from the branchial tissue of a pearl oyster. × 30.

„ 54. The same under greater magnification. × 10. Lettering as in fig. 55.

„ 55. The same larva freed from its capsule, and under slight pressure. × 90. *c.s.*, cuticular spines; *e.v.*, excretory vesicle; *d.c.*, digestive cæca; *e.*, eye-spots; *ex.p.*, excretory pore; *p.sh.*, penis sheath; *ph.*, pharynx; *s.v.*, seminal vesicle; *v.s.*, ventral sucker.

„ 56. Penis sheath of same larva.

„ 57. Anterior extremity of same larva. × 240. *c.s.*, cuticular spines; *e.*, eye; *ex.t.*, excretory tubules.

PLATE IV. (4 on Plate).

Fig. 58. *Musalia herdmani*, immature specimen from the mantle of a pearl oyster. Natural appearance fully extended. Letters as in fig. 59.

„ 59. The same shortened and broadened under pressure. Life size on right. *e.v.*, excretory vesicle; *d.c.*, digestive cæca; *ex.p.*, excretory pore; *ex.t.*, excretory trunks; *œ.p.*, œsophageal pouch; *o.s.*, oral sucker; *ov.*, ovary; *ph.*, pharynx; *p.sh.*, penis sheath; *t.*, testis; *v.*, vagina; *v.s.*, ventral sucker.

„ 60. *Aspidogaster margaritiferæ*; adult from the pericardial chamber of a pearl oyster, seen ventro-laterally. The tube feet are retracted. *dig.c.*, digestive cæcum; *ex.t.*, double excretory trunks; *o.s.*, oral sucker; *p.d.*, pedal disc; *ph.*, pharynx; *s.p.*, sucker pits.

Fig. 61. The same seen from the ventral aspect while crawling over a glass plate. The dotted outlines *a* and *b* show the leech-like mobility of the anterior region of the body in attitudes assumed frequently when the worm is restless. *t.f.*, tube feet. The other letters as in fig. 60.

,, 62. View of the posterior extremity of the same, from above, showing the sucker-pits (*s.p.*) closed by the approximation of their lips. The fine transverse wrinkling characteristic of the dorsum of the trunk is also shown in the figure.

,, 63. Ciliated ectoparasite from gills of pearl oyster with paired trilobed eyes.

,, 64. Another characteristic appearance of the same. A contractile vacuole is seen posteriorly and two triradiate eye-spots anteriorly.

,, 65. Diagram of pearl oyster to show at *a* the position of the cyst enclosing *Musalia herdmani*, in the tissues of the pearl oyster. $\times \frac{1}{2}$.

,, 66. A portion of the pedal disc seen when an *Aspidogaster margaritiferæ* is detached from its hold and turned upon its back. The edges of the disc then recurve inwards to varying degrees.

,, 67. Highly magnified view of the end of a proboscis of *Tetrarhynchus minimus*, showing the various sized hooks and their arrangement.

,, 68. Tube feet of *Aspidogaster margaritiferæ* in various states of extension and retraction.

,, 69. *a*, *b*, *c*, successive attitudes assumed by *A. margaritiferæ* during progression. *d*, another view of the same when about to change position.

,, 70. Head of *Tetrarhynchus minimus*.

,, 71. Optical section of the same.

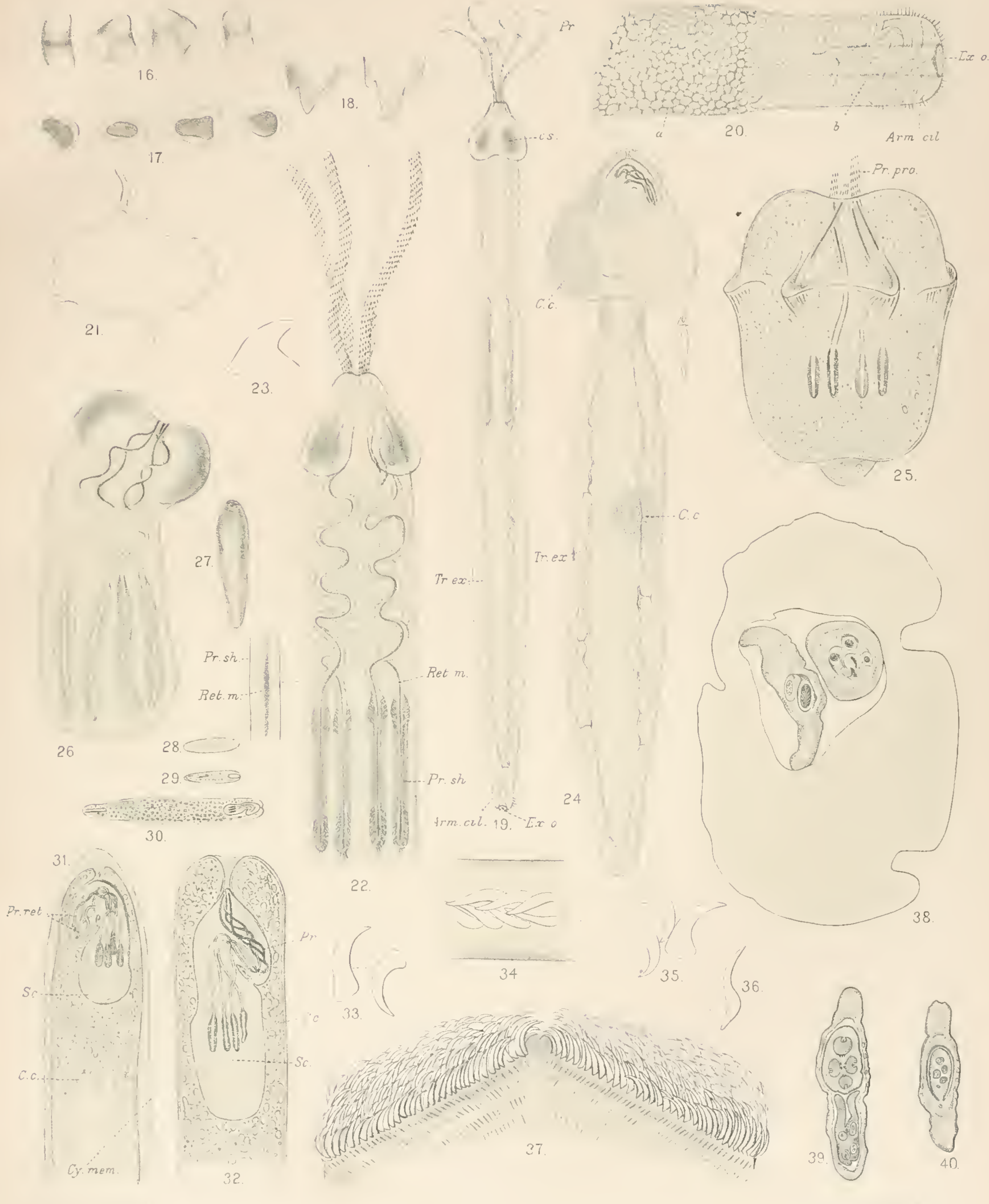
,, 72. *Tetrarhynchus minimus*, showing proglottides.

NOTE.—Owing to an error in the lithographer's office, Plates III. and IV. have been printed as 3 and 4, in Arabic numerals.

J.H. & A.E.S. del.

Edwin Wilson Cambridge

PARASITES OF THE PEARL OYSTER



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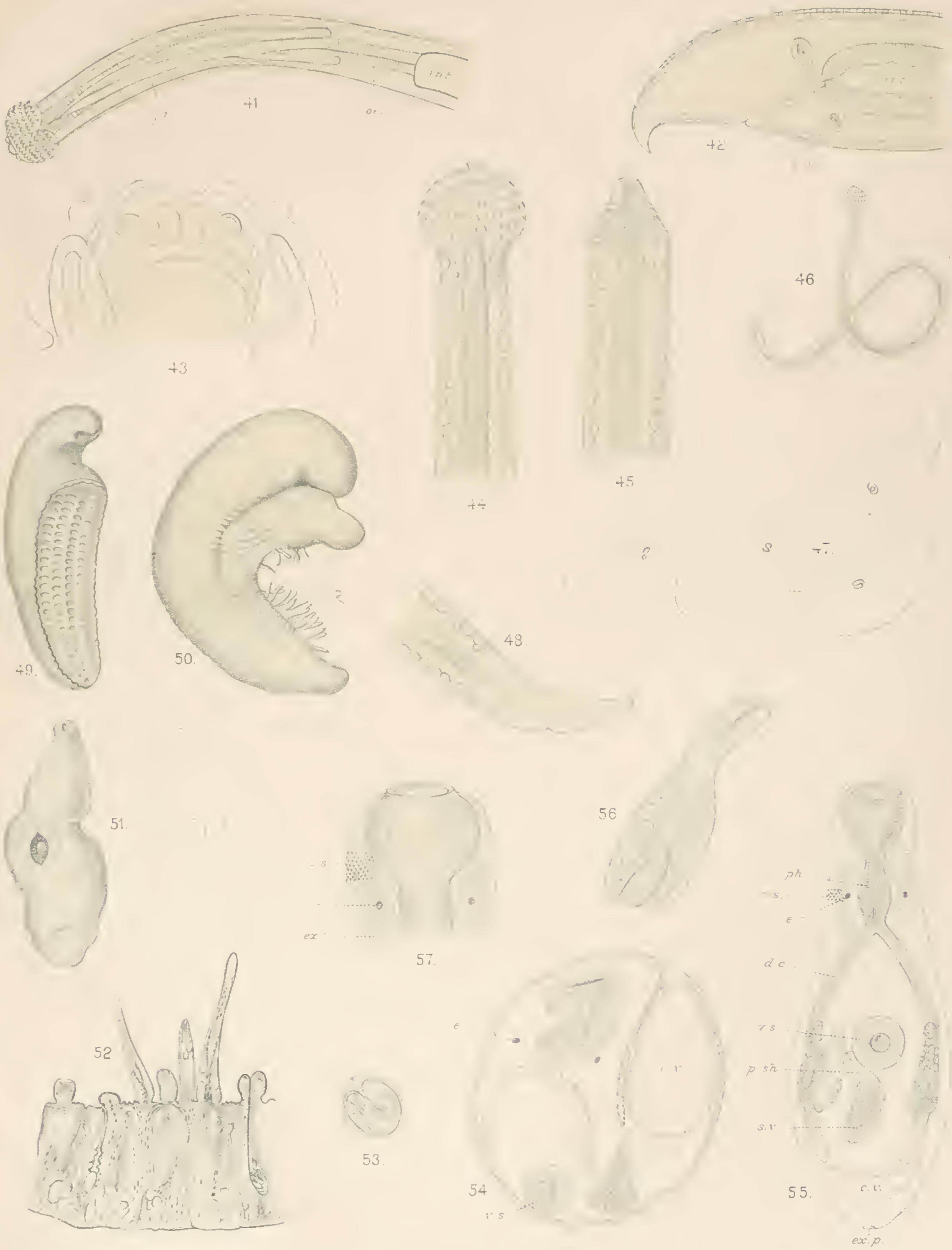
PARASITES OF THE PEARL OYSTER



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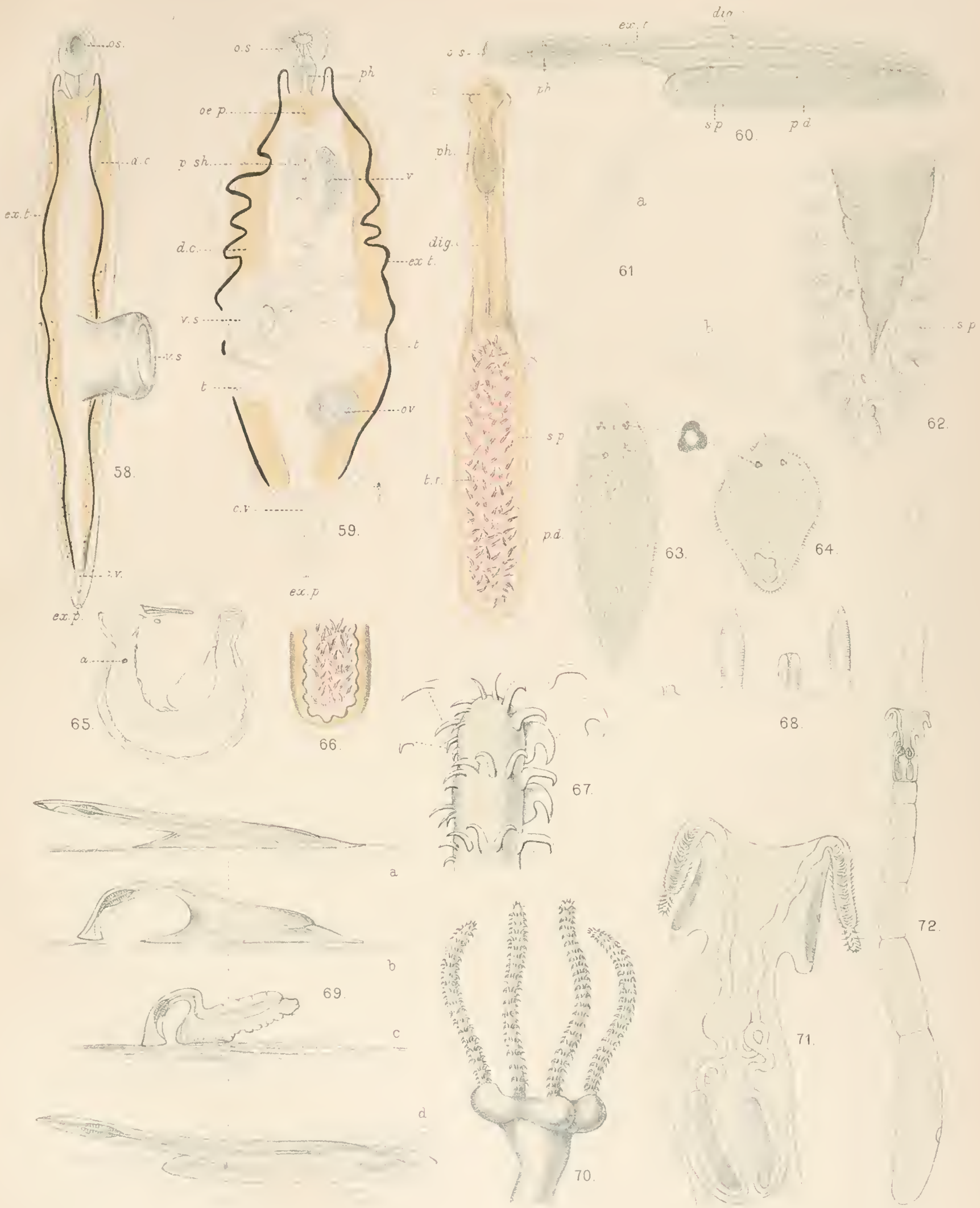
PARASITES OF THE PEARL OYSTER



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PARASITES OF THE PEARL OYSTER

REPORT

ON THE

HYDROIDA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

LAURA R. THORNELY.

[WITH PLATES I. TO III. AND TEXT-FIGURES.]

INTRODUCTORY.

THIS collection of Hydroids from Ceylon comprises 43 species, of which 13 are now described as new to science, and one of these requires the formation of a new genus. A few specimens are too small in quantity to have more than a generic name assigned to them.

Our knowledge of the Hydroid fauna of Indian seas* is mainly due to ARMSTRONG, who described a few species from the Bay of Bengal, two of which are represented in our series; to ALLMAN, who worked out a small collection sent home by Mr. HOLDSWORTH from Ceylon in 1874, containing two of our most striking species; and to HINCKS, who described a small collection made by Dr. JOHN ANDERSON in the Mergui Archipelago in 1889, two species of which we have.

But the faunas of Australia and the East Indies are evidently similar in many of their species, and we have several of those described by BALE and VON LENDENFELD. It is also clear that some of our species have a wide distribution over the globe, as we find in our Ceylon list *Plumularia setacea* and *Cuspidella costata*, both British species, and the former recorded from North America, Australia, and New Zealand, while the latter has been found in North America.

* See List of Literature, p. 125.

Most of the specimens in this collection were dredged by Professor HERDMAN during the cruise of the "Lady Havelock" round Ceylon in February and March, 1902, but some were also obtained by the native divers from the pearl banks, or were picked off the experimental cages in which pearl oysters were kept suspended from the ship.

It is probable that the Ceylon fauna contains many more species of Hydroid Zoophytes, some of which are unknown to science, since there are many small specimens and fragments in the collection which are not large enough or complete enough to be described, but which evidently do not agree with the characters of any known species.

The following is a list of the species described in this Report. Those marked with a star are, I believe, additions to the recorded fauna of the Indian seas :—

ATHECATA.

**Corydendrium chevalense*, n. sp.
Bougainvillia, sp.
**Eudendrium pusillum*, von Lendenfeld.
**Podocoryne denhami*, n. sp.
**Clavactinia gallensis*, n. gen. & sp.
**Tubularia gracilis*, von Lendenfeld.

THECAPHORA.

Halecium, sp.
**H. flexile*, Allman.
**Clytia geniculata*, n. sp.
**Obelia hyalina*, Clarke.
**O. australis*, von Lendenfeld.
O. andersoni, Hincks.
Campanularia juncea, Allman.
**C. corrugata*, n. sp.
**Hebella calcarata* (A. Agassiz).
**Lafoea serrata*, Clarke.
**Cuspidella costata*, Hincks.
**Sertularia gracilis*, Hassall.
**S. ligulata*, n. sp.
**S. fissa*, n. sp.
**S. tenuis*, Bale.
**S. loculosa*, Busk.
**S. rugosissima*, n. sp.
**Diphasia mutulata* (Busk).
Sertularella, sp.
Thuiaria, sp.
**T. palans*, n. sp.
**Desmocyphus palkensis*, n. sp.
**Synthecium orthogonia* (Busk).
Pasythea hexodon, Busk.
Idia pristis, Lamouroux.
**Plumularia setacea*, Ellis.
**P. buskii*, Bale.
**Monostaechas quadridens* (McCrady).
**Antennella gracilis*, Allman.
A. allmani, Armstrong.
**Aglaophenia perforata*, Allman.
**A. phœnicea*, Busk.
Halicornaria insignis, Allman.
H. setosa, Armstrong.
**Lytocarpus hornelli*, n. sp.
**L. fasciculatus*, n. sp.
**L. plumosus*, n. sp.

This list shows in all thirty-two species added to the list for the Indian seas in addition to seven previously known and four left specifically undetermined.

HYDROIDA.

Sub-order I.: ATHECATA.

Family: TURRIDÆ.

Corydendrium chevalense, n. sp.—Plate I., fig. 4.

Trophosome.—Colony reaching the height of $\frac{1}{2}$ an inch, with a simple or branched stem of a pale straw colour, slightly wrinkled, but never ringed. Branches lying alongside the stem for a short distance near their origin, then diverging; very much twisted and entangled (see Plate I., fig. 4). Hydranths varying in size, those on unbranched stems the largest, with about 18 tentacles scattered on the upper $\frac{2}{3}$ of their length.

Gonosome.—Medusiform gonophores on short peduncles, springing singly or 2 or 3 near one another, often 2 opposite, on both sides of the stem, between the origin of the branches and the hydranth.

Locality:—On *Pecten* shells and on sea-weeds from the Cheval Paar, Gulf of Manaar, 6 to 8 fathoms.

From indications in the gonophores, which vary much in their stages of development on the same specimen, the manubrium appears to be four-lipped, the radiating canals four, and the tentacles many. The form of the medusa of *Corydendrium* has not yet been traced, and the one species, *C. parasiticum*, Cavolini, has now remained so long imperfectly known that it seems doubtful whether its description will ever be completed. In the meantime it seems better to place the present species here rather than to form a new genus or to place it with *Turris*, only known as an unbranched form.

The fully developed trophosome of *Turris* has, however, not yet been seen. If, therefore, the further development of the present gonophores should lead to their identification with those of *Turris*, as appears possible, then this species will require to be transferred to that genus, the definition of which will be altered so as to include simple *or branched* forms.

Family: BOUGAINVILLIDÆ.

Bougainvillia, sp.

This is not recognisable as any known species, and there is not sufficient material to enable me to describe it fully as a new species. One peculiarity of the form is that the branches have frequently blunt-ended tendrils growing from them.

Locality:—Found growing among colonies of a Campanularian (*Obelia australis*) from the Cheval Paar, Gulf of Manaar, 6 to 8 fathoms.

FAMILY: EUDENDRIIDÆ.

Eudendrium pusillum, VON LENDENFELD (17).—Plate I., fig. 5.

From their mode of growth, smooth stems and the colour of the zooids, and also from the position of the gonophores, I believe the present Ceylon specimens to belong to this species. Many of the colonies are only half an inch in height, but some are larger than has yet been described for *E. pusillum*, reaching $1\frac{1}{4}$ inches. The main stem is of a very dark brown, annulated at its origin and with a few rings occurring here and there, up the stem. The branches are alternate, ringed above their origin, and the ramuli which terminate in hydranths bearing gonophores are ringed or wrinkled throughout. These last are not so long as the ordinary ramuli, their hydranths never lose all the tentacles, although they become atrophied. There are only female gonophores present. The hydranths have about 26 tentacles each. As this species has not been figured before, I show it on Plate I., fig. 5.

Locality:—This species, previously known from Port Jackson, Australia, occurred on the experimental pearl-oyster cages hung over the side of the ship at Cheval Paar, in the Gulf of Manaar, in April, 1902.

FAMILY: HYDRACTINIIDÆ.

Podocoryne denhami, n. sp.—Plate I., fig. 6.

TROPHOSOME.—Basal crust beset with numerous tall, stout, linear, reddish spines. Hydranths white, with about 24 tentacles on the barren ones and only 4 or 5 on those bearing gonophores, and these latter are also considerably smaller.

GONOSOME.—A pair of large and globose gonophores to each hydranth.

Locality:—Growing on a *Murex* shell containing a Pagurid dredged in Palk Strait.

This species resembles *Podocoryne areolata* (ALDER) in general appearance of the hydranths, the spines and the gonophores, as figured by HINCKS, but the tentacles are far more numerous on the larger hydranths of the colony, and the gonophores when separated from the colony are found to be borne on hydranths in place of being sessile on the common base, as at first sight they appear to be.

At Professor HERDMAN'S suggestion, this interesting new species from the north of Ceylon is named in honour of Mr. E. B. DENHAM, C.C.S., Assistant Government Agent in the Manaar district, near where the specimen was obtained.

Clavactinia, n. gen.

TROPHOSOME.—Hydranths claviform, sessile, with filiform tentacles forming several verticils below the base of a conical proboscis; borne on an expanded crust.

GONOSOME.—Sporosacs borne on blastostyles which rise directly from the crust between the hydranths.

This genus differs from *Hydractinia* in having several verticils of tentacles (see Plate I., fig. 3), and in not having globular clusters of thread-cells in place of tentacles on the blastostyle.

Clavactinia gallensis, n. sp.—Plate I., fig. 3.

Trophosome.—Colonies an inch square, or more, having a yellowish crust spotted with minute dark red spines, and with larger ridged spines of the same colour placed at intervals. Hydranths opaque white with about 14 tentacles surrounding the upper portion of the body.

Gonosome.—Sporosacs borne on very short-stemmed blastostyles, 5 or 6 on each, almost round in shape and showing about 5 divisions.

Locality:—Growing on gastropod shells belonging to *Eburna* and *Neritina;* dredged in Galle Bay, 2 fathoms.

There are no spiral zooids on these colonies, which have, with their spinous crusts, so much the appearance of a *Hydractinia*. The blastostyles are very short, and the sporosacs on them are in various stages of development. The *Eburna* shells are covered with the colonies, many of them not fully grown; these shells contained the living animal at the time they were taken. On the *Neritina* shell the hydranths and gonophores cover the crust much more fully, but the hydranths are smaller and have their tentacles so contracted as to appear almost capitate.

Family: TUBULARIIDÆ.

Tubularia gracilis, von Lendenfeld (17).

From the general resemblance and the large number of gonophores, borne on erect peduncles, I am inclined to consider that the present specimens belong to this Australian species, although when more material is at hand for examination, further details may appear which will require their separation as a distinct form. The stems are unbranched, entangled with others at their bases by their rhizomes. They are smooth, like von Lendenfeld's specimens of *T. gracilis*, for the most part, but are occasionally ringed at the base and here and there up the stem. The largest are only $\frac{3}{4}$ of an inch in height, but as the zooids vary a good deal in general size, the stems may possibly grow to the usual height of *T. gracilis* under favourable circumstances. The hydranths are slightly smaller than those of *T. gracilis*, the largest present being only about $\frac{2}{10}$ of an inch across the tentacles and $\frac{1}{10}$ of an inch in total height. They are reddish in colour when living, and the gonophores are greenish-yellow. The gonophores are borne on short, branched peduncles, and are present in various stages of development. The most fully developed have 4 lobes, and show a division of their sides by 4 longitudinal grooves. A hydranth carries about 9 peduncles with about 30 gonophores on each.

Locality:—This species, previously known only from Port Jackson, Australia, was found growing on the fibre of the "coir" baskets containing experimental pearl oysters suspended from a buoy in Galle Bay during June, 1902.

SUB-ORDER II.: THECAPHORA.

FAMILY: HALECIIDÆ.

Halecium, sp.

There are only a few fragments of this interesting looking species with very widely expanded hydrothecæ. It looks somewhat like *Diplocyathus*, ALLMAN (4), but is without the nematophore-like cup characteristic of that genus.

Locality:—North of Cheval Paar, 7 to 10 fathoms.

Halecium flexile, ALLMAN (4).

Several young colonies, only $\frac{1}{2}$ an inch in height, were found growing on the oyster cages suspended from the side of the ship at Cheval Paar, in the Gulf of Manaar.

These colonies may seem too small to be referred to this species with certainty, but they are evidently young, only here and there show the beginning of a fascicled stem and have no gonophores present. The hydranths are very large and very much swollen below the base of the tentacles. The specimens are beautifully preserved, showing the details of internal structure clearly. The hydrophores do not stand away from the internode so much as is shown in ALLMAN'S figures, but the shallow annulation of the internodes is the same.

Locality:—This species was previously recorded from near Marion Island and from Patagonia; and the present specimens were found on oyster cages at the Cheval Paar, in the Gulf of Manaar.

FAMILY: CAMPANULARIIDÆ.

Clytia geniculata, n. sp.—Plate III., figs. 4, 4A.

TROPHOSOME.—Colony $\frac{3}{5}$ of an inch in height. Stem bending slightly to right and left, a hydrotheca on a ringed pedicel at each flexure, which has a decided knee-like bend (Plate III., fig. 4). Stem monosiphonic, branched sparingly, a branch either taking the place of a hydrotheca or being given off from the hydrothecal pedicel near its base. Hydrothecæ on long or short pedicels, ringed throughout, or only above and below, with from 5 to 20 rings; large and deep (fig. 4), with long 2-spined teeth, and very compressible.

GONOSOME.—Gonothecæ cylindrical above, narrowing rapidly downwards, on short, ringed stalks (fig. 4A), about 5 rings, and with a very short neck and wide rim to the aperture, situated near the base of the pedicels of the hydrothecæ and containing medusoid gonophores, the most advanced of which show 4 rudimentary tentacles.

Locality:—Growing on oyster cages suspended over the side of the ship, between February 15 and March 10, on the north-east Cheval Paar, Gulf of Manaar.

The peculiar mode of branching is the most striking feature of this form (Plate III., fig. 4), one pedicel bearing a hydrotheca gives off another from its side which starts with a knee-like bend and then runs up almost parallel with the first; another is given off from this one again on the opposite side from the first, and so on alternately, sometimes for nine times in succession, with no other form of branching. A more complicated form of growth is seen when two branches are given off almost opposite each other, or when the branches divide again.

The sides of the hydrotheca are so compressible that the form of the teeth, in these preserved specimens, cannot be seen satisfactorily. They are folded over as in BALE's figure of *Campanularia bispinosa* (12), and so are probably arranged in pairs as in that species.

Obelia hyalina, CLARKE (13).

A few fragments, probably of this form, previously found north of Goblos Island, were found growing on oyster cages hung from the ship, between February 15 and March 10, on the north-east of the Cheval Paar.

Obelia australis, VON LENDENFELD (17).

A few fragments of this form, previously found in New Zealand, were growing on oyster cages hung from the ship, between February 15 and March 10, on the north-east of the Cheval Paar.

Obelia andersoni, HINCKS (14).

These specimens have rather more rings on the pedicels of the hydrothecæ and teeth on the hydrotheca margin than HINCKS gives. He does not mention the height of the colonies, nor whether they are branched. Our specimens are $\frac{1}{4}$ of an inch in height, and they branch occasionally, in which case there is always a hydrotheca in the axil. The shape of the hydrothecæ, which HINCKS lays most stress on in his diagnosis of the species, corresponds with these specimens. The line represented in HINCKS' figures running round the hydrotheca, near the base, is only to indicate the beginning of the cylindrical portion, I believe; it is not visible in our specimens. This is a most delicately beautiful little species.

Locality:—Previously known from the Mergui Archipelago, it now occurs growing on oyster cages hung over from the ship, between February 15 and March 10, on the north-east Cheval Paar.

Campanularia juncea, ALLMAN (1).—Plate I., figs. 1 to 1B.

The specimens of this form in the present collection agree with ALLMAN's description for the most part, but our colonies reach a height of 18 inches instead of only 12, while gonothecæ are present, and in some cases an operculum on the hydrotheca—both structures previously unknown. Moreover, our colonies do not show the division of the stem into internodes which ALLMAN describes and figures. Still, this is such a striking form that there can be no doubt about the identification.

There are two kinds of gonothecæ borne on separate colonies, which are thus of distinct sexes. They are placed beneath hydrothecæ on the stems and branches, and turn downwards at about the same angle that the hydrothecæ stand upwards. The male gonotheca (Plate I., fig. 1) is cylindrical, with a wrinkled outline and rounded top, about $\frac{1}{3}$ as long again as the hydrotheca; while the female (Plate I., fig. 1A) is truncated above, with a marginal rim and a boss to one side of the upper surface, and is broader and not so long as the first. They both have the same coarse, granular texture as the hydrothecæ.


Fig. 1. *Campanularia juncea*—showing expanded zooid, and hydrotheca with operculum. Magnified.

In a few specimens of about 2 inches in height, the details of the zooid (text-fig. 1), its 34 tentacles, its base resting on a floor above the base of the hydrotheca, &c., are quite visible, and in these can be seen distinct opercula with 4 valves (Plate I., fig. 1B). A trace here and there of what may be broken portions are the only indications of the operculum in the rest of the material, which is composed of larger colonies (text-figs. 2, 3), opaque and older looking in comparison with these small fresh bits. If the specimens with opercula are not to be regarded as a different species from those without, which I have not the least inclination to believe, then the genus *Thyroscyphus*, ALLMAN (3), founded for species having a 4-valved operculum, must either be given up or the present species must be removed to that genus. I prefer the former course; and it seems probable that the opercula are only present in the young condition and become lost in older colonies.

For a Campanularian this is a remarkable species on account of its great size and coarse habit, and its marked resemblance to a Sertularian (text-figs. 2, 3). It grows in great profusion over some parts of the pearl banks, and is said to be characteristic of the East Cheval Paar, where, in the Inspector's reports, the great masses sometimes brought up by the divers are alluded to as "heather." Text-fig. 2 shows the species in the fresh living state, and fig. 3 shows older coarser tufts, largely dead, such as form the "heather" of the diver.

Locality:—Generally distributed round the coast of Ceylon, but especially large and abundant on some parts of the pearl banks in the Gulf of Manaar.

Campanularia corrugata, n. sp.—Plate I., fig. 2.

TROPHOSOME.—Stems of varying length rise from a creeping stolon, both being thick and wrinkled, but without rings. Hydrothecæ about $\frac{1}{10}$ of an inch in height usually, but varying in size with age; cylindrical, the same width all their length; transversely ringed more or less, sometimes with as many as 8 rings; the aperture obliquely sloped with an everted even rim which is often reduplicated, while sometimes a complete new hydrotheca rises out of the old one, its stem passing through this, and standing at varying heights above it (Plate I., fig. 2). Zooid with about 20 tentacles. Gonosome not present.

Locality:—Found creeping over shells and zoophytes, north of Cheval Paar, 7 to 10 fathoms.

This species has very much the appearance of *Campanularia grandis*, Allman (1),

Fig. 2. *Campanularia juncea*—well-grown but living. This and fig. 3 are about $\frac{1}{3}$ natural size.

Fig. 3. *Campanularia juncea*—old coarse tufts ("heather"), mostly dead.

but has no node below the hydrotheca, although there are sometimes one or two joints, and it does not narrow towards the margin. It has apparently a tendency to completely reduplicate itself, a habit I have only seen described in the case of *Clytia poterium*, L. Ag. (8). The older hydrotheca has always lost its zooid when this happens, and also its corrugated sides, and looks old and worn.

Hebella calcarata (A. Agassiz) (9).

This species, previously known from Woods Holl, on the east coast of North America, was found creeping over Sertularians from the Gulf of Manaar.

Family: LAFOËIDÆ.

Lafoea serrata, Clarke (13).

A few colonies of this delicate little form were found creeping over Sertularians from the Gulf of Manaar. Previously known from Cuba.

Cuspidella costata, Hincks (15).

One or two broken fragments of this distinctive form were found creeping over a Sertularian from the Gulf of Manaar. The species was previously known from both sides of the North Atlantic—Woods Holl and Britain.

Family: SERTULARIIDÆ.

Sertularia gracilis, Hassall—Plate II., fig. 3.

Our Ceylon specimens correspond with Hincks' (15) description of this form in all its parts, but are much more attenuated than his figures represent, both in stem and hydrotheca, so that they have quite a different appearance (see Plate II., fig. 3). Many of the hydrothecæ have reduplicated margins, which adds length to them; also in the preserved specimens the operculum often stands open and adds further to the appearance of length. The species is known from both shores of the North Atlantic (Britain and North America).

Locality:—Galle and onwards up the West Coast of Ceylon, deep water; attached to Algæ, &c.

Sertularia ligulata, n. sp.—Plate II., figs. 1 to 1b.

Trophosome.—Colony about $1\frac{1}{4}$ inches in height in the largest specimens, with simple or sparingly branched stems. Branches mostly given off from one side of the stem, either two or three near together, or widely separated and few (Plate II., fig. 1). They are narrowest at their junction with the stem below a pair of hydrothecæ, are smooth near the base, and have an oblique joint below their lowest pair of hydrothecæ (Plate II., fig. 1a). Both stem and branches usually end in tendrils terminated by large flat disks which adhere to foreign objects (fig. 1a).

Hydrothecæ always in opposite pairs, one pair to an internode. They touch each other for $\frac{2}{3}$ of their length in front and are widely separated behind; the free portion is abruptly divergent, so as to leave a fold across the front of the cell; orifice bilabiate.

A good length of internode is seen below the hydrothecæ, and, usually, a joint just above a pair of hydrothecæ. A peculiar process like a little tongue or strap (hence the name I give this species) protrudes from the orifice above the zooid, and is sometimes contracted within the hydrotheca (fig. 1a).

Gonosome.—Gonothecæ resemble closely those of *Sertularia complexa*, Clarke (13), barrel-shaped and rugose, borne on the stems singly below hydrothecæ (fig. 1b).

Locality :—Found growing on stems of other Hydroids and on the experimental oyster cages in the Gulf of Manaar.

I have seen no account or figure of anything corresponding with the peculiar tongue-like process described above, except in Hincks' description (16) of the contents of the nematophores of some Plumularians. In *Diplocyathus*, Allman (4), and *Hypophyxis*, Allman (4), we have other forms of Hydroids outside the Plumulariidæ which show nematophores, but in the present species there is no containing receptacle for this process apart from the hydrotheca itself. The process appears to reach from the centre of the stem and proceeds along the upper bent portion of the hydrotheca.

The orifice of this species is bilabiate, the upper surface slightly peaked, but when the operculum is open it often appears to be even-rimmed and hooded.

Sertularia fissa, n. sp.—Plate II., figs. 2 to 2f.

Trophosome.—Colony a tangled mass of loose, straggling, rather coarse, brown stems, about 3 inches in height, dichotomously branched (Plate II., fig. 2); both stem and branches bearing hydrothecæ, in opposite pairs widely separated from one another (figs. 2d and 2f). Branches given off from before and behind a pair of hydrothecæ, not from their sides; occasionally two branches coalesce, and there are two pairs of hydrothecæ found back to back (see figs. 2d, e, f). Hydrothecæ adherent for $\frac{2}{3}$ of their length, free above, and diverging at right angles with the stem. They touch each other in front (fig. 2a), on the upper pairs, on the branches; but are separated below, and are widely apart at the back (fig. 2b). Margin with an upper and 2 lateral teeth, often reduplicated, and having an operculum.

Gonosome.—Gonothecæ borne on stem and branches, attached just below a hydrotheca (fig. 2c) by a short pedicel, and turned abruptly up to lie along the branches. They are about 3 times the length of the hydrothecæ, oval, with a short, broad neck and even rim, and strongly ribbed.

Locality :—Found on worm tubes from off Galle, off Mount Lavinia, off Kaltura, and on the Cheval Paar, depths of from 6 to 30 fathoms.

Sertularia tenuis, Bale (11).—Plate II., fig. 5.

The present specimens agree with Bale's figures and description of the unbranched form of *Sertularia tenuis* in size and shape of the hydrothecæ—there are no gonothecæ. These colonies show the margin of the hydrothecæ often reduplicated, and there is a bivalved operculum. There is one colony which may be mentioned as possibly only an abnormality in this species. It has a branch which proceeds from one of a pair of the hydrothecæ of the stem (see fig. 5), a feature of the genus *Thecocladium*, ALLMAN (2), with which genus, however, this species has nothing else in common. The species is known from Williamstown, Australia.

Locality :—The Ceylon specimens were attached to worm tubes, shells, algæ, &c., from the Cheval Paar, Gulf of Manaar.

Sertularia loculosa, BUSK (10).

These specimens correspond with the description of the unbranched form in BALE'S catalogue, they are rather shorter and have no gonothecæ present.

Locality :—This species, previously known from Australia, was found north of the Cheval Paar, 7 to 10 fathoms, growing on the calcareous alga *Halimeda*.

Sertularia rugosissima, n. sp.—Plate II., fig. 4.

Stems simple, rather less than $\frac{1}{2}$ an inch in height, of a bright brown colour. Hydrothecæ, one pair to an internode, corrugated for the upper $\frac{3}{4}$ of their length (fig. 4). They touch in front, excepting the lower ones on the stem, and are separated behind, and are free and divergent at right angles for $\frac{1}{2}$ their length. They have two lateral teeth and are closed by a bivalve operculum.

Gonosome not present.

This is a neat, minute form, quite half as small as *Sertularia pumila*, and is the only Sertularian with opposite annulated hydrothecæ.

Locality :—Found creeping over algæ from the Gulf of Manaar.

Diphasia mutulata (BUSK), **(10).**—Plate II., figs. 6 to 6B.

This form corresponds entirely with BUSK'S descriptions. The pieces are only about an inch in height, and are unbranched and bear male gonothecæ (Plate II., fig. 6). On some specimens the hydrothecæ are smaller and less prominent than on others, and sometimes subalternate (fig. 6B), and the gonothecæ on these have only a few spines near the top and are of smaller size. This form is shown on Plate II., fig. 6A. The species has been found at Torres Strait and Port Molle, Australia.

Locality :—Our specimens were growing on stems of *Lytocarpus*, &c., at several localities : off Galle ; Station I., off Negombo ; and in the Gulf of Manaar.

Sertularella, sp.

A fragment of a *Sertularella* was found on the Cheval Paar, Gulf of Manaar.

Thuiaria, sp.

TROPHOSOME.—Stems branched, about $\frac{3}{4}$ of an inch in height, not fascicled, having two, alternate, hydrothecæ to an internode on the unbranched portion of the stem, and where there is a branch, one hydrotheca is present also in its axil. Branches alternate, with a joint shortly above their origin.

Hydrothecæ alternate, well separated, except near the tops of branches, where they slightly overlap one another, and are more oval in shape. Margin with two teeth. No gonothecæ present.

There is such a small piece of this, that although the characters do not agree with those of any known species of *Thuiaria*, still I do not feel justified in describing it as a new form.

Locality :—Gulf of Manaar.

Thuiaria palans, n. sp.—Plate III., figs. 5, 5A.

TROPHOSOME.—Stem of a bright brown colour, branched, with a joint just below the origin of each branch. Branches alternate, long and straggling. Hydrothecæ two or three to an internode on the stem, four or five on the branches, adherent up to quite near the top, when they become free and divergent; margins reduplicated and with two lateral teeth.

There is only one broken piece of this form $2\frac{1}{2}$ inches in height, but it seems so distinct from all previously described species that I feel bound to describe it as new, and I believe the above characters will determine it.

Locality :—Palk Bay, 7 fathoms.

Desmocyphus palkensis, n. sp.—Plate II., figs. 7 to 7B.

TROPHOSOME.—Hydrocaulus $2\frac{1}{2}$ inches in height, with a dark brown stem, pinnately branched; the pinnæ paler in colour, alternate, one to an internode, with a straight and an oblique joint shortly above their point of origin.

Hydrothecæ alternate on the stem and separated from each other by its width (Plate II., fig. 7), adnate for $\frac{2}{3}$ of their length, one in the axil of each pinna and one on either side of the internode above; on the pinnæ they are opposite, a pair to each internode (fig. 7A), adnate for $\frac{2}{3}$ of their length in front, free and divergent above, with two lateral teeth and an operculum.

GONOSOME.—Gonothecæ borne on short stems below the hydrothecæ on the stem, oval, strongly ringed, with a wide neck (fig. 7B).

Locality :—Palk Bay, 7 fathoms.

These specimens are broken off above and below, but have the appearance of being nearly complete. They resemble *Desmocyphus longitheca*, ALLMAN (**3**), in some respects, but the hydrothecæ on the stem are never opposite and adnate to one another and the specimens are $1\frac{1}{2}$ inches taller.

Synthecium orthogonia (BUSK) (**10**).

A few of the hydrothecæ on these specimens are subalternate.

Locality :—The species is known from Port Jackson. Our Ceylon specimens were found on the experimental oyster cages on the Cheval Paar, Gulf of Manaar.

Pasythea hexodon, Busk (10).

There are some unbranched colonies of this species with from four to ten hydrothecæ in a set, and with one or two gonothecæ.

The species is known from Australia. Our specimens were found growing on stems of *Halicornaria insignis*, &c., on the north of Cheval Paar, Gulf of Manaar.

FAMILY: IDIIDÆ.

Idia pristis, Lamouroux.

The largest piece of these specimens is broken off at the top, and is $3\frac{1}{2}$ inches in height. Gonothecæ are present.

This species is known from Torres Strait, Bahia, and the Persian Gulf. Our Ceylon specimens were on worm tubes, &c., from off Galle, and onwards up the west coast to Mount Lavinia and Kaltura, and also in the Gulf of Manaar.

FAMILY: PLUMULARIIDÆ.

Plumularia setacea, Ellis.

A good many colonies of this species were found, and gonothecæ are present.

It was previously known from Australia, Messina, North America, and Britain.

Locality:—Our Ceylon specimens were attached to worm tubes, &c., from the north end of Cheval Paar, 7 to 10 fathoms, and elsewhere in the Gulf of Manaar.

Plumularia buskii, Bale (11).

There are a few colonies only of this form, about 1 inch in height, and without gonothecæ, but otherwise following Bale's description, excepting that, in some cases, a few of the lower pinnæ on the stems are opposite instead of alternate, an arrangement that has been described in the case of *Plumularia cornucopia*, Hincks (16).

The species is only known from Australia. Our Ceylon specimens were found in the Gulf of Manaar.

Monostæchas quadridens (McCrady) (18).

The specimens of this form are about the size of those first described when Allman founded the genus; half an inch is the height of the largest colony.

The species is known from Pacific reef, Barbadoes, and the North Atlantic.

Locality:—North of Cheval Paar, 7 to 10 fathoms, Gulf of Manaar.

Antennella gracilis, Allman (3).

These specimens agree with the description of *Antennella gracilis* in all respects but size, and are probably from their position young colonies. They are about $\frac{1}{4}$ inch instead of 1 inch in height. In the details of stems, hydrothecæ and nematophores they agree. The hydrothecæ are not quite cylindrical, narrowing downwards slightly.

There are a few gonothecæ, which is important, as these have not been observed before in the genus *Antennella*. They are identical in position and shape with those of *Monostæchas quadridens*, ALLMAN (3), and have the two nematophores at their base. These colonies resemble the branches of *M. quadridens* exactly, but are on a smaller scale.

This species was known previously only from the West Indies, between Cuba and Florida. Our Ceylon specimens were found growing on the experimental oyster cages on the Cheval Paar, Gulf of Manaar.

Antennella allmani, ARMSTRONG (7).

There is very little of this form. The lateral nematophores are very long, and the hydrothecæ have everted rims, as figured by ARMSTRONG (7).

This is an Indian Ocean species which was dredged off Galle and onwards up the west coast of Ceylon.

Aglaophenia perforata, ALLMAN (2).

In the absence of corbulæ, I cannot be quite sure of the identity of this species, of which a quantity was found growing over Amphipod tubes. It differs from ALLMAN'S description in being rather larger, colonies reaching the height of half instead of only quarter of an inch, and in the number of marginal teeth on the hydrothecæ not exceeding ten. There is a nematophore at the base of each pinna and one below, on the same internode of the stem as the pinna, which is not described by ALLMAN. ALLMAN'S specimens were from the St. Vincent Islands. The Ceylon specimens were found growing on masses of Amphipod tubes and on small pearl oysters in the experimental oyster cages in the Gulf of Manaar.

Aglaophenia phœnicea, BUSK (10).

There are a few colonies of this form growing over worm tubes from the north end of the Cheval Paar, 7 to 10 fathoms. It was previously known only from Torres Strait.

Halicornaria insignis, ALLMAN (1)—(Text-fig. 4).

The species described under this name by ALLMAN was 9 inches in height, unbranched, with a stout, monosiphonic stem, of a dark brown colour; the hydrocladia paler in colour; two, opposite, hydrocladia to an internode; hydrothecæ winged and toothed, with a long, curved, mesial nematophore, and two lateral nematophores taller than the hydrothecæ.

The present specimens correspond exactly with this description, but that the colonies are of far greater height, one reaching a size of $15\frac{1}{4}$ inches, spreading from the base in a beautiful fern-like way (see text-fig. 4), and that they are covered with gonothecæ.

There is also one colony of about 9 inches in height, exactly corresponding with

ALLMAN's description, except for the addition of the gonothecæ. This colony and the larger colonies evidently belong to the same species, so that I do not hesitate to call

Fig. 4. *Halicornaria insignis.* About ¼ natural size.

them all *Halicornaria insignis*, and to add the description of the gonosome, previously unknown.

The gonothecæ resemble those of *H. bipinnata*, ALLMAN (1). They are of the same colour as the hydrothecæ, obconic in form, one side more convex than the other, truncated above, and attached below, by a short stem, to the hydrocladia below its lowest hydrotheca. As the hydrocladia are opposite and closely set, the gonothecæ form a thick double row up the stems.

There are some specimens of the little bivalve mollusc *Avicula* (*Margaritifera*) *zebra*, REEVE, attached to these colonies, and so coloured and banded as to present the appearance of being part of the Zoophyte.

Locality :—Pearl banks, Gulf of Manaar.

Halicornaria setosa, ARMSTRONG (7).

The specimen from off Kaltura differs from the others very much in appearance, owing to the pinnæ being less fasciculated and twice as long, but this does not seem a sufficient reason for making a new species, unless, when more material has been examined, other special characteristics are found.

Locality :—Off Mount Lavinia and Kaltura, and on the Cheval Paar, Gulf of Manaar.

Lytocarpus (?) hornelli, n. sp.—Plate III., figs. 1 to 1B.

Trophosome.—Colony slender, 16 inches to 18 inches in height, with long, straggling branched stems (fig. 1). Stem and branches polysiphonic, of the same thickness, and dark brown colour. Branches alternate usually, but occasionally several given off near together and from one side of a stem. Branchlets carrying hydrocladia about $\frac{1}{10}$ of an inch in length, arranged in loose, bottle-brush form on the branches, having monosiphonic stems, an oblique joint some little way from their bases, and, below that, transverse joints which make long and short internodes to the base.

Cauline nematophores form a line up the central fascicle of the main stem and branches.

Hydrocladia are of a pale straw colour, not closely set; they branch alternately from the upper side of the branchlets, one from each internode, and there is one nematophore on each internode above this which is long and tubular and bends in the opposite direction to the hydrocladia.

Near the base of each hydrocladia there is a solitary nematophore; then follow hydrothecæ, closely set, separated by transverse joints. They are beautifully transparent and elegant, with an even, outwardly curved rim, and are about twice as deep as they are wide, having no anterior fold (fig. 1A).

The mesial nematophore reaches about halfway up the hydrotheca, is adnate below, tubular and diverging outwards above, with two orifices. The lateral nematophores are tubular, adnate to the hydrotheca below its rim and rising about as much above it. The intrathecal ridge is very near the base of the hydrotheca and reaches more than halfway across it.

Between each branchlet on the upper portion of the stem is a string of nematophores in threes, sometimes as many as twelve sets in a line (fig. 1B).

Gonosome not present.

Locality:—Off Mount Lavinia and Kaltura; also Station I., off Negombo.

Lytocarpus fasciculatus, n. sp.—Plate III., figs. 3 to 3B.

Trophosome.—Colony, stems fascicled, thick, of a pale brown colour; giving off, at intervals of about an inch, alternate branches, less thick, but fascicled like the stem, and of the same colour (fig. 3). These are about $2\frac{3}{4}$ inches in length, and carry closely set hydrocladia, about $\frac{6}{10}$ of an inch long, of a paler colour than the stems, branching alternately and pointing forwards and outwards, with a short cauline nematophore between each.

Hydrothecæ (fig. 3A) closely set, deep, with a crenate margin and a central tooth, the sides sloping upwards from the tooth, and backwards, and being free from the stem for a short distance from the top. Mesial nematophore short, barely half as long as the hydrotheca, free and spout-like for a third of its length. Lateral nematophores short and broad, not reaching to the top of the hydrotheca.

Intrathecal ridge very low down, reaching about half-way across the hydrotheca.

Phylactocarps (fig. 3B) of the same length as the hydrocladia, occurring at intervals up the branches among these, a hydrotheca at the base, succeeding internodes being alternately barren or with a spine which has a large flattened gonotheca at its base. The spines all turn to the same side.

Locality :—Off Galle and onwards up the west coast to Kaltura and Mount Lavinia.

There are only pieces broken from the tops of colonies of this form, and they appear to belong to a large species. In some respects they resemble *Lytocarpus secundus*, but the branches are not so closely set on the stems and have not such a one-sided mode of growth, and are about $\frac{1}{2}$ an inch longer, $\frac{6}{10}$ of an inch instead of $\frac{2}{10}$. Also the phylactocarps in *L. secundus* are only half as long as the hydrocladia, while here they are as long, and the hydrotheca at their base is not described as being present in *L. secundus*.

Lytocarpus plumosus, n. sp.—Plate III., figs. 2 to 2B.

Trophosome.—Colony about 2 inches in height, unbranched, plumose (fig. 2); the stem monosiphonic, of a dark brown colour. Hydrocladia closely set, $\frac{4}{10}$ of an inch in length, pale yellow, given off alternately to right and left from the front of the stems, one to each internode, which carries besides two cauline nematophores, one at the base of the hydrocladia and one below it. Hydrothecæ (fig. 2A) fairly deep, narrowing downwards from the rim, which is toothed, one small tooth in front and two on either side. Mesial nematophores about the height of the hydrothecæ, free and spout-like near the top. Intrathecal ridge sloping upwards, from low down posteriorly to about opposite the middle of the nematophore.

Phylactocarps (fig. 2B) scattered up the stems, about half as long as the hydrocladia. They have one hydrotheca at the base of each and spines, branching to either side alternately, above it.

Gonosome.—Gonothecæ at the bases of the spines, one to each.

Locality :—Growing on worm tubes from the Gulf of Manaar.

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(16.) Hincks.—Annals and Magazine of Nat. Hist., Series 4, vol. X., 1872.

(17.) Von Lendenfeld.—Proc. Linn. Soc., N. S. Wales, vol. IX., 1884.

(18.) McCrady.—Proc. Elliot Soc., 1857.

EXPLANATION OF PLATES.

PLATE I.

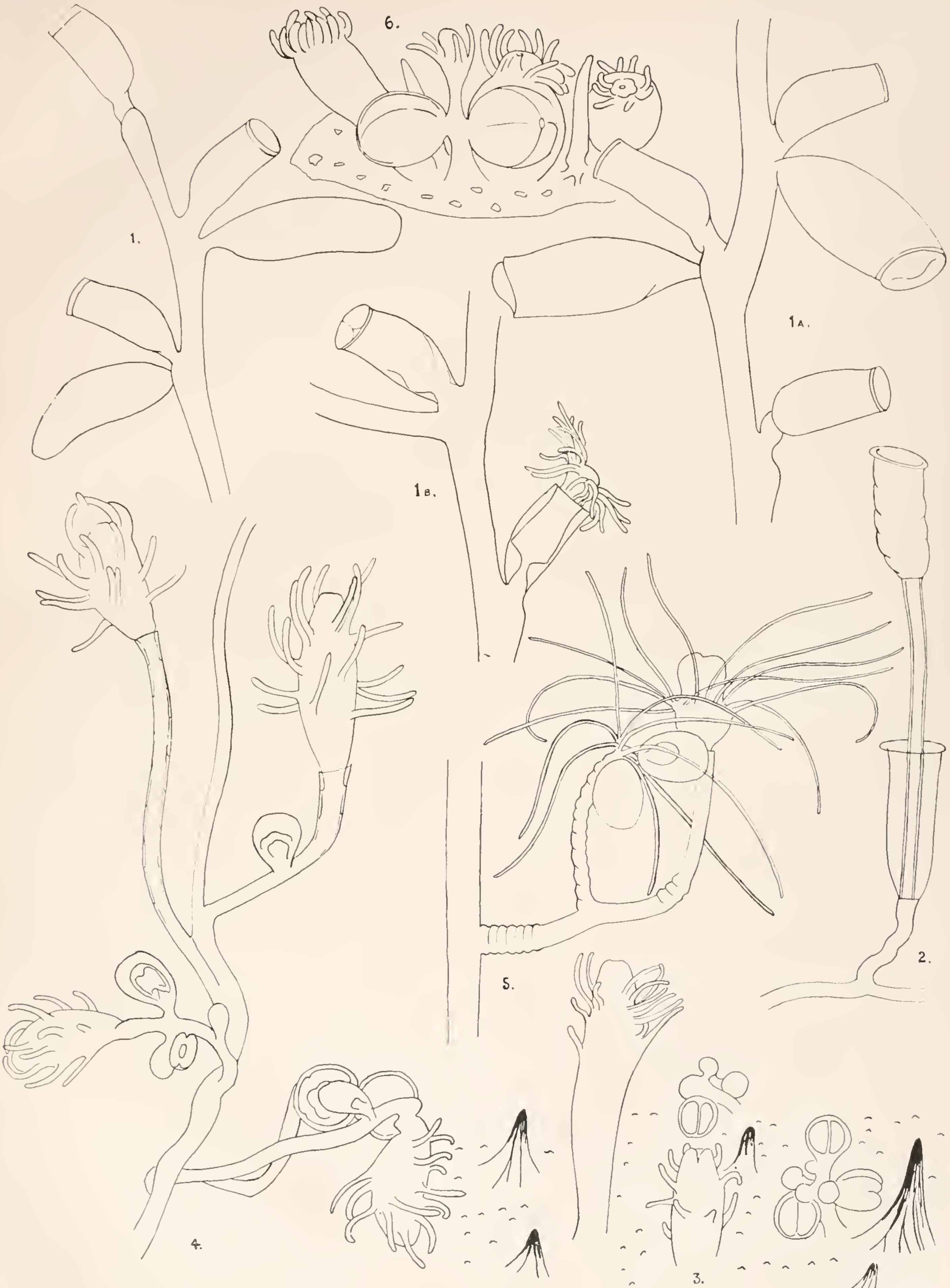
Fig. 1. *Campanularia juncea*, showing male gonothecæ.
,, 1A. ,, ,, female gonothecæ.
,, 1B. ,, ,, operculum and zooid.
,, 2. *Campanularia corrugata*, n. sp.
,, 3. *Clavactinia gallensis*, n. sp.
,, 4. *Corydendrium chevalense*, n. sp.
,, 5. *Eudendrium pusillum*, v. LENDENFELD.
,, 6. *Podocoryne denhami*, n. sp.

PLATE II.

Fig. 1. *Sertularia ligulata*, n. sp. Nat. size.
,, 1A. ,, ,, portion enlarged.
,, 1B. ,, ,, gonotheca.
,, 2. *Sertularia fissa*, n. sp. Nat. size.
,, 2A. ,, ,, front of hydrotheca.
,, 2B. ,, ,, back ,,
,, 2C. ,, ,, gonotheca.
,, 2D. ,, ,, showing modes of branching.
,, 2E. ,, ,, ,, ,,
,, 2F. ,, ,, ,, ,,
,, 3. *Sertularia gracilis*, HASS., showing attenuated form.
,, 4. *Sertularia rugosissima*, n. sp.
,, 5. *Sertularia tenuis*, BALE, showing abnormal mode of branching.
,, 6. *Diphasia mutulata* (BUSK), male gonotheca.
,, 6A. ,, ,, smaller form.
,, 6B. ,, ,, showing alternate hydrothecæ.
,, 7. *Desmoscyphus palkensis*, n. sp.
,, 7A. ,, ,, hydrothecæ.
,, 7B. ,, ,, gonotheca.

PLATE III.

Fig. 1. *Lytocarpus* (?) *hornelli*, n. sp. Nat. size.
,, 1A. ,, ,, hydrothecæ.
,, 1B. ,, ,, series of nematophores.
,, 2. *Lytocarpus plumosus*, n. sp. Nat. size.
,, 2A. ,, ,, hydrothecæ.
,, 2B. ,, ,, phylactocarps.
,, 3. *Lytocarpus fasciculatus*, n. sp. Nat. size.
,, 3A. ,, ,, hydrothecæ.
,, 3B. ,, ,, phylactocarps.
,, 4. *Clytia geniculata*, n. sp.
,, 4A. ,, ,, gonotheca.
,, 5. *Thuiaria palans*, n. sp.
,, 5A. ,, ,, hydrothecæ.



L. R. T. *del.*

Fig. 1. *Campanularia juncea.* Fig. 2. *Campanularia corrugata.* Fig. 3. *Clavactinia gallensis.* Fig. 4. *Corydendrium chevalense.* Fig. 5. *Eudendrium pusillum.* Fig. 6. *Podocoryne denhami.*

L. R. T. *del.*

Fig. 1. *Sertularia ligulata.* Fig. 2. *Sertularia fissa.* Fig. 3. *Sertularia gracilis.* Fig. 4. *Sertularia rugosissima.* Fig. 5. *Sertularia tenuis.* Fig. 6. *Diphasia mutulata.* Fig. 7. *Desmoscyphus palkensis.*

L. R. T. *del.*

Fig. 1. *Lytocarpus hornelli.* Fig. 2. *Lytocarpus plumosus.* Fig. 3. *Lytocarpus fasciculatus.* Fig. 4. *Clytia geniculata.* Fig. 5. *Thuiaria palans.*

REPORT

ON THE

POLYCLAD TURBELLARIA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

FRANK FORTESCUE LAIDLAW, B.A. CANTAB.

[WITH ONE PLATE.]

THE seas lying about the island of Ceylon appear to support a particularly rich Planarian fauna. Although a greater number of species have already been described from these waters than from any other part of the world, the Mediterranean Sea alone excepted, I have not been able to identify any of the species mentioned below with any already described from them.

A large collection was made by SCHMARDA,* who describes no fewer than twenty-nine species from the Ceylon seas, whilst nineteen others are recorded by Dr. COLLINGWOOD.† Coloured figures carefully executed are available for all these species, so that I believe I have not overlooked any identities. Unfortunately neither of these writers was able to give sufficient account of the internal anatomy of the species they described, consequently the generic determination of their species is often a matter of uncertainty, and hence it is not possible at present to compare the general characters of this fauna with that of other parts of the world.

LANG‡ apparently makes no additions to the list; and since the publication of

* 'Neue wirbellose Thiere, beobachtet und gesammelt auf einer Reise um die Erde 1853 bis 1857,' I Band, "Turbellarien, Rotatorien und Anneliden," I. Hälfte, Leipzig, 1859.

† 'Trans. Linnean Society,' 2nd Series, Zoology, vol. I., p. 83, Plates XVII.–XIX. Three species, *Planaria aurea*, *Penula fulva* and *Penula alba*, are omitted by Dr. COLLINGWOOD from his account of KELAART'S species. See KELAART, 'Journ. Ceylon Branch Roy. Asiat. Soc.,' 1856–1858, pp. 134–139.

‡ 'Fauna und Flora des Golfes von Neapel,' XI., Polycladen, 1884.

LANG's monograph I can find no further records, save of *Cestoplana ceylanica* added by myself.*

Three of the species described below were collected in Ceylon by Mr. GARDINER in 1899. He has been good enough to permit me to incorporate my account of them with that of the species with which Professor HERDMAN has kindly entrusted me.

Paraplanocera aurora, LAIDLAW.

Paraplanocera aurora, LAIDLAW, 'P.Z.S.,' 1903, vol. II., Part I., p. 102, Plate IX., fig. 1.

One specimen which agrees in every respect with the type specimen from Zanzibar, save that it is nearly twice as large, being about 30 millims. in length, whilst Mr. CROSSLAND's specimen was only 15 millims. long. The Ceylon specimen was found at Station XVI., on the Periya Paar, in the Gulf of Manaar, at a depth of 9 fathoms.

Woodworthia, n. gen.

Closely allied to *Idioplana*. Body rounded, no notch on the anterior margin. A complete series of marginal eye-spots present. Prostate provided with a duct which joins the vesicular duct at the base of the penis. Female aperture separated from male; vagina of great length, having a bilaterally symmetrical accessory vesicle.

Woodworthia insignis, n. sp.—Plate, figs. 1 and 9.

One specimen, pearl banks, Gulf of Manaar.

Measurements.—Length, about 25 millims.; breadth, about 22 millims. Buccal opening sub-median. Male aperture about 4 millims. from hind end of body; female aperture about 0·5 millim. behind male. Tentacles 5 millims. apart.

Coloration.—In the spirit specimen an uniform whitish brown, in the living creature probably white. Scattered irregularly over the whole dorsal surface are numerous minute black dots of pigment.

Eye-spots.—These are grouped in a dense cluster at the foot of each tentacle, over the brain, and round the margin of the body. The spots over the brain are few in number and rather widely scattered. Those on the margin are very minute and are irregularly arranged; on the front part of the margin they may be two or three rows deep.

Body-wall.—The epidermis, both on the ventral and on the dorsal sides, contains numerous long, rather slender rhabdites, those on the dorsal side being nearly half as long again as those on the ventral side.

The basement membrane is remarkably thick. The muscles of the body-wall consist on the dorsal side of a longitudinal layer next the basement membrane, followed by diagonal fibres, and on their inner side a circular layer. On the ventral

* LAIDLAW, in GARDINER's 'Fauna and Geography of the Maldive and Laccadive Archipelagoes,' vol. I., Part III., p. 302, fig. 72.

side there is, in addition to these, an inner diagonal layer, and, lastly, an inner longitudinal layer.

Gut.—The pharynx is large and folded, of the type usually found in Planoceroids. The gut branches are very numerous and anastomose freely. The cells forming the epithelium appear to have broken away, in most cases, from the gut-wall, and to have rounded themselves into little spheres which lie free in the lumen. This is possibly due to some delay in fixing the tissues after the specimen was taken from the dredge.

Genital Apparatus.—The ovaries are dorsal; the testes cannot be distinguished in my sections, although the ends of the vasa deferentia are crowded with spermatozoa. The relations of the rather complicated terminal parts of the genital ducts will be rendered more easily comprehensible by a reference to the accompanying Plate, fig. 9.

Terminal Male Organs.—The small conical penis (*pe.*), which is unarmed, projects into the antrum masculinum (*a.m.*), which is a simple chamber lined with what appears to be a secreting, non-ciliated epithelium. Into the base of the penis run two ducts: one, that lying more dorsally, conveying secretion from a small muscular prostate gland (*pr.*), the other, the more ventral of the two, runs backwards and downwards for some distance to widen into a vesicula seminalis (*v.s.*). This latter duct is lined with ciliated epithelium and has rather thick muscular walls. It widens quite gradually into the vesicula, which receives on its dorsal side, some way behind its anterior end, the two vasa deferentia (*v.d.*), which, as they approach the vesicula, become endowed with muscular walls, composed, as in the case of the vesicula and its duct, of circular fibres.

The prostate duct is very short and enters the prostate immediately after it passes out of the penis. The interior of the prostate is divided into three longitudinal chambers (see Plate, fig. 1) by the folding of its secretory wall, outside which is a thick layer of circular muscle fibres traversed by a few radial and longitudinal strands.

Female Terminal Ducts.—The vagina is chiefly remarkable for its extreme length. The antrum (*a.f.*) is small, it opens vertically upwards. From it the vagina (*va.*) runs straight forward close to the dorsal body-wall. It consists here of a tube of rather narrow diameter, lined with ciliated epithelium, and surrounded by a few circular muscle-fibres. It continues forward until it has passed right beyond the level of the male organs. Its diameter then increases and it bends downwards and forwards for some distance, then turns upwards, receiving the secretion of the large shell glands (*sh.gl.*) at this level. Finally, near the dorsal body-wall, it turns sharply backwards, running parallel to the first part of its course and at about the same level with it, so that the two parts often lie side by side. At a level considerably in front of the extreme front end of the male apparatus the backwardly-directed part of the vagina receives the common duct running into it from the two uteri (*c.d.*). This duct is rather longer than is usual. The backward course of the vagina is continued until the level of the antrum femininum is almost reached. The structure of this part is similar to that of its first part. Finally it ends by opening in the middle line into a large crescentic accessory vesicle (*acc.ves.*), whose "horns," lying one on either side of the middle line, are directed forward. The two halves of the accessory vesicle end in large, rather rounded lobes (*l.*). Its walls are composed of an active secretory epithelium which is at first columnar, but becomes more cubical in the lobes. These lobes contain a quantity of thick spongy secretion. In this secretion mass lie a large number of remarkable spindle-shaped bodies which vary considerably in size, and stain very deeply. They are shown in fig. 1, on the Plate. Each of these bodies lies in a small clear cavity which is spherical in shape. In the sections it is, of course, seen as a clear round patch, in which the dark-stained spindle-shaped body lies equatorially. The nature of these bodies is quite unknown to me, and the state of preservation of the tissues in the single specimen prevents a more detailed description. I am inclined to conjecture, however, that they may be spermatophores. In one or two cases the clear space surrounding them seems to be occupied by a gelatinous lightly-staining substance (x, in fig. 1, on Plate).

The most striking features of the genital apparatus of this species are (i) the great length of the vagina and (ii) the shape of the accessory vesicle, which is, roughly speaking, bilaterally symmetrical. The first of these peculiarities is paralleled in *Idioplana australiensis*, a species described by WOODWORTH.* This species also resembles that under discussion in the following respects:—Distribution of the eye-spots, coloration, and structure of the terminal parts of the male ducts. Consequently we may conclude that the two are closely related.

Idioplana, however, differs from *Woodworthia* in shape, in possessing a peculiar notch on the anterior margin, and in the fact that the prostatic duct and the vesicular duct open to the exterior almost independently of one another.

Woodworthia, on the other hand, possesses an accessory vesicle which is bilaterally symmetrical. These differences are sufficient to warrant a generic separation of the two forms.

Stylochus ceylanicus, n. sp.

Three specimens from Cheval Paar.

Measurement (of largest specimen).—Length, about 47 millims.; breadth, 27 millims. Genital aperture 4 millims. from hinder end of body. Tentacles 4 millims. apart. Buccal opening sub-central.

Coloration.—Judging from the preserved specimens, this must be, on the dorsal surface, a dull yellow covered with very numerous small ill-defined black spots which are absent in the area lying just over the brain. Ventral surface plain yellowish-white.

Eye-spots.—Numerous spots lie close together about the base of either tentacle;

* WOODWORTH, 'Bull. Mus. Harvard,' vol. XXXII., No. 4, p. 63, Plate XXXII., figs 2–5, 1898.

there are a number of scattered eye-spots about equal in size to those lying at the base of the tentacles, over the brain. In addition there are very numerous smaller spots on the margin. These do not extend completely round the body, but only about halfway along the margin on either side. They form anteriorly two or three irregular rows.

Genital Organs.—The ovaries are dorsal. The most striking peculiarity of this species is found in connection with the hinder ends of the vasa deferentia just before they enter the vesicula seminalis. They are provided in that neighbourhood with very thick muscular walls, which are quite as thick as the walls of the vesicula seminalis itself. The prostate is divided into a number of parallel chambers, its walls are formed of muscle-fibres which have a very definite "lattice-work" appearance.

In one specimen the penis was completely everted. The vagina opens into the same wide shallow depression as that into which the antrum masculinum passes.

This species may be defined as a *Stylochus* with an incomplete series of marginal eye-spots, with the ovaries occupying a dorsal position, and with the genital apertures closely approximated. The prostate is divided into a number of parallel chambers, and the lower ends of the vasa deferentia are highly muscular.

Stylochocestus, n. gen.

Body elongated, with neither marginal nor tentacle eye-spots. Buccal aperture sub-central.

Prostate gland large, provided with a short duct which joins the vesicular duct at the base of the penis. Vagina without accessory vesicle.

Stylochocestus gracilis, n. sp.—Plate, fig. 7.

Several specimens (Gardiner).

Measurements.—Length, about 14 millims.; breadth, about 3 millims. Male aperture 4·5 millims. from hinder end of body; female aperture 0·5 millim. behind male. Buccal opening sub-median.

I have no information as to the *coloration* of this species during life.

The *eye-spots* are arranged in two parallel rows over the brain.

Body-wall.—The epidermis of the dorsal surface contains rather large rhabdites, and in places also pseudorhabdites equal in length to the rhabdites, but much broader and rather irregular in outline. These are both absent from the ventral surface, except towards the margin of the body, whilst the ventral epithelium is flatter.

The basement membrane is thin, but stains deeply. The muscles lying immediately below it on the dorsal side are first a longitudinal layer, then a double diagonal layer, and lastly a circular layer. On the ventral side this is again succeeded by an inner longitudinal layer.

The *gut branches* do not anastomose.

Genital Apparatus.—The testes, which are very numerous and of large size, lie between the gut branches at almost the same level as the ovaries, being only a trifle more ventral in position.

Terminal Ducts (see Plate, fig. 7).

Male.—The two vasa deferentia (*v.d.*) enter the anterior end of a small vesicula seminalis (*v.s.*) which lies close against the dorsal body-wall. It is lined with a ciliated epithelium, outside which is a narrow layer of circular muscle fibres; it tapers at its posterior distal end into a duct (*d.e.*) without muscular walls, but with rather a wide lumen which runs to the penis (*pe.*). At the base of the penis it joins another duct which runs a short course directly from the penis to the prostate gland (*pr.*), an elongate oval body of about twice the size of the vesicula seminalis, lined with a well-developed secretory tissue enclosed in a layer of circular muscle fibres. The prostate duct is very short. The antrum masculinum (*a.m.*) is of moderate size, and in one of the specimens from which I prepared sections it is full of the secretion from the prostate.

Female Ducts.—The vagina (*va.*) runs upwards from the female aperture, then close to the dorsal body-wall it turns forward for a short distance and ends receiving the two uteri. The shell-glands (*sh.gl.*) lie about the first part of its course.

Thalamoplana, n. gen.

Closely allied to *Discocelis.* Male and female apertures separated. Antrum masculinum very large; its walls carry muscular projections, at the free ends of which lie the prostatic glands. The penis is of large size, truncate, and also carries prostatic glands at its end. In other respects the genus is similar to *Discocelis.*

Thalamoplana herdmani, n. sp.—Plate, figs. 2–5 and 8.

Two specimens were found in the lagoon at Galle.

Measurements.—Length, about 25 millims.; breadth, 17·5 millims. Buccal opening, 12 millims. from anterior end; male opening, 2 millims. behind buccal; female opening, close behind, but quite distinct from male.

Coloration.—Dorsal surface white with brown mottling. Along the mid-dorsal line is a brown frond-like pattern consisting of a median stripe bearing lateral lobes or segments in pairs, which are irregular in shape and size, but, roughly speaking, smaller and larger pairs alternate. The ventral surface is white.

Eye-spots.—These are arranged much as in *Discocelis tigrina* (see fig. 3 on Plate). On either side of the brain is a small elongate cluster of spots; these clusters diverge from each other posteriorly. Between them lie several diffusely scattered spots over the brain. Marginal eyes are also present on the anterior margin.

Body-wall.—The epidermis consists of columnar ciliated cells which are of considerably greater length on the ventral side of the body than on the dorsal. There are no rhabdites, but the cells appear to contain secretions of the nature of pseudorhabdites. The basement membrane is very thick, especially on the dorsal side; on the other hand, the muscles of the body-wall are but feebly developed.

The *pharynx* is large and much folded. The *gut-branches* are numerous; there is no anastomosis.

Genital Apparatus.—Reference to the Plate, fig. 8, will render the account given below more readily intelligible.

Terminal Male Organs.—The two wide vasa deferentia (*v.d.*) unite to enter a median duct running to the penis. The proximal end of this duct is slightly swollen and has rather thick muscular walls; this part may be regarded as a vesicula seminalis (*v.s.*). Beyond it the duct (*d.e.*, ductus ejaculatorius) runs into the penis (*p.*), a large fleshy organ which projects backwards and downwards into the spacious antrum masculinum (*a.m.*). At its free end the penis is studded with a ring of curious large glands evidently of a prostatic character (*pr.gl.*), which lie around the rather wide opening of the lumen of the penis. These glands appear to be precisely similar in character to those found in *Discocelis tigrina.* As in that species, other glands of the same character are found on the walls of the antrum, but in the present instance they lie at the free ends of certain curious muscular prominences which project from the walls of the antrum. They are distributed as follows:—In front of the penis there is a crescentic muscular ridge which carries a number (about 15) of these glands. In the diagram it is shown in section at *m.pr.'*, the glands are marked *pr. gl.*, and they project at their distal ends to some extent from the surface of the ridge.

Behind the penis there lies on either side of the middle line a pair of prominences shaped rather like the penis, but folded in towards each other. Like the penis, they each carry glands, 3 or 4 apiece at their free ends. They are indicated on the diagram at $m.pr.^2$ (see too, Plate, fig. 4). The floor of the antrum is formed of a very thin fold of the integument, which extends backward as far as the level of the paired prominences spoken of above. The antrum is lined throughout with a thin layer of flattened epithelium which bears very short cilia.

The glands have a length of about 0·1 millim. They are pear-shaped, their narrower end is directed outwards and ends in a conical point which passes through the epithelium lining the antral walls (Plate, fig. 5, *a.gl.*). The gland is in every case filled with a fine darkly staining network, in the interstices of which in some of the glands lies a quantity of finely granular secretion. The nuclei lie about the walls of the gland, none occur in the reticulum. The walls are without muscle fibres.

Female Terminal Ducts.—These bear a very strong resemblance to those of *Discocelis tigrina.* The female aperture opens into the terminal part of the vagina (*va.*), which is at first rather wide and runs in a dorsal direction. It then turns backwards, its lumen narrows, and its muscular walls become thicker. After receiving the common opening of the uteri (*ut.*) it is prolonged back for some distance. This hinder part may be termed the accessory part of the vagina (*acc.* in diagram). It is wider than that part immediately in front of the uterine opening, its walls are thinner, and the lining epithelium is flattened and non-ciliated, whilst in the anterior part the lining epithelium is columnar or square and appears to be ciliated. At its hinder end the accessory part of the vagina opens into the accessory vesicle (*acc.ves.*) which has no muscular walls; its lining epithelium consists of large square secretory cells, and in its lumen lies a lump of secreted substance.

The shell glands are very large, they pass their secretion into the anterior part of the vagina (*sh.gl.*). A very curious feature is the presence of a considerable fold of the body-wall (*pl.*) on either side of the female aperture. This is easily visible in the whole specimen when examined with a simple lens, and in conjunction with the still more prominent external male organs serve to distinguish this species at a glance from any other with which I am acquainted. The position of the ovaries is dorsal.

This is certainly the most interesting species in the collection. It is the type of a genus which may be regarded as a specialized form of *Discocelis* which has retained a single primitive feature which the latter has lost, namely, the widely separated genital apertures.

The feature most worthy of remark is the development of muscular projections of the walls of the antrum to carry the prostatic glands, which are sessile in *Discocelis*. They are of importance, since they suggest a probable explanation of the manner in which the curious intromittent prostate organ of the Diposthiidæ may have arisen, and because they further give an indication of the manner in which a re-duplication of the penial organs may have come about. In fact, if the genus *Discocelis* were not known, one would be almost tempted to suppose that *Thalamoplana* was derived from an ancestral form possessed of a large number of penes, which are here to be seen in process of reduction.

The three genera *Semonia*,* *Discocelis*,† and *Thalamoplana* may conveniently be grouped in a distinct sub-family of the Leptoplanidæ, characterized by the possession of marginal eye-spots, of a large blunt penis, and by the absence of an internal prostate gland. *Semonia*, like *Discocelis*, has a common genital atrium, whilst *Thalamoplana* resembles *Discocelis* in possessing external prostatic glands and a bilaterally symmetrical accessory vesicle connected with the vagina.

Leptoplana gardineri, n. sp.

One specimen, collected by Mr. GARDINER in 1899.

Colour in spirit specimen uniform yellowish-white.

Measurement.—Length, about 16 millims.; breadth, 7·5 millims. Buccal opening sub-central. Female aperture about 6 millims. from the hinder end of the body.

* VON PLEHN, 'Jen. Zeitschr. f. Naturwissenschaft,' Band XXX., pp. 157–159, Taf. XI., figs. 5, 12; Taf. XIII., fig. 3. See also LAIDLAW, 'Proc. Zool. Soc.,' 1903, p. 309.

† See especially LANG, *loc. cit.*, Taf. XIII., fig. 1.

The arrangement of the *eye-spots* is shown in fig. 6 on Plate.

This species is a true *Leptoplana* belonging to the section of the genus* in which the penis is not armed with a stylet. The prostate is chambered, with some five compartments, it is small and of considerable length.

L. gardineri is nearly related to *L. chierchiæ*, VON PLEHN, from which it is readily distinguished by the very different arrangement of the eye-spots, by the greater relative length of the prostate, and by the relatively small size of the accessory vesicle of the vagina.

Pseudoceros, sp.

One specimen, referable to this genus, from the pearl banks, Gulf of Manaar, is unfortunately not in suitable condition for accurate description. It apparently belongs to the section of the genus which is provided with only a single penis; the colour is white with a fine black margin. The total length of the specimen is about 20 millims.

Prosthiostomum singulare, n. sp.

One specimen from Ceylon (GARDINER).

Measurements.—Length, about 40 millims.; breadth, about 6 millims. Buccal opening 6 millims. from the anterior end. Male aperture 16 millims. behind buccal opening; female aperture 1·5 millims. behind male. Sucker 2 millims. behind female aperture.

The *colour* of the spirit specimen is uniform white.

The marginal *eye-spots* are relatively very small and lie in an irregular row round the front margin, extending back on either side for 3 or 4 millims. There are no "brain-eyes"; in this respect *P. singulare* differs from all other known members of the genus.

Genital Organs.—The outer chamber of the antrum masculinum is very large and is provided with thick muscular walls, in which on the dorsal side the accessory vesicles, the vesicula seminalis and part of their ducts are embedded. The accessory vesicles are relatively small and their ducts short. In other respects the sexual organs are exactly as in *P. siphunculus*.

* In my list of the species of the genus *Leptoplana* given in the 'Proc. Zool. Soc.,' 1903, pp. 307, 308, *L. nationalis*, v. PLEHN, was by mistake referred to a division of section A of the genus which included species in which the prostate gland is not chambered. It should, of course, be put in the division A (*b*) near *L. vitrea*, LANG.

EXPLANATION OF PLATE.

Fig. 1. Part of a transverse section across the body of *Woodworthia insignis*. Epidermis and gut shown quite diagrammatically. The section is in the plane AB, shown in fig. 9, and the part drawn shows the median organs and those a little to the right of the middle line.

,, 2. *Thalamoplana herdmani*, sketch of the appearance of the entire animal, showing the colour pattern. × 4 diam.

,, 3. Dorsal eye-spots of the same.

,, 4. Section across the hinder end of the antrum masculinum of the same, in the plane marked AB in fig. 8. The epidermis and body-wall muscles are shown diagrammatically. The two glands (*pr.gl.*) are secreting actively and contain a finely granular secreted substance.

,, 5. Section across three prostatic glands of the same more highly magnified. These glands are exhausted and show only the protoplasmic reticulum.

,, 6. Eye-spots of *Leptoplana gardineri*.

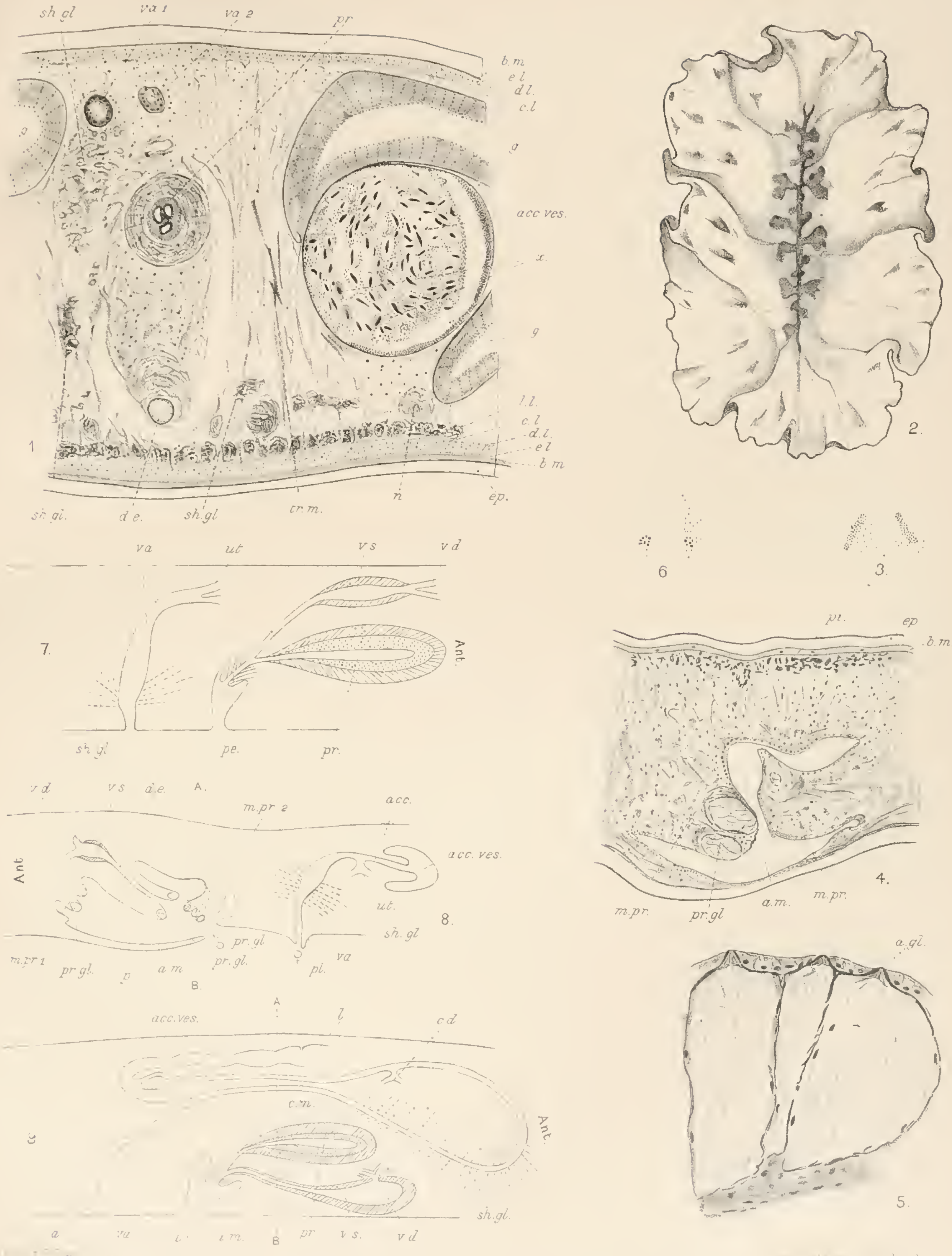
,, 7. Diagram of genital ducts of *Stylochocestus gracilis*, n. gen. and sp.

,, 8. Diagram of genital ducts of *Thalamoplana herdmani*, n. gen. and sp.

,, 9. Diagram of genital ducts of *Woodworthia insignis*, n. gen. and sp.

Explanation of Lettering.

a.f., antrum femininum.
a.gl., aperture of prostatic gland.
a.m., antrum masculinum.
acc.ves., accessory vesicle.
b.m., basement membrane.
c.d., common uterine duct.
c.l., circular muscle layer.
d.e., ductus ejaculatorius (vesicular duct).
d.l., diagonal muscle layer.
e.l., external longitudinal muscle layer (ventral).
ep., epidermis.
g., gut.
i.l., inner longitudinal muscle layer.
l., lobes of accessory vesicle.
m.pr., muscular projection from antrum.
n., nervous tissue.
pe., penis.
pi., pigment.
pr., prostate.
pr.gl., prostatic gland.
sh.gl., shell gland.
tr.m., dorsiventral muscles.
ut., uteri.
v.s., vesicula seminalis.
v.d., vas deferens.
va., vagina.
va[2]., accessory part of vagina.
x., dark body in the accessory vesicle surrounded by gelatinous substance.



Figs 1 and 9 Woodworthia insignis Fig 6 Leptoplana gardineri
Figs 2, 5 and 8. Thalamoplana herdmani Fig. 7 Stylochocestus gracilis

REPORT

ON THE

ECHINODERMA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

W. A. HERDMAN, D.Sc., F.R.S., AND JANE B. HERDMAN, B.Sc. (LOND.),

WITH NOTES AND ADDITIONS

BY

F. JEFFREY BELL, M.A.,

EMERITUS PROFESSOR AND FELLOW OF KING'S COLLEGE, LONDON.

[WITH TEXT-FIGURES.]

[EDITORIAL NOTE.—The HOLOTHURIOIDEA of this collection were described in Mr. PEARSON'S Report published in PART I. (p. 181, 1903), and the CRINOIDEA are reported upon separately by Mr. CHADWICK in this Part (see p. 151, below).

The greater part of the labour in connection with the remaining groups of Echinoderma has been undertaken by my wife, who separated out most of the species and identified the Echinoidea. I should naturally have let her name stand alone in the title of the Report, but as I took some part in the work, exercised a general supervision and identified the commoner starfishes, she prefers that I should be jointly responsible.

Professor JEFFREY BELL, while on a short visit to us in September, kindly went over the greater part of the collection with me and confirmed the identifications. Most of the Ophiuroids and some of the smaller or more doubtful Echinoids and Asteroids were, at his suggestion, sent to him at the British Museum, with the result that he has contributed some additions to our list, and the interesting Notes on some forms and remarks on the more general aspects of the collection, which will be found under his own name at p. 148.—W. A. H.]

ECHINODERMA.

In the year 1882, we are told by BELL, only 4 species of Echinoderms were known from Ceylon. HAECKEL'S collection, described by WALTER, added 16 species, but most of our knowledge is due to the successive collections made for the British Museum by Dr. ONDAATJE, which enabled BELL to add about 20 species in 1882 and to raise the number to over 50 in 1887. The collection of P. and F. SARASIN, made at Trincomalee in 1884–86, yielded to DÖDERLEIN 16 species of Asteroids, 10 Ophiuroids, and 18 Echinoids. Adding these, along with 16 Holothurians (LUDWIG) and 5 Crinoids (BELL), to the forms previously known raised the total in 1888 to about 90 species. A few species have since been added by THURSTON and others.

There seem to be about 109 species of Ceylon Echinoderms in all in the present collection. Mr. PEARSON recorded 30 species of Holothurioidea, and Mr. CHADWICK gives 13 species of Crinoidea in the Report that follows this. In the present lists we have 28 species of Echinoidea, 24 species of Asteroidea, and about 14 species of Ophiuroidea. There were no forms unknown to science in the three last-named groups, but some of the species are of interest from the point of view of distribution, habitat and variation.

ECHINOIDEA.

DESMOSTICHA.

CIDARIDÆ.

Cidaris metularia (LAMK.).

Station XL., 10 miles off Galle, 34 fathoms, 2 specimens, about 1 centim. diameter; Station LV., south-west of Periya Paar, 11 to 24 fathoms, 2 specimens, 1 centim. and 1·5 centim. diameter; Station LXIII., west of Periya Paar, 36 fathoms, 1 specimen, about 1 centim. diameter.

Stephanocidaris bispinosa (LAMK.).

Pearl banks, Gulf of Manaar; 4 specimens. Also another "very young Cidaris."

Phyllacanthus baculosa (LAMK.).

Many specimens were dredged from 10 to 12 miles off Galle, at Stations XL. and XLI., depths 34 to 100 fathoms. Also further on up the west coast of Ceylon, towards Colombo, and off Kaltura and Mount Lavinia, at Station XLVI., depth 25 to 30 fathoms. Also in the Gulf of Manaar, at Station LIV., south of Adam's Bridge, 4 to 40 fathoms; at Station LV., south-west of Periya Paar, 11 to 24 fathoms; at

Station LX., outside Donnan's Paar, 20 to 30 fathoms, and from Cheval Paar, 7 fathoms. obtained by the divers. The diameters of the specimens, without the spines, ranged from 1 centim. to 4·5 centims.

Phyllacanthus imperialis (Lamk.).

One specimen from the Gulf of Manaar, at Station LVII., outside Dutch Modragam Paar, 12 to 36 fathoms; it measures about 2 inches in diameter, without the spines, and about 6 inches including them.

DIADEMATIDÆ.

Diadema saxatile (Linn.).

One small specimen was obtained at Station XL., 10 miles off Galle, depth 34 fathoms. This specimen has long spines on the upper surface, banded straw-coloured and red.

Echinothrix diadema (Linn.).

Obtained at Station XL., 10 miles off Galle, depth 34 fathoms.

ECHINOMETRIDÆ.

Stomopneustes variolaris (Lamk.).

Many specimens were found at the south-eastern corner of Welligam Bay, south end of Ceylon, in hollows in rock pools and also under the sea, in cavities and crevices of the rock. They were of a very deep purple colour when alive, but are now, both the dried and the spirit specimens, of a greenish-black colour. This species was also observed in the lagoon inside the reef at Galle.

Pseudoboletia maculata, Trosch.

One specimen, diameter about 6·5 centims., was obtained from the Cheval Paar, 7 fathoms, by native diver.

Echinostrephus molare (de Bl.).

This little species was obtained in coral blocks in the Gulf of Manaar, at Station XV., on Periya Paar, 9 fathoms, 2 specimens; at Station LXII., between Periya Paar Kerrai and Periya Paar, depth 7 fathoms to 13 fathoms, 2 specimens, 1·5 centims. and 2 centims. in diameter; and on the Jokkenpiddai Paar, obtained by native divers, many specimens, 1 centim. to 1·5 centims. in diameter.

All the specimens of this little purple Echinid were dug out of deep holes in massive blocks of dead coral; and the top-shaped or obovate form of the test, with all the long spines on the abactinal surface, seems well adapted to the burrowing habit. It was noticed on the living specimen that the shorter spines on the actinal surface around the mouth are arranged so as to show a spiral twist such as would be produced by a rotation of the animal within its burrow.

TEMNOPLEURIDÆ.

Temnopleurus toreumaticus (Leske).

A number of small Temnopleurids, which probably belong to this species, were obtained (1) south of Galle, in deep water, and (2) at Station LXIII., west of Periya Paar, 36 fathoms, 9 specimens, of 1·5 centims. to 2 centims. diameter.

Temnopleurus, sp. ?

Some small cream-coloured Temnopleurids were obtained from Station XV., on Periya Paar, 9 fathoms; 10 miles off Galle, in deep water; on the Cheval Paar (off Aripu), 7 fathoms; and at Station I., west of Negombo, 12 fathoms to 20 fathoms.

Salmacis bicolor, Agass.

This species was obtained (1) off Galle, Station XXXIX., depth 16 fathoms to 30 fathoms; (2) south-west of Periya Paar, Station LV., depth 11 fathoms to 24 fathoms; (3) at various localities on Cheval Paar and other pearl banks off Aripu, depth 6 fathoms to 7 fathoms; and (4) at Station XVIII., in Palk Bay, 7 fathoms.

The specimens range from 1 centim. to 6·5 centims in diameter.

Salmacis dussumieri, Agass.

This species was obtained (1) at Station II., north-west of Negombo, 8 fathoms, 12 specimens, from 2 centims. to 4 centims. in diameter; (2) at Station XLVIII., between East and West Cheval Paars, depth 7 fathoms, many specimens, ranging from 0·5 centim. to 2·5 centims. in diameter; (3) at Station LXIII., west of Periya Paar, 36 fathoms; and at several other places on the pearl banks.

Salmacis sulcata, Agass.

Specimens were obtained (1) at Station I., off Negombo, 12 fathoms to 20 fathoms, 3 specimens, 1·5 centims. to 2·5 centims. in diameter; (2) at Station XLVIII., on the Cheval Paar; and at other localities amongst the pearl banks off Aripu, depths 6 fathoms to 8 fathoms, many specimens, ranging from 1 centim. to 4 centims. in diameter.

TRIPLECHINIDÆ.

Toxopneustes pileolus (Lamk.).

Three specimens were dredged in the Gulf of Manaar, from Station LV., south-west of Periya Paar, 11 fathoms to 24 fathoms; on North-west Cheval Paar, 8 fathoms; and again on Cheval Paar, 7 fathoms. They range in diameter from 7·5 centims. to 10 centims.

Most of the pedicellariæ of this species are very remarkable and striking, both in size and colour, when seen alive. They show the three valves connected by a large discoid membranous extension, which is of a beautiful deep-red colour edged by a band of snowy white. In the preserved specimens the membrane is now contracted to a triangular peltate form, but the white band is still visible.

CLYPEASTRIDA.

EUCLYPEASTRIDÆ.

Fibularia australis, Desml. (?).

Many specimens, ranging from 6 millims. to 10 millims. in length, were dredged outside Dutch Modragam Paar, at Station LVII., 11 to 36 fathoms; and two specimens, 8 millims. and 12 millims. in length, were obtained in deep water outside Galle. These specimens have many more than 4 pairs of pores on the petals—generally 12 to 15 pairs are present.

ECHINANTHIDÆ.

Clypeaster humilis (Leske) = **C. rosaceus**, Linn., *fide* Lovén.

Dredged all round the coast of Ceylon, at Stations I., II., IV., IX., XI., XII., XIV., XXXVIII., XLIV., XLVI., XLVIII., XLIX., LI., LIII., LVII., LXIX. The specimens ranged from 1 centim. to 15 centims. in length.

This species seems commonest in depths of 8 to 10 fathoms on the pearl banks in the Gulf of Manaar.

Clypeaster scutiformis (Gmel.).

Two specimens, about 50 millims. and 40 millims. in length, were dredged to the west of the Periya Paar, at Station LXIII., 17 to 55 fathoms.

Two specimens, about 30 millims. long, were dredged in deep water 10 miles off Galle, at Station XL., 34 fathoms, and 6 miles west of Kaltura, depth 22 fathoms, at Station XLIII.

Echinanthus testudinarius (Gray).

At Station III., off Chilaw, 9 to 14 fathoms; at Station XLI., 12 miles south of Galle, about 100 fathoms; at Station XLIX., south of Cheval and Periya paars, about 12 fathoms.

Echinanthus, sp. ?

A young specimen which we cannot identify with certainty was dredged at Station LXVI., off Mutwal Island, 10 to 35 fathoms.

LAGANIDÆ.

Laganum depressum, Less.

Many specimens, ranging in length from 1·8 centims. to 4 centims., were dredged all round the coast of Ceylon, at Stations II., XII., XXI., XLIII., XLVI., XLVIII., LIII., LVI., and LVII.

They were particularly abundant at Back Bay, Trincomalee, in 8 to 12 fathoms.

SCUTELLIDÆ.

Echinodiscus auritus, Leske.

Dredged at many points on the west and south coasts of Ceylon, including Stations I., II., XI., XII., XIV., XXXIV., XXXVIII., XXXIX., XLIX., LI., LVI., LXII., and LXIX.

The specimens ranged from 1 centim. to 11 centims. in length.

PETALOSTICHA.

CASSIDULIDÆ.

Echinoneus cyclostomus, Leske.

One specimen, about 1·8 centims. in length, was dredged to the west of Periya Paar, at Station LXIII.; depth, 17 to 55 fathoms.

Echinolampas oviformis (Gmel.).

Dredged on the pearl banks, Gulf of Manaar, at Stations IV., XI., XLVIII., XLIX., LV., and LXIII.

The specimens ranged in diameter from 2 centims. to 10 centims.

SPATANGIDÆ.

Maretia planulata (Lamk.).

A few specimens, from 2 centims. to 3·5 centims. in length, were dredged in the Gulf of Manaar, at Station IV., opposite Karkopani, 6 to 9 fathoms; Station XLIX., south of Cheval Paar, 12 fathoms; Station LV. and LXIII., west of Periya Paar, 11 to 36 fathoms.

Maretia alta, A. Agass.

At Station XXXIII., south of Arugam Bay, east of Ceylon, 18 fathoms; off Galle; and south of Modragam.

Lovenia elongata (Gray).

Several specimens were dredged between Colombo and Palk Strait, and also off Welligam and Galle, at Stations I., IV., XI., XXXIV., XXXIX., XL., XLIII., XLVIII., XLIX., LV., and LXIII., at depths of 2 to 40 fathoms. They range in length from 2 centims. to 6 centims.

LESKIIDÆ.

Schizaster gibberulus, Agass.

One specimen (2·5 centims. in length) from Station LV., south-west of Periya Paar, 11 to 24 fathoms.

ASTEROIDEA.

ASTROPECTINIDÆ.

On the characters of the species of *Astropecten* see Professor BELL's Notes (p. 148, below).

Astropecten hemprichi, M. and T.

Stations I., IV., X., XIV., XX., XXVIII., XXXII., XXXIX., XLII., XLVII. and LIV., practically all round the island, at depths of 4 to 40 fathoms. It is especially abundant on some parts of the pearl banks.

Astropecten euryacanthus, LÜTKEN.

Station XX., Back Bay, Trincomalee, 11 to 13 fathoms.

Astropecten polyacanthus, M. and T.

Station XXVIII., Trincomalee, 7 to 14 fathoms; Station XXXVIII., off Galle, 9 to 22 fathoms; Station LX., outside Muttuvaratu Paar, 20 to 30 fathoms; Station XLIII., west of Kaltura, 22 fathoms; and Station LXIII., west of Periya Paar, 36 fathoms.

Astropecten indicus, DODERLEIN.

Off Galle. Also Station XXXIV., off Welligam, at south end of Ceylon, 7 fathoms.

Astropecten zebra, SLADEN.

Trincomalee. (See Professor BELL's Notes, p. 149, below.)

Luidia maculata, M. and T.

Abundant all round Ceylon, and especially in the shallow water of the pearl banks in the Gulf of Manaar, where we obtained specimens of all sizes from a couple of centimetres up to well over a foot across.

Luidia hardwickii (GRAY).

Pearl banks, Gulf of Manaar. Professor BELL reports that "from the same locality there is a very interesting young specimen which belongs either to some undescribed species, or is, as is quite likely, the armed young of an unarmed adult, for it is provided with spines on the surface of its rays."

PENTAGONASTERIDÆ.

Stellaster incei (GRAY).

Stations XX. and XXI., Trincomalee, many; between Colombo and Palk Strait;

off Galle, 16 to 20 fathoms; 12 miles south of Galle, 100 fathoms; Station XLIV., off Kaltura, 30 fathoms; Station LIV., south of Adam's Bridge, 4 to 40 fathoms.

Young Stellasters from Station XLIII., west of Kaltura, 22 fathoms; from Back Bay, Trincomalee, and from other localities, are in the collection.

ANTHENEIDÆ.

Anthenea sp?

In the lagoon of the reef at Galle.

Goniodiscus, sp. (?)

Professor BELL adds "? young *Goniodiscus*," from locality (?) in Gulf of Manaar.

FAMILY: PENTACEROTIDÆ.

Pentaceros lincki, DE BL.

From lagoon inside reef, Galle. Common on the pearl banks in the Gulf of Manaar, and of importance as an enemy of the pearl oyster (see figure on p. 147).

Pentaceros mammillatus (M. and T.).

West of Periya Paar; at Station LXIV., south-east of Modragam Paar, 5 fathoms.

Pentaceros nodosus (GRAY).

Station III., off Chilaw, 12 fathoms; Station XLII., off Barberyn, 40 fathoms; Station LIV., south of Adam's Bridge, 4 to 40 fathoms; Station LXIV., south-east of Modragam Paar, 5 fathoms.

Pentaceros, sp. (young).

Station XLIII., west of Kaltura, 22 fathoms.

Culcita schmideliana (RETZ.).

Station LIX., Muttuvaratu Paar, 8 fathoms; and Station LX., outside Muttuvaratu Paar, 20 to 30 fathoms.

This cushion-like starfish is almost circular in outline when alive, but shows on the oral surface a bright orange-coloured pentagon closely papillated and with the ambulacral grooves running as narrow red lines out to the angles. On the aboral surface there are short red spines on the well-marked lobed areas, while the surface between has a fine fluffy or velvet-like appearance. The larger specimen measures 19 centims. in diameter and 10 centims. in height, and is much less spiny on the aboral surface than the smaller specimen, which is about 14 centims. in diameter and 8 centims. in height. The animal when alive has a much more globular form than have preserved specimens.

ASTERINIDÆ.

Asterina cepheus (M. & T.).

Station LXVI., off Mutwal Island, 10 to 35 fathoms; off Galle, in deep water; on Navakaddu Paar, April 2nd, 1902; Station IV., off Karkopani, 6 to 9 fathoms; Station XLI., 12 miles south of Galle, 100 fathoms.

LINCKIIDÆ.

Ophidiaster cylindricus (Lamk.).

Station XXXVIII., outside Watering Point, Galle, 9 to 22 fathoms.

Ophidiaster helicostichus (Sladen).

What may be the young of this little-known species was taken south of Galle, in deep water.

Linckia multiforis (Lamk.).

Specimens (including "comet forms") were obtained from Back Bay, Trincomalee; also at Station XXIII., 6 fathoms.

Linckia lævigata (Gmel.).

On the pearl banks in the Gulf of Manaar; and at Station XIV., west of Cheval Paar, 8 fathoms.

Linckia pacifica, var. **diplax** (*teste* Sladen).

Muttuvaratu Paar, Gulf of Manaar.

Nardoa tuberculata, Gray.

From lagoon inside the reef, Galle; and at Station LX., outside Muttuvaratu Paar, 20 to 30 fathoms.

Metrodira subulata (Gray).

Station XLIII., west of Kaltura, 22 fathoms.

PTERASTERIDÆ.

Retaster cribrosus, v. Mart.

At Station XLII., between Galle and Barberyn, 40 fathoms, one specimen (see Professor Bell's Notes, below).

ECHINASTERIDÆ.

Echinaster purpureus (Gray).

Station LXIV., south-east of Modragam Paar, 5 fathoms; Station VI., Muttuvaratu Paar, 6 to 9 fathoms; Station XIV., west of Cheval Paar, 8 fathoms; and other localities on the pearl banks, Gulf of Manaar.

OPHIUROIDEA.

Pectinura gorgonia (M. and T.).

Gulf of Manaar, pearl banks; Station LXIII., west of Periya Paar, 36 fathoms; Station X., off East Cheval Paar, 6 fathoms.

Both adult and young stages were found in abundance on the pearl banks.

Pectinura intermedia, Bell.

Gulf of Manaar, pearl banks; Station I., off Negombo, 12 to 20 fathoms.

Ophiura, sp.

From the Cheval Paar. This is not *O. kinbergi*, which is known from this neighbourhood.

Amphiura, sp.

At Station LIII., 10 miles north of Cheval Paar, 9 fathoms; Station XLVII., south of Cheval Paar, 9 fathoms; also off the south-east coast of Ceylon (see Professor Bell's Notes below, p. 149).

Ophionereis, **?** sp.

Young forms from the Cheval Paar, 6 to 8 fathoms.

Ophiocnemis marmorata (Lamk.).

Trincomalee, various localities, February, 1902; Gulf of Manaar, March, 1902; Station VI., Muttuvaratu Paar, 6 to 9 fathoms; Station XVII., west of Periya Paar, 11 fathoms; Station XX., Back Bay, Trincomalee, 11 to 13 fathoms.

Ophiocoma scolopendrina, Agass.

Station LX., outside Muttuvaratu Paar, 20 to 30 fathoms.

Ophiarachna incrassata, M. and T.

Very young specimens, probably of this species, were dredged in deep water off Galle.

Ophiothrix, spp. (**? O. aspidota, O. nereidina,** and others).

Station XLVI., off Mount Lavinia, 25 to 30 fathoms; Station LXIII., west of Periya Paar, 36 fathoms; off Galle, deep water, up to 100 fathoms; Station XLV., off Pantura, 25 fathoms; on Jokkenpiddai Paar, April 3rd, 1902; on Aripu Reef, shallow water.

Three "species" from Cheval Paar, from Trincomalee, and from Gulf of Manaar (see Professor Bell's Notes below, p. 150).

Ophiomaza cacaotica, LYM.

Gulf of Manaar, pearl banks; Station XV., on Periya Paar, 9 fathoms.

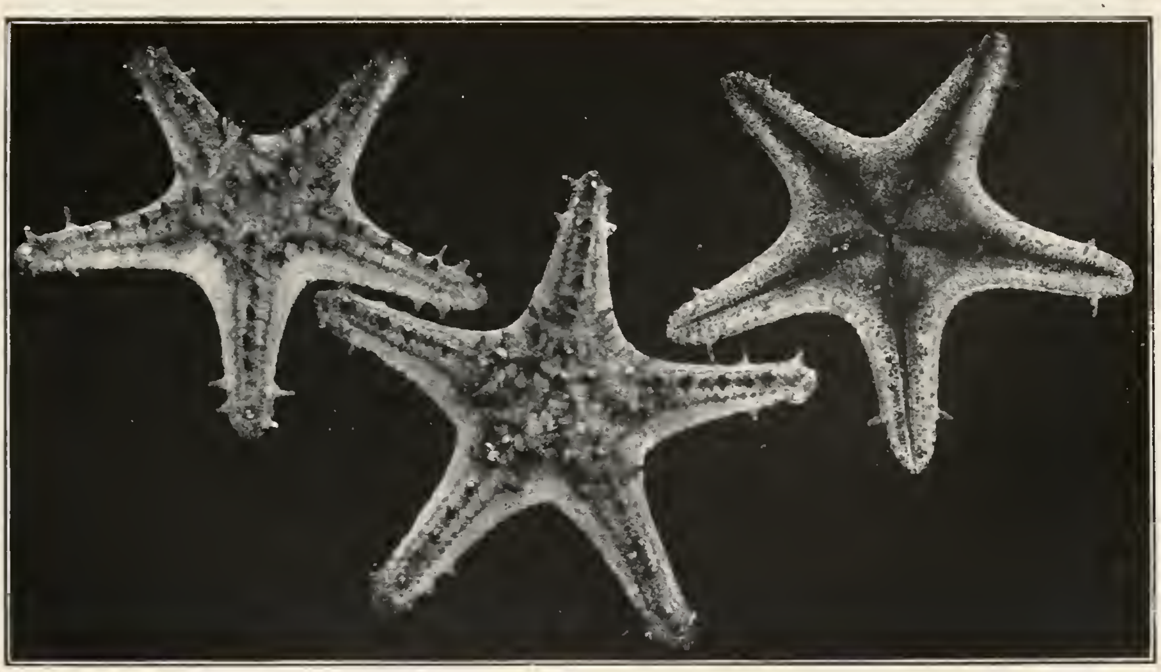
Ophiopteron elegans, LUDWIG.

Station LXIII., west of Periya Paar, 17 to 55 fathoms.

Ophiomyxa, ? sp.

Young specimens from deep water off Galle and from Trincomalee.

There are probably other species of Ophiuroids in the collection. A number of the smaller—possibly immature and in some cases imperfect—specimens remain unnamed. Professor BELL's remarks below refer to some of these.



Specimens of *Pentaceros lincki*, DE BL., from the Gulf of Manaar.

SOME NOTES ON THE ABOVE-NAMED COLLECTION OF ECHINODERMS.

BY

F. JEFFREY BELL, M.A.,

EMERITUS PROFESSOR AND FELLOW OF KING'S COLLEGE, LONDON.

I had the advantage of going through the eleutherozoic actinogonidiate Echinoderms with Professor HERDMAN himself, and he has included my determinations in the above list. The more difficult specimens I brought to London for determination in the National Collection, and on these, and on some general aspects of the subject, I take leave to say a few words.

(1.) The collection contains a large number of specimens of common Indo-Pacific Echinoderms and a goodly store of young forms; these it is most necessary to keep with their generic allies; the determination of their *species* is quite a trivial matter as compared with the importance of obtaining a rich and extensive series of stages, showing the variations due to increase in size, and also the numerous individual variations which wide-spread species of Echinoderms always exhibit.

(2.) The absence of some of the species which at present we are inclined to associate with Ceylon, such as *Asthenosoma urens*, *Fromia tumida*, *Ophiothela holdsworthi*, is to be deplored, but the general character of the collection leads us to suppose that these species are local even in Ceylon; the presence of *Ophiopteron elegans*, which Mr. STANLEY GARDINER obtained in his expedition to the Laccadives, confirms me in my view that this species is widely distributed in the tropical waters of the Indian Ocean.

(3.) On one important matter I have at last some hope that we are on the way to a solution. In 1887 the late P. M. DUNCAN* observed "One of the commonest species of the Ophiurida is a . . . . . form which is usually found without a top to the disk," but the fact, apart from the difficulty it produced as to naming the genus, did not appear to him to be of any interest.

In 1888† I somewhat pointedly drew attention to the same phenomenon, and I ventured to remark, "Naturalists who have the opportunity of observing this long-armed form in life should direct particular attention to this loss of the disk, with a view to answering such questions as to whether the loss is in any way associated with the act of reproduction, whether the disk becomes restored, and, if so, whether the restoration is effected rapidly."

* 'Journ. Linn. Soc. Zool.,' vol. XXI., p. 90.

† 'Ann. and Mag. Nat. Hist.,' p. 368.

Dr. SLUITER* has since put on record his regret that he did not become acquainted with my note, when he still had under his eyes Ophiuroids that were living in his aquaria without the dorsal covering to their disks. The phenomenon seems to be pretty common, and there are a number of interesting biological problems associated with it which should attract naturalists in tropical and subtropical seas.

After some search I lit on a long-armed Ophiuroid with the upper surface of the disk intact; it was soon easy to see that this was not the *Ophiocnida imbricata* in which Dr. SLUITER had noticed the phenomenon, and I was inclined to ascribe it to *Amphiura divaricata*, but the arms of that species, as described by LJUNGMAN, are much shorter. It appears to be a true, but unnamed, Amphiuran.

(4.) I beg once more to offer an example of the variability of Echinoderms, and to call attention to the mode of distribution of the spicules on the superomarginal plates of *Astropecten hemprichi;* the three figures here shown are taken from the three

specimens found in the bottle to which the late Mr. SLADEN affixed the name of *Astropecten zebra.* In the "Challenger" Report *A. zebra* occupies the following position in the author's "key":—

(A.) With small spinelet, on the first four or five plates.

(*a.*) With four or five spinelets. A well-developed series of pseudo-pedicellariæ . . . . *zebra.*

(*b.*) With one spine only on the first plate. No pedicellariæ . . *velitaris.*

Inspection of my photographs will show how little constant is the number of spinelets, and the uselessness of the character as an aid to specific distinction.

* 'Tijds Nederl. Dierk. Ver.,' v. (1898), p. 306.

A. zebra should, I think, be united with *A. hemprichi*.* Perhaps, also, SLADEN'S *A. notograptus* is another synonym.†

(5.) The evidence in favour of the great variability of Echinoderms is now overwhelming, and new species should only be made on the most solid grounds. The condition into which the genus *Ophiothrix* has been allowed to fall by the uncritical establishment of a multitude of species is such that I had to tell Professor HERDMAN that I could not undertake the determination of the numerous forms in his collection that appear to the cabinet naturalist to be very different, but which, if we may argue from what we know of the genus in our own seas, would be all brought up by one haul of the dredge. A critical revision of the described species of *Ophiothrix* by a naturalist of unlimited leisure would be a boon to the systematist; the uncritical addition to our list of forms "which appear to be distinct" is of no service whatever to science.

(6.) As in all carefully prepared collections, there are a number of small Ophiuroids, many more or less broken; I have referred all I can to their genus, and have sometimes made suggestions as to their species.

(7.) A small specimen of *Retaster*, from deep water off Galle, is not unlike a young example which BEDFORD has placed in the same bottle as an adult *R. cribrosus;* this species is already recorded from Ceylon. With *R. cribrosus*, BEDFORD associates *R. insignis* of SLADEN. The chorology of this species is given by its author as including "Port Jackson (*fide* BELL)." The punctuation of the sentence is faulty, but I do not delay over that, as I have to point out that I think the locality, "Port Jackson," is an error. The statement is made in a paper of mine in vol. 9 of the 'Proceedings of the Linnean Society of New South Wales,' the proofs of which were never seen by me, and which teems with misprints; *Retaster* itself is misprinted. In the British Museum there is no specimen of the species from so far south as Port Jackson, and in the report of the "Alert" collections, written while the collections of the Australian Museum were in my hands, I record specimens from Port Molle and Thursday Island (p. 134), while on p. 173 I cite the species as one limited to "inter-tropical Australia."

* I have taken the opportunity of examining the "types" of *A. velutans;* they are all immature, and are, perhaps, not members of the same species.

† Describers of young Star-fishes should have their memoirs placed in some scientific Index Expurgatorius; they take no trouble, and give much.

REPORT

ON THE

CRINOIDEA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

HERBERT C. CHADWICK,
CURATOR OF THE BIOLOGICAL STATION, PORT ERIN, ISLE OF MAN.

[WITH ONE PLATE.]

THE collection of Crinoidea obtained by Professor HERDMAN during his expedition to Ceylon, and kindly placed in my hands for examination, is a most interesting one, and makes a substantial addition to our knowledge of the Comatulid fauna of Ceylon. No less than 10 species, of which one at least appears to be new to science, are added to the list of species already known from that country, and although it is remarkable that in so large a collection no specimen of *Antedon adeonæ*, one of the first species recorded from thence, should be found, it is very satisfactory to be able to give a full description of another early, but little-known species, *A. reynaudi*.

I wish here to express my sincere thanks to Professor HERDMAN for his kindness in entrusting the collection to me, and in procuring for me copies of several important papers. For similar generous help in regard to literature I would thank also my friends Dr. W. E. HOYLE, Mr. F. W. HEADLEY, Mr. R. OKELL and Mr. C. ROEDER.

The following is a list of the stations at which Comatulidæ were obtained, arranged according to their geographical position :—

West Coast of Ceylon.

STATION I.—Five miles west and south-west of Negombo, 12 to 20 fathoms ; bottom coarse yellow sand with a few dead shells ; temperature of sea, 77·5° F.

STATION II.—From 7 to 14 miles north of Négombo, 5 miles off shore ; 8 to 9 fathoms ; bottom coarse yellow sand, shells, stones, and small coral ; temperature of sea, 77·5° F. ; specific gravity, 1·023.

STATION III.—Off Chilaw, $2\frac{1}{2}$ to 4 miles off shore; 9 to 14 fathoms; bottom coarse sand and small corals; temperature of sea, 77·75° F.; specific gravity, 1·023.

STATION XLVI.—From off Mount Lavinia northwards to off Colombo, from 7 to 12 miles off shore; depth 25 to 30 fathoms; bottom Nullipore balls (*Lithothamnion fruticulosum*), Coral fragments and some Orbitolites sand.

STATION LXVI.—From south of Donnan's Muttuvaratu Paar along the west of the northern part of Mutwal Island as far as off Mudalaikuli Paar; depth 10 to 35 fathoms; bottom Nullipore and Orbitolites sand, some red Algæ and dead Coral.

STATION LXVIII.—From off Coppeluddi southwards to Navakaddu Paar; depth 8 to $18\frac{1}{2}$ fathoms; bottom Nullipores (*Lithothamnion fruticulosum*), Coral and muddy Orbitolites sand.

STATION LXIX.—On and to the east of the north end of Chilaw Paar; depth 8 to 11 fathoms; bottom yellow quartz sand, with some Coral fragments. Yellow Algæ with Oyster spat.

Gulf of Manaar.

STATION IX.—On south-west corner of West Cheval Paar, about 12 miles from land; depth 7 fathoms; bottom fine quartz gravel, Nullipore concretions and many dead young pearl oyster shells; temperature of sea, 78° F.; specific gravity, 1·023.

STATION LIII.—Ten to 12 miles north of Cheval Paar and about 12 miles due west of Vankali (or Bangalli) Church; depth $7\frac{1}{2}$ to 9 fathoms; bottom muddy sand with some dead shells.

STATION LIV.—In northern part of Gulf of Manaar, south of Adam's Bridge; depth from 4 to 40 fathoms; bottom varied, from sand to living Coral.

STATION LVII.—Outside Dutch Moderagam Paar; $11\frac{1}{2}$ to 36 fathoms; bottom Orbitolites sand, Nullipores and dead Corals.

STATION LXIII.—To the west of Periya Paar, going south; depths 17 to 55 fathoms; bottom Orbitolites sand, some dead Coral, shells and pieces of Nullipore.

Off Trincomalee.

STATION XXIII.—Close to Swami Rock, Back Bay; depth $4\frac{1}{2}$ to 8 fathoms, mostly between 5 and 6 fathoms; bottom sand, shells, and in places stones and Corals.

STATION XXIV.—Two and a half to 3 miles north of Foul Point; depth ranging from 46 to 24 fathoms; bottom hard and rough—probably rock.

STATION XXV.—Three-quarters of a mile to 1 mile west north-west of Foul Point; depth 8 fathoms; bottom firm, Orbitolites sand and Nullipores.

South Coast of Ceylon.

STATION XXXIV.—Welligam Bay, various parts; depths 2 to 7 fathoms; bottom shell sand and a little mud; sea temperature at 7 A.M., 77·8° F., specific gravity, 1·0225.

STATION XXXIX.—From 2 miles south of Point de Galle westwards to Gallehogalle Bank; depths 16 to 30 fathoms; bottom fine sand; stones and Nullipore on the bank.

STATION XLI.—South of Galle, about 12 miles off land; depth along the 100-fathom line; bottom composed of masses of calcareous branched and ramifying Foraminiferal tubes.

List of Ceylon Comatulidæ.

The species marked with an asterisk were collected by Professor Herdman and were not previously known from Ceylon. The species new to science is indicated by a dagger. *Antedon carinata* and *A. reynaudi* are the only species in the collection previously recorded from Ceylon.

**Antedon serripinna*, Carpenter.	*Antedon palmata* (Müller).
* ,, *milberti* (Müller).	,, *reynaudi* (Müller).
,, *carinata* (Lamarck).	* ,, *anceps*, Carpenter.
,, *adeonæ* (Lamarck).	* ,, *variipinna*, Carpenter.
* ,, *marginata*, Carpenter.	*Actinometra cumingi* (Müller).
* ,, *indica*, Smith.	* ,, *notata*, Carpenter.
* ,, *bella*, Hartlaub.	* ,, *multiradiata* (Linn.).
† ,, *okelli*, n. sp.	,, *parvicirra* (Müller).

CRINOIDEA.

COMATULIDÆ.

Antedon serripinna, Carpenter.—Plate, figs. 1, 2, 2A.

The type specimen of this species described by P. H. Carpenter has only 12 marginal cirri, in which the number of joints is 18, while the specimens described by Hartlaub have 20 cirri, consisting of 20 joints. The specimens in this collection from Ceylon have 15 cirri, consisting of 17 joints, of which all from the second to the antepenultimate have a strong transverse dorsal ridge. This is near the distal end in the first few joints, but becomes median and, viewed in profile, spine-like in the later ones. The penultimate joint has a strong opposing spine (Plate, figs. 2, 2A). The arms of the Ceylon specimens are slender and serrate, and contain about 150 joints. The 2nd and 3rd syzygies are situated in the 8th and 12th brachials respectively, as in the specimens described by HARTLAUB, but in the type the 2nd syzygy is between the 11th and 15th brachials. In the specimens under notice, the succeeding syzygies occur in every 5th to 7th joint. The pinnule of the 2nd brachial (Plate, fig. 1) has 11 joints, the first 3 broad, the remaining ones cylindrical, twice as long as broad, and having 2 very minute spines projecting from their distal ends. The pinnule of the 4th brachial is stouter than, and nearly twice as long as that of the 2nd, and has 13 joints of very similar character; while that of the 6th brachial has 9 or 10 joints, and is a smaller pinnule than that of the 2nd. The pinnules of the 3rd, 5th, and 7th brachials are smaller than those of the 2nd, 4th, and 6th, but the joints are similar, as are those of the next 10 or 12 pairs, though in the latter the basal ones differ in diameter less markedly from their successors.

Localities:—Stations XXIII., XXIV., and XXV., off Trincomalee: a number of more or less mutilated specimens. Many greyish mottled ones were found upon a large colony of *Gorgonia* (*Rhipidogorgia*) *flabellum* from Station XXIII.

Antedon milberti (MÜLLER).

A small specimen of this species was obtained at Station L., and 2 full-grown ones at Station LVII. In one of the arms of one of these, unfortunately detached when found, the 5th brachial beyond the 3rd syzygy is an axillary, and there is a syzygy in each of the 3rd brachials beyond it.

Antedon carinata (LAMARCK).

One specimen of this widely distributed species was dredged at Station LIV., and several mutilated ones at Station LXVIII.

Antedon marginata, CARPENTER.

One considerably mutilated specimen of this species was dredged at Station XXXIX. It has 11 arms, and most of the 2nd pinnules agree well with those of the single specimen dredged by the "Challenger" at Station 208, off Manilla, which CARPENTER says "Terminate so abruptly that they seem to have been broken off by some accident and not completely repaired. The diameter of the joints suddenly decreases, and there are from 1 to 4 quite small joints at the end of a large and stout one which is considerably longer than wide." A small specimen from Welligam Bay (Station XXXIV.) may possibly belong to this species. The number of arms cannot be determined, but in one of the rays the outer face of the distichal axillary bears two palmars.

Antedon indica, SMITH.

One specimen of this species, with 29 arms, was dredged at Station LIV. The original visceral mass is almost completely displaced, but remains in organic continuity with a new one in an early stage of formation.

Antedon bella, Hartlaub.

Specimens of this beautiful species were dredged at Stations LIII. and LVII. One of those from the first-named station has 28 arms, and the other, now much mutilated, must have had the same number when living, palmars being present on the outer side of both distichal series in three of the rays. The specimens from Station LVII. agree with the type in possessing 20 arms. A specimen of what appears to be Hartlaub's variety *brunnea* was obtained at the last-named station.

Antedon okelli, n. sp.—Plate, figs. 3 to 5.

Centro-dorsal a moderately thick, roughly circular disk, with flat or very slightly convex dorsal surface, and bearing upon its sloping sides 20 to 25 cirri. These have 25 to 28 joints, of which the more distal ones are compressed and carinate, and the penultimate bears an opposing spine (Plate, fig. 4). First radials distinctly visible; the 2nd broad, well rounded, and forming a tubercular elevation in their median line of junction with the axillaries, which are broadly pentagonal and about $1\frac{1}{2}$ times the length of the 2nd radials (Plate, fig. 3). Two distichals and 2 palmars, the axillaries without syzygy. The palmars are borne upon the outer face of the distichal axillaries of one or both sides of the ray, generally the latter. Median tubercles formed by both distichals and palmars. The rays have slight marginal projections. Twenty-six to 30 arms, of about 120 joints, of which the first 7 or 8 are moderately thick disks. These are followed by rather more than 20 triangular joints, and these again by wedge-shaped ones, which become longer in proportion to their width as the tip of the arm is reached. Syzygies in the 3rd, 13th or 14th, 20th or 21st joints, and then every seventh or eighth joint.

Of the first pair of pinnules, that borne by the 2nd brachial on the outer side of the ray has 18 to 20 joints, of which only a few of the more distal ones are longer than wide (Plate, fig. 5). Its fellow on the 3rd brachial is smaller and more slender, and has 16 or 17 joints. The pinnule of the 4th brachial has 20 to 22, or even 24 joints. It is considerably stouter and longer than that of the 2nd, and its joints diminish in size more gradually; while that of the 5th brachial has 19 or 20 joints, but in all other respects is precisely like that of the 4th. The 3rd pair of pinnules, borne by the 6th and 7th brachials respectively, are smaller than the 1st, and have 14 to 16 joints. The basal joints of all these pinnules and of the 3 or 4 succeeding pairs are distinctly carinate, the latter especially so. The corresponding pinnules on the inner arms of the rays are a little smaller and have slightly fewer joints.

Colour in spirit—creamy white, mottled and striped with deep reddish-brown. Margins of bases of rays and long tubular anal funnel with spots of same colour (Station I.). These are described as "black and white" when living. Others ashy or purplish-grey to deep purple, almost black. In the paler specimens the skeletal joints are marked with narrow bands of deep purple, and the disk has spots of the same colour. Sacculi abundant on pinnules, less so on disk.

Disk, 1 centim., deeply incised; spread, 10 centims.

Locality:—Stations I., II., and LVII. Twenty-two specimens, of which 12 were from Station II.

This species is closely allied to *Antedon brevicuneata*, CARP., *Antedon similis*, CARP., and *Antedon regalis*, CARP. It differs, however, from each of them in having all 3 radials visible, a much smaller number of cirri, shorter arms, and carinate basal joints on the lower pinnules.

I have associated this species with the name of Mr. ROBERT OKELL, B.A., F.L.S., Hon. Secretary of the Isle of Man Sea-Fish Hatchery Committee, to whom I am indebted for much kind help with the literature of the subject.

Antedon reynaudi (MÜLLER)—Plate, figs. 6 to 12.

As this species was very briefly described by MÜLLER, and is still very imperfectly known, I have thought it useful to give the following full description of the Ceylon specimen, accompanied by the necessary figures.

Description of an Individual.—Centro-dorsal a thick disk, with convex dorsal surface, and bearing on its sloping sides, in two alternating rows, 25 cirri. Of these all but a few immature ones are rather more than 2 centims. long, and have 35 or 36 joints, all of which are slightly wider than long, the later ones being laterally compressed, and bearing, from the 14th onwards, a strong and forwardly directed spine (Plate, fig. 8).

First radials entirely concealed; the 2nd just visible beneath the bases of the cirri, and in almost complete contact laterally. Axillaries widely pentagonal, about half as long again as the 2nd radials and without syzygy. Eighteen arms of about 200 short and slightly overlapping joints (fig. 12). The 1st distichals are in almost complete contact laterally, and form a slight tubercular elevation in their median line of junction with the second. The first 8 brachials are discoid, the two 1st in almost complete contact laterally, and are succeeded by about 30 shortly triangular joints. These again are followed by discoid ones which continue to the tip of the arm.

Two of the rays have each two series of 3 distichals (fig. 7), the axillaries having a syzygy; other two have each (fig. 6) one series of 3 distichals, the axillaries having a syzygy, and one series of brachials arising directly from the radial axillary. The remaining ray has two series of 2 distichals, the axillaries having no syzygy. The position of the brachials in which syzygies occur is very irregular, as shown by their enumeration in 6 series, as follows:—

(1.)	Brachials,	3, 12, 19, 25, 33, 42, 50, 58, 66.
(2.)	,,	3, 8, 12, 18, 25, 28, 35, 42, 55, 63, 67, 73, 80.
(3.)	,,	3, 14, 23, 31, 38.
(4.)	,,	3, 14, 23, 32, 46, 55.
(5.)	,,	3, 15, 21, 28, 34.
(6.)	,,	3, 6, 29.

The distichal pinnule (fig. 9) is about 1 centim. long, flagellate, and composed of 31 joints, the first 7 broad, flattened, and carinate, the later ones gradually becoming cylindrical, longer than broad and with rounded ends. The 1st and 3rd pairs of brachial pinnules are about equal in size, those borne by the 2nd and 6th brachials (fig. 11) having about 29 joints. The 2nd pair of pinnules are the largest on the arm, that of the 4th brachial (fig. 10) being about 15 millims. long, but having 27 joints only. The basal joints of these 3 pairs of pinnules are flattened and more or less carinate. The 5th pair are the shortest, the succeeding one gradually increasing in length. Disk considerably incised and ambulacra naked. Sacculi abundant and close-set on arms and pinnules, absent on disk.

Colour in spirit—disk chocolate-brown, fading to white in the interambulacral angles; arm joints pinkish, with the articulations of the proximal fourth marked with bands of deep reddish-brown, which gradually fade into dots on the sides of the arms. Pinnules irregularly banded with brown and white.

Disk 1 centim., spread probably 22 centims.

Locality:—Station XXXIV.

It is to be regretted that strong reflexion of the arms over the dorsal surface of the disk in the only specimen obtained has made delineation of the skeleton rather difficult. The bidistichate ray is not improbably an abnormality.

Antedon anceps, Carpenter.

Two specimens of this species were dredged, one at Station XXIV., and the other at Station LVII. Both have a single distichal series and 11 arms. The colour, when living, was black.

Antedon variipinna, Carpenter.

A considerable number of specimens of this remarkable species were dredged at Station II. They have 20 to 21 fairly smooth arms, 30 to 36 cirrus joints, the later ones carinate, and the 1st radials are only visible in side view.

Actinometra notata, Carpenter.

One specimen of this species was obtained at Station LIV. Carpenter's diagnosis assigns to it 30 to 35 cirri and 31 to 50 arms, but the specimen under notice has only 20 cirri, 8 of which are quite small and immature, and 20 arms. The 1st radials are distinctly visible and almost completely united laterally. They are also connected with the centro-dorsal by five interradial projections from the latter.

Actinometra multiradiata (Linn.).

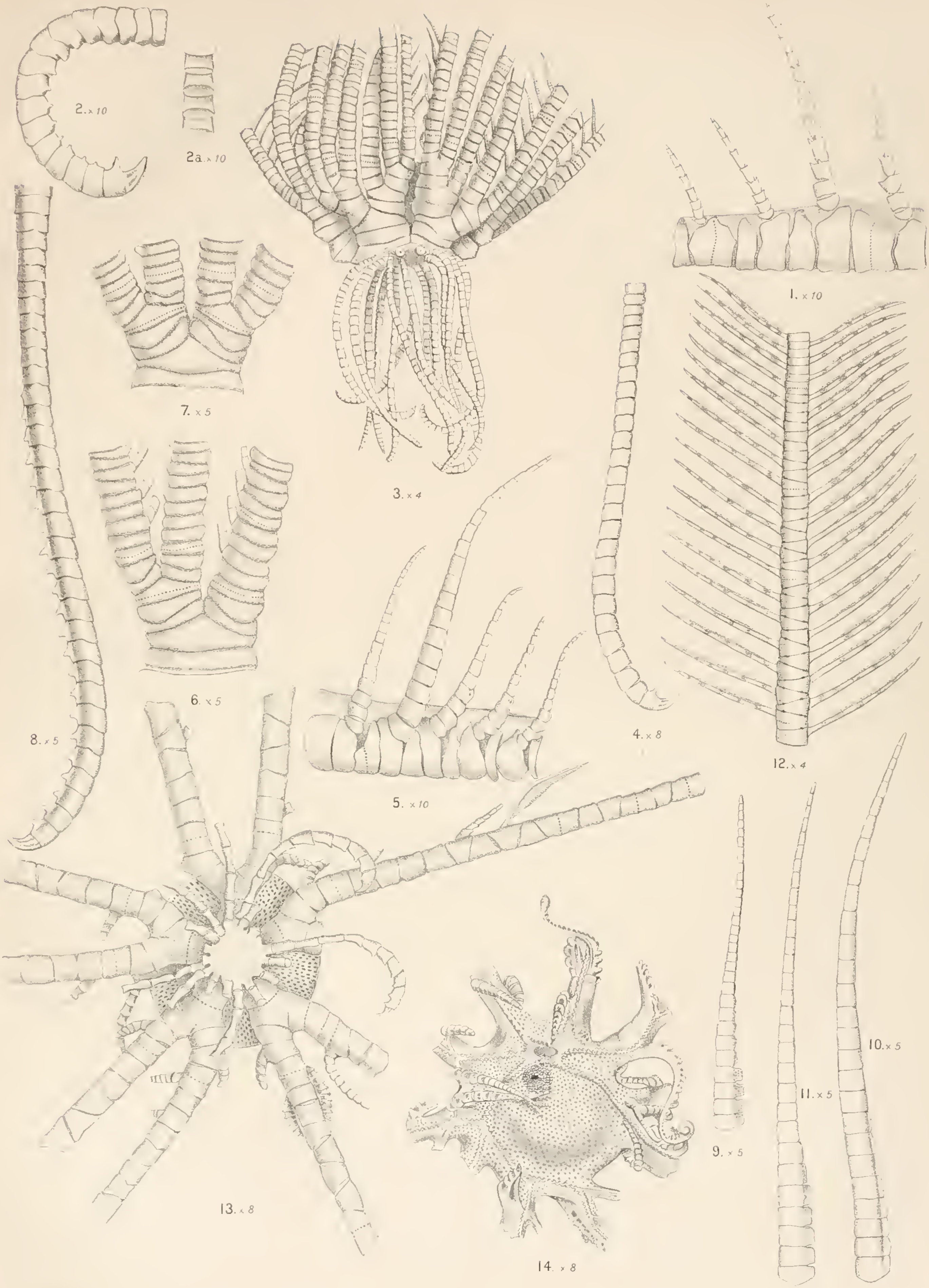
Single specimens of this species were dredged at Stations IX., XLI., LIII., and LXVI. That from the first-named station has 12 arms only. Two of the rays have each a series of 3 distichals, the axillary with a syzygy, and a syzygy in each of the 2nd brachials; but in all the arms which arise directly from the radial axillaries the 1st syzygy is in the 3rd brachial. The diameter of the 22 arms of the specimen from Station LXVI. gradually increases from the 1st to about the 20th brachial.

Actinometra parvicirra (Müller)—Plate, figs. 13, 14.

Specimens of this well-known species were dredged at Stations IX., XLI., XLVI., LIV., LVII., LXIII., and LXIX. The number of arms varies from 10 in a specimen from Station XLI. and 11 in one from Station LVII. to 48 in one from Station IX. So far as I am aware, no 10-armed specimen of this species has hitherto been discovered; and as the form and disposition of the 2nd and 3rd radials of the one under notice differ markedly from the same parts in the other specimens in the collection and from those figured in Carpenter's Report on the Comatulidæ of the "Challenger" Expedition, I have thought it worthy of illustration (fig. 13). It will be seen that the disk is covered with minute scale-like plates (fig. 14), which, I presume, are similar to those covering the disk of the specimen from Torres Straits, mentioned by Carpenter. The specimens with 44 and 48 arms respectively approach *Actinometra regalis*, Carp., in having no spines, or but feebly developed ones, on the penultimate joints of the cirri, and in the close lateral contact of the 2nd and 3rd radials and 1st distichals. Several distichal series consisting of two joints occur in most of the specimens. The colour of one of the specimens from Station LXIX. is described in Professor Herdman's diary as being, when living, "of a deep olive-brown with yellow tips to the pinnules, and having an olive-brown species of *Alphæus* striped with grey living on it." Some of those from Station XLVI. were "dark purple," others "orange coloured."

DESCRIPTION OF PLATE.

Fig. 1. Base of an arm of *Antedon serripinna*, with pinnules of 2nd, 4th, 6th, and 8th brachials. × 10.
" 2. A cirrus of *Antedon serripinna*. × 10.
" 2*a*. Portion of same, viewed from the dorsal surface. × 10.
" 3. *Antedon okelli*, n. sp. × 4.
" 4. A cirrus of *Antedon okelli*. × 8.
" 5. Base of an arm of *Antedon okelli*, with pinnules of 2nd, 4th, 6th, 8th, and 10th brachials. × 10.
" 6. A ray of *Antedon reynaudi*, with one series of distichals and an arm springing directly from the radial axillary. × 5.
" 7. A ray of *Antedon reynaudi*, with two series of distichals. × 5.
" 8. A cirrus of *Antedon reynaudi*. × 5.
" 9. Distichal pinnule of *Antedon reynaudi*. × 5.
" 10. Pinnule of 4th brachial of *Antedon reynaudi*. × 5.
" 11. Pinnule of 6th brachial of *Antedon reynaudi*. × 5.
" 12. Portion of an arm of *Antedon reynaudi*, viewed from the dorsal surface. × 4.
" 13. A 10-armed specimen of *Actinometra parvicirra*, viewed from the dorsal surface. × 8.
" 14. Disk of the same specimen, viewed from the ventral surface. × 8.



H C C del. Edwin Wilson, Cambridge

FIGS. 1, 2, ANTEDON SERRIPINNA. FIGS. 3-5, ANTEDON OKELLI.
FIGS. 6-12, ANTEDON REYNAUDI. FIGS. 13, 14 ACTINOMETRA PARVICIRRA.

REPORT

ON THE

CUMACEA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

W. T. CALMAN, D.Sc.

[WITH PLATES I. TO V.]

THIS paper deals with the Crustacea belonging to the Order CUMACEA * collected in Ceylon by Professor W. A. HERDMAN, F.R.S., and his Assistant, Mr. HORNELL. The following ten species are described in detail, and all of these are regarded as new except one :—

1. *Eocuma taprobanica*, n. sp.
2. *Eocuma affinis*, n. sp.
3. *Eocuma sarsii* (KOSSMANN).
4. *Cyclaspis costata*, n. sp.
5. *Cyclaspis picta*, n. sp.
6. *Cyclaspis herdmani*, n. sp.
7. *Cyclaspis hornelli*, n. sp.
8. *Iphinoë macrobrachium*, n. sp.
9. *Paradiastylis brachyura*, n. sp.
10. *Nannastacus stebbingi*, n. sp.

In addition to these the collection includes the following six species which are not dealt with more fully here for the reason that they are represented by solitary or immature specimens, or that they belong to species of which more abundant material is at hand in other collections now in course of examination. The list is given in order to complete, as far as possible, the record of the Ceylon fauna as shown by the present collection :—

* Mr. STEBBING has shown (WILLEY'S 'Zool. Results,' Part V., Crustacea, p. 609) that the generic name *Cuma*, H. MILNE-EDWARDS, is preoccupied and must give way to *Bodotria*, GOODSIR, and he has proposed to change the name of the order to SYMPODA. So far as I am aware, no rule of zoological nomenclature is infringed by retaining the familiar name CUMACEA, which may still be thought not "wholly inappropriate and misleading" for an order comprising many genera with names like *Pseudocuma*, *Leptocuma*, *Eocuma* and so forth.

(1.) *Eocuma* sp.—Taken in the tow-net in Galle Bay after dark. A young and damaged specimen, apparently distinct from any of the species described below.

(2.) Bodotriidæ, n. gen. and sp.—Gulf of Manaar, near the shoal buoy, north of Karativo Island. A very young specimen belonging to an undescribed species (representing a new genus), of which a large series of specimens from the Gulf of Siam is in the collection of the Copenhagen Museum.

(3.) *Cyclaspis* sp.—From the Cheval Paar and Kondatchi Paar. Two young specimens of a species which is also represented in the Copenhagen collection from Siam.

(4.) *Cumopsis* (?) spp.—Several immature specimens from various localities on the Cheval Paar, and off Chilavaturai, in the Gulf of Manaar.

(5.) *Cumella* sp.—From the Cheval Paar and near the shoal buoy north of Karativo Island.

(6.) *Nannastacus* sp.—From the Cheval Paar, and $2\frac{3}{4}$ miles south-south-west of Chilavaturai, in the Gulf of Manaar.

The great majority of the species of Cumacea hitherto described are inhabitants of northern seas, and only a very few (some 13 out of a total of about 170 species) have been found within the tropics. It can hardly be doubted, however, that, as in the case of other groups of micro-crustacea, this preponderance of northern species is more apparent than real, and is due to the fact that collectors in tropical countries have their attention claimed by the more conspicuous elements of the fauna to the exclusion of the more minute and less obtrusive forms. No Cumacea have hitherto been recorded from any part of the Indian Ocean, although four species have been described by Paulson and by Kossmann from the Red Sea, and one of these is represented in the present collection.

The types of the species described below have been presented by Professor Herdman to the British Museum (Natural History).

Family: BODOTRIIDÆ.

Eocuma, Marcusen.

Marcusen, 'S.-B. Ges. naturf. Fr.,' Berlin, 1894, p. 170; Hilgendorf, *Tom. cit.*, p. 171; Zimmer, 'Zool. Jahrb.,' Syst. XVIII., p. 669, 1903.

Carapace sub-globular or more or less flattened dorso-ventrally, having a pair of procurved lateral cornua, behind which the lateral margin is usually sharply keeled. Four thoracic somites are free behind the carapace. First pair of legs having the basis produced distally into a pointed lobe on the upper (or inner) side of the articulation of the ischium. Second legs generally very short, composed of six segments, the ischium being suppressed. Uropods having the peduncle shorter than the rami.

The genus *Eocuma* was established by MARCUSEN in 1894 for the reception of a Japanese species, to which he gave the name *E. hilgendorfi*. The paper was published after the death of the author, with some additional notes by HILGENDORF, and was not accompanied by any figures. Recently the species has been re-described and figured by ZIMMER from two of HILGENDORF'S specimens, the actual type specimens having been lost. In the original description the chief characters given as distinctive of the genus are the flattened form of the carapace and the meeting in the middle line of the basal segments of the first pair of legs. The last-named character does not hold good, as ZIMMER has shown, for the sub-adult female, while on the other hand I find it in immature specimens of several other genera. The flattening of the carapace is much less marked in the adult male than in the female in the species described below as *E. taprobanica*, and it is clearly impossible to base the genus on this character alone. I propose therefore to modify the generic definition so as to include all those species of Bodotriidæ in which the carapace bears a pair of curved lateral horns. In this way we obtain the following assemblage of species which appears to be a natural one, the various forms agreeing also in the above-mentioned characters of the first and second legs and of the uropods :—

Eocuma hilgendorfi, MARCUSEN, 1894. Type of the genus.
E. ferox (FISCHER) = *Bodotria ferox*, FISCHER, 1872 = *Cyclaspis cornigera*, G. O. SARS, 1879 = *Cyclaspoides ferox*, BONNIER, 1896.
E. sarsii (KOSSMANN) = *Cyclaspis sarsii*, KOSSMANN, re-described below.
E. taprobanica, n. sp.
E. affinis, n. sp.

The genus *Cyclaspoides* of BONNIER ('Ann. Univ., Lyon,' 1896, "Campagne du 'Caudan,' Édriophthalmes," p. 530) is distinguished from *Cyclaspis* only by the fact that the second legs are composed of six instead of seven segments. Of the two species referred to it, *C. sarsii*, BONNIER, and *C. ferox* (FISCHER), neither is explicitly named as the type of the genus. *C. sarsii*, however, differs in so many particulars from *C. ferox* that it may conveniently be left in a different genus, for which the name *Cyclaspoides* may be retained.

The distinguishing characters of the species here referred to *Eocuma* may be summarised as follows :—

A. Lateral margins of carapace carinated.
  1. Pseudorostrum reaching forwards beyond the level of the lateral cornua. Carapace much depressed, surface smooth.
    a. Antero-lateral tooth on either side of pseudorostrum inconspicuous (♀) or absent (♂). No paired ridges on dorsal surface of carapace. *E. taprobanica.*

b. Antero-lateral teeth very prominent, reaching as far forward as pseudorostrum, from which they are separated only by a shallow concavity on each side. Dorsal surface of carapace with a longitudinal ridge on the branchial region on each side. *E. hilgendorfi.*

2. Pseudorostrum not projecting beyond tips of lateral cornua, squarely truncate. Antero-lateral teeth well defined. Carapace somewhat inflated, surface rough and uneven. *E. sarsii.*

B. Lateral margins of carapace rounded.

1. Carapace (of male) about one-fourth of total length and one-fifth longer than broad. *E. ferox.*

2. Carapace (of male) about one-third of total length, nearly twice as long as broad. *E. affinis.*

Eocuma taprobanica, n. sp.—Plate I., figs. 1 to 20; Plate II., figs. 21 to 28.

Description of *Female*, sub-adult, with developing oostegites. Total length,* 11·1 millims. (figs. 1, 2, 6):—

The carapace is about two-sevenths of the total length, very broad and flattened, with a well-marked lateral carina on each side. The greatest width is about five-sixths of the length, and is at a distance of less than one-third of the length of the carapace from the front, where are situated the incurved lateral cornua. Behind this the slightly convex sides converge towards the hind margin, where the width is about one-half of that measured across the cornua. The pseudorostrum is prominent, and the tip, as seen from above, is broadly notched. External to it on each side the antero-lateral margin forms a blunt tooth, between which and the lateral cornu the outline is again slightly convex. The dorsal surface, which is slightly arched from before backwards and more strongly so from side to side, presents a faintly marked median keel, becoming more distinct anteriorly, where there is a shallow depression on either side of the cephalic lobe. The sides of the carapace are sharply inflected at the lateral edge, so that the under surface is nearly flat. A transverse ridge runs from each of the lateral cornua to the lower or free margin of the carapace on the under side. The hinder edge, seen from the side, slopes backwards, forming an oblique angle with the lower and with the lateral margins, which meet at its lower end. The ocular lobe is slightly broader than long, and the pseudorostral plates meet in front of it for a distance equal to its width. The eye is not pigmented in the specimens examined; there are three corneal facets, large in size, but indistinctly defined. The surface of the carapace presents a faint and inconspicuous pitting which does not interrupt the minute and regularly reticulate texture of the exoskeleton.

The transverse width of the thoracic somites diminishes regularly, tapering down

* The "total length" given in each case excludes the uropods.

to the slender abdomen. The first leg-bearing somite is not distinct, though a rather faint line which marks off a narrow, diamond-shaped area from the hinder part of the carapace above may (as ZIMMER has suggested in *E. hilgendorfi*) represent its line of fusion with the carapace. The second somite also appears to be firmly united to the carapace. The third and fourth somites are reduced above to narrow transverse bars, connected with each other by wide spaces of articular membrane, so that this region of the body is very mobile and is usually strongly flexed dorsally, the dorsal portion of the third somite being quite concealed beneath the second.

The abdomen is very slender, longer by one-fifth than the cephalothoracic region. The somites, which are sub-cylindrical, with a slight median dorsal keel, diminish a little in width, so that the fifth, which is the longest, is also the narrowest, being nearly four times as long as broad. The last somite is a little depressed and broadened posteriorly. In the lateral articulations of the somites the anterior articular process of each is met by and overlaps a single process from the somite in front, instead of engaging in a notch as in most species of *Cyclaspis*.

The antennules (fig. 7) have the basal segment large and of peculiar form. Its distal half is bent at an angle to the proximal part and is flattened and triangular in form, very broad at the base, and narrowing distally to the articulation of the second segment. In the natural position of the parts this triangular portion appears to be firmly fixed in a notch in the free edge of the carapace, corresponding, no doubt, to the "antennal notch" in more normal Cumacea, but in the present case, owing to the flattening of the carapace, carried round to the under surface and quite invisible from the side or from above. The second and third segments of the antennular peduncle are slender, the third half as long again as the second. The external flagellum is about half the length of the last peduncular segment and is composed of two sub-equal segments. The internal flagellum is quite rudimentary and exceedingly minute.

The antenna (fig. 7) is a simple rounded nodule bearing two plumose setæ. No trace could be discovered of the narrow terminal segment generally present in allied genera.

The mandibles (fig. 10) are of the normal type, and carry a row of about 13 spines.

The lower lip (fig. 11) has broadly rounded lobes, clothed with fine setæ.

The maxillulæ (fig. 12) have a slender palp longer by one-half than the distance between its base and the tip of the distal lobe, and carrying two apical setæ.

The maxillæ are of normal structure.

The first maxillipeds (fig. 13) have the basis very broad and shorter than the rest of the limb. The branchial apparatus is remarkably well developed. Its posterior division (epipod) is produced forwards as a rounded lobe which reaches as far as the end of the basis. The branchial lobules are broad, lamellar, and about 22 in number. A reflexed anterior lobule could not be discovered. In the anterior division (exopod of SARS) the oval chitinous plate, which forms a valve-like lid to the respiratory aperture, is well defined.

The second maxillipeds (fig. 15) have the basis sub-equal in length to the remaining segments together. The ischium, which is not distinct in most species of *Cyclaspis*, is here well defined though small.

The third maxillipeds (figs. 16, 16A) are expanded, and are opercular in function, serving along with the basal segments of the first legs to completely cover in the other mouth parts. The basis is in the natural position of the parts partly covered by the basis of the first leg, and its distal part, which is exposed, is more strongly calcified and sharply defined from the concealed proximal part. At its distal end the segment is produced into a long and narrow curved process reaching nearly to the end of the merus. The ischium, unlike that of *Cyclaspis*, is very broad, not narrower than the succeeding segment. The three distal segments are comparatively slender.

The first legs (fig. 21) are long, extending beyond the pseudorostrum by nearly the length of the last two segments. The basis is very broad and flattened, narrowing suddenly at about its distal third and produced beyond and (in the natural position) above the articulation of the next segment into a sharply pointed process which extends beyond the distal end of the ischium. The rest of the limb is slender, and the last three segments are much elongated, the carpus and the propodus sub-equal and a little longer than the dactylus.

The second legs (fig. 17) are much shorter than the succeeding pairs and have a peculiar form. The basis is about equal to the remaining segments together. The ischium is suppressed. The merus is very short, but is produced distally on the inner side and bears a stout spine which reaches almost to the end of the limb. The next two segments are short and sub-equal, and together equal in length to the terminal segment, which bears three apical setæ and one lateral.

The fourth legs are slightly longer than either the third or the fifth (figs. 18 to 20). In each the basis bears several long setæ, and the terminal segment is very short, with a rather stout claw.

The uropods (fig. 27) are rather less than one and a-half times the length of the terminal somite. The peduncle is about two-fifths of the length of the sub-equal rami. The endopod bears a few spinules and plumose setæ on its inner edge. The outer edge of the exopod is obscurely serrate, its inner edge unarmed. The apices of both rami (fig. 27, A, B) have a rather peculiar structure. The endopod tapers down to a minute rounded knob, beyond which projects a flattened or rather winged spine consisting of a central rachis with a striated wing or web running down either side. The tip of the exopod is bifid, the two points close together, the lower having the same structure as the tip of the endopod, the upper differing in being without the knob-like process.

Adult *Male*, 9·3 millims. in length (figs. 3, 4) :—

Carapace much narrower than in the female, its greatest width about five-ninths of its length. Lateral cornua less prominent, directed forwards. Antero-lateral margins between pseudorostrum and lateral cornua simply convex with hardly an indication of the antero-lateral tooth. The lateral keel is well marked, as is also the transverse ridge running inwards from the lateral cornu on the lower surface. The median ridge is more distinct on the posterior part of the dorsal surface. The ocular lobe nearly twice as broad as long, the corneal areas much larger and more distinct than in the female. Anterior abdominal somites hardly narrower and somewhat deeper than posterior thoracic; sixth abdominal somite narrowing suddenly about the middle of its length.

Antennule (fig. 8) having three segments in the outer flagellum.

Antenna (fig. 9) of normal type, its flagellum about as long as the body. First two segments of peduncle bearing each a plumose seta.

Branchial apparatus (fig. 14) more fully developed than in the female, the laminæ much longer and 33 in number.

First leg (fig. 22) a little shorter than that of the female, the basis longer and narrower and having a group of spines on its lower surface near the inner edge.

Second leg (fig. 23) closely resembling that of female, except that the ischium is a little longer. The remaining legs (figs. 24 to 26) stouter than in the female and having more numerous and longer plumose setæ on the proximal segments.

Uropods (fig. 28) differing from those of the female in having the inner edges of the peduncle and endopod densely set with plumose setæ and in having a few setæ on the outer edge of the exopod.

Young Specimen, 4·8 millims. in length :—

The outline of the carapace (fig. 5) differs considerably from that of the adults. The lateral margins behind the cornua are nearly straight, the pseudorostral lobes are relatively much broader, the antero-lateral tooth is more prominent and more angular, and that portion of the antero-lateral margin lying between the tooth and the lateral cornu is straight instead of convex as in the female.

Localities.—Many specimens from the Gulf of Manaar, on the Cheval Paar, depth 6 to 7 fathoms; and on the Periya Paar Kerrai, depth 8 to 9 fathoms.

Eocuma affinis, n. sp.—Plate II., figs. 29 to 34.

Description of adult *Male*, 6·7 millims. in length :—

Differing from the last species in the narrower and less depressed form of the carapace, which is about three-tenths of the total length and evenly rounded at the sides without any lateral keels. Seen from above, the sides are nearly parallel, and the greatest width is little more than half of the length. The cornua are rather prominent, curved, and directed forwards. In front, the antero-lateral margin is finely serrate. On the dorsal surface a transverse depression crosses the hinder part of the cephalic lobe. The pitting of the surface of the carapace (fig. 31) is more marked than in the last species and the minute reticular texture is less distinct.

A minute granule is set in the centre of each pit, and between the pits are scattered here and there small tubercular elevations.

The first legs (fig. 32) have the basis narrower than in the last species, and the spines on its lower surface more numerous. The dactylus is only half the length of the preceding segment.

The second legs (fig. 33) have the basis very short, only one-third of the whole length of the limb. The spine on the ischium only reaches to the end ot the succeeding segment.

The uropods (fig. 34) are nearly twice as long as the terminal somite, the peduncle nearly one-third of the length of the rami. The inner edges of peduncle and endopod clothed with setæ, among which are one or two spinules. The outer and inner edges of the exopod each bear a number of setæ.

Locality.—The Cheval Paar, in the Gulf of Manaar, depth 7 fathoms. Two specimens.

Eocuma sarsii (KOSSMANN)—Plate II., figs. 35 to 38.

Cyclaspis sarsii, KOSSMANN, 'Zool. Ergeb. einer Reise in die Küstengebiete des rothen Meeres,' II., 1te Lief., III., Malacostraca (2. Theil; Anomura), pp. 88 to 90, Plate IV., fig. 3, 1880.

A single immature specimen, 4 millims. in length, probably female, which I refer to this species, has the following characters: Carapace hardly depressed, about five-sixteenths of total length, with very stout curved lateral cornua, behind which the lateral margin is marked by a low irregularly serrate ridge. The breadth across the cornua is four-fifths of the length. The cornua reach forward as far as the level of the pseudorostrum, which is broad and squarely truncate, as seen from above. External to the pseudorostrum on each side is an almost rectangular tooth, the anterior edge of which is serrate. This tooth is separated from the lateral cornu by a deep semicircular excavation. The dorsal surface is raised into a median keel anteriorly, where also there is a slight elevation on each side of the cephalic lobe. At its anterior end the median keel bifurcates on the ocular lobe to separate from each other the three not very distinct corneal areas. About the middle of the length of the carapace the median keel dies out and is replaced by a pair of longitudinal ridges some distance apart. The hinder margin of the carapace is elevated in the middle line into a rounded tubercle. The ocular lobe is nearly twice as broad as long, and there is no ocular pigment. The pseudorostral plates meet in front for a distance about equal to the length of the ocular lobe. Seen from the side, the pseudorostrum is obliquely truncated. The surface of the carapace (and, less distinctly, the rest of the exoskeleton) is covered with shallow circular pits, in the centre of each of which is a minute granule. The surface between the pits forms a raised network, which shows more or less distinctly the primary reticular texture of the exoskeleton, and is here and there raised into tubercles, giving the whole surface a rough and uneven aspect (fig. 37).

The first leg-bearing somite is not exposed. The second is much lower than the hind margin of the carapace. The remaining thoracic somites diminish gradually in width ; a pair of tubercles is present on the dorsal surface of each of the two last.

The abdomen is stout, but on account of an injury to the posterior somites the relative length of this region cannot be stated. All the somites, including the two last, have a prominent median dorsal keel. Seen from above, each of the somites is markedly constricted anteriorly, and also a little before its hinder margin. The lateral articular processes do not overlap.

The first legs are relatively short and stout, the basis not much less than half the total length of the limb.

The second legs are much shorter than the next succeeding pair. They are composed of six segments, as in the above-described species, but there is no spine developed on the merus.

The uropods (fig. 38) are short and stout, about two-thirds longer than the last somite. The peduncle is not much longer than broad, and is about two-fifths the length of the sub-equal rami. Its inner edge bears a few spinules. Both rami end in spiniform terminations marked off by indistinct suture lines, and bluntly rounded and bent outwards at the tip. A single seta accompanies the terminal spine on the exopod, which is otherwise unarmed. The endopod has a row of minute spinules on its inner edge.

Locality.—From the Cheval Paar, in the Gulf of Manaar, depth 7 fathoms.

The identity of the form here described with Kossmann's *Cyclaspis sarsii* from the Red Sea is at once suggested by its general shape, and especially by the thick clumsy form of the lateral cornua. Kossmann's figure shows the cornua as relatively smaller than in the present specimen, and the lateral margins behind them nearly straight. The paired ridges on the dorsal surface of the carapace are close together, and there are two oblique ridges on the dorsal surface of the peduncle of the uropods. It seems likely, however, that some of these differences may be due to the difference in age and in sex, Kossmann's specimen being a male, 9 millims. in length, more than twice the length of the present specimen, which is probably a young female. Kossmann's description of the sculpturing of the exoskeleton agrees exactly with that observed in this specimen.

Cyclaspis, G. O. Sars.

G. O. Sars, 'Forh. Vidensk. Selsk. Christiania,' 1864 (1865), p. 206.

The genus *Cyclaspis*, even after the removal of the species above transferred to *Eocuma*, still includes a somewhat varied assemblage of forms, and becomes increasingly difficult to define from the neighbouring genera of Bodotriidæ. Without attempting, for the present, to frame a fresh definition, it may be pointed out that the species described below, which are referred to *Cyclaspis* on the ground of general similarity in form to species already included therein, differ from them in the fact that they possess, in the adult female at least, five distinct thoracic somites behind the carapace. Since, however, the first somite is entirely hidden in most cases in the adult male as well as in immature specimens of both sexes, it seems inadvisable to make this character the ground for separating these species generically from those in which the somite in question is concealed or suppressed in both sexes at all stages of growth.

Cyclaspis costata, n. sp.—Plate III., figs. 39 to 53.

Description of adult *Female*. Total length 3·75 millims :—

Carapace about three-eighths of total length, its vertical height nearly two-thirds of its length, compressed, the dorsal surface rounded posteriorly, but keeled in its anterior half, where there is a well-marked depression on either side of the middle line. Pseudorostrum acute, prominent and slightly upturned as seen from the side. Antennal notch shallow and widely open, the antennal tooth obtuse. Ocular lobe large, sub-circular, pseudorostral plates meeting in front of it for a distance equal to its diameter. The eye pigmented and apparently well developed. The sides of the carapace, behind and below the depressions mentioned above, are beset with longitudinal ridges formed by rows of minute granules. There are about twelve such ridges on either side in the specimen figured, with fainter secondary ridges interposed between some of them. In a larger female specimen the ridges are more numerous and closer together, owing apparently to the greater prominence of the secondary ridges.

First leg-bearing somite well exposed. Second somite produced dorsally into a median crest. Fourth and fifth having the dorsal surface raised into a rounded tubercle on each side of the middle line.

Abdomen shorter than the cephalothoracic region, the somites comparatively stout, with a faintly indicated dorsal keel, and with well-developed "peg and socket" articulations laterally.

Antennules (fig. 42) very short, first segment of peduncle much enlarged and longer than the other two segments together, outer flagellum with two segments, inner flagellum very minute.

Antennæ (fig. 43) unjointed, not produced, bearing two plumose setæ.

The mouth-parts closely resemble those of *C. australis;* the mandibles bear about 13 spines. The branchial apparatus was not examined.

The third maxillipeds (fig. 44) have the basis abruptly bent at about the middle of its length, and slightly longer than the succeeding segments together. The external process of the merus is very large, extending far beyond the process of the basis. The propodus is expanded, not much narrower than the carpus, and the dactylus is almost rudimentary.

The first legs (fig. 45) are very short, just reaching to the antennal angle of the carapace when extended forwards. The basis is about equal in length to the succeeding segments together.

The second leg (fig. 47) exhibits the full number of segments; it is short and stout, and its terminal segment is armed with three spines. The third legs are longer than the second, and the fourth and fifth successively diminish in length by shortening of the basis (figs. 49 to 51). The propodus and dactylus of these limbs are rather slender.

The uropods (fig. 52) are short and stout; the peduncle is about equal to the terminal somite in length and finely serrate on its inner margin. The rami are subequal and a little shorter than the peduncle. Each is tipped by a stout spine. The exopod is otherwise unarmed except for a small spinule implanted external to the base of the large spine. The endopod has a single spine on its inner edge near the distal end.

In addition to scattered pigment spots on the carapace and free thoracic somites, there is a more or less well-marked pigmentation of the first two and the last abdominal somites.

Adult *Male*. Total length, 3·9 millims. (fig. 41) :—

The carapace is less deep than in the female, with the dorsal outline less arched. The pseudorostrum is shorter and truncated, the plates meeting for only a short distance in front of the ocular lobe. The latter is large, inflated, with large and distinct corneal lenses. On the upper part of the side of the carapace the longitudinal ridges only occupy the posterior third, stopping short at a vertical ridge in front of which the surface is irregularly granulated.

The first leg-bearing somite is exposed dorsally and the second is not distinctly crested. The posterior thoracic somites are broad and depressed, with prominent dorso-lateral corners. The abdomen is remarkably stout, a little longer than the cephalothoracic region, the anterior somites broader and deeper than long, the fifth somite narrowing suddenly about the middle of its length.

The various appendages, so far as seen without dissection, resemble closely those of the female. The basis of the first leg (fig. 46) bears on its inner edge a series of four stout spines.

The basis of the second leg (fig. 48) has its anterior edge cut into a series of fine recurved teeth not observed in the female.

The uropods (fig. 53) are shorter than in the female. The peduncle is shorter than the terminal somite and bears a series of long plumose hairs on its inner edge. The rami are broad and flattened. The endopod has a series of serrate spines on its inner edge increasing in length distally, the two distal spines close to the stout apical one and separated by a little interval from the others; the outer edge and the distal part of the inner edge are serrate. The exopod has several plumose hairs on its inner edge.

Localities.—Gulf of Manaar; several specimens from Kondatchi Paar, one specimen from Periya Paar Kerrai; depth, 8 to 9 fathoms.

This new species resembles a little in general form the *C. australis* of Sars, but differs from it and from all the species of *Cyclaspis* hitherto described not only in the longitudinally-ribbed carapace, but also in the shortness of the first legs, the short abdomen, especially of the female, and in the stoutness and armature of the uropods. In the fact that the first leg-bearing somite is distinct in the female, it agrees with the species described below, but no other species is yet known in which this somite is exposed in the male also.

Cyclaspis picta, n. sp.—Plate III., figs. 54 and 55.

Description of *Female* with rudimentary oostegites. Total length, 3 millims:—

The carapace is a little more than one-third of the total length and is somewhat compressed, the dorsal surface keeled, especially in front. Seen from the side, the dorsal edge is evenly arched, the pseudorostrum is prominent and sharply triangular, the lateral plates meeting in front of the ocular lobe for a distance equal to the transverse diameter of the latter. Antennal notch widely open, antennal tooth sharp, with a spiniform point. Ocular lobe of moderate size, acuminate anteriorly, not sharply constricted off from cephalic lobe, eye well pigmented, corneal lenses not distinct. The sides of the carapace are quite smooth, devoid of ridges or tubercles. The texture of the exoskeleton is (in this specimen) regularly reticulate, with a faintly indicated shallow pitting over the whole of the carapace.

First leg-bearing somite well exposed, but apparently firmly united to the carapace, the suture line being somewhat faintly shown.

Abdomen rather slender, nearly equal in length to the cephalothoracic region, the somites sub-cylindrical, with well-marked articular processes laterally.

First legs comparatively short, extending beyond the antennal tooth by little more than the terminal segment. Second legs with the ischium distinct.

Uropods (fig. 55) having the peduncle nearly twice as long as the last somite and more than twice as long as the rami, which are sub-equal, the endopod especially rather broad and flattened, tipped with a spine, and having two spines on its serrate inner edge. The exopod has a terminal spine and a small spinule close to it on the outer side.

Both the specimens show a peculiarly shaped pigment patch on the carapace. The last thoracic and some of the abdominal somites are also pigmented.

Locality.—Gulf of Manaar, Cheval Paar; depth, 7 fathoms; 2 specimens.

This form belongs, with the two following, to a group of species characterised by the smoothness of the carapace and including *C. longicaudata*, Sars; *C. pusilla*, Sars; *C. levis*, Thomson; and *C. argus*, Zimmer. From all of these it seems to be sufficiently distinguished by the presence of five distinct thoracic somites, by the acute pseudorostrum, and by the much longer peduncle of the uropods.

Cyclaspis herdmani, n. sp.—Plate III., figs. 56 to 59; Plate IV., figs. 60 to 66.

Description of adult *Female*. Total length, 4·4 millims. (fig. 56):—

Carapace nearly $3\frac{1}{2}$ times in total length, moderately compressed. The dorsal edge very slightly arched, keeled anteriorly where there is a shallow depression on either side, and having a more faintly marked double keel posteriorly. The junction of the median with the double keel is marked by a shallow pit. Pseudorostrum truncated, the ocular lobe reaching quite to the tip. Antennal notch narrow, antennal tooth sub-acute. Ocular lobe moderately large, not longer than broad, somewhat projecting dorsally; eye well pigmented, corneal lenses indistinctly defined. Sides of carapace smooth, with a faint pitting over the whole surface.

First leg-bearing somite well exposed in adult (in the young female, as in the male, it is wholly concealed). Second somite slightly crested dorsally.

Abdomen rather slender, a little longer than the cephalothoracic region, the somites sub-cylindrical, with well developed lateral articular processes.

Antennules (fig. 58) having the first segment of peduncle longer than the other two together, the second a little shorter than the third. External flagellum of two segments, internal flagellum not observed in the specimen dissected.

Antenna (fig. 59) produced into a narrow process defined by a distinct suture-line. Two plumose setæ on basal part.

The mouth-parts are normal.

The first legs (fig. 60) extend a little way beyond the pseudorostrum. The basis is rather narrow, and is equal in length to the remaining segments together. At its distal end, on the side which in the natural position of the limb is ventral, it is produced into a stout tooth which reaches to the end of the next segment. The merus and carpus are somewhat expanded, and the carpus, propodus, and dactylus are of equal length.

The second legs (fig. 62) have the ischium distinct, the carpus hardly more than half the length of the merus and little longer than the propodus. The dactylus is shorter than the two preceding segments together and bears three unequal spines at the tip. In the remaining legs (fig. 63) the carpus is sub-equal to the merus.

The uropods (fig. 65) are rather slender, the peduncle about $1\frac{2}{5}$ths the length of the last somite, and equal to the length of the sub-equal rami. Both rami are acutely pointed, without terminal spines, and the endopod bears a series of about six spinules on the middle third of its inner edge.

The last two or three thoracic somites are always more or less pigmented.

Adult *Male*. Total length, 4·3 millims. (fig. 57):—

The carapace resembles in shape that of the female, but is less deep. The ocular lobe is more prominent dorsally and the corneal lenses are large and conspicuous. The antennal notch is shallow and widely open. On the surface of the carapace the dorsal keels and depressions are only faintly indicated. Abdominal somites, as usual, much stouter, and the whole abdomen longer than the cephalothorax.

The first legs (fig. 61) are somewhat longer and more slender than in the female; the basal segment bears on its inner edge a group of spines, and the dactylus is a little shorter than carpus or propodus. The remaining legs do not differ conspicuously from those of the female.

The uropods (fig. 66) have the peduncle fringed on the inner edge with setæ. The exopod is a little longer than the endopod and equal to the peduncle, and has a few plumose hairs on its inner edge. The endopod has about 23 spinules on its inner edge, diminishing in length distally, and leaving the distal third of its length unarmed. Both rami are simply pointed at the tip.

Localities.—Gulf of Manaar, various parts of the Cheval Paar; depth 7 fathoms; several specimens.

This species approaches most closely to *C. levis*, Thomson, and *C. argus*, Zimmer. The latter is distinguished in the male sex by a different form of the anterior margin of the carapace, the antennal notch being widely open and shallow, by having the second leg-bearing somite produced dorsally, and by the shorter uropods, of which the peduncle is equal in length to the last somite. *C. levis* is distinguished, according to Thomson, by having a long, slender and acute process from the distal end of the basal segment of the first legs. I am inclined to suspect some error of observation in regard to this character, in which case *C. levis* would resemble very closely the form here described. The characters of the uropods, however, appear to distinguish the species, those of *C. levis* having the peduncle not longer than the last somite, and their armature being somewhat different.

Cyclaspis hornelli, n. sp.—Plate IV., figs. 67 to 71.

Closely resembling in both sexes the preceding species, but differing from it in the following characters:—The carapace is still smoother, and the dorsal keel is simple and less strongly marked. The first legs (fig. 67) are much longer, reaching far beyond the anterior end of the body; the basis is about three-fourths of the length of the remaining segments together, and the propodus is twice and the dactylus one and a half times as long as the carpus. The second legs (fig. 68) have the terminal segment longer and with more numerous spines. In the last three pairs of legs the distal segments are more elongated, the carpus of the fifth pair (fig. 70) being half as long again as the merus. The uropods (fig. 71) resemble those of *C. herdmani*, but the exopod is a little shorter than the peduncle, and bears three to five spinules about the middle of its inner margin, while at the tip are two unequal spinules and another close to them on the inner edge. The endopod is simply pointed and bears in the female six, and in the male 14 spines on its inner edge. Total length, female 5·3 millims., male 4·2 millims.

Localities.—Gulf of Manaar, Cheval Paar, depth 7 fathoms, several spp., and the Periya Paar Kerrai, depth 8 to 9 fathoms, several.

At the suggestion of Professor Herdman, I have pleasure in associating with this species the name of Mr. JAMES HORNELL, to whom, I am told, no small share of credit is due for getting together this interesting series of a group of animals neglected by most collectors.

Iphinoë macrobrachium, n. sp.—Plate IV., figs. 72 to 75.

Description of immature *Female*. Total length, 1 millim. :—

Carapace about one-fourth of the total length, its length in the middle line nearly one and a half times its height, moderately compressed, with a well marked dorsal keel. Dorsal edge slightly arched. Pseudorostrum prominent, upturned, truncated, the lateral plates meeting in front of the ocular lobe for a distance nearly equal to the breadth of the latter. Antennal notch rather deep, angular, antennal tooth acute. Ocular lobe transverse, its width more than twice its length. On the side of the carapace are two very faintly marked longitudinal ridges. The upper is continued backwards for a short distance from the pseudorostrum, the lower is just above the lower margin of the carapace. The free thoracic somites are faintly keeled dorsally.

Antennules and third maxillipeds resembling those of *Iphinoë crassipes*, HANSEN. First legs (fig. 73) very long, basis less than half the length of the remaining segments; relative proportions of the latter as in *I. crassipes*, but the propodus rather more slender. Second legs (fig. 74) resembling those of *I. crassipes*, the two distal segments indistinctly separated.

Uropods (fig. 75) with the peduncle stout and a little longer than the last somite, with five or six strong spines on its inner edge. Rami unequal, the endopod a little longer than the peduncle, its proximal segment with four or five spines on its inner edge, and nearly half as long again as the distal segment, which has three terminal spines and two or three on its inner edge. Exopod about two-thirds of the length of the endopod, unarmed except for the terminal group of six or seven spines and stout setæ.

Localities.—Gulf of Manaar, Cheval Paar, 7 fathoms, 1 specimen, and Kondatchi Paar, 4 to 5 fathoms, 1 specimen.

This species presents a close resemblance to the *Iphinoë crassipes* of HANSEN from the Gulf of Guinea. Although HANSEN'S specimen, like those here described, was immature, there appear to be sufficient grounds for regarding the species as distinct. The outline of the carapace is somewhat different, the basal segment of the first legs is much shorter, and the rami of the uropods are conspicuously unequal, while in *I. crassipes* they are nearly of the same length.

FAMILY: DIASTYLIDÆ.

Paradiastylis, n. gen.

Third maxillipeds without exopod. Third and fourth pairs of legs with no rudiments of exopods. Telson very short, the post-anal part reduced to a spiniform process tipped with two small spinules and without lateral spines.

Paradiastylis brachyura, n. sp.—Plate V., figs. 76 to 90.

Description of sub-adult *Female*. Total length 3·2 millims. :—

Carapace inflated, a little less than one-third of the total length, its breadth about three-fourths, and its depth two-thirds of its length. Pseudorostrum acute, horizontal, the lateral plates meeting in front of the ocular lobe for a distance equal to the width of the latter. The tip of the pseudorostrum is armed with a pair of divergent spines. Antennal notch shallow. Antero-lateral angle not produced, rounded, serrate. On each side of the carapace are four curved ridges running obliquely from above downwards and forwards. The most anterior and strongest of these is serrate, and the area in front of and above it is depressed on each side, leaving a median keel. The fourth or hindmost ridge on either side is much less prominent than the others. On the dorsal surface a pair of short longitudinal serrate crests, some distance apart, connect the upper ends of the first and second ridges, and form a strong tooth at the upper end of the first. The median keel bears two procurved teeth, and a pair are set side by side on the ocular lobe. On the lower part of the side of the carapace anteriorly a curved row of spines starting from the pseudorostrum runs backwards and downwards towards the lower margin, crossing the lower ends of the oblique ridges. The posterior edge of the carapace is raised to form a marginal ridge which is strongest on the dorsal side. The ocular lobe is twice as broad as long. There is no eye-pigment nor distinct corneal lenses.

The posterior angles of the last thoracic somite are not produced.

The abdomen is slender, about equal in length to the cephalothoracic region. The somites have slight serrate dorso-lateral crests. The fifth somite is not greatly elongated.

Telson (figs. 89 and 90) a little shorter than the last somite, somewhat narrowed at its base, its greatest breadth at about one-third of its length from the base, where it bears a pair of lateral tubercles, then narrowing suddenly a little before the middle of its length, the sides converging to an acute point. Viewed from the side (fig. 89), the tip is seen to project beyond the obliquely placed anal valves by about one-third of its length. A pair of very minute apical spinules are present, flanked by a pair of small setæ, with another pair of setæ a little way further down the side.

Antennules (figs. 78 and 78A) hardly reaching beyond the tip of the pseudorostrum, the proximal segment more than twice, the third segment one and a half times the length of the second. Outer flagellum shorter than the last segment of the peduncle, consisting of three segments, the terminal one very minute. Inner flagellum two-thirds the length of the outer, composed of two segments, the proximal very short.

Antennæ (fig. 80) consisting of three segments.

Mouth-parts of normal type. Mandibles with about nine spines. Lobes of lower lip with incurved tips. Palp of maxillulæ (fig. 81) not longer than the distance between its base and the tip of the distal lobe, with two apical setæ. Branchial apparatus not examined. Second maxillipeds (fig. 82) rather short, basis hardly more than one-third of the total length.

Third maxillipeds (figs. 83) without exopods. The basis is curved, much expanded distally and about equal in length to the remaining segments together. At its distal end it bears a series of very long setæ.

First legs (fig. 84) reaching beyond the tip of the pseudorostrum by about half the length of the carapace. The basis rather short, less than two-fifths the length of the remaining segments; the distal segments stout, propodus a little longer than the carpus and more than twice as long as the dactylus.

Second legs (fig. 85) about as long as the third pair, basis enlarged, ischium reduced to a narrow ring, distal segments not greatly elongated, propodus three-fourths of the length of the dactylus, which is armed with two or three apical spines and several setæ. Remaining legs (figs. 86 and 87) rather stout, successively diminishing in length, merus much longer than carpus.

Uropods (fig. 88) slender and elongate, peduncle twice as long as the sixth abdominal somite, with six spines on distal part of its inner edge, two tubercles on its lower surface and one above. Rami slightly unequal, exopod a little more than half the length of the peduncle and a little shorter than the endopod, unarmed except for a few minute setæ and for a slender apical spine equal in length to the ramus carrying it. Exopod of three segments, of which the first and longest bears two spines and each of the others one on the inner edge; distal segment ending in a slender apical spine.

No adult male is in the collection, but one or two immature male specimens, resembling the female in general form and in the sculpture of the carapace, have the antennular peduncle (fig. 79), and especially its distal segments, much enlarged, suggesting that in the adult a modification of this appendage may take place similar to that occurring in *Leptostylis;* the outer flagellum also possesses an additional segment not observed in the female. Two pairs of pleopods are present as rudiments and both are bilobed.

Locality.—Gulf of Manaar, Cheval Paar, 7 fathoms; several specimens.

The most remarkable feature of the present form, and one which distinguishes it from all *Cumacea* hitherto described, is the absence of an exopod from the third maxilliped. The facility with which this appendage becomes detached in dissection from the limb which carries it, might suggest possible error of observation on this point were it not that I have observed the same character in an undescribed species from New Zealand, closely allied to that above described. This character is so unusual that it seems advisable to recognise it by establishing a new genus for the reception of the species.

The *Leptostylis brevicaudata* described by ZIMMER ('Zool. Jahrb. Syst.,' XVIII.,

p. 685), from Japan, presents a great resemblance to this species in general form, in the shape and proportions of the telson, and in the sculpturing of the carapace. Its third maxilliped is not described, but it possesses rudimentary exopods on the third and fourth legs, a character which led to its being referred to the genus *Leptostylis*, although differing in several points from the typical members of that genus. Should it prove to be the case that *L. brevicaudata* is without an exopod on the third maxilliped, it will, I think, be necessary to include it with the present species in the genus *Paradiastylis* in spite of the difference in structure of the third and fourth legs. In the *Diastylopsis dubia* of BONNIER ('Ann. Univ. Lyon,' "Campagne du 'Caudan,'" Édriophthalmes, p. 559), the presence or absence of rudimentary exopods on these limbs seems to be a matter of individual variation, suggesting that no great importance can attach to this feature as a generic distinction within the family Diastylidæ.

FAMILY: NANNASTACIDÆ.

Nannastacus stebbingi, n. sp.—Plate V., figs. 91 to 93.

Description of adult *Male*. Total length, 1·38 millims. :—

Carapace a little over one-third of total length, rather broader than deep, dorsal surface a little depressed in middle line between the swollen branchial regions. On either side, a little way behind the eye, is a rounded knob-like prominence (present also, although less conspicuous, in *N. unguiculatus*). Pseudorostrum, seen from the side, upturned and rounded, with two faintly marked ridges parallel to its distal margin; immediately below the pseudorostrum, and above the insertion of the antennule, the concave antero-lateral margin bears a group of three curved spines, of which the upper and largest is very conspicuous. Antero-lateral angle not produced, rounded, not serrate, but with a single small spine springing from the outer surface. Seen from above, the pseudorostral plates do not meet in front of the eyes and the respiratory channel is widely open. The eyes are large, each with three prominent corneal lenses. The width of the interocular margin is about equal to the diameter of the eye.

All the free thoracic somites have sub-marginal lateral crests of laminar spines, the last three also with paired serrated crests on the dorsal surface.

Abdomen shorter than the cephalothoracic region, fifth somite not much longer than the preceding. As in *N. unguiculatus*, all the somites bear serrated lateral crests overhanging the lateral grooves, and each, except the last, has a pair of stouter dorsal crests ending behind in a strong curved tooth. On the last somite, apparently, the lateral crests alone are present running on to the dorsal surface, and the posterior border of the somite is produced into a sharp median spine.

In the last pair of legs the carpus is longer than the propodus.

Uropods (fig. 93), excluding the apical spines, longer than the last two somites;

peduncle very short, with a serrate crest on the dorsal surface; endopod about three times as long as the peduncle, serrate on the inner edge, and having an apical spine nearly two-thirds of its own length, with two short spines at its base internally; exopod nearly half as long as the endopod, apical spine one and a half times the length of the ramus.

Locality.—Gulf of Manaar, $2\frac{3}{4}$ miles south-south-west of Chilavaturai, depth 2 fathoms; 1 specimen.

This species resembles generally the male of *N. unguiculatus*, but differs in the smoother carapace, in the antero-lateral angle, not serrate, but having a single apical spine, in the group of spines below the pseudorostrum, and in the greater relative length of the exopod of the uropods. The *N. ossiani* described by Mr. STEBBING (WILLEY'S 'Zool. Results,' Part V., Crustacea, p. 612) resembles the present species in the concentric ridges of the pseudorostrum, which, however, appear to be much more strongly marked than in our specimen. It differs in the stouter abdomen, in the more pronounced dorsal depression of the carapace, in the last two thoracic somites, which have the "dorsal centre strongly raised," without the double dorsal crests, and in the absence of the group of spines below the pseudorostrum. Owing to an accident to the present specimen I am unfortunately unable to state exactly the relative proportions of the segments of the last pair of legs. As far as could be seen in the undissected specimen, however, the difference in length between the carpus and propodus was less than in *N. ossiani*. Mr. STEBBING compares his species with the female of SARS' *N. suhmii*, which he suggests may be specifically distinct from the male with which SARS has associated it. The arguments given in favour of this suggestion are not very conclusive, and in particular Mr. STEBBING'S remark that in *N. unguiculatus* "the sexual dimorphism so common in the present order is less striking than usual" does not seem at all applicable to that species. A re-examination of the type specimens of *N. suhmii* in the "Challenger" collection does not support Mr. STEBBING'S suggestion. The specimens, in consequence of the Canada balsam becoming opaque, have had to be removed from the slide on which they were mounted and are therefore more accessible for examination than formerly. I find that the male specimens almost certainly belong to two species, but that the larger and better preserved among them, which alone correspond with SARS' figure (except that the antero-lateral angle of the carapace is less narrowed and produced than is there shown), agree with the female specimen and differ from all the species of *Nannastacus* hitherto described in the extreme reduction of the exopod of the uropods. In the males this ramus, including its terminal spine, does not exceed one-fourth of the total length of the endopod.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. *Eocuma taprobanica*, n. sp., sub-adult female, from side.
,, 2. ,, ,, ,, ,, above.
,, 3. ,, ,, adult male, from side.
,, 4. ,, ,, ,, ,, above.
,, 5. ,, ,, young specimen, outline of carapace, from above.
,, 6. ,, ,, female, anterior part of body, from below.
,, 7. ,, ,, antennules and antenna of female.
,, 8. ,, ,, antennule of male.
,, 9. ,, ,, basal part of antenna of male.
,, 10. ,, ,, mandible of female.
,, 11. ,, ,, lower lip.
,, 12. ,, ,, maxillula.
,, 13. ,, ,, first maxilliped, with branchial apparatus of female.
,, 14. ,, ,, ,, ,, ,, male.
,, 15. ,, ,, second maxilliped of female.
,, 16. ,, ,, third maxilliped, from below.
,, 16A. ,, ,, part of same, from above.
,, 17. ,, ,, second leg of female.
,, 18. ,, ,, third ,,
,, 19. ,, ,, fourth ,,
,, 20. ,, ,, fifth ,,

PLATE II.

Fig. 21. *Eocuma taprobanica*, first leg of female.
,, 22. ,, ,, male.
,, 23. ,, second leg of male.
,, 24. ,, third ,,
,, 25. ,, fourth ,,
,, 26. ,, fifth ,,
,, 27. ,, last somite and uropod of female, from above.
,, 27A. ,, uropod from side.
,, 27B. ,, tip of exopod of uropod, further enlarged.
,, 28. ,, last somite and uropod of male, from above.
,, 29. *Eocuma affinis*, n. sp., adult male, from side.
,, 30. ,, ,, carapace of same, from above.
,, 31. ,, ,, portion of surface of carapace, further enlarged.
,, 32. ,, ,, first leg.
,, 32A. ,, ,, ,, distal end of basal segment, from above.
,, 33. ,, ,, second leg.
,, 34. ,, ,, last somite and uropod.
,, 35. *Eocuma sarsii* (KOSSMANN), female, from side.
,, 36. ,, ,, ,, above.
,, 37. ,, ,, portion of surface of carapace, further enlarged.
,, 38. ,, ,, last somite and uropod.

PLATE III.

Fig. 39. *Cyclaspis costata*, n. sp., adult female, from side.
,, 40. ,, ,, ,, ,, above.
,, 41. ,, ,, adult male, from side.
,, 42. ,, ,, antennule of female.
,, 43. ,, ,, antenna ,,
,, 44. ,, ,, third maxilliped.
,, 45. ,, ,, first leg of female.
,, 46. ,, ,, ,, male.
,, 47. ,, ,, second leg of female.
,, 48. ,, ,, ,, male.
,, 49. ,, ,, third leg of female.
,, 50. ,, ,, fourth leg ,,
,, 51. ,, ,, fifth leg ,,
,, 52. ,, ,, last somite and uropod of female.
,, 53. ,, ,, ,, ,, male.
,, 54. *Cyclaspis picta*, n. sp., immature female.
,, 55. ,, ,, last somite and uropod.
,, 56. *Cyclaspis herdmani*, n. sp., adult female.
,, 57. ,, ,, ,, male.
,, 58. ,, ,, antennule of female.
,, 59. ,, ,, antenna ,,

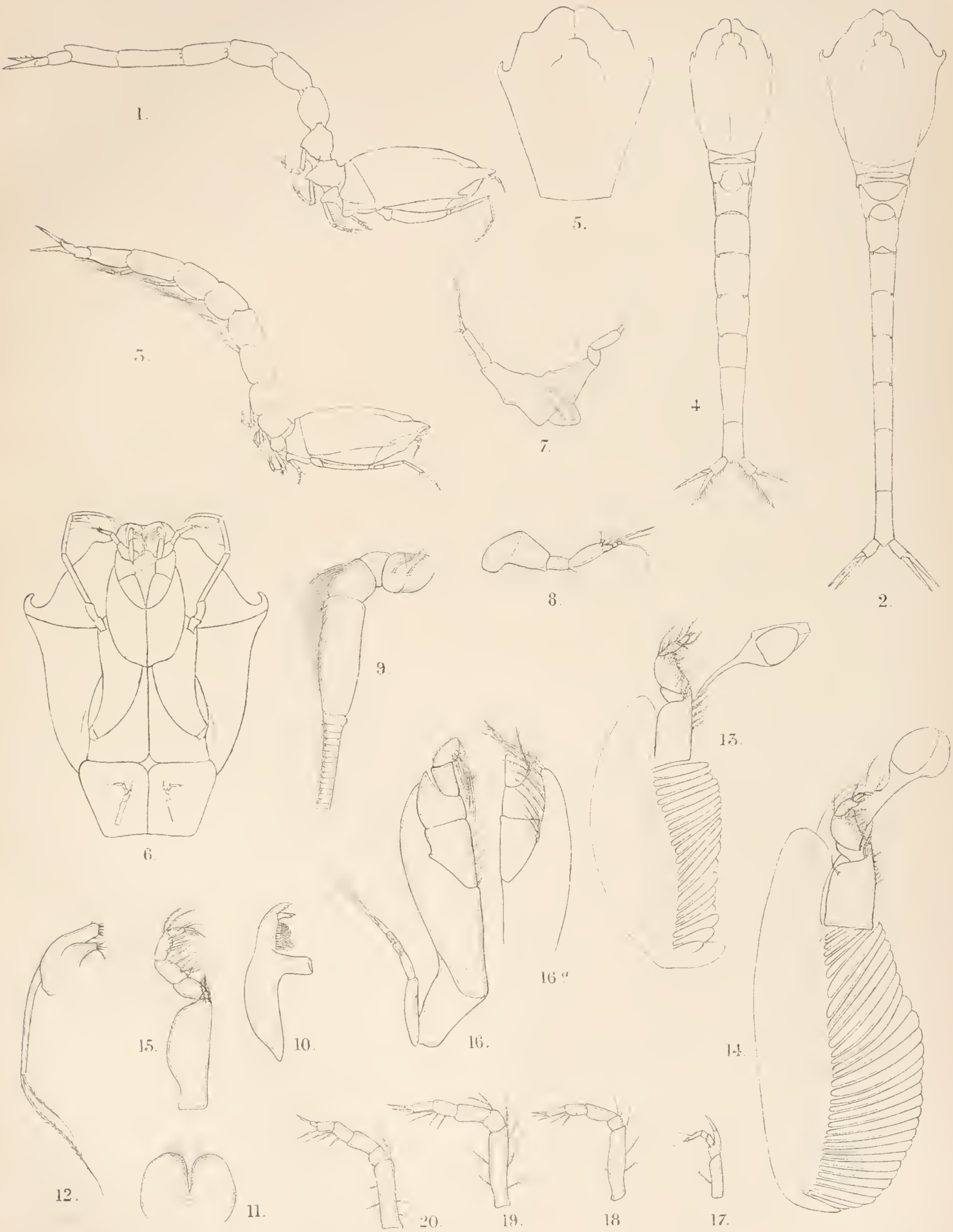
PLATE IV.

Fig. 60. *Cyclaspis herdmani*, first leg of female.
,, 61. ,, ,, male.
,, 62. ,, second leg of female.
,, 63. ,, fourth ,,
,, 64. ,, fifth ,,
,, 65. ,, last somite and uropod of female.
,, 66. ,, ,, ,, male.
,, 67. *Cyclaspis hornelli*, n. sp., first leg of male.
,, 68. ,, ,, second leg of male.
,, 69. ,, ,, third ,,
,, 70. ,, ,, fifth ,, terminal segments.
,, 71. ,, ,, last somite and uropod of female.
,, 72. *Iphinoë macrobrachium*, n. sp., young female, from side.
,, 73. ,, ,, first leg.
,, 74. ,, ,, second leg.
,, 75. ,, ,, last somite and uropod.

PLATE V.

Fig. 76. *Paradiastylis brachyura*, n. sp., sub-adult female, from side.
,, 77. ,, ,, ,, above.
,, 78. ,, ,, antennule of adult female.

Fig. 78A. *Paradiastylis brachyura*, n. sp., terminal part of same, further enlarged.
" 79. " " antennule of young male, terminal part.
" 80. " " antenna } of adult female.
" 81. " " maxillula
" 82. " " second maxilliped
" 83. " " third maxilliped
" 84. " " first leg
" 85. " " second leg
" 86. " " fourth "
" 87. " " fifth "
" 88. " " last somite, telson and uropod of young male.
" 89. " " " and telson from side.
" 90. " " telson of a female specimen.
" 91. *Nannastacus stebbingi*, n. sp., male, from side.
" 92. " " " above.
" 93. " " last somite and uropod.



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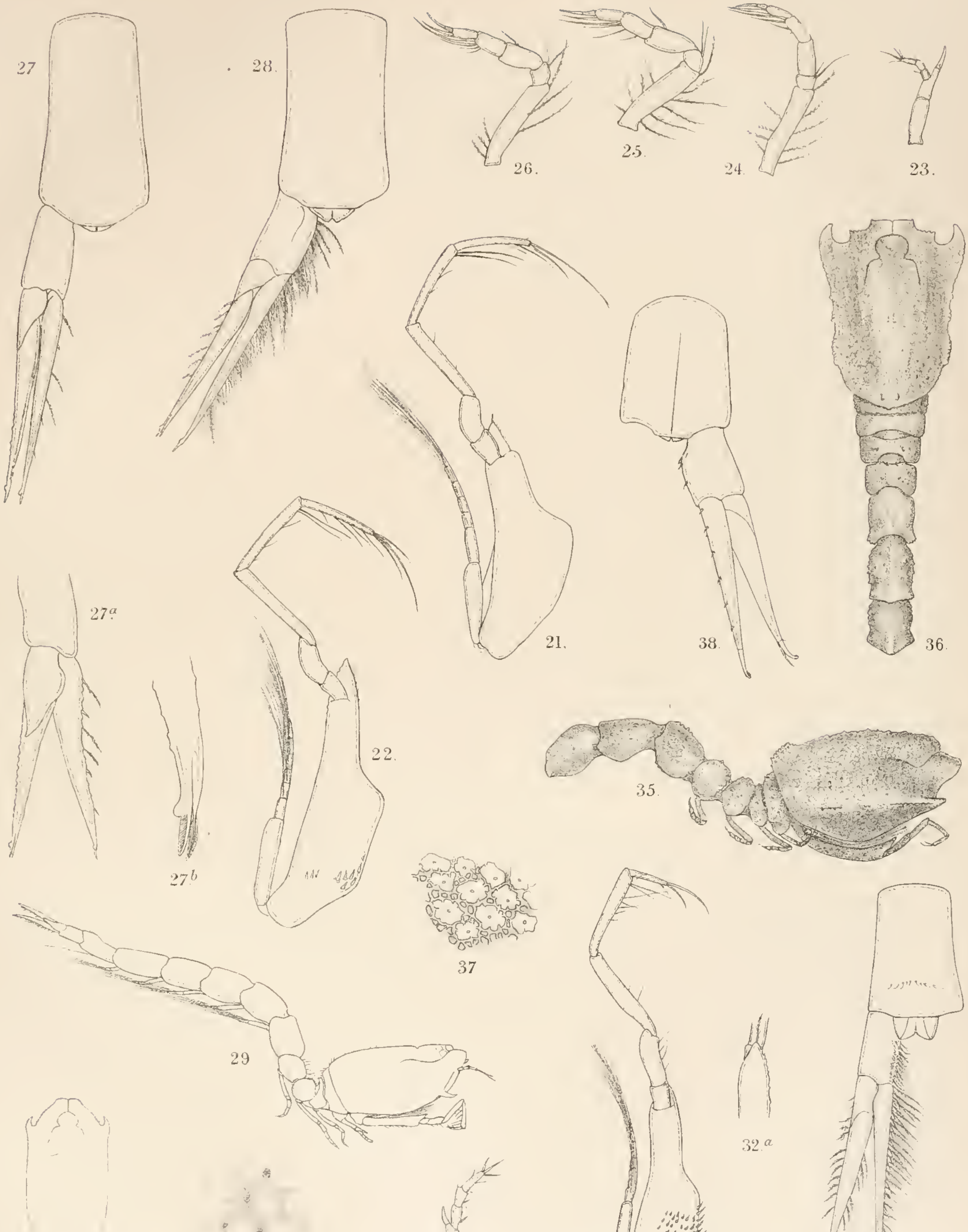
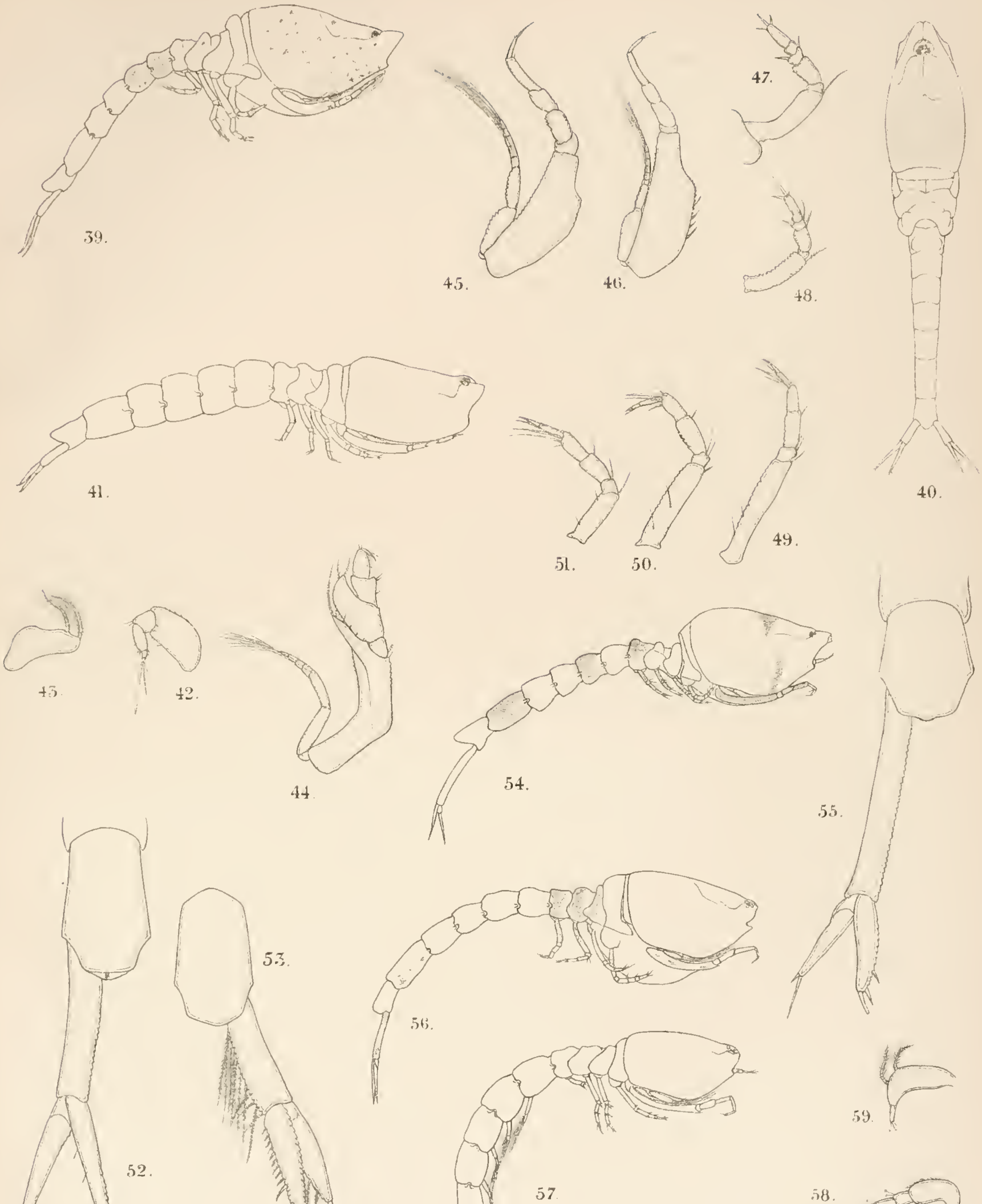
EOCUMA TAPROBANICA.



FIGS. 21-28, EOCUMA TAPROBANICA. FIGS. 29-34, EOCUMA AFFINIS. FIGS. 35-38, EOCUMA SARSII



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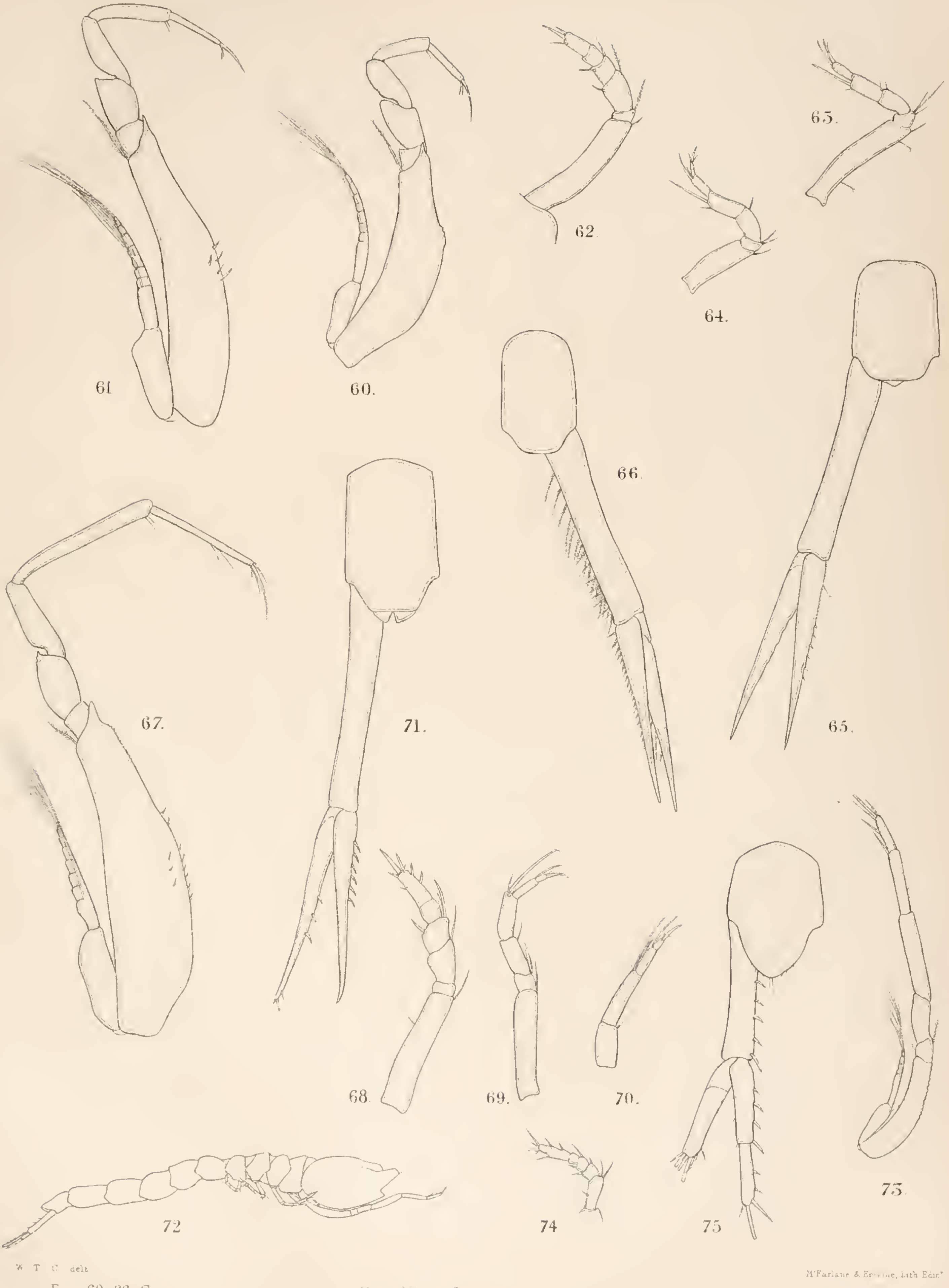
Figs. 39-53, Cyclaspis costata. Figs. 54, 55, Cyclaspis picta. Figs. 56-59, Cyclaspis herdmani



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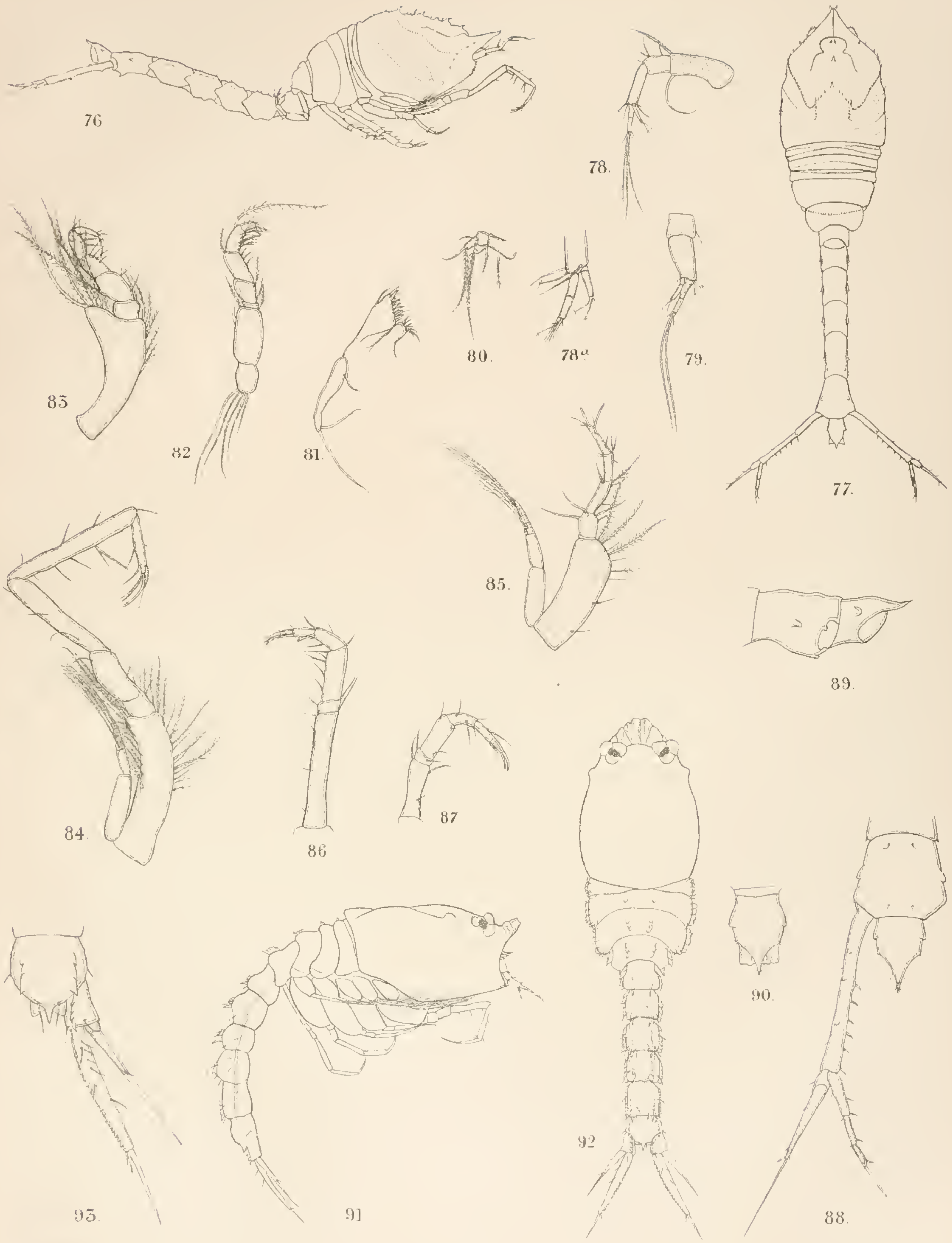
Figs 60-66, Cyclaspis herdmani   Figs 67-71, Cyclaspis hornelli   Figs 72-75, Iphinoe macrobrachium



W. T. C. del.

M'Farlane & Erskine Lith. Edin.

Figs. 76-90, Paradiastylis brachyura. Figs. 91-93, Nannastacus stebbingi.

REPORT

ON THE

PANTOPODA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

GEO. H. CARPENTER, B.Sc., M.R.I.A.,
OF THE SCIENCE AND ART MUSEUM, DUBLIN.

[WITH ONE PLATE.]

THE Pycnogons collected by Professor HERDMAN and his colleague comprise two species, both obtained in comparatively shallow water in the Gulf of Manaar and along other parts of the Ceylonese coast. One belongs to *Nymphon* and the other to *Phoxichilus*, both widely distributed genera, ranging from the Arctic Ocean to the southern seas. *Nymphon* is, however, a genus much richer in species, and shows a wider distribution than *Phoxichilus*. Both the forms seem to be referable to new species, and as numerous individuals have been collected in an excellent state of preservation, it is easy to describe and figure their distinctive characters. The *Nymphon* is abundantly distinct from any known species. *Phoxichilus*, on the other hand, is a genus whose named forms are of doubtful "specific" value. But all the more on that account is a careful study of specimens from new localities desirable as a guide to the extent and nature of variation.

I am much indebted to Professor HERDMAN for entrusting me with this interesting, if small, collection for examination and report.

FAMILY: PHOXICHILIDÆ.

Phoxichilus, LATR.

Phoxichilus mollis, n. sp.—Plate, figs. 1–7.

Length 5 millims. Body proportioned as in *P. lævis*, GRUBE,* but almost entirely unarmed, only a few minute spines on the lateral processes and on the head-segment (figs. 1, 2). Femur of each leg evenly swollen distally without angular projections, armed only with a series of minute spines along the edges and four terminal spines (figs. 1, 3). Male with 24 cement glands on each femur (figs. 3, 4, *c.g.*). False leg of male with 6th segment greatly thickened and enlarged laterally (figs. 5, 6). Propodus with 5 stout basal teeth (the 3rd the longest) and 6 small distal teeth (fig. 7).

Habitat:—Coasts of Ceylon. Two males and several females picked off experimental oyster cage hung over side of ship on the North-East Cheval Paar, 15th February, 1903. Cheval Paar, 2 males, one with eggs and one young female. Deep water off Galle; young female.

The above characters will serve to distinguish this species from any form of *Phoxichilus* hitherto described, the feeble armature of the trunk and femora being the most striking character. The armature of the tibial segments, though feebler than in the European forms, approaches the usual type of the genus, while the tarsus, propodus, and claws differ but slightly from those of other species of *Phoxichilus*. It seems, therefore, that the loss of spines begins on the trunk and extends slowly towards the extremities.

The two forms of *Phoxichilus* most nearly related to the present species are *P. meridionalis*, BÖHM,† from Singapore, and the problematical *P. inermis*, HESSE.‡ The former of these, however, has very prominent spines on the femur, and seems to approach *P. lævis* rather closely, while the latter is said to be 10 millims. long, with almost entirely unarmed legs and a 3-segmented abdomen (the last statement needs confirmation).

I have elsewhere§ drawn attention to the slight comparative characters by which the various described forms of *Phoxichilus* are distinguished from one another, and I think it likely that when specimens of this genus have been obtained from many other parts of the world, it will be impossible to maintain "specific" distinctions. Already we have a series beginning with the well-armed *P. spinosus*, MONT., passing through *P. lævis*, GRUBE, *P. vulgaris*, DOHRN, *P. meridionalis*, BÖHM, to *P. mollis* and *P. inermis*, HESSE, in which the spiny armature has become, to a great extent, lost. And it is of special interest in this connection to note that in one of the Ceylon

* 'Abhandl. d. Schles. Gesellsch. f. vaterl. Cultur,' 1869–72, p. 124–126, Taf. 1, fig. 1.

† 'Monatsber. d. Königl. Akad. Wissensch. Berlin,' 1879, p. 189–191, Plate 2, fig. 4.

‡ 'Ann. Sci. Nat.' (Zool.), (5), vii., 1867, pp. 199–201.

§ 'Sci. Proc. R. Dublin Soc.,' vol. viii., 1893, pp. 200–202.

males of *P. mollis*, the femur both in its form and armature (fig. 3A) shows some approach to what we find in the European species of *Phoxichilus*. The young individuals, too, are markedly spinose as compared with the adults.

The colour of these Ceylon specimens is a pale yellowish-green, the food-canal showing through the semi-transparent body in bluish-green streaks. The male carries the eggs in a large flat cake-like mass of somewhat irregular form (fig. 3).

Family: NYMPHONIDÆ.

Nymphon, Fabr.

Nymphon longicaudatum, n. sp.—Plate, figs. 8–14.

Length, 6 millims. to 8 millims. Head segment nearly as long as the three thoracic segments taken together, neck slender and elongate. Proboscis swollen centrally and constricted behind mouth (fig. 8). Eye eminence with low conical apex (fig. 9). Chelifori elongate; scape nearly as long as proboscis; hand rather longer than scape, with slender, tapering, evenly curved fingers (figs. 8, 10). Palp half as long as body; relative length of its segments as 2 : 8 : 9 : 10 : 6. False leg as long as body; relative length of its segments as 2 : 4 : 4 : 20 : 24 : 10 : 6 : 4 : 4 : 3; denticulate spines with a short sharp basal point, and six to eight sinuous serrations on each side (figs. 11, 12, 13). Legs slender and elongate, spines present only at the tip of the second tibial segment; propodus four times as long as tarsus; principal claw slender, slightly longer than tarsus; auxiliary claws four-fifths as long as principal claw (fig. 14). Abdomen very elongate, slender and club-shaped (fig. 8); as long as the first two thoracic segments together. Colour of body and legs yellow, with a variable amount of dark pigment which is specially well developed along two lateral longitudinal lines on the thoracic segments.

Habitat:—Gulf of Manaar, coral reefs and pearl banks, February and March, 1902. South of Manaar Island (Station LIV., 8 to 9 fathoms), March 8th, 1902. West of Periya Paar (Station LXI., 12 fathoms), March 12th, 1902.

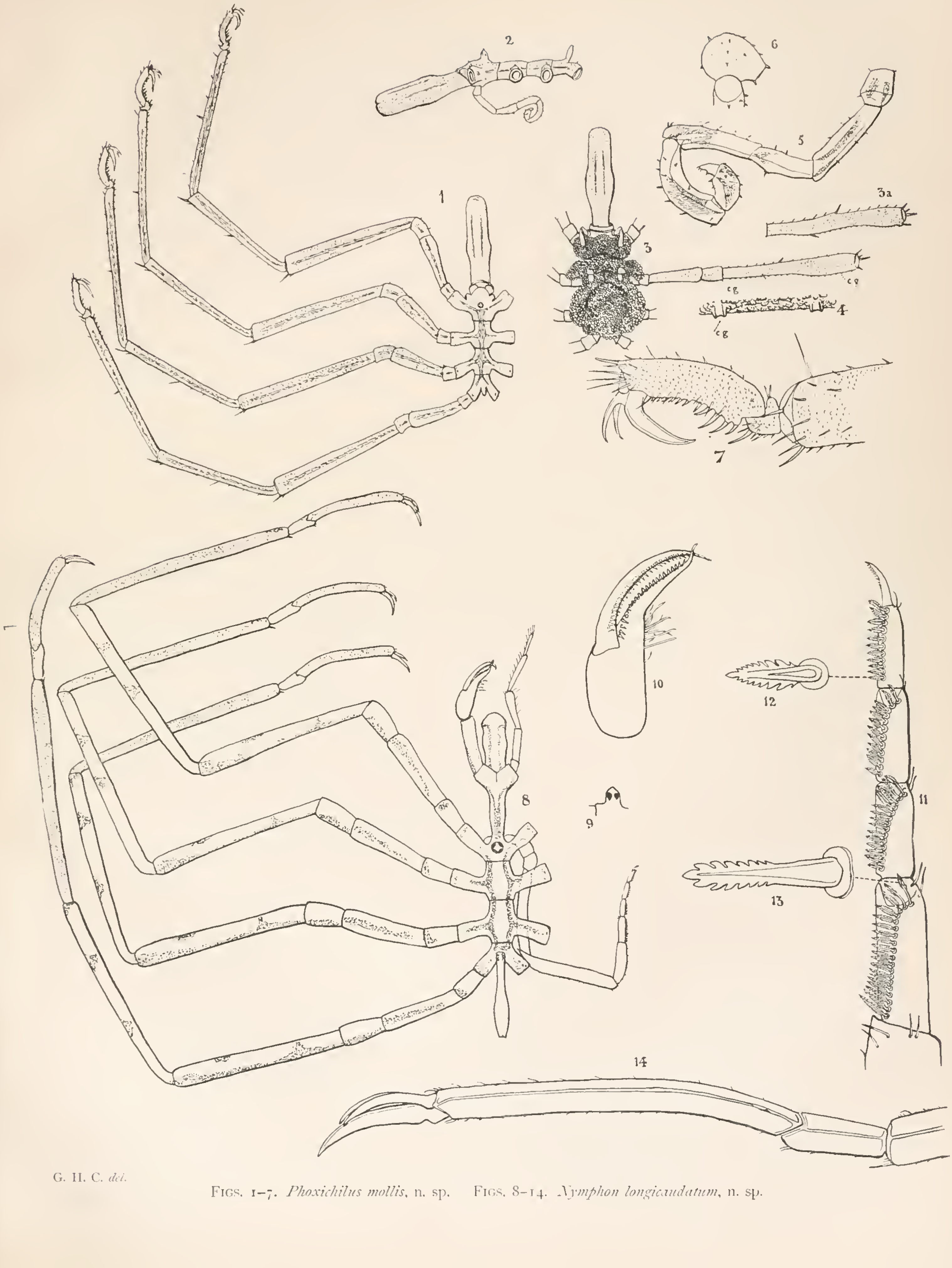
This *Nymphon* is markedly distinguished from any species of the genus known to me by the elongate abdomen, the proportion of the tarsus to the propodus, and the distinct linear pattern on the trunk segments due to the dark pigment. The almost complete absence of spines on the body and legs—which are clothed only with a few scattered, minute hairs—is another striking character.

As usual in this genus, there is no marked difference between the sexes. In the female the proboscis and neck are relatively shorter than in the male.

It is of interest to note that both these species are remarkably poor in spiny or hairy armature or clothing as compared with other members of their genera. Possibly those naturalists who have had the good fortune to observe the animals amid their natural surroundings may be able to suggest some explanation of this modification.

EXPLANATION OF PLATE.

Fig. 1. *Phoxichilus mollis*, n. sp. Female. Dorsal view. × 9.
,, 2. ,, ,, Male. Side view. × 9.
,, 3. ,, ,, ,, Ventral view. × 9. *c.g.*, cement glands.
,, 3A. ,, ,, ,, (Another specimen.) Femur showing variation for comparison with fig. 3. × 9.
,, 4. ,, ,, ,, Hind edge of femur, showing two cement gland openings (*c.g.*). × 460.
,, 5. ,, ,, ,, False leg. × 32.
,, 6. ,, ,, ,, End of 5th and 6th segment. Ventral view. × 32.
,, 7. ,, ,, Female. Tarsus and propodus. × 36.
,, 8. *Nymphon longicaudatum*, n. sp. Male. Dorsal view. × 9.
,, 9. ,, ,, ,, Eye eminence. × 9.
,, 10. ,, ,, ,, Cheliforus. × 27.
,, 11. ,, ,, ,, Terminal segments of false leg. × 50.
,, 12. ,, ,, ,, } Serrated spines of false leg. × 230.
,, 13. ,, ,, ,, }
,, 14. ,, ,, ,, Tarsus and propodus. × 32.



G. H. C. *del.*

FIGS. 1–7. *Phoxichilus mollis*, n. sp. FIGS. 8–14. *Nymphon longicaudatum*, n. sp.

REPORT

ON THE

CEPHALOPODA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

WILLIAM E. HOYLE, M.A., D.Sc.,
DIRECTOR OF THE MANCHESTER MUSEUM.

[WITH THREE PLATES.]

THE collection of CEPHALOPODA, though small, contains several forms of interest. The greatest novelty is a small Octopus, with branched processes scattered over the body, which I have named *Polypus arborescens.* In the integument of these processes are certain peculiar organs, which I have described as well as the state of preservation of the specimens would allow.

A very striking peculiarity of the collection is the preponderance of Octopods; the Decapods are represented only by very few forms, and there is an entire absence of any of the usual pelagic types, owing, no doubt, to the collection having been made for the most part in shallow water on a continental shore.

The number of small Octopods is very large; judging from it these little creatures must swarm on the reefs in those regions. Though very interesting, these immature forms are very baffling and in some respects unsatisfactory as material for a report. In the first place, it is impossible to name them. Their distinctive marks admit of their being grouped pretty readily into sets which presumably correspond to species, but to which of the numerous named adult forms they belong it is quite impossible to say. So far as I am aware, no one has yet studied or described the changes which take place in an Octopus from the time of its emergence from the egg till it attains maturity, and as we are ignorant of this in the commonest forms, it is hopeless to expect the information in the case of the rarer exotic species. I have, therefore, contented myself with describing the more conspicuous varieties of these young Octopods, but without affixing any specific names.

The information given by these young specimens is, however, satisfactory, inasmuch as it shows that even at so early a period different forms can be separated from each other by characters as definite as those which are used in the discrimination of the adult species, not that this is saying much in the case of Octopods, for we are still very much in the dark as to the best specific characters and the range of variation in this bewildering genus.

List of Stations

at which Cephalopoda were obtained, with the species collected at each. The numbers in square brackets correspond to my register of specimens examined :—

STATION I.—First haul of trawl, 31.1.02; 5 miles west and south-west of Negombo; 12 to 20 fathoms; bottom coarse yellow sand with a few dead shells; temperature of sea, 77·5° F.

Sepia rouxi [246].

STATIONS II. and III.—West Ceylon, 1.2.02; various localities between Negombo and Chilaw; 4 to 5 miles off land; depth 8 to 14 fathoms.

Polypus arborescens, n. sp.	[213–215].	*Polypus* J	[205, 206].
,, C	[203, 204].	,, *macropus* (?)	[230].
,, E	[202].	,, *granulatus*, juv.	[195].
,, G	[208].		

STATION LVI.—Half-a-mile east of Dutch Modragam, 2nd haul, 10.3.02; depth 8 to 9 fathoms; bottom coarse quartz sand, with red weed.

Polypus aculeatus	[200].	*Polypus* B	[244].

STATION L. or LI.—Pearl banks, Cheval Paar, 4.3.02; depth 7 to 8 fathoms; bottom sand and dead shells.

Polypus C [196].

STATION LXV.—South end of Cheval Paar.

Polypus herdmani, n. sp.	[231].	*Polypus granulatus*	[211].

STATION XVI.—On Periya Paar; depth 9 fathoms; bottom varied, sand to Nullipores and Coral.

Polypus arborescens, n. sp.	[217].	*Polypus herdmani*, n. sp.	[216].

STATIONS IX. to XIV., XLVIII. and XLIX.—Pearl banks, Gulf of Manaar, Cheval district.

Polypus herdmani, n. sp.	[224–226, 228, 229].	*Polypus macropus*, juv. (?)	[275].
,, *arborescens*, n. sp.	[212, 239–243].	,, A	[233–237, 636 (?)].
,, *aculeatus*	[218–221, 266, 276, 630–632].	,, B (?)	[635].
,, ,, (?)	[197].	,, C	[247–261, 633].
,, *granulatus*	[222, 223, 238].	,, D	[227, 267, 638].
,, *boscii*	[271].	,, G	[194].
,, ,, var. *pallida*	[272, 274].	,, H	[209, 210].
		Inioteuthis maculosa	[198].
		Euprymna morsei	[245].
		Sepia singalensis	[270].

STATION XVIII.—Palk Bay, 14.3.02; south-east of Catchetivo Island; 7 fathoms.

Polypus C [199]. | *Polypus granulatus* [268, 269].

STATION XIX.—Palk Bay; depth $4\frac{1}{2}$ to 8 fathoms; bottom, sand and shells to mud; sea temperature, 7 A.M., 82·8° F.; 5 P.M., 84° F.

Polypus herdmani, n. sp. [201].

STATION XXIII.—Trincomalee, close to Swami Rock, Back Bay; depth $4\frac{1}{2}$ to 8 fathoms; bottom sand, shells, and in places stones and Corals.

Polypus F [207].

STATION XXXIX.—Galle, trawled; from 2 miles south of Point de Galle westwards to Gallehogalle Bank: depth 16 to 30 fathoms; bottom fine sand; stones and Nullipore on the bank.

Sepiadarium kochi [232]. | *Sepia singalensis*, juv. [262–265].

Galle, captured by Professor HERDMAN in the lagoon.

Polypus herdmani, n. sp. [277].

CEPHALOPODA.

SUB-ORDER: OCTOPODA

FAMILY: POLYPODIDÆ.

Polypus herdmani, n. sp.—Plate I.

The Body is comparatively small, purse-shaped, considerably wider behind than at the margin of the mantle; there is no groove on the ventral surface. The mantle opening is very wide, extending more than half-way round the body, and ending a short distance below and behind the eyes. The siphon is comparatively short, extending rather less than half-way to the umbrella margin.

The Head is comparatively small, and the eyes but slightly prominent.

The Arms are long and stout, on an average nearly four times as long as the body. The umbrella is moderately developed; it is narrowest between the two dorsal arms, somewhat broader between the two ventral, and between the lateral arms about equal to the length of the body. The suckers are of moderate size and closely packed; the first four are in a single series, the remainder in two series.

The Surface is wrinkled by folds, probably due to contraction in spirit. It bears a large number of prominent warts or tubercles; on the back, these are for the most part elongated antero-posteriorly, and the skin around them is thrown up into a series of radiating folds; four of these are arranged at the corners of a rhombus with its long axis in the median line, a little distance behind the eyes, and about a dozen others are distributed more or less irregularly on the posterior part of the back. There are also a number of these elongated warts on the proximal portion of the dorsal and dorso-lateral arms. There are two or three very minute warts above and behind the eye.

The Colour is a dull brownish-grey, paler below. At the base of the ventro-lateral arm, about one-third of the distance between the eye and the edge of the umbrella, is a large eye-like spot, about 13 millims. in diameter, consisting of a pale centre surrounded by a broad dark ring; this in its turn is surrounded by a narrow pale ring, again succeeded by a narrow dark one.

Dimensions of Specimen No. 277.

		Millims.
Length, total		550
End of body to eye		95
Breadth of body		58
,, head		47
Eye to edge of umbrella, between dorsal arms		50
,, ,, ,, ,, lateral ,,		80
Length of first arm	Right 316,	Left 228
,, second arm	,, 356,	,, 316
,, third arm	,, 330,	,, 330
,, fourth arm	,, 356,	,, 285

Localities:—Galle, caught by Professor Herdman in the lagoon. One specimen, female [277].

Station XIX., Palk Bay. One specimen, sex (?) [201].

Station XVI., north of Periya Paar. One specimen, female [216].

Pearl banks, Gulf of Manaar. Five specimens [224, male; 225, 226, female; 228, 229, arms mutilated, sex uncertain].

Station LXV., south end of Cheval Paar. One specimen, sex (?) [231].

The species seems to me sufficiently characterised by the presence of the peculiar ocellar spot near the base of the ventro-lateral arm, which is presented with more than usual constancy in all the specimens of the series recorded above. A few minor modifications which occur in the different individuals may be recorded as a means of indicating the amount of variation in the species.

In specimen 201, measuring 10 millims. from the hinder end of the body to the eye, the skin is comparatively smooth, three of the four warts forming the lozenge on the back can be made out; there are a few small warts around the eye, especially on the left side, and the bases of the dorsal arms are granular. In the left ocellus the pale ring is elevated above the general surface, and the pale spot in the centre also forms a raised papilla.

Specimen 216, measuring 10 millims. from the end of the body to the eye, is very firm and shrivelled, and appears at some time to have been allowed to dry up. The four warts on the back are very distinct, and some of the ridge-like warts on the bases of the arms are also visible.

Specimen 224, measuring 10 millims. from the end of the body to the eye, is somewhat more developed than Nos. 225 and 226 found with it. The ocellar spot on the left side is very distinct, but in the centre is a minute black point instead of a pale patch. The four warts, arranged at the angles of a lozenge, are present, as well as some on the bases of the arms. There is also a wart above and behind each eye.

Polypus arborescens, n. sp.—Plate II., figs. 8, 9 and 12, and Plate III.

The Body is rounded, oblong, usually ending in an acuminate point behind; the mantle opening is narrow, extending only about one-third the distance towards the eye from the siphon, which is short and truncated, and reaches only one-third from the mantle opening towards the margin of the umbrella.

The Head is about as wide as the body, and the eyes are only slightly prominent.

The Arms are on an average about twice as long as the body, measured from the posterior end to the eye; those of the fourth pair are the largest, the first the shortest. The umbrella extends up them rather more than one-third their length. The suckers present no unusual characters, the first four are in a single row, both in a specimen with the arms strongly bent outwards and one in which they are nearly parallel. The hectocotylus is of the form usual in the genus, with a very small tip.

The Surface presents a number of branched papillæ, which constitute the most characteristic peculiarity of the species and suggested its specific name. One of these, larger than the others, occupies the acuminate posterior extremity of the body above alluded to; there are one or two over each eye, about a dozen on the back, a few on the ventral surface, and in most cases one or two on the outer aspect of each arm.

They vary somewhat both in size and arrangement. An account of their minute structure will be found below.

The Colour is a dull grey with irregular, oval ring-like markings on the dorsal surface and the bases of the arms.

Localities :—Station II. or III., west of Ceylon. Three specimens [213–215].

Cheval Pearl Banks, Gulf of Manaar. Six specimens [212, 239–243].

Station XVI., on Periya Paar ; depth 9 fathoms. One specimen [217].

I am not acquainted with any other species at all resembling this one in its surface decoration.

The fact of the proximal suckers being in a single row, not only in arms which are bent outwards, but also in those which are straight, is of some interest. The arrangement of these suckers has often been made use of as a specific character, but has always appeared to me to be of very doubtful validity, because there is no doubt that in many instances it varies with the curvature of the arm. The present instance suggests that it may have more value than I have hitherto supposed.

Structure of the Branched Papillae.

The Papillæ vary a good deal in dimensions. An average one (Plate II., fig. 8) would be 0·75 millim. high by 0·4 millim. in diameter, whilst a large one (Plate II., fig. 9) would attain 1·65 millims. in height by 0·6 millim. in diameter. Each consists of a stem and branches, both of which are plentifully bestrewn with chromatophores. Between the larger papillæ are small ones of various degrees of complexity ; some are simple, some bifurcated, some with three or more branches. Papillæ of the smaller kinds are found on the bases of the arms.

The Stem is conical in form, arising gradually from a broad base. In the smaller papillæ (Plate II., fig. 8) the stem remains unbranched to the apex and there gives rise to branches, from two or three to about half a dozen in number. In the larger (Plate II., fig. 9) the branches are given off at intervals from near the base. Sometimes the apex is seen to persist independently of the branches; in other instances there is no definite apex, but the stem divides into a tuft of branches at the top. The apex sometimes presents a yellowish appearance as though a yellow internal mass were shining through the integument.

The Branches are almost cylindrical, tapering only very slightly towards the tips, which are bluntly rounded off. Their diameter varies from 0·03 millim. at the tip to 0·15 millim. at their junction with the stem, and their length from 0·8 millim. to 0·25 millim. In most cases they are simple, but in a few instances they bifurcate (Plate II., fig. 8), and still more rarely trifurcate (Plate II., fig. 9).

When a series of sections is examined, it is found that in those taken near the base, just above the muscles of the body wall, there is in the centre a mass of tissue (Plate III., fig. 1, *cm.*) from 0·21 millim. to 0·24 millim. in diameter. It stains but faintly and presents the appearance of a number of delicate fibrils twisting about in all directions and leaving spaces in which nuclei are situated, though no definite cell boundaries can be distinguished (fig. 4, *c.m.*). The nuclei measure about 0·0058 millim. in diameter, and nucleoli can be seen in them. This central mass rises as a rounded lump to a height of about 0·18 millim.

The greater part of the centre of the stem is made up of a peculiar radially arranged supporting tissue, which stains very deeply with hæmatoxylin. In sections near the base of the papilla this tissue appears as a ring around the central mass and consists of very thin radiating fibres (Plate III., figs. 1 to 4, *r.*), which are collected together in masses forming little trabeculæ, which arise from the surface of the central mass and pass outwards, slightly diverging from each other and leaving clear spaces between them. The rounded spaces at the outer ends of the trabeculæ are occupied by bundles of fibres, which run parallel with the axis of the stem: transverse sections of these bundles are seen in fig. 4, *b.* The trabeculæ stain a deep purple with hæmatoxylin, and thus are in marked contrast with the central mass. They present a number of ovoid nuclei intercalated here and there among the fibres. Above the central mass this axial structure occupies the centre of the stem (compare figs. 1 and 2), and rises up to a height of about 0·7 millim., when it gradually merges into the other tissues of the stem. This axial supporting tissue is produced into the branches, but here it has the appearance of irregular transverse septa (fig. 6, *r.*) with spaces between. The septa are not separate, but continuous with the adjacent ones on either side, owing to their curved form and to connecting pieces passing from one to another. Towards the tip of the branches this tissue becomes less abundant and merges into the surrounding connective-tissue. In the stem this axial tissue is seen to be supplied with blood vessels (fig. 4, *bl.*), but I have not succeeded in detecting any nerves in it.

Around this central column is a layer of connective-tissue (figs. 1 to 3, *c.*) varying from 0·05 millim. to 0·02 millim. in thickness. This is of a loose open nature, with delicate fibrils and numerous large lacunæ; small ovate or spheroidal nuclei are scattered in it here and there. This layer extends into the branches, in the larger of which it is about 0·03 millim. in thickness (fig. 5, *c.*), and gradually disappears towards the tips. Within this connective-tissue layer are the chromatophores and another granular element to be described below.

The chromatophores (*ch.*) are situated in the outer layers of this connective-tissue, either immediately below the epithelium or not very far removed from it. They have the form of little sacs, on an average about 0·035 millim. in diameter. Very often there is a vacant space immediately below the chromatophores (figs. 4 and 13, *l.*). Where the section passes tangentially through the wall of a chromatophore the pigment is seen to be composed of minute granules (fig. 12, *ch.*).

In the connective-tissue layer are also seen here and there masses of substance staining of a paler and more reddish colour than the other tissues and of homogeneous granular nature (figs. 5, 7, *g.*). This substance is highly refringent and, as above mentioned, stains a pale reddish colour with hæmatoxylin and pale yellow with picronigrosin. I thought at first that it might perhaps be muscular, but on further examination it appeared to consist of rounded masses not fibrils, and at present its nature and function seem to be quite uncertain. It does not appear in the basal portion of the papilla, but commences about halfway up the stem, and is most abundant in its distal portions and in the stouter branches, where it sometimes occupies quite a large proportion of the transverse section (fig. 5, *g.*), and I think it is the cause of the yellowish appearance of the apex mentioned above. It extends in gradually decreasing amount along the branches, but ceases some distance from the tips (figs. 7 and 8). Towards the tips of the branches the various component tissues gradually disappear, leaving only the connective-tissue and epithelium (fig. 8).

The epithelium covering the papillæ (figs. 1 to 9, *ep.*) consists of a single layer of cells, and is about 0·02 millim. in thickness. The cells are of rounded quadrangular outline and have large spheroidal nuclei.

In relation with the epithelium are certain peculiar spherules (Plate III., figs. 9 to 13), the nature of which seems to me very problematical. There are between 15 and 20 of these arranged in a ring around the stem of the papilla quite close to its base. They are irregularly placed, sometimes in a single row, sometimes in two, and they vary in diameter from 0·034 millim. to 0·05 millim. Very few of them come to the surface, and I was unable to find any trace of them by surface examination. I am inclined to think that the different appearances presented by these bodies indicate developmental stages, and I will therefore first describe what seems to be the most complete form.

The central part of the organ consists of a cylindrical plug (figs. 9 to 13, *p.*), the outer end of which is almost on a level with the surface of the epithelium, the other extremity penetrating somewhat below it. The outer end is slightly convex, the inner appears to merge gradually into the tissue beneath. In transverse sections the plug is oval, the diameters being 0·03 millim. and 0·025 millim.; the length of the plug cannot be measured exactly, owing to its fusion with the other tissues at the lower end, but it may be taken at about 0·035 millim. The composition of this plug is faintly granular and almost homogeneous; it shows traces of breaking up here and there into fragments by transverse lines, but this is probably an effect of shrinkage. Below the plug and sometimes apparently rising up around it is a mass of tissue of a flattened spheroidal shape (*m.*). The plug fits into a depression in the outer surface of it, and its lateral expansions support the superficial epithelium. In the only longitudinal section I have of one of these structures (fig. 10) the diameter of this lower portion is 0·065 millim., and its depth below the epithelium 0·021 millim. approximately. In this longitudinal section it appears granular and faintly stained like that of the plug, but there is a distinct tendency for the granules to be arranged in layers (figs. 10, 11, *m.*). In sections at right angles to this the structural arrangement is concentric with the plug. Definite layers cannot be made out, but portions of greater and less density alternate with each other (figs. 12, 13, *m.*). In some instances I was able to make out a nucleus either in the plug itself or in the subjacent granular tissue. This spheroidal mass has no definite boundary, but gradually passes over into the connective-tissue lying beneath the epithelium.

The epithelium covering the surface of the papilla undergoes a modification in the neighbourhood of these organs. For a little distance around, the cells become columnar instead of cubical, and their nuclei long and attenuated instead of spheroidal (compare figs. 11 and 13). It seems probable that this is due to a compression caused by the plug pushing its way to the surface from beneath. The cells closely surrounding the plug are even more flattened, so as to form an envelope round the sides of the plug, and often to extend inwards a little way below the general lower surface of the epithelium (fig. 9), so that a section parallel with the surface shows them as a ring surrounding the plug, and in their turn encircled by the granular mass (fig. 12, *ep.*).

The upper surface of the plug shows a dense deeply stained boundary, outside which is sometimes a thicker more faintly stained layer (fig. 10), and from this arises a bunch of radiating fibres (figs. 10, 11, *f.*). These are extremely thin, straight, and many of them have slight swellings at the end. They are about 0·06 millim. in length, and their diameter too small to be measured by any appliances at my disposal; it is certainly less than 0·0015 millim. Generally they appear quite discrete, but in one section there seemed to be a delicate transparent substance connecting their tips, and spreading out beyond their extremities into a sort of thin cloud. I did not observe this in any other sections and conclude that it is in some way due to artificial causes.

It is only some half-dozen of these organs which present the appearance just described, that is to say, which come up to the surface and give off a tuft of fibrils. The remainder are completely covered by the epithelium, and hence I conclude they are similar bodies in course of development, which have not yet reached the surface.

The nature of these bodies seems to me very obscure; the different possibilities are as follows:—In the first place they may be parasitic; the radiating tuft of fibrils with thickened ends suggests an Acinetan, but against this are to be set the following considerations: these bodies appear to originate from within and not from without, there is no definite boundary between them and the surrounding connective-tissue, and their granular substance does not resemble the cell contents of the Protozoa.

Assuming that they belong to the Cephalopod, there seem to be difficulties in the way of referring them to any recognised type. The possibility of their being either glandular or phosphorescent seems to be excluded by the tuft of radiating fibrils, whilst against a sensory function must be urged the fusion of their lower portion with the surrounding tissues and the fact that no nerves have yet been traced to them. On the whole, this last view would seem to present less difficulty than the others, and it may, therefore, be adopted as a working hypothesis. Dr. ASHWORTH has called my attention to their similarity to the lateral organs of Annelids, described by EISIG ('87) and himself (:01).

With respect to the function of the papilla as a whole, the most plausible explanation appeared to me that they are protective. In the spirit specimens they are not altogether unlike the tentacle-bearing heads of polyps, such as *Hydractinia*, and I thought they might furnish the Octopus with a disguise to assist it in concealing itself. Professor HERDMAN, however, tells me that this theory does not agree with his observations on the living animal, which he kept for some time in a small tank. Under these conditions "the papillæ do not look at all like polyps; they are contractile and are kept frequently moving—uncoiling to a considerable length and then curling up again suddenly."

Polypus aculeatus (D'ORBIGNY); GOODRICH ('96)—Plate II., figs. 10 and 13.

Localities:—Pearl Banks, Gulf of Manaar, Cheval district. Ten specimens [197, male (?); 218–221, female; 266, male; 276, female; 630–632, sex (?)].

Station LVI., half-a-mile east of Dutch Modragam. One specimen, sex (?) [200].

. The coloration of these young specimens so closely resembles that of D'ORBIGNY'S species (*Octopus aculeatus*) that I feel but little hesitation in referring them to it. This identification is confirmed in most instances by the presence of small tubercles arising from the centre of the pale circular patches on the upper surface. The general appearance of these examples is shown in Plate II., fig. 13.

Specimen 197 was very small, only 5 millims. in length from the end of the mantle to the eye; the patches were indistinct and no tubercles were visible, so that the determination is less certain than in the other cases.

Specimen 266 was the largest, and measured 15 millims. from the hinder end of the body to the eye. The hectocotylised arm (Plate II., fig. 10) had apparently been mutilated and subsequently repaired. It is normal up to within 2 centims. of the extremity; there it becomes swollen up (*a*) and the suckers suddenly cease; the groove on the ventral aspect (*b*) runs out on the surface where the suckers should be and stops abruptly, about 5 millims. beyond the gap in the series of suckers. From this point there grows out a new tip, quite normal in appearance and about 10 millims. long (*c*). A new groove (*d*) has been formed, starting from a point a little beyond the place where the original groove ceases and quite disconnected from it, and the usual spud-shaped extremity has been formed at the apex of the arm (*e*). This reproduction is of special interest by reason of its rarity. STEENSTRUP ('56, p. 107, footnote) was of opinion that the hectocotylised arm was never replaced, and that consequently the animals exercised special care in order to prevent injury to it. The examination of this specimen further raises the interesting question: If the function of the groove be to transmit the spermatophores, could this action be carried out in the event of the groove being interrupted?

Specimen 276, measuring 9 millims. from the hinder end to the eye, has many characters in common with the others above mentioned, but the colouring is much darker; the papillæ in the centres of the rounded areas are black instead of pale, and there are also black papillæ on the outer aspect of the proximal half of the arms. At present it seems to me most likely a melanic example of *Polypus aculeatus*, but it may perhaps be the young of some undescribed species.

Polypus boscii (Lesueur).

Localities :—Pearl banks, Gulf of Manaar, Cheval district. Three small specimens [271, male; 272, female; 274, male].

This species has hitherto only been recorded from the Australian region. Specimens 272 and 274 are characteristic examples of the var. *pallida*, first obtained by H.M.S. 'Challenger' (Hoyle, '86, p. 81, plate I.).

Polypus macropus (Risso) (?); Goodrich ('96).

Localities :— Station II. or III., West Ceylon. One young specimen [230, female].

Pearl banks, Gulf of Manaar, Cheval district. One specimen [275, male].

Two small specimens, 11 millims. and 8 millims. in length from the end of the body to the eye respectively, may be the young of this widely-distributed species.

Polypus granulatus (Lamarck); Hoyle ('86); Goodrich ('96).

Localities :—Station II. or III., West Ceylon. One young specimen, sex (?) [195].

Station LXV., south end of Cheval Paar. One specimen, sex (?) [211].

Pearl banks, Gulf of Manaar, Cheval district. Three specimens [222, 223, 238].

Station XVIII., Palk Bay, south-east of Catchetivo Island, 7 fathoms. Two specimens [268, 269].

Specimen 195, measuring 8 millims. from the end of the body to the eye, is paler in colour than usual and has a double row of small chromatophores along the outer surface of each arm.

Specimen 211, measuring 12 millims. from the end of the body to the eye, I thought at first must be a male, in which the hectocotylisation was just beginning; it has a slight ridge along the ventral aspect of the third right arm, but no modified tip is to be seen. I have, however, since seen similar ridges on several different arms.

Polypus, juv., A—Plate II., fig. 1.

A number of small Octopods, averaging 5 millims. in length from the hinder end of the mantle to the eye, agree in having a smooth body, long slender arms, connected by a very delicate umbrella extending 4 millims. to 6 millims. from the base, a double row of small dark chromatophores on the outer surface of each arm, and a conspicuous patch of them on the under surface of the mantle.

Locality :—Pearl banks, Cheval neighbourhood, Gulf of Manaar. Five specimens [233–237].

Polypus, juv., B—Plate II., fig. 4.

A smooth form, with very prominent eyes and a few scattered granules on the upper surface.

Locality :—Station LVI. (?), half-a-mile east of Dutch Modragam, second haul. One specimen, sex (?) [244].

Polypus, juv., C—Plate II., figs. 2 and 5.

The specimens enumerated below all appear to me to be the young of one and the same species, which it is just possible may be *P. granulatus* (Plate II., fig. 2). Their most conspicuous characters are a plump, rounded body, short arms, with a rudimentary umbrella between them, a slight but distinct granulation on the back and between the eyes; there is a single row of rather large pale chromatophores on the outer surface of the arms, and one or more bands of them run along the under surface of the mantle parallel with the opening (fig. 5).

Localities :—Station L. (?), pearl banks, Cheval Paar, 4.3.02. One specimen [196].

Station XVIII., Palk Bay, S.E. of Catchetivo Island, 7 fathoms. One specimen [199].

Station II. or III., West Ceylon Two specimens [203, 204].

Pearl banks, Cheval neighbourhood, Gulf of Mánaar. Fifteen specimens [247–261].

Polypus, juv., D—Plate II., fig. 11.

A young form, 10 millims. in length from the hinder end of the mantle to the eye, with a short, rounded body, prominent eyes, with a small wart over each, long slender arms (25 millims. to 30 millims. in length), united by a broad umbrella (10 millims. in breadth, except between the dorsal arms, where it is much less), two irregular rows of small chromatophores along the outer surface of each arm, and a conspicuous patch of chromatophores on the ventral surface. There are two or three moderate-sized warts on the back and a number of small ones on the broad portion of the upper arms. The measurements are taken from specimen 227.

Locality :—Pearl banks, Cheval neighbourhood, Gulf of Mánaar. Two specimens [227, female ; 267, male].

This form agrees with that which I have marked A in the conspicuous patch of chromatophores on the ventral surface and the rather wide, delicate umbrella, but it differs in the presence of well-marked warts over the eyes, and in the chromatophores on the arms being much less delicate and regular. I think they are the young of distinct species.

Polypus, juv., E.

This specimen, 6 millims. in length from the hinder extremity to the eye, has a roughish surface, small warts over the eyes, and two rows of chromatophores widely separated along the outer surface of the arms, which are of moderate length (10 millims. to 12 millims.).

Locality :—Station II., off Chilaw, west of Ceylon. One specimen, sex (?) [202].

This form differs from the one marked A in being more granular, in having small but distinct warts over the eye, and in the arms being comparatively shorter and with a much smaller web.

Polypus, juv., F—Plate II., fig. 6.

This young specimen, 7·5 millims. from the hinder end to the eyes, has the upper surface slightly granular, more markedly so between the eyes, and to some extent on the upper and outer surface of the umbrella and between the dorsal arms. There are two small indistinct warts above each eye; the colour is a dull purplish-grey, paler below. There are two rather irregular rows of chromatophores along each arm and a few large ones scattered on the under surface. The arms are subequal and about 15 millims. in length. This species differs from the last-named in the granular surface of the upper part of the head and body, and in the fact that the chromatophores are absent on the hinder extremity and much smaller and less abundant on the inferior surface of the mantle.

Locality :—Station XXIII., off Trincomalee. One specimen, sex (?) [207].

Polypus, juv., G—Plate II., fig. 3.

Two young examples, 6·5 millims. and 7·5 millims. in length from the hinder end to the eyes, agree in a general resemblance to those marked C, but the chromatophores on the arms are in two rows, with a very narrow line between them (fig. 3), and on the under surface they are evenly distributed instead of being collected in a band along the opening of the mantle. The arms are short, 10 millims. to 12 millims. in length, measured from the eye.

Localities :—Cheval Paar. One specimen, sex (?) [194].

Station II., off Chilaw, west of Ceylon. One specimen, sex (?) [208].

Polypus, juv., H.

These two specimens, like those just mentioned, closely resemble the series marked C; they have a single row of chromatophores on the outer aspect of each arm, but the arms are much longer in proportion, measuring 10 millims. to 12 millims. in comparison with a body length of 5 millims. There is a minute wart over each eye.

Locality :—Gulf of Manaar. Two specimens [209, 210].

Polypus, juv., J—Plate II., fig. 7.

Two specimens, 5 millims. and 6·5 millims. in length of body respectively, agree in having a curious mottled and variegated surface. The smaller is decidedly darker than the larger. Here and there on the body are rough irregular warts, and it is just possible that they might be the young of *Polypus arborescens.* I do not think this is so, as I should have expected the branched warts to be more developed in a specimen of the size of No. 206.

Locality :—Station II., off Chilaw, west of Ceylon. Two specimens, sex (?) [205, 206].

SUB-ORDER: DECAPODA.

FAMILY: SEPIOLIDÆ.

Inioteuthis maculosa, GOODRICH ('96).

Locality:—Pearl Banks, Cheval neighbourhood, Gulf of Manaar. One specimen, female [198].

Euprymna morsei (VERRILL).

Locality:—Pearl Banks, Cheval neighbourhood, Gulf of Manaar. One specimen, female [245].

The *Inioteuthis morsei* of VERRILL ('81, p. 417); see HOYLE ('86, :04); STEENSTRUP ('87); GOODRICH ('96).

Sepiadarium kochi, STEENSTRUP.

Locality:—Station XXXIX. (?), two miles south of Point de Galle. One specimen, male [232].

The researches of APPELLÖF ('98) on this species and allied forms seem to me to justify his action in classifying it with *Sepiola* and *Rossia* rather than with *Sepia* and *Loligo*, as maintained by STEENSTRUP.

FAMILY: SEPIIDÆ.

Sepia rouxi, FÉRUSSAC and D'ORBIGNY ('35).

Locality:—Station I., off Negombo, first haul of trawl, 31.1.02. One specimen, female [246].

Sepia singalensis, GOODRICH.

Localities:—Pearl Banks, Gulf of Manaar. One specimen, female [270]. Station XXXIX., two miles south of Point de Galle. Four specimens, female [262–265].

Specimens 262–265 are, I think, the young of the same species, but I was not able to make out with certainty the suckers on the buccal membrane.

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EXPLANATION OF PLATES.

PLATE I.—*Polypus herdmani*, n. sp.

Fig. 1. Dorsal view of the type specimen. Natural size.

PLATE II.

Fig. 1. *Polypus* A. Natural size.
,, 2. ,, C. ,,
,, 3. ,, G. The second arm on the left side, to show the double row of chromatophores. × 6 diameters.
,, 4. ,, B. Natural size.
,, 5. ,, C. Ventral surface to show the rows of chromatophores parallel with the margin of the mantle. × 5 diameters.
,, 6. ,, F. ,, ,, ,, arrangement of the large chromatophores on the ventral surface. × 5 diameters.
,, 7. ,, J. Two specimens. × 2 diameters.
,, 8. ,, *arborescens*, n. sp., one of the medium sized branched papillæ. × 43 diameters.
,, 9. ,, ,, ,, ,, larger branched papillæ. × 43 diameters.
,, 10. ,, *aculeatus*, tip of the hectocotylised arm of specimen 266. × $2\frac{1}{2}$ diameters.
,, 11. ,, D. Ventral surface to show the patch of large chromatophores. × 3 diameters.
,, 12. ,, *arborescens*, n. sp., specimens in various attitudes to show the branched papillæ. Nat. size.
,, 13. ,, *aculeatus*, specimens showing the characteristic surface markings. Natural size.

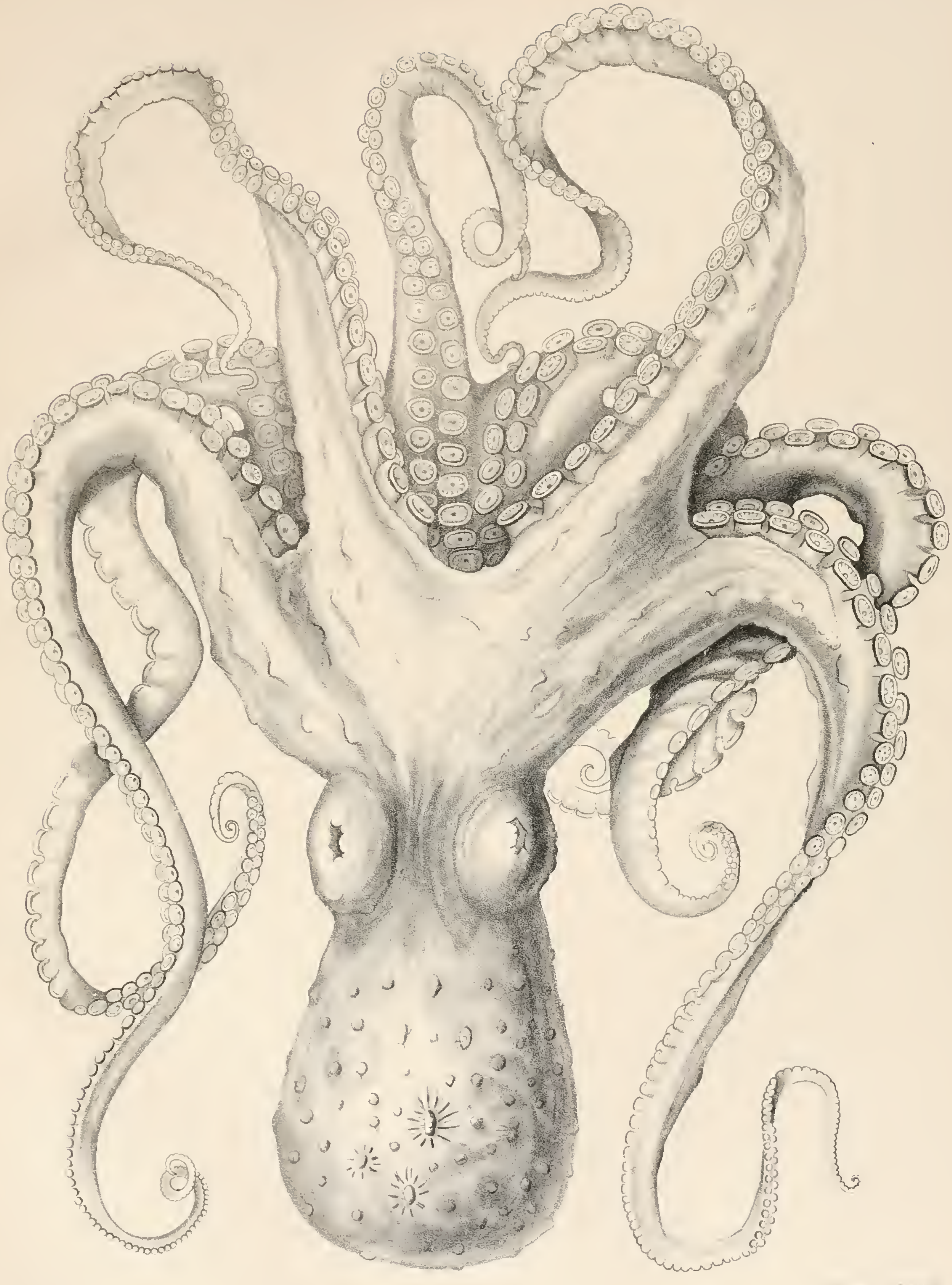
Figs. 1, 2, 4, 7, 12 and 13 are from photographs.

PLATE III.—Papillæ of *Polypus arborescens*, n. sp.

Fig. 1. Section near the base of a papilla. × 38.
,, 2. ,, somewhat higher up. × 38.
,, 3. ,, taken where the lateral branches begin. × 38.
,, 4. A portion of a section such as fig. 1, extending from the central mass to the outside. × 286.
,, 5. Section through a branch, showing a large amount of granular material. × 250.
,, 6. Longitudinal section of one of the thicker branches. × 250.
,, 7. Section through one of the thinner branches. × 286.
,, 8. ,, close to the tip of one of the branches. × 286.
,, 9. Diagrammatic vertical section of one of these organs. × 286.
,, 10. Section at right angle to the surface through one of the epithelial organs. × 430.
,, 11. Oblique section, showing the nucleus. × 430.
,, 12. Horizontal section, taken at the level *A*, *B* in fig. 9, showing the central plug, with layer of epithelial cells and connective-tissue around this again. × 430.
,, 13. A similar section, taken somewhat lower down, at the level of *C*, *D*, fig. 9. × 430.

EXPLANATION OF LETTERS.

b., bundles of fibres parallel to axis of papilla.
bl., blood vessels.
c., connective-tissue.
ch., chromatophores.
c.m., central mass.
ep., epithelium.
f., bunch of fibrils, radiating from the surface of the epithelial organs.
g., granular tissue.
l., lacunæ.
m., mass of granular tissue in epithelial organs.
n., nuclei.
or., organs in the epithelium.
p., central plug of granular material in epithelial organs.
r., radiating connective-tissue fibres.



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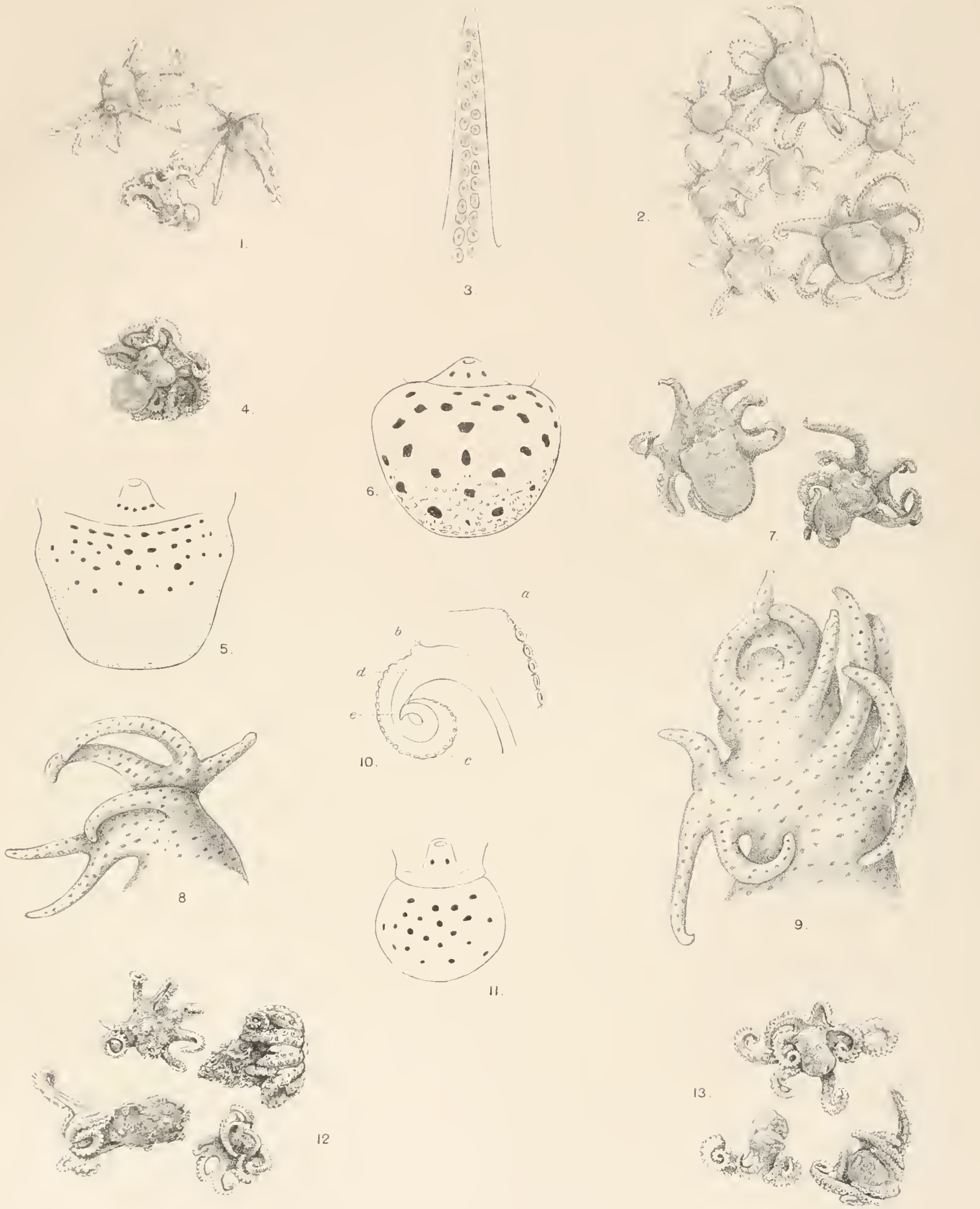
POLYPUS HERDMANI, n.sp.



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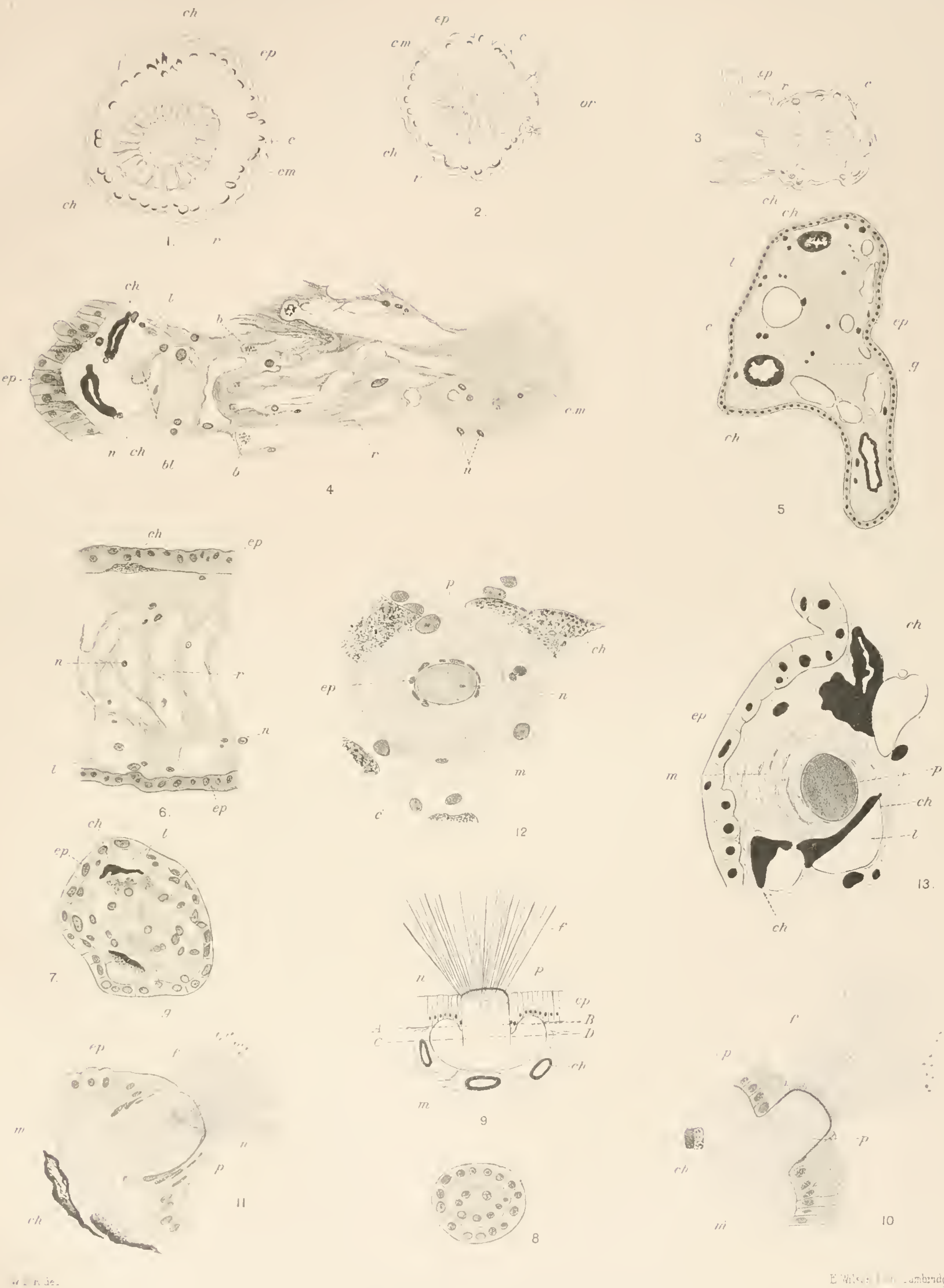
POLYPUS.



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REPORT

ON THE

MARINE FISHES

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH TWO PLATES AND TWO FIGURES IN THE TEXT.]

THE collection of fishes made by Professor HERDMAN in the Gulf of Manaar and elsewhere around Ceylon contains 117 species belonging to 73 genera. One species, *Salarias furcatus*, is now described for the first time. Several other specimens obtained are also of much interest. A series of stages, including the adult female, of ALCOCK'S *Psettylis ocellata* were obtained, and, since the original description of this species was based on immature specimens, I have been enabled to revise both generic and specific diagnoses. *Solea oculus*, ALCOCK, of which only two specimens have hitherto been obtained, has also been taken by Professor HERDMAN. An undescribed immature form, belonging apparently to the genus *Scatophagus*, which has previously been found off the coast of Patani, in the Malay Peninsula, was also collected.

DAY (**5**), in his revision of Indian Fishes, records about 1010 marine fishes from Indian seas, and ALCOCK (**4**) subsequently gave an additional list of 202 species, mostly deep-sea forms, which were not recorded by DAY. The present collection, therefore, contains about one-tenth of the species known to inhabit the Indian area. The Gulf of Manaar, however, has a more abundant piscine fauna than the present list represents. E. THURSTON (**10**), in a survey of the pearl banks in this area, collected 107 fishes and, owing apparently to the different method of collection adopted, only 16 species are common to the two lists. The total number of fishes obtained from the Gulf of Manaar is therefore 202.

Twelve species in the present collection are now recorded from Indian shores for the first time. These are:—

Monacanthus tomentosus (L.).—Gulf of Manaar.
Hippocampus villosus, GÜNTHER.—At Station LIV., south of Adam's Bridge.
Solenostoma paradoxum, PALL.—Gulf of Manaar.
Opichthys timorensis, GÜNTHER.—At Station LIV., south of Adam's Bridge.
Platycephalus asper, CUV. and VAL.—At Station XX., Trincomalee.
Arnoglossus spilurus, GÜNTHER.—Common.
Pseudochcilinus hexatænia, BLEEKER.—South of Galle.
Pegasus volans, LINN.—At Aripu Reef.
Aploactis aspersa, TEMM. and SCHLEG.—South of Adam's Bridge.
Erythrichthys leucogrammicus (BLEEKER).—Cheval Paar.
Apogon encastigma, RÜPPELL.—At Aripu Reef.
Apogon septemstriatus, GÜNTHER.—At Station XLIV., south-west of Ceylon.

The classification and nomenclature used by DAY have been adhered to for the most part in the following list, with such changes as have been necessitated by the works of GÜNTHER and ALCOCK.

PISCES.

ELASMOBRANCHII.

CARCHARIIDÆ.

Carcharias, sp.

A fœtus, about 14 inches long, which was taken from an unidentified shark, about 5 feet in length, caught in the Gulf of Manaar.

TORPEDINIDÆ.

Narcine timlei (BL. SCHN.)

Two specimens, largest about 6 inches long. Palk Straits.

TRYGONIDÆ.

Pteroplatea micrura (BL. SCHN.).

A small specimen, about 13 inches across the disc. Pearl banks off Aripu.

MYLIOBATIDÆ.

Dicerobatis eregoodoo, RUSSELL.

A large female was taken at the south end of the Periya Paar; the disc was 38 inches long and the tail about 13 inches. A fœtus was taken from this fish which is about 12½ inches across the disc; the disc is about 8 inches and the tail about 14½ inches long.

TELEOSTEI.

SCLERODERMI.

Monacanthus choirocephalus (Bleeker).

Two specimens from pearl banks off Aripu.

Monacanthus setifer, Bennett.

One specimen from the Aripu pearl banks. The skin is velvety and the "pile" is markedly higher on the body between the second dorsal and anal fin than elsewhere. The dorsal spine has 4 very prominent barbs on either postero-lateral margin, and each of these barbs bears a fleshy tentacle which is leaf-like and serrated on both edges. There are somewhat similar tentacles on the body.

Monacanthus tomentosus (Linn.).—Plate I., fig. 2.

Height of body (including ventral spine, but not including dorsal spine) $\frac{1}{2}$ of the total length; dorsal spine about $4\frac{1}{2}$ in the total length; diameter of eye about $\frac{1}{2}$ the length of the dorsal spine. Eyes above and in front of the gill slits.

Radial formula: D. 27; A. 27; P. 12; C. 12.

Dorsal spine with 4 rows of barbs directed downwards. The 2 anterior rows are closer together than the posterior ones, about 5 barbs in each row. A number of smaller barbs irregularly arranged at the base of the spine. Ventral spine very rough with numerous spinules, 6 of which are larger than the rest and are arranged round the base of the spine. A thick membrane joins the spine to the ventral body wall.

Lateral line with two obtuse angles.

The ground colour (in spirit) is light brown, with dark longitudinal, but rather irregular bars.

Skin velvety to the touch, covered with minute spines.

One immature specimen, 1·4 inches long, was found in the Gulf of Manaar.

Triacanthus brevirostris, Temm. and Schleg.

One specimen from pearl banks off Aripu.

Ostracion turritus, Forsk.

One specimen from Aripu.

Ostracion punctatus, Bl. Schn.

One specimen from Trincomalee.

Ostracion nasus, Bloch.

A number of immature specimens ($\frac{1}{2}$ inch and less in length) were taken at Galle. Station XX.

Balistes stellatus, Lacépède.

Skin of specimen about 17 inches long. Galle.

GYMNODONTES.

Tetrodon margaritatus, Rüppell.

One specimen, about $2\frac{1}{2}$ inches long, from Aripu.

Tetrodon lunaris, Bl. Schn.

Numerous immature specimens from Aripu, also one specimen, 6 inches long, which was taken on a line in the Gulf of Manaar.

SYNGNATHIDÆ.

Syngnathus longirostris (Kaup).

Two specimens about $7\frac{1}{2}$ inches long.

Ichthyocampus carce, Ham. Buch.

One immature specimen from south of Galle.

Gastrotokeus biaculeatus (Bloch).

One specimen, 6 inches long, from Gult of Manaar.

Hippocampus villosus, Günther.

Two specimens were obtained which I refer to this species. They differ slightly from Günther's description: the groups of filaments on the tubercles are more dendritic than is represented in his figure. There are about 45 body rings present; the dorsal fin has 16 rays; the length of the snout, which was equal to the distance between the lens of the eye and the gill opening in Günther's specimen, is less in the Ceylon ones, so that the snout appears somewhat shorter. The species, however, are most probably the same.

Two specimens, 1·9 inches long, at Station LIV. (south of Adam's Bridge).

Hippocampus guttulatus, Cuvier.

Two specimens from Station LIV. (south of Adam's Bridge).

SOLENOSTOMIDÆ.

Solenostoma paradoxum, Pall.

One specimen, about $3\frac{3}{4}$ inches in extreme length, from the Gulf of Manaar. The colours, in alcohol, are light orange on the body and crimson on the tips of the fins and on the eyes. The specimen is a female, and has a brood pouch containing both eggs and newly hatched larvæ. Mr. Hornell has since found a specimen covered with arborescent filaments (and with radial formula:—D. 5, 19; A. 21; P. 25; V. 7; C. 16; and two elongated black marks on front dorsal fin) which may be a distinct species.

MURÆNIDÆ.

Muræna picta, Günther.

One specimen from Galle Lagoon.

Opichthys timorensis, Günther.

Two eels, about $9\frac{1}{4}$ inches long, were obtained on Station LXV. (west of Cheval Paar), which appear to belong to this species. The dorsal and anal fins are very low, almost absent ; the former begins immediately above the gill slits, the latter a little distance behind the anus. The tail is a little longer than the body ; the head is contained 7 times in the distance between the snout and the anus ; the body is lumbriciform. The teeth are small and pointed ; there are 2 rows on the vomer and a single row in the upper and lower jaws. The coloration is almost uniform (in spirit), yellowish, with brown granular dots on the back.

CHIROCENTRIDÆ.

Chirocentrus dorab (Forsk.).

One specimen, about $12\frac{1}{2}$ inches long, from Palk Strait.

CLUPEIDÆ.

Engraulis commersonianus (Lacépède).

A number of specimens, about 3 inches long, from pearl banks off Aripu.

Clupea fimbriata (Cuv. and Val.).

From pearl banks off Aripu.

Pellona indica, Swainson.

From pearl banks off Aripu.

SCOMBRESOCIDÆ.

Belone, sp.

A young fish, about $\frac{9}{10}$ inch long, found in the Gulf of Manaar, is referred to this genus. The characters of the young differ so much from those of the adults, that it is hardly possible to determine the genus with accuracy. The jaws are not prolonged, and the caudal is truncated. The dorsal fin has 23 rays and the anal 22.

SCOPELIDÆ.

Saurus indicus, Day.

Galle ; very numerous ; also Palk Bay.

Saurus myops (Forsk.).

Galle ; very numerous.

Saurida tumbil (BLOCH).

Galle and Aripu; very numerous.

Saurida nebulosa (SOLANDER).

One specimen was dredged $\frac{3}{4}$ mile north-north-west of Foul Point, Trincomalee, Station XXIV.

SILURIDÆ.

Freshwater fishes were not collected, so that this family is only slightly represented.

Arius venosus, CUV. and VAL.

Three specimens, the largest of which is about 12 inches long, were obtained at Station XVII., on the pearl banks off Aripu.

PLEURONECTIDÆ.

Flat fishes are, as might be expected, very well represented in this collection. Eight genera and 16 species altogether were collected.

Psettodes erumei (BL. SCHN.).

Numerous specimens up to 14 inches long were obtained from the pearl banks off Aripu. This species appears to be indifferently sinistral and dextral. The single specimen examined was sinistral.

Pseudorhombus arsius, BLEEKER.

Numerous specimens, varying in length from 12 inches downwards, were collected from Station II., near Negombo, and from the pearl banks off Aripu.

Solea oculus, ALCOCK.

The only specimen belonging to this genus was obtained in Palk Bay, Station XIX. It agrees in every particular with the beautiful species obtained by ALCOCK (3) in Bengal Bay, 32 miles south-west of Puri. It is $3\frac{1}{10}$ inches in extreme length. The depth of water it was obtained from is curiously enough exactly that (7 fathoms) recorded by ALCOCK.

Synaptura cornuta, CUV.

One specimen, about 5 inches in extreme length, was obtained in deep water (25 to 30 fathoms) off Galle, Station XLVI. There are 14 dark bands on the ocular side which are perfectly parallel and transverse to the long axis; each is darker at its margins. The anterior thickened first ray of the dorsal fin is markedly on the blind side. The pectoral fins are short and thickened; their bases are covered with small scales, and they are continuous with the upper margin of the opercular fold. The scales are peculiar; the projecting margins are thickly covered with skin, and on the head, on the blind side of the body, these integumentary margins become thicker and might be regarded as short tentacles. The scales are continued on both sides of the body for a short distance into the gill cavities.

Psettyllis pellucida, ALCOCK.

Palk Bay, 3 specimens, 1·3 inches to 1·6 inches.

Psettyllis ocellata, ALCOCK.

Palk Bay, 7 specimens, 1·6 inches to 2·2 inches, and a mature female, 4·7 inches long—the latter is figured (Plate I., fig. 3) as only an immature stage was known.

Note on the genus **Psettyllis**.—Plate I., fig 3, and Plate II.

Psettyllis was created by ALCOCK (1) in 1890 for the reception of a number of Pleuronectids allied to *Rhomboidichthys* which he obtained off the Ganjam and Vizagapatam coasts in 7 to 13 fathoms of water. ALCOCK entertained the possibility that these forms might be "larval or stunted" flat-fish; but in the relative proportions of the body, the completed symmetry, the unilateral restriction of the pigment, the perfect ossification of the skeleton, the slight unilateral atrophy of the paired fins, and the character of the vertical fins, he saw indications of development which warranted generic and specific discrimination. Many of these characters are not, however, absolutely diagnostic of completed development; the ossification of the skeleton, for instance, is already almost perfect in very small plaice, and some pigmentation of the blind side would appear to be quite a normal feature in some tropical species of Pleuronectidæ, in some species of *Arnoglossus* for instance. Study of the specimens of *Psettyllis* obtained by Professor HERDMAN in Palk Bay affords conclusive proof that the forms described by ALCOCK as *P. ocellata* are certainly, and that those described as *P. pellucida* are probably, immature.

The 8 specimens of *P. ocellata* (Plate II., figs. 3 to 8) form a natural series and have the following characters in common:—(1) The pigmentation, in so far as the form and distribution of the ocelli are concerned: there is a most characteristic ocellus behind the lateral line elevation and a number of differently shaped ocelli on the body and vertical fins; (2) the lateral line: there is a peculiar elevation above the pectoral fin on the ocular side, which presents two almost right angles; and (3) the scales: the surface of the body is covered with small cycloid scales, but close to the bases of the dorsal and anal fins on the ocular side there are one or more rows of ctenoid scales.

Two of these specimens belong to the stage figured and described by ALCOCK. The general surface of the body is colourless; the eyes are separated by an inter-orbital space equal to 1·7 times the major diameter of the eye; the scales are very small and are apparent only on a microscopical examination of the skin; the ctenoid scales along the fin margins are just indicated; and the ratio of the height of the body to the length (exclusive in both cases of the fins) is 0·73 : 1.

Five specimens differ slightly from the above. The general surface of the body is pigmented (brownish in spirit); the interorbital space is nearly equal to the major diameter of the eye; the ctenoid scales along the fin margins are very evident; and the ratio of the height to the length of the body in the largest is 0·69 : 1.

The single large specimen (Plate II., fig. 3) is 4·7 inches in total length. It is a female with ripe ovaries. The interorbital space is nearly equal to the major diameter of the eye. The ratio of the height of the body to the length is 0·65 : 1. The length of the head is contained $4\frac{2}{3}$ times in the total length, the tail $5\frac{1}{2}$ times; the length of the maxilla is contained $3\frac{1}{2}$ times in the length of the head. The upper ray of the pectoral fin on the ocular side is elongated and is nearly $\frac{1}{3}$ of the total length. The scales are cycloid, except for several rows along the fin margins on the ocular side, which are strongly ctenoid. They are very small, and there are about 80 in the lateral line. The jaws are slightly, and the teeth markedly, asymmetrical. The cleft of the mouth is twisted dorsally on the blind side and on that side the teeth are strongly developed, there being several rows in both jaws. On the ocular side there are also several rows of less strongly developed teeth. Teeth are absent on the vomer and palatines.

The radial formula is: D. 96; A. 69; P. 8; V. 6; C. 17.

The dorsal fin begins on the snout on the blind side. The positions of the ventral fins are markedly asymmetrical.

The anus is situated on the blind side and the urinary opening on the ocular, in both cases some little distance from the ventral margin of the body.

ALCOCK's definition of the genus must then be amended. The body is sub-circular (in the young); jaws and dentition asymmetrical; length of maxilla more than $\frac{1}{4}$ of the length of the head; eyes on the left side separated by a broad concave space; dorsal fin commencing on the snout; its rays and those of the anal simple; scales small, those on the general body surface cycloid, but along the bases of the dorsal and anal fin strongly ctenoid; lateral line with an angular elevation above the pectoral fin; the latter with its upper ray (sometimes) elongated.

The genus is closely allied to *Rhomboidichthys*, and *Psettyllis ocellata* to *Rhomboidichthys ocellatus*, AGASSIZ. Some species of *Rhomboidichthys, i.e.*, *R. podas* and *R. mancus*, possess spinous scales along the fin margins, and in many others the pectoral fin may be elongate. *Psettylis*, however, seems to differ in the following characters: (1) cycloid scales on the general surface of the body and (2) the asymmetrical jaws and dentition.

It is not improbable that *Psettyllis pellucida* may be the young of some form belonging to another genus; at any rate, the characters given by ALCOCK are probably not those of the adult.

Cynoglossus arel (Bl. Schn.).

Two specimens of this fish were obtained, the longest of which is about 15 inches in extreme length. Day's figure of this species is very unsatisfactory and shows too many scales in the longitudinal diameter. Palk Bay, Station XVIII., soft mud, 7 to 8 fathoms.

Cynoglossus brachyrhynchus (Bleeker).

Pearl banks off Aripu.

Cynoglossus hamiltoni (Günther).

Pearl banks off Aripu.

Cynoglossus brevirostris, Day.

Pearl banks off Aripu.

Cynoglossus oligolepis (Bleeker).

Cynoglossus bengalensis (Bleeker).

One specimen from Palk Bay, Station XVIII. Also from Station IV., off Chilaw, about 4 inches in extreme length.

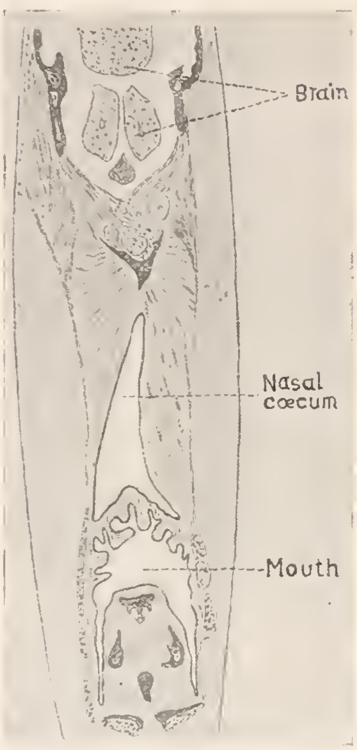
Cynoglossus, sp.

A single specimen was obtained which is unfortunately in a bad state of preservation, most of the scales on both sides being rubbed off. The extreme length is $1\frac{1}{3}$ inches, but the specimen is a mature female, the ovaries being largely distended on both sides. The colour is reddish-violet towards the margins of the body. The scales on both sides are coarsely ctenoid. The small size at sexual maturity is extraordinary, but we know little of the rate of growth of tropical Pleuronectids. Station XXV., off Foul Point, Trincomalee, 8 fathoms.

Note on "Naso-pharyngeal" Communications in *Cynoglossus*.

Kyle, in 1900 (9), gave a description of a communication between the nose and mouth in a species of *Cynoglossus*—*C. semilævis,* Günther. This was found in one specimen out of five examined and is considered by the author to be a structural detail of considerable morphological importance. A number of specimens of *Cynoglossus* were found in working over the present collection, and another from the Patani coast, several were dissected and serial sections were made of others. The following species were examined in this way: *C. arel, C. bengalensis, C. macrolepidotus, C. brachyrhynchus,* and *C. brevirostris.* In none of these specimens were any traces of a naso-pharyngeal communication to be found.

A nasal cæcum was found in every fish examined. This structure answers to the description given by Kyle; text-fig. 1, which is part of a transverse section through the head of a young specimen of *C. bengalensis*, shows the relations of the nasal cœcum to the mouth. It is a large thin-walled sac, triangular in transverse section, lying dorsally to the mouth and only separated from the latter by the buccal epithelium and its own wall. It extends backwards for a considerable distance. Anteriorly it is formed, as Kyle's figures show, by the union of two lateral, relatively narrow canals, one proceeding from each olfactory sac. These pass downwards and fuse together over the roof of the mouth.



Text-fig. 1. Transverse section through head of *Cynoglossus bengalensis*. × about 12 diameters.

The perforation joining the cavity of this sac with that of the mouth lay apparently in Kyle's specimen about the middle of the length of the cœcum.

The occurrence of this opening in only one specimen of a number examined suggests that it is quite abnormal, and most probably the result of an accident. In one specimen, *C. brevirostris*, which was cut into serial sections, a Copepod parasite possessing convoluted egg sacs was found in the cœcum. Several other larger specimens were then dissected, and in one of these (*C. brachyrhynchus*) a single Copepod parasite was found, which is described in Part I. of this Report (p. 294) as *Chondracanthus cynoglottidis*, Thompson and Scott. The anchor hooks of this Copepod were embedded in the muscles outside the dorsal wall of the cœcum, and its body lay on the thin ventral wall, so that it was immediately apparent on opening the buccal cavity sufficiently to show the roof of the mouth.

The occurrence of this Copepod in such a situation suggests what is doubtless the real explanation of the naso-pharyngeal communication—that is, that the perforation was an injury due to this or a similar parasite. Either the body and egg sacs resting on the thin ventral wall of the cœcum had produced the rupture of the latter, or the anchor hooks had themselves become embedded in this part of the wall and, as the parasite increased in size, broke through it. With such an origin the perforation would have no morphological significance whatever; and the speculations of its discoverer on the origin of the internal nares of vertebrata, which are based on its occurrence, are therefore without real value.

Rhomboidichthys azureus, Alcock.

Two specimens answer to the description of this species, except that the number of scales on the lateral line is 58 to 60 instead of about 55, the number counted by Alcock.

Galle, Station XXXIX., 16 to 30 fathoms, on a bottom of fine sand. The area from which this fish was obtained had a very rich fish fauna; about 1350 specimens were trawled belonging to the following species:—*Rhomboidichthys azureus*, *Arnoglossus spilurus* (very abundant), *A. macrolophus*, *Callionymus longicaudatus*, and *C. sagitta*.

Arnoglossus spilurus, Günther.

A large number of specimens of a species of *Arnoglossus* were collected, the characters of which correspond almost entirely with those of the above species, which was first found by the "Challenger" in the Arafura Sea.

The dorsal fin has about 86 rays, and the anal 63 to 68.

There are 48 scales in the lateral line. The upper ray of the pectoral fin is greatly enlarged in the males (in some cases, however, the sex is difficult to determine on account of the immaturity of the specimens). In most cases the extreme length of this elongated ray is two-thirds of the height of the body. There is a pointed knob on the anterior part of the maxilla on the ocular side. The blind side of the body is of a uniform smoky-grey colour (in spirit).

Size, $1\frac{1}{3}$ inches to $3\frac{1}{2}$ inches in extreme length. From the pearl banks off Aripu; Galle; south of Cheval Paar; and south of Adam's Bridge. Common.

Arnoglossus macrolophus, Alcock.

A mature female, about $2\frac{3}{4}$ inches in total length, is apparently this species. The first few rays of the dorsal fin are more elongate than the others. The radial formula is D. 85; A. 65; L.L. 55. Off Galle, Station XXXIX.

OPHIDIIDÆ.

Fierasfer homei, Richardson.

Two specimens, 4 inches and $4\frac{1}{2}$ inches long, were obtained south of Adam's Bridge, Station LIV. I refer them to *Fierasfer homei*, though they differ in a few respects from the descriptions of that species. The head is contained $6\frac{1}{2}$ times in the total length and its breadth is one-half of its length. The greatest depth of the body is $10\frac{1}{2}$ in the total length.

There are several rows of teeth in the upper jaw, the external of which are the strongest; several teeth on either side of the symphysis are larger than the rest. On the vomer there are three large teeth forming a median ridge.

The colour (in spirit) is yellowish, with a row of stellate markings above and below the lateral line on each side.

Alcock (**2**, p. 44), observed cases of commensalism between *F homei* and *Stichopus* in the seas of the Laccadive and Andaman Islands.

LABRIDÆ.

Platyglossus hyrtlii (BLEEKER).

Several specimens, about 4 inches long, from pearl banks off Aripu.

Pseudocheilinus hexatænia, BLEEKER.

One specimen, about $1\frac{3}{4}$ inches long, was obtained from south of Galle, Station XLI.

GLYPHIDODONTIDÆ.

Amphiprion sebæ, BLEEKER.

Two specimens, the largest of which was about $3\frac{1}{2}$ inches long, were taken off Aripu.

Pomacentrus jerdoni, DAY.

Numerous specimens, about 2 inches to $2\frac{1}{2}$ inches long, were obtained off Aripu.

Pomacentrus cyanopsilus, BLEEKER.

Two specimens, about 2 inches in total length, were collected. The colours in spirit are: dorsal, anal, and pelvic fins dark brown, a dark brown spot at the superior margin of the base of the pectoral.

There are light blue spots on the scales on the head and cheeks, above the pelvic and anal fins, and underneath the dorsal. The scales on the rest of the body have each a blue vertical line.

D. 12/13, A. 2/13; height of body $2\frac{1}{8}$ in total length.

Pomacentrus bankanensis, BLEEKER.

One specimen from the Pearl Bank, Station VI., uniform blackish-brown in spirit, with the exception of the caudal, which is yellow. There is a dark spot on the operculum near the origin of the lateral line.

CENTRISCIDÆ.

Amphisile scutata (LINN.).

Very numerous off Aripu; 2 inches to $5\frac{1}{4}$ inches long.

The number of fin-rays in the dorsal and caudal fins appears to be very constant; the number in the anal varies from 12 to 14, and in the pectoral from 9 to 11.

BLENNIIDÆ.

Petroscirtes breviceps (CUV. and VAL.).

Three specimens from south of Adam's Bridge, Station LIV., and also from Cheval Paar.

Petroscirtes lienardi, DAY.

One specimen from south of Adam's Bridge. It has no tentacles on the cheeks, but there are two unfringed ones on the lower jaw.

Petroscirtes cyprinoides (Cuv. and Val.).

Three specimens from off Mutwal Island.

Salarias alboguttatus, Day.

Three specimens of this Blenny were taken off Muttuvaratu Paar. The largest is nearly 2 inches long. They appear to belong to the above species, but differ in some respects. The radial formula is: D. XII. 17; A. 19; V. 2; P. 11; and the dorsal fin is deeply notched.

There are 8 or 9 broad dark bands (in spirit) with narrow interspaces descending from near the dorsal fin to the lateral line. The ground colour is light yellow. There is a short tentacle over the anterior part of the orbit.

Salarias furcatus, n. sp.—Plate I., fig. 4.

The head is contained $5\frac{1}{3}$, the height of the body $6\frac{3}{4}$, and the extreme length of the caudal 4 times in the total length.

Radial formula: D. XI., 17; A. 18; P. 13; V. 2; C. 24.

The dorsal fin is very faintly notched, but the membrane between the last spine and the first ray is wider than elsewhere in the fin; two portions are about the same height; the soft dorsal does not extend on to the caudal. The caudal is deeply forked, two of the outer rays being prolonged. The arrangement of the rays is: 1–6, **7**, 8–15, **16**, 17–24, beginning with the extreme dorsal ray; the rays outside the prolonged rays are very small.

The head is without a crest; there are two simple tentacles, one long and the other short, on each side of the head in front of the orbit.

The teeth in both jaws are movable and comb-like. Canines are absent.

The colour (in spirit) is nearly uniform blackish-brown; there is a black blotch on the dorsal fin between the first and third spines.

One specimen, 2·4 inches long, from Chilaw Paar, Station LXIX., on a bottom of sand and coral.

The diagnostic feature of the species is the deeply concave caudal fin.

CALLIONYMIDÆ.

Callionymus longicaudatus, Temm. and Schleg.

From Galle.

Callionymus sagitta, Pall.

From Galle.

A fish egg obtained in one of the tow-nettings had all the characters of the eggs of the British Callionymi. Its diameter was, unfortunately, not measured, but the reticulations on the shell are well shown in Mr. Hornell's drawing.

GOBIIDÆ.

Gobius griseus, Day.

From Palk Bay, Station XIX.

Gobius viridipunctatus, Cuv. and Val.

Two specimens, about $\frac{1}{2}$ inch in length, were taken. These have numerous rows of wart-like protuberances, not only on the cheeks, opercula, and head, but also on the pelvic fins, the rays of the latter being covered by them. Galle reef.

Gobius masoni, Day.

South of Cheval Paar, Gulf of Manaar.

Gobius melanosticta, Day.

One specimen, about 2 inches long, from Gulf of Manaar.

Gobius acutipinnis, Cuv. and Val.

South of Adam's Bridge, Station LIV.

Gobius biocellatus, Cuv. and Val.

South of Cheval Paar, Station XLVII.

Gobiodon citrinus, Rüppell.

Several specimens, the largest of which is about $1\frac{3}{4}$ inches long, from Aripu reef.

Periophthalmus kœlreuteri (Pall.).

A number of specimens, about 5 inches long and less, were taken in the mangrove swamps at Trincomalee.

Trypauchen vagina (Bl. Schn.).

A single specimen, about $5\frac{3}{4}$ inches long, was obtained in Palk Strait.

CATAPHRACTI.

Pegasus draconis, Linn.

A number of specimens, about $2\frac{1}{2}$ inches long, were obtained from Aripu reef, south of Cheval Paar, and south of Adam's Bridge.

Pegasus natans, Linn.

One specimen was collected on Aripu reef. This species has apparently been previously recorded only from Chinese and Australian seas.

Pegasus volans, Linn.

One specimen, about 2·1 inches long, was obtained from Aripu reef. The fifth rays of the pectoral fins are greatly thickened. The tail is rather over one-half of the total body length; the head is contained thrice in the body length; the rostrum is short, about one-sixth of the length of the head.

This species has not been obtained previously from Indian waters.

TRICHONOTIDÆ.

Trichonotus setigerus, Bl. Schn.—Plate I., fig. 7.

Several specimens of this species were obtained from south of Adam's Bridge, Station LIV., north of Cheval Paar Station LII., and outside Periya Paar, Station XVII. The largest is 3·8 inches long, its radial formula is D. 50; A. 40. There are 58 scales in a longitudinal, and $\frac{5}{6}$ in a transverse series. These are almost exactly the numbers given by Alcock (2) for *Tæniolabrus cyclograptus*, and they approximate very closely to the corresponding numbers for *T. setigerus*. The elongated first dorsal rays said to be present in the species are absent in the specimens from Ceylon. They may, however, be broken off, as the fins are in other respects somewhat injured.

Several specimens collected are referred to *T. setigerus* (see Plate I., fig. 7), but differ in possessing fewer rays in the dorsal and anal fins and in the larger size of the scales. They may eventually prove to be a new species.

Radial formula: D. 43; A. 35; P. 13; V.I. 5; C. 13.

Scales: L.l. 51; L.tr. $\frac{4}{4}$.

Length of the head nearly 5, height of the body 14, in total length. Lower jaw protruding, and a knob at the mandibular symphysis. Mouth very wide. Eyes close together.

Colours (in spirit), one specimen reddish-brown (ground colour), the rest colourless; a row of ocelli on the back on each side of the dorsal fin; a black blotch on the commencement of the latter.

Four specimens, $2\frac{1}{2}$ inches to $1\frac{1}{3}$ inches in total length, from Aripu reef, south of Cheval Paar, Station LXII. (on pearl banks), and in Palk Bay.

COTTIDÆ.

Platycephalus tuberculatus, Cuv. and Val.

A number of specimens were taken on Cheval Paar.

Platycephalus insidiator, Forsk.

A single immature specimen from south of Adam's Bridge.

Platycephalus serratus, Cuv. and Val.

One specimen from Station XX., Back Bay, Trincomalee.

Platycephalus punctatus, Cuv. and Val.

Several specimens, 6 inches long and less, from Cheval Paar, Station X.

Platycephalus asper, Cuv. and Val.

A large number of specimens were obtained off Galle. There are 5 preopercular spines present. The upper is the largest, and the next three become successively smaller. The lowest is large and is directed forward.

PEDICULATI.

Antennarius mummifer (Cuv.).

From pearl banks off Aripu. One specimen.

Antennarius marmoratus (Less.).

A single specimen, about 1 inch long, obtained from Galle Lagoon, is most probably a variety of this species. The colour (in spirit) is uniform blackish, with the exception of the tips of the caudal, anal, pectoral, and pelvic fins, which are white. The skin is rough, being covered with minute granules. The first dorsal spine is nearly as long as the second, and has an oval lobe or flap at the free end. D. 3/12; A. 7; P. 9.

Halieuta stellata (Wahl.).

A single specimen, about 1 inch long, from Galle.

TRACHINIDÆ.

Percis punctata, Cuv. and Val.

One specimen from off Mutwal Island.

Percis pulchella, Temm. and Schleg.

Several specimens, about $1\frac{1}{2}$ inches long, from south of Cheval Paar, Station XLVII.

STROMATEIDÆ.

Stromateus sinensis, Euphrasin.

From Palk Strait.

CARANGIDÆ.

Caranx hippos (Linn.).

One specimen, about 8 inches long, from Palk Strait.

Caranx leptolepis, Cuv. and Val.

A number of specimens, about 5 inches long, from the pearl banks off Aripu.

Seriola nigrofasciata (Rüppell).

A single specimen, $1\frac{1}{4}$ inches long.

Equula splendens, Cuv.

Numerous in Palk Bay, Stations XVIII. and XIX.

Gazza equulæformis, Rüppell.

A single specimen, about 6 inches long, from Palk Bay, Station XVIII. The other species of fishes taken at Station XVIII. in Palk Bay were *Gazza equulæformis*, *Equula splendens*, *Psettodes erumei*, *Trichonotus setigerus*, *Sciæna maculata*, *Cynoglossus arel*, *C. bengalensis*, *Pseudorhombus arsius* and *Caranx hippos*.

TRICHIURIDÆ.

Trichiurus savala, Cuv. and Val.

One specimen, 23 inches long, from Palk Strait.

The first pair of teeth in the upper jaw are very large curved fangs, which are received into depressions in the lower jaw, the remaining teeth in both jaws are much smaller and are flattened from side to side, so as to form pointed, cutting instruments.

SCIÆNIDÆ.

Sciæna diacanthus (Lacépède).

One specimen, about 12 inches long, from Palk Strait.

Sciæna maculata (Bl. Schn.).

One specimen, about 7 inches long, from Palk Bay.

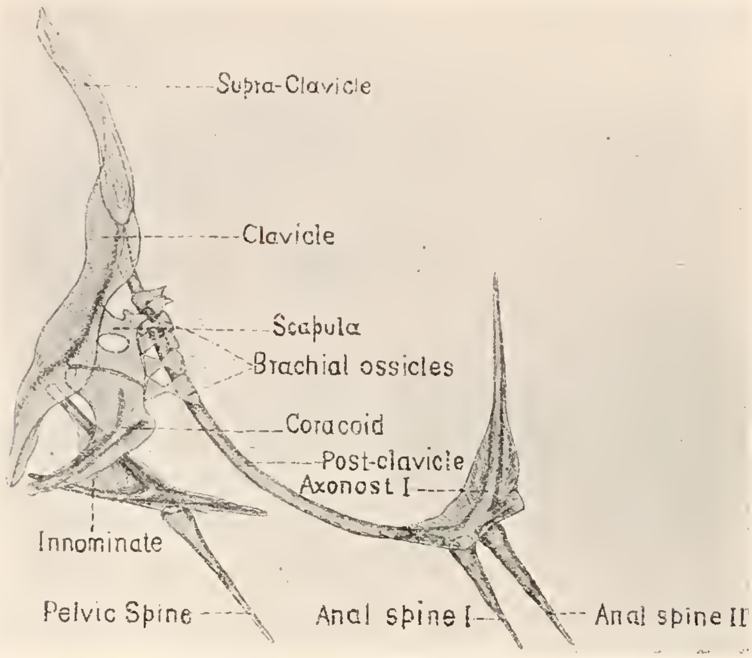
TEUTHIDIDÆ.

Teuthis oramin, Günther.

A number of specimens from south of Cheval Paar, at Station XLVII.

Note on the Limb Girdles of *Teuthis oramin*.

The limb girdles in the genus *Teuthis* present several interesting peculiarities which have not, so far as I am aware, been figured. Text-figure 2 shows the natural relations of these structures in a specimen about 2 inches long. A faint line is visible in the skin of the fish, extending from above the base of the pectoral fin to the root of the anal. On dissection this is seen to be produced by a curved bony bar, which is obviously the post-clavicle. Its upper extremity articulates with the clavicle near the upper end of the latter. Its lower extremity is connected to the anterior end of the 1st axonost by a strong fibrous bundle. The latter bone is very stout, is strengthened by anterior and posterior ridges, and is grooved on its ventral surface for the reception of the first two anal spines. Scapula and coracoid are quite distinct, but are closely connected; the former has a large fenestra; there are four brachial ossicles, three of which articulate with the scapula and one partly with this bone and partly with the coracoid. The two upper rays of the pectoral fin articulate



Text-fig. 2. Limb girdles of *Teuthis oramin.* × 4 diameters.

directly with the scapula; the coracoid is a thin bone with an external strengthening ridge.

The two innominates are very closely bound together and lie nearly in the middle line of the body. Each consists of a triradiate bony mass and the two anterior spurs are connected together by a thin bony lamella.

The post-clavicles thus form two subsidiary arches supporting the side walls of the abdominal cavity.

SCORPÆNIDÆ.

Scorpæna haplodactylus, Bleeker.

One specimen, about 3 inches long, and several much smaller ones, were obtained from south of Adam's Bridge.

Scorpænopsis guamensis (Quoy and Gaim.).

Two specimens, about $1\frac{1}{4}$ inches long.

Scorpænopsis cirrhosa (Thunb.).

One specimen, 3 inches long, from Gulf of Manaar.

Scorpænopsis oxycephala (Bleeker).

Numerous, south of Adam's Bridge; Galle; south of Cheval Paar. 2 inches or less in length.

Aploactis aspersa, Temm. and Schleg.—Plate I., fig. 5.

Length of head $3\frac{1}{2}$ inches; height of body $3\frac{1}{2}$ times in the total length. Cleft of the mouth directed obliquely upwards; length $\frac{1}{4}$ that of head. Eyes very small, diameter about $\frac{1}{7}$ of the length of the head. Nostrils, especially the anterior ones, tubular. General shape of head monstrous; prominent preorbital processes; cheeks and opercula with blunt spines and ridges.

Radial formula: D. 4, 19; A. 10; P. 13; V. 4; C. 14.

The first 4 spines of the dorsal fin are separated from the rest; there are about 10 spines following this portion, but it is difficult to determine the exact number; ventrals reduced; caudal rounded.

Skin everywhere covered with blunt, soft tubercles; these are present on all the fins and are especially large and rough on the first portion of the dorsal; 11 large tubercles on the lateral line of one side and 13 on the other.

One specimen, 2·1 inches long, from south of Adam's Bridge.

Pterois zebra, Cuv. and Val.

Pointed nasal tentacles are present. The orbital tentacles are flat and fringed on their posterior margins.

There is a flat tentacle on the premaxilla, near the angle of the mouth, and 3 short ones on the preoperculum.

Two specimens, the largest about 3 inches long, Gulf of Manaar.

Gymnapistus niger (Cuv. and Val.).

One specimen, about 2 inches long, from Periya Paar.

Gymnapistus dracæna (Cuv. and Val.).

A single specimen, about $2\frac{1}{4}$ inches long, from south of Adam's Bridge.

Minous monodactylus (Bl. Schn.).

Two specimens, about $2\frac{1}{2}$ inches long, from south of Adam's Bridge.

Choridactylus multibarbis, Richardson.

A single specimen, $1\frac{3}{4}$ inches long, from south of Adam's Bridge.

CIRRHITIDÆ.

Cirrhitichthys aureus (Temm. and Schleg.).

The free pectoral rays reach to just beyond the anal spines. The 1st dorsal ray is not prolonged. The colour is uniformly red-brown in spirit.

One specimen, about 2 inches long, Gulf of Manaar.

MULLIDÆ.

Upenoides tragula (RICHARDSON).

Several specimens, about 3 inches long, from Aripu and south of Cheval Paar.

SQUAMIPINNES.

Ephippus orbis (BLOCH).

One specimen from pearl banks off Aripu.

Scatophagus argus (GMEL.).—Plate I., fig. 1.

A single specimen of an apparently immature fish (Plate I., fig. 1) which probably belongs to this species was obtained by Professor HERDMAN, but the locality cannot, unfortunately, be traced. It is identical with a Tholichthys-like form which I have described from Patani Bay, Malay Peninsula (8), and which has been identified by Mr. G. A. BOULENGER as *Scatophagus argus*. The head is armed heavily with bony plates; the opercular pieces are very massive and carry two strong spines; the radial formula is: D. XI., 18; A. IV., 16; Pect. 16; Pelv. I., 5; C. 26. The skin is covered with minute spines. The number of spines in the dorsal fin was slightly variable in the specimens collected by Messrs. ANNANDALE and ROBINSON. Mr. ROBINSON informs me that they were "not uncommon in the Jambu estuary, generally swimming near the surface in companies of three or four."

PERCIDÆ.

This family is very sparingly represented in the present collection.

Apogon ellioti, DAY.

Several specimens from Galle, the largest of which is about $2\frac{3}{4}$ inches long.

Apogon eneastigma, RÜPPELL.

RÜPPELL obtained this species from Massana, in the Red Sea. The specimens obtained in Ceylon agree closely with his description. D. $7/\frac{1}{9}$; A. 2/8; L. l. 27.

There is a prominent dark, white edged ocellus (in spirit) behind the operculum.

Three specimens from Aripu reef, the largest of which is $2\frac{1}{3}$ inches long.

Apogon septemstriatus, GÜNTHER.

This species has been previously taken only by the "Challenger" in the Arafura Sea. The Ceylon specimens agree closely with GÜNTHER's description and figure.

The 1st dorsal spine is very small and is absent in some specimens.

A number of specimens, $1\frac{1}{4}$ inches to $2\frac{1}{4}$ inches long, from Galle and south of Adam's Bridge, Station LIV.

Therapon puta, CUV. and VAL.

Several specimens from the pearl banks off Aripu. The average length is about 5 inches.

Scolopsis phæops (BENNETT).

A single specimen, $1\frac{3}{4}$ inches long, from Aripu reef.

PRISTIPOMATIDÆ.

Erythrichthys leucogrammicus (BLEEKER)—Plate I., fig. 6.

The genus *Erythrichthys* is comparatively rare, and has not hitherto been recorded from the coasts of India. It has been found in Cuba, Molucca, and Sunda seas, Australia, New Zealand, Japan, and Sea of Valparaiso. It appears usually to inhabit open water or rather deep seas.

Height of body almost 6, length of head $4\frac{1}{2}$ in total length; body fusiform; vertical fins terminating some distance from the caudal fin; spines and rays of vertical fins very weak; caudal fin deeply forked; abdomen rounded.

Radial formula: D. IX, V, I, 10; A. III, 10; P. 19; V. I, 5; C. 17.

The first dorsal and anal spines very short; 5 free spines in the dorsal; operculum completely covered with scales; a flat, pointed spine immediately above the origin of the pectoral; inferior angle rounded. Lateral line nearly straight and with 79 scales in a longitudinal row. L.tr. $\frac{9}{19}$.

Teeth completely absent; mouth very protractile.

Colours in spirit, silvery below the lateral line; brownish above, but with a faint crimson band directly above the lateral line.

A single specimen, $3\frac{6}{10}$ inches long, from Cheval Paar in 7 fathoms.

Synagris bleekeri, DAY.

Several specimens, $2\frac{3}{4}$ inches long, from off Galle.

NOTE.—Several species of fishes, in addition to those recorded in the above list, were also observed, and have been identified from the sketches made by Professor HERDMAN and Mr. HORNELL. Several species of *Balistes* are of particular interest, since they form the intermediate host for the *Tetrarhynchus*, which is the parasite concerned in pearl-formation. *Balistes undulatus*, MUNGO PARK, and *B. mitis*, BENNETT, occur, and a third form observed may possibly be *B. erythrodon*, GÜNTHER. A large Trygon-ray, in which an adult *Tetrarhynchus* occurred, was sketched by Mr. HORNELL, and has been identified by Mr. BOULENGER as *Tæniura melanospilos*, BLEEKER; also the cockle-eating ray *Ætobatis narinari*, MARCGR. Finally, a species of *Echineis* was caught, which appears to be *E. albescens*, TEMM. and SCHLEG.

I am greatly indebted to Mr. G. A. BOULENGER, F.R.S., for much kind assistance in the identification of several doubtful species.

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EXPLANATION OF PLATES.

PLATE I.

Fig. 1. A "Tholichthys" stage: probably the immature form of *Scatophagus argus* (GMEL.). × 4.
„ 2. *Monacanthus tomentosus* (L.), juv. × 3.
„ 3. *Psettylis ocellata*, ALCOCK; mature female; nat. size.
„ 4. *Salarias furcatus*, n. sp. × $1\frac{1}{2}$.
„ 5. *Aploactis aspersa*, TEMM. and SCHLEG. × $1\frac{1}{2}$.
„ 6. *Erythrichthys leucogrammicus* (BLEEKER); nat. size.
„ 7. *Trichonotus setigerus*, BL. SCHN. × $\frac{1}{2}$.

PLATE II.

All the figures are directly reproduced from photographs taken by Mr. A. SCOTT. Figs. 1 and 2 represent two immature specimens of *Psettylis pellucida*, ALCOCK; and figs. 3 to 8 six immature specimens of *Psettylis ocellata*, ALCOCK. The six latter specimens form a series, 3 being the most, and 8 the least immature. Fig. 3, Plate I., represents the mature female of *P. ocellata*.

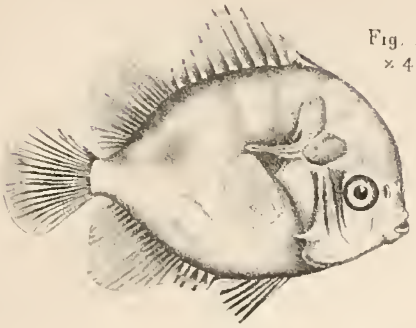


Fig. 1 × 4 dia

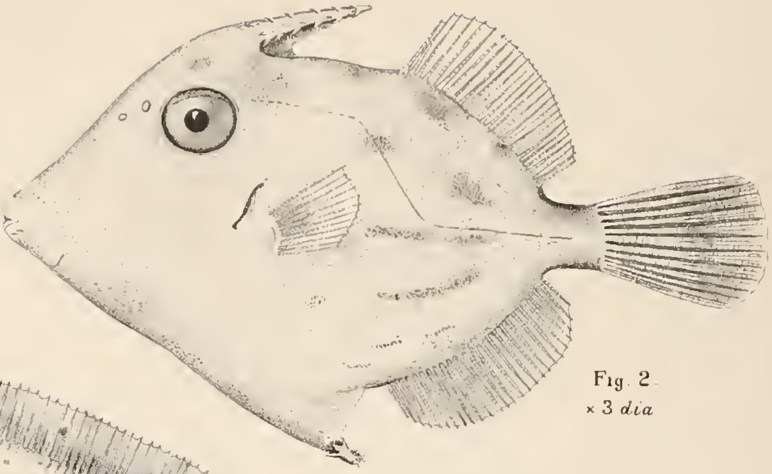


Fig. 2. × 3 dia

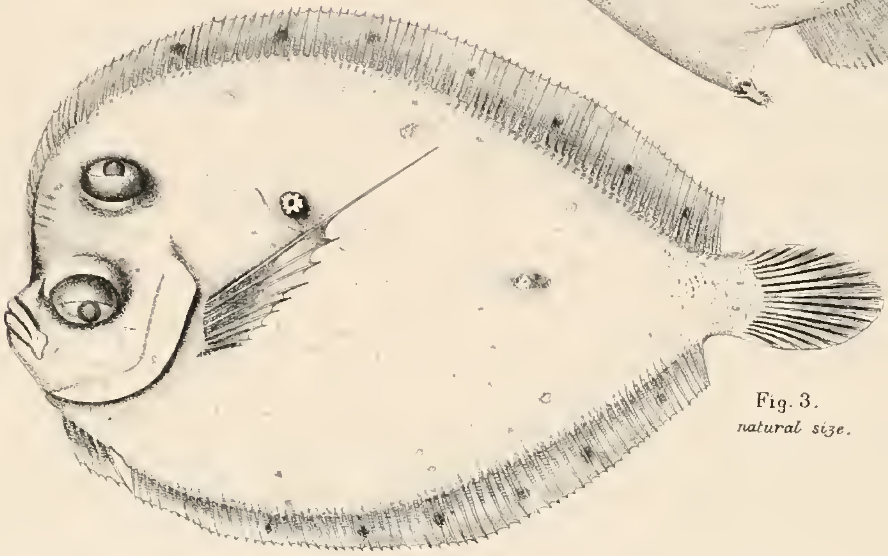


Fig. 3. natural size.

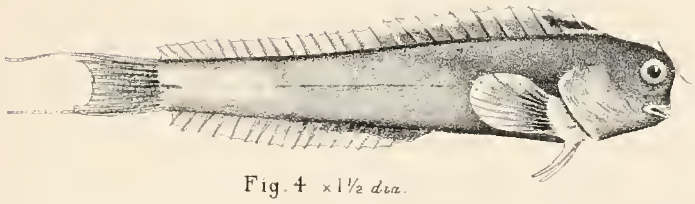


Fig. 4 × 1½ dia.

Fig. 5. × 1½ dia.

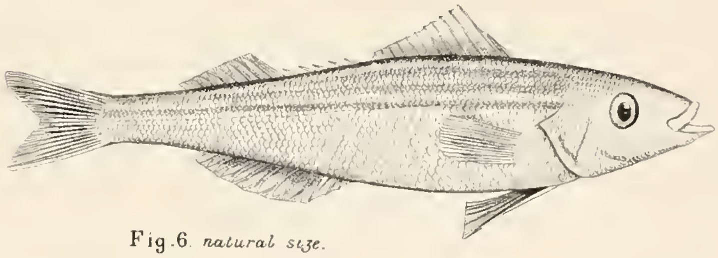


Fig. 6. natural size.

Fig 7 × 1½ dia.

J. J. del.
Fig. 5, S. J. B. del.

E. Wilson, Lith. Cambridge.

FIG. 1, "THOLICHTHYS" STAGE OF SCATOPHAGUS ARGUS; FIG 2, MONACANTHUS TOMENTOSUS, juv.; FIG 3, PSETTYLIS OCELLATA; FIG. 4, SALARIAS FURCATUS, n.sp.; FIG. 5, APLOACTIS ASPERSA; FIG. 6, ERYTHRICHTHYS LEUCOGRAMMICUS, FIG 7, TRICHONOTUS SETIGERUS;

Fig. 1.

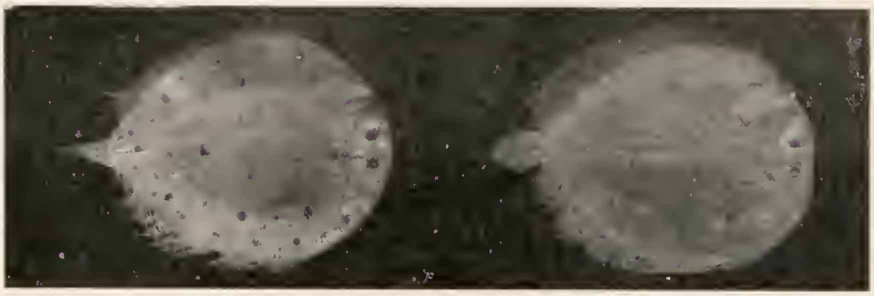


Fig. 2.

Fig. 3.

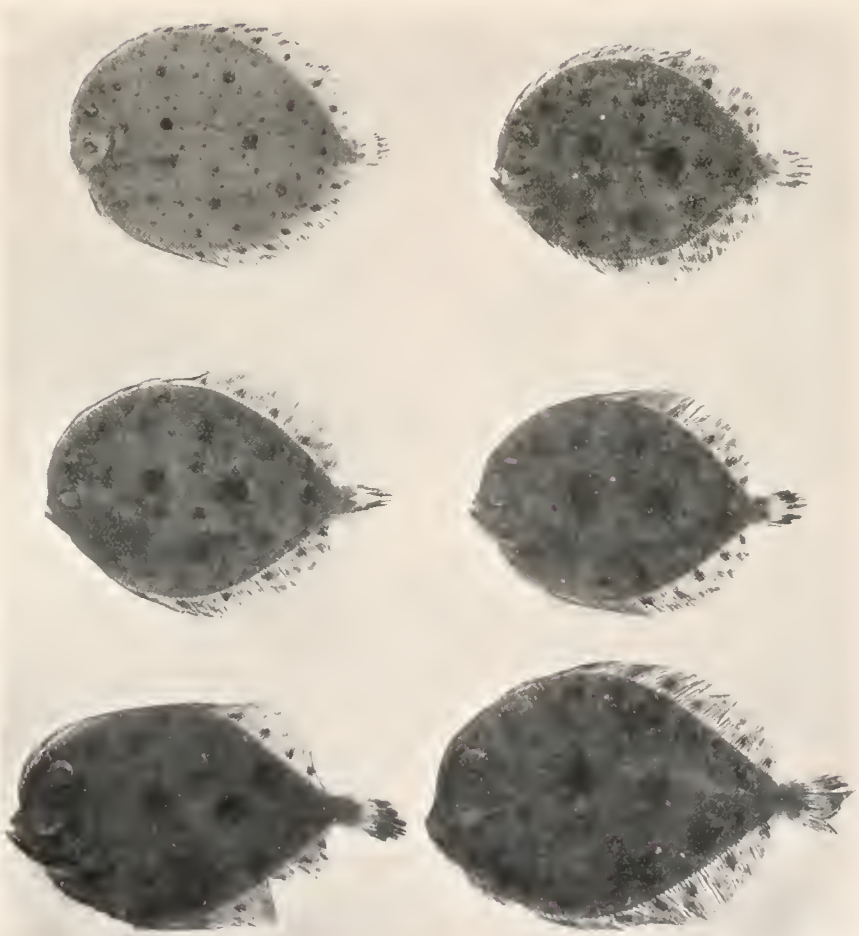
Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.



Immature Psettylis.

REPORT

ON THE

CAPRELLIDÆ

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

DR. P. MAYER,
OF THE NAPLES ZOOLOGICAL STATION.

[WITH NINE TEXT-FIGURES.]

THE collection of Caprellids from Ceylon, kindly entrusted to me by Professor HERDMAN, contains nothing of unusual interest. The genera *Metaprotella*, *Monoliropus*, *Paracaprella*, and *Paradeutella* are represented. Of these *Metaprotella* and *Paradeutella* have already been reported from this region,* and exactly the same species have now been found again, viz., *M. excentrica*, *M. problematica*, and *P. bidentata*. *Paracaprella* is represented in the collection by a single female, concerning the specific identity of which I am uncertain. On the other hand, there is no doubt that the species of *Monoliropus* in this collection is new. The genus itself was known before from East Indian waters, but not from Ceylon.

I will first give a list of the species arranged according to the localities at which they were collected, and will then make such remarks as seem necessary on the specimens, and describe the single new species.

LIST OF CEYLON CAPRELLIDÆ FAUNISTICALLY ARRANGED.

Gulf of Manaar, Station LVIII., 10 to 20 fathoms: *Monoliropus falcimanus*, n. sp.
Cheval Paar, shoal buoy, 4 fathoms: *Monoliropus falcimanus*, n. sp.
Pearl Banks, off Aripu, 7 to 8 fathoms: *Monoliropus falcimanus*, n. sp. (?).

* P. MAYER, 'Die Caprellidæ der Siboga-Expedition,' 1903, p. 145.

Gulf of Manaar, Station V., Chilaw Paar, 10 fathoms: *Metaprotella excentrica*, Mayer; *Monoliropus falcimanus*, n. sp.

East of shoal buoy, Pearl Banks, 6 fathoms: *Metaprotella excentrica*, Mayer; *Monoliropus falcimanus*, n. sp.

Kondatchi Paar, 5 fathoms: *Monoliropus falcimanus*, n. sp.

Periya Paar Kerrai, 9 fathoms: *Metaprotella excentrica*, Mayer; *Monoliropus falcimanus*, n. sp.

Muttuvaratu pearl oyster washings, 8 fathoms: *Metaprotella problematica*, Mayer (?); *Monoliropus*, sp. (?).

East Cheval Paar, 6 fathoms: *Metaprotella excentrica*, Mayer; *Monoliropus*, sp. (?).

Cheval Paar, 7 fathoms: *Metaprotella excentrica*, Mayer; *Monoliropus falcimanus*, n. sp.

From pearl oyster washings, East Cheval Paar, 6 fathoms: *Metaprotella excentrica*, Mayer; *Metaprotella problematica*, Mayer; *Paradeutella bidentata*, Mayer; *Monoliropus falcimanus*, n. sp.

Cheval Paar, 8 fathoms: *Paracaprella*, sp. (?)

Notes on the Species.

Metaprotella excentrica, Mayer.

This species, already reported from the East Indies, is represented by specimens from various localities.

A.—From Station V., north end of Chilaw Paar, 10 fathoms. The heads, antennæ, and backs of the larger examples are covered with small mussels. The largest male is over 13 millims. long, and the flagellum of the first antenna has 14 joints; the tubercle at the base of the antenna is very variable. The old males do not possess the pair of spines on the back of segment 3; a younger male, however, possesses it, besides an unpaired spine on the back of segment 2. The only female (with 13 joints in the flagellum) has the same spines as this male, but the pair of spines on segment 2 is very conspicuous; ventro-laterally on the end of segment 4 is an obtuse ridge. The spine at the base of the second antenna in the female is small, and it is entirely wanting in the young males. For the rest, the examples agree well with my former description ('Nachtrag zur Monographie,' 1890, p. 25).

B.—From the East Cheval Paar oyster washings there are some good sized males, one female with eggs in the brood-pouch, and numerous young ones. The large males are provided also on segment 3 with a pair of spines of quite variable length.

C.—From East Cheval Paar, 6 fathoms, the examples all have their hind extremities missing. Of the four females, two carry eggs in the brood-pouch; the pair of spines on segment 3 is not always present.

D.—Periya Paar Kerrai affords only a young female; Cheval Paar, 7 fathoms, only a young male and a young female.

I do not feel quite sure whether the four specimens from East of shoal buoy, 6 fathoms (all of them without the hind legs), also belong to *M. excentrica*, since they seem to be rather clumsier, and their gills rather rounder, than usual. The largest male has 12 joints in the flagellum, and a pair of spines both on the head and segment 2; another male has the same also on segment 3. But evidently they do not belong to any other known species of *Metaprotella*.

Metaprotella problematica, Mayer.

The washings from East Cheval Paar oysters furnish a good many examples of this species which I described in 1890 ('Nachtrag zur Monographie,' p. 26). The largest male is 7 millims. long and has 16 joints in the flagellum of the first antenna; a female, 5·5 millims. long, has a 15-jointed flagellum, and is accordingly older than that which I had formerly described. The palmar edge of the hind legs is not particularly concave; nevertheless it is much more concave than that of *Metaprotella excentrica*, as I correctly supposed.

Very probably the two badly preserved young males from the Muttuvaratu pearl oyster washings belong to *M. problematica*.

Paradeutella bidentata, Mayer.

There are 10 examples from the East Cheval Paar oyster washings. The largest male is not quite 5 millims. long and has 12 joints on the flagellum of the first antenna. One female has on its head a Foraminifer of rather gigantic dimensions relatively to its host.

Paracaprella, sp. ?

The locality "Cheval Paar, 8 fathoms," affords a female 4·5 millims. long, and without hind legs, which belongs to the genus *Paracaprella*. The animal is quite smooth. Flagellum of the first antenna 9-jointed. The mandibular palp is represented by only one bristle. The hand of the second leg (= second gnathopod of author's) has no poison-tooth. To which species this female belongs I would not venture to determine.

Monoliropus falcimanus, n. sp.—(Text-figures, p. 226.)

The genus *Monoliropus*, which I founded only a short time ago ('Siboga-Exped.,' 1903, p 53), on examples of the species *M. agilis* from Siam, now is enriched by a second species. Of this new species a good deal of material is furnished from the following localities:—Station LVIII. (5 specimens); Shoal buoy, 4 fathoms (3 specimens); Station V. (4 male specimens); East of shoal buoy, 6 fathoms (14 specimens); Kondatchi Paar (3 quite small specimens); Periya Paar Kerrai (2 female specimens); Cheval Paar, 7 fathoms (30 specimens); and East Cheval Paar oyster washings (12 specimens).

Unfortunately, in most of the specimens the hind legs are lost.

This new species is distinguished from *Monoliropus agilis*, first, by the fact that the locking spine ("Einschlagdorn") on foot 6 and 7 is not notched terminally as in *Proto ventricosa*, but is simply obliquely truncated. Further, the hand of the second

Fig. 1. *Monoliropus falcimanus*, n. sp. Lateral view of nearly adult male; of the hind legs only the last one is represented. × 19.
,, 2. ,, ,, ,, Second leg of adult male. × 19.
,, 3. ,, ,, ,, ,, ,, young male. × 45.
,, 4. ,, ,, ,, ,, ,, adult female. × 45.
,, 5. ,, ,, ,, Mandibular palp } of male represented in fig. 1. × 165.
,, 6. ,, ,, ,, Maxilliped } of male represented in fig. 1. × 165.
,, 7. ,, ,, ,, Gill and corresponding leg of young male represented in fig. 3. × 78.
,, 8. ,, ,, ,, Gill and corresponding leg of adult female represented in fig. 4. × 78.
,, 9. ,, ,, ,, Lateral view of abdomen of male represented in fig. 1. × 78.

leg of the old male (fig. 2) is sickle-shaped,* while in the oldest-known male of *M. agilis* it is shaped as in the young males and in the females of the new species.

* The *specific* name is based on this character.

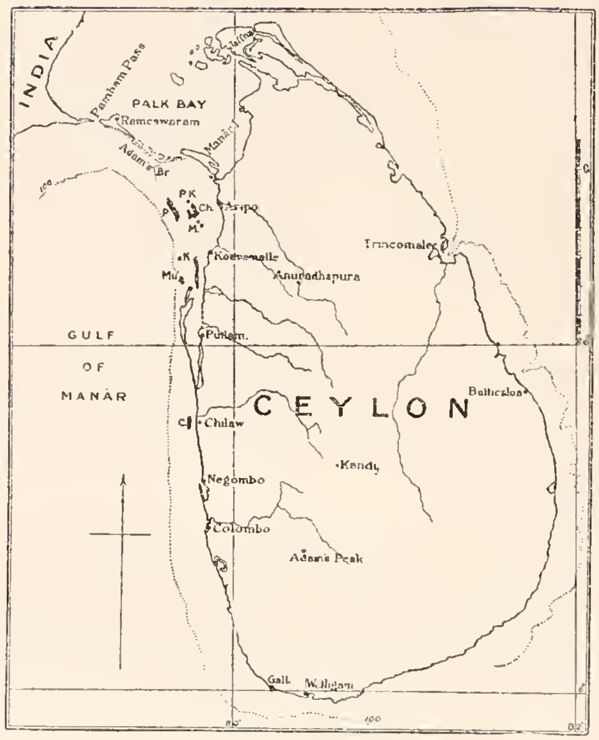
Finally, the penultimate joint of the palp of the maxilliped (fig. 6) is produced into a pointed process, which appears to be occasionally absent, and, at any rate, affords no easily distinguishable characteristic.

The length of the male is about 8·5 millims., that of the female not quite 4 millims. Dorsal surface of body smooth, save that the second segment in the male may bear a pair of very small tubercles anteriorly (fig. 1). Laterally, on segments 2 to 4, short ridges are present anteriorly, which in the female project less strongly, just as in *M. agilis*. First antenna short; flagellum in the male with 9, in the female with 8 joints. Second leg short; arm thin, joints 2 and 3 with a short lateral ridge, which in the old male (fig. 2) is relatively small; joint 4 round. The hand of the male is long, slender and sickle-shaped, its palmar edge covered with long bristles; in females and young males (figs. 4 and 3) it is relatively broader and not sickle-shaped; the locking spine is proximal, the poison-tooth distal, the claw is long. Gills long and slender; the corresponding legs very small in the old males, in the females and young males (figs. 8 and 7) relatively larger and less pointed. Leg 5, in place of the locking spine, has one or two somewhat strong hairs; legs 6 and 7 have one (exceptionally, in old males, two, one after the other) locking spine which is obliquely truncated.

The mandibular palp in the old males has at the end of the third joint a palette and 1 long, 3 small, and 2 middle-sized hairs (studied *in situ*). I give a figure of that of a not quite adult male (fig. 5) and also of the maxilliped (fig. 6). The first maxilla bears on its outer plate 7 hairs.

A profile-view of the abdomen of the male is given in fig. 9.

I am not quite certain whether to this species belong some small and badly preserved specimens from the following localities:—Pearl banks off Aripu (1 female); Muttuvaratu pearl oyster washings (1 female with two large eggs in the brood-pouch); and East Cheval Paar, 6 fathoms (1 young female).



Sketch-map of the Ceylon coast, showing the principal pearl-banks in the Gulf of Manaar, from which most of the specimens were collected. C., Chilaw Paar; Ch., Cheval Paar; K., Karativo Paar; M., Modragam Paars; Mu., Muttuvaratu Paar; P., Periya Paar; P.K., Periya Paar Kerrai.

REPORT

ON THE

AMPHIPODA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

ALFRED O. WALKER, F.L.S., F.Z.S.

[WITH EIGHT PLATES.]

THE collection of AMPHIPODA made by Professor HERDMAN and Mr. HORNELL on the coasts of Ceylon is undoubtedly the most important that has ever been brought from a tropical sea. It consists of 80 species, of which 36 are new to science. Six new genera have been found necessary for the reception of some of the species. Several interesting forms have been found among them. The new genus *Vijaya* is characterized by a curious difference in the structure of the upper antennæ in the males and females, as is also the case with the remarkable genus *Platyischnopus*, STEBBING, the male of which is now first described. *Gallea tecticauda*, n. gen. and sp., seems to be an abundant form of peculiar structure, being a link between the Amphilochidæ and Leucothoidæ, though I have thought it desirable to place it in the former family. *Cheralia aviculæ*, again, I have found difficult to place—its affinities are with the Photidæ on the one hand, and the Corophiidæ on the other. So far it has only been found in pearl oyster washings, and as it is probably, from the structure of the last 3 pairs of peræopods, tubicolous, it is possible that it may be confined to these shells.

Two of the species taken, *Hyperia galba* and *Leucothoë spinicarpa*, appear to be cosmopolitan, and as the first is commonly found in Medusæ and the second in Tunicates, it is interesting to note that, possibly from this cause, they show a remarkable power of accommodating themselves to great changes of temperature.

The size of the Ceylon specimens is generally small, even as compared with Amphipoda from our own coasts, while they are pigmies alongside of those from the Arctic and Antarctic seas. The largest measured is 10 millims. long; our own *Amathilla homari* is 25 millims. and some of the Arctic and Antarctic species are still larger.

Two species of different families, viz., *Melita anisochir* and *Cheiriphotis megacheles*, deserve notice from the great size of the "hands" of the 2nd pair of feet (gnathopods) in the males and their resemblance to a broken bit of shell. One would suppose their use to be protective, as they are large enough to cover the animal when half buried in sand, but it is difficult to see why the males only should be so protected; in both instances the females have quite small hands.

The list of areas from which species have been previously recorded is only to be regarded as an indication of distribution and does not pretend to be complete, nor is that of much importance, as the Amphipoda have been so little collected in most seas. Roughly speaking, it may be said that of the Gammaridea 19 species have been recorded from the Northern Hemisphere, 8 from the Southern, and 7 may be considered Equatorial, but it must be remembered that the number of collectors is far greater in the North. The greatest number of individuals taken in this collection belong to the Southern genus *Platophium*.

The Caprellidæ are treated separately, by Dr. PAUL MAYER, in the Report that precedes this in the present volume.

The following Amphipoda were taken by Professor HERDMAN while tow-netting in the Indian Ocean to the south of Sokotra and eastwards towards Ceylon from January 15 to January 18, 1902:—

Vibilia viatrix, BOVALLIUS, 2 specimens;
Paraphronima gracilis, CLAUS, 2 specimens;
Hyperia bengalensis (GILES), several specimens;
Phrosina semilunata, RISSO, 1 young male, length 2 millims.;
Anchylomera blossevillei, M. EDW., a considerable number of specimens;
Sympronoë parva, CLAUS, 1 male specimen.

CLASSIFIED LIST OF SPECIES IN THE COLLECTION.

The capital letters affixed to the names of the species in the list below indicate parts of the coast of Ceylon, as follows:—

(A), south of Karativo to Colombo (Stations I. to V. and LXVI. to LXIX.).
(B), north of Karativo to Kodramallai Point (Stations VI. to VIII. and LVI. to LX.).
(C), north of Kodramallai to Bengalli (Stations IX. to XVII., XLVII. to LII., LV., and LXI. to LXV.).

(D), north of Bengalli (Stations LIII. and LIV.).
(E), south of Colombo (Stations XLII. to XLVI.).
(F), in or near Galle Harbour (Stations XXXV. to XLI.).
(G), in or near Trincomalee Harbour (Stations XX. to XXXI.).
(H), general coast of Ceylon, under 100 fathoms, exact locality not recorded.

The localities and other details of the stations referred to in Roman numerals will be found in the "Narrative," at p. 17, in Part I. of this series of Reports.

Tribe: HYPERIIDEA.

Family: HYPERIIDÆ.

Hyperia galba (Mont.)—(F). Probably cosmopolitan.
H. crucipes, Bovallius—(B). Tropical Atlantic; off Barbadoes (Bov.).
H. bengalensis. Giles—(B). Bay of Bengal.
Hyperoche cryptodactylus, Stebbing—(F). Near Cape of Good Hope.

Family: PHROSINIDÆ (Stebbing, 1888).

Phrosina sp.

Family: SCELIDÆ (Claus, 1879).

Parascelus parvus, Claus—(C). Atlantic Ocean.

Family: LYCÆIDÆ (Claus, 1879).

Elsia indica, Giles—(B) (D). Bay of Bengal.

Tribe: GAMMARIDEA.

Family: ORCHESTIIDÆ.

Hyale nilssoni (Rathke)—(B). Atlantic and Mediterranean; Azores; Sokotra.

Family: LYSIANASSIDÆ.

Ichnopus taurus, Costa—(F). Mediterranean.
Socarnes schmardæ (Heller)—(B). Mediterranean.
Socarnella bonnieri, n. gen. and sp.—(F).
Lysianax cinghalensis, Steb.—(B) (C). Ceylon.
L. calochir, n. sp.—(B) (D).
Orchomenella nana (Kröyer)—(C). Norwegian, British and French coasts.
Tryphosa cucullata, n. sp.—(B).
Vijaya tenuipes, n. gen. and sp.—(H).

Family: PONTOPOREIIDÆ.

Urothoë spinidigitus, n. sp.—(C).

Family: ARGISSIDÆ, nov.

Argissa hamatipes (Norman)—(B). Greenland (Hansen); Norway; Britain.
Platyischnopus herdmani, n. sp.—(C).

Family: PHOXOCEPHALIDÆ.

Leptophoxus uncirostratus (Giles)—(G). Bay of Bengal.

Family: AMPELISCIDÆ.

Ampelisca tridens, n. sp.—(B) (C) (D) (F).
A. scabripes, n. sp.—(A) (C) (H).
A. brachyceras, n. sp.—(B) (C).
A. brevicornis, Costa—(B) (F). Atlantic; Mediterranean.
A. cyclops, n. sp—(B) (F).
A. chevreuxi, n. sp.—(B) (C).

Family: AMPHILOCHIDÆ.

Amphilochus neapolitanus, Della Valle—(B). Mediterranean; Britain.
Gallea tecticauda, n. gen. and sp.—(B) (C) (D) (F).

Family: LEUCOTHOIDÆ.

Leucothoë spinicarpa (Abild.)—(A) (B) (C) (F) (H). Probably cosmopolitan; from Greenland to the Azores and perhaps Australia.
L. hornelli, n. sp.—(A) (D) (G).
L. stegoceras, n. sp.—Singapore.

Family: ANAMIXIDÆ (Stebbing, 1898*).

Anamixis stebbingi, n. sp.—(B).

Family: STENOTHOIDÆ.†

Stenothoë marina (Sp. Bate)—(C). Norway; Britain; France; Mediterranean.
S. monoculoides (Mont.)—(C) (F). do. do. do. do.
S. gallensis, n. sp.—(B) (C) (F) (H).

Family: ŒDICERIDÆ.

Perioculodes serra, n. sp.—(B) (C).
Synchelidium brevicarpum (Sp. Bate)—(C). Britain; Norway.

* 'Ann. and Mag. Nat. Hist.' (7), vol. IV., 1898, p. 210.

† Owing to the connexion between Amphilochidæ and Leucothoidæ shown by *Gallea*, I have placed the latter family before instead of after Stenothoidæ.

Family: SYRRHOIDÆ.

Tiron thompsoni, n. sp.—(B).

Family: CALLIOPIIDÆ.

Eusiroides cæsaris, Steb.—(B) (C) (F). Australia.
E. orchomenipes, n. sp. (?)—(C).

Family: ATYLIDÆ.

Paratylus granulosus, n. sp.—(C).

Family: DEXAMINIDÆ (Stebbing, Ann. and Mag., *loc. cit.*).

Dexamine serraticrus, n. sp.—(A).
Tritata antarctica, Stebbing—(A) (C) (H). Australia.
Guernea lævis, Chevreux—(B) (C). France.

Family: GAMMARIDÆ.

Hornellia incerta, n. gen. and sp.—(B) (C).
Melita obtusata (Mont.)—(A) (C) (D) (E) (G). Norway; Britain; France; Mediterranean.
M. anisochir (Kröyer)—(A) (B) (C) (G) (H). Rio Janeiro.
Mæra othonides, n. sp.—(A) (C) (D) (F) (H).
M. scissimana, Costa—(B) (F) (H). Mediterranean.
M. rubromaculata (Stimpson)—(B) (C) (E) (F). Pacific; Australia; Cape Agulhas.
M. tenella (Dana)—(C). Fiji Islands.
M. tenuicornis (Dana)—(C). New Zealand.
Elasmopus subcarinatus (Haswell)—(A) (B) (C) (D) (F) (G). Australasia.
E. spinimanus, n. sp.—(F).
E. serrula, n. sp.—(C) (F).
E. dubius, n. sp.—(C).
Parelasmopus suluensis (Dana)—(C). North Australia; Sulu Sea.
Cheirocratus sp.—(C).
Megaluropus agilis, Norman—(B) (C). Britain; Holland; Mediterranean.

Family: LILLJEBORGIDÆ (Stebbing, *loc. cit.*).

Lilljeborgia pallida, Sp. Bate—(B) (D) (H). Norway; Britain; France.

Family: AORIDÆ (Steb., *loc. cit.*).

Lembos podoceroides, n. sp.—(B) (C) (D) (G) (H).
L. chelatus, n. sp.—(A).

FAMILY: PHOTIDÆ.

Gammaropsis zeylanicus, n. sp.—(A) (B) (C) (D) (F) (G).

Cheiriphotis (n. gen.) *megacheles* (GILES)—(A) (B) (C) (D). Bay of Bengal.

Photis longicaudata (SP. BATE)—(B) (C) (F). Norway; Britain; France; Mediterranean.

P. longimanus, n. sp.—(C).

P. nana, n. sp.—(B).

Chevalia aviculæ, n. gen. and sp.—(B) (C).

FAMILY: AMPHITHOIDÆ (STEB., *loc. cit.*)

Amphithoë intermedia, n. sp.—(A) (B) (C) (Station XXXIV.).

A. vaillanti, LUCAS—(B). Mediterranean.

FAMILY: ISCHYROCERIDÆ (STEB., *loc. cit.*).

Ischyrocerus anguipes, KR.—(H). Arctic Seas; Norway.

Jassa, sp.—(B).

Erichthonius abditus (TEMPLETON)—(A) (B) (C) (F). European coasts; Azores.

E. macrodactylus (DANA)—(D). Sulu Sea.

FAMILY: COROPHIIDÆ.

Cerapus calamicola (GILES)—(C) (D) (H). Bay of Bengal; Australia; Sokotra.

Siphonœcetes orientalis, n. sp.—(A) (B) (D).

Corophium crassicorne, BRUZELIUS—(C). Jan Mayen; Norway; Britain; France.

FAMILY: DULICHIDÆ.

Platophium læve (HASWELL)—(A) (B) (C). Australia.

P. synaptochir, n. sp.—(B) (C) (F).

P. zeylanicum, n. sp.—(C).

FAMILY: COLOMASTIGIDÆ (STEB., *loc. cit.*).

Colomastix pusilla, GRUBE—(B). Britain; France; Mediterranean.

DESCRIPTION OF THE SPECIES.

The following terms are used in the description :—

"Pleon" = Metasome, G. O. SARS; the first 3 abdominal segments.

"Urus" = Urosome, G. O. S.; the last 3 abdominal segments.

"Ocular lobe" = Lateral angle of the head.

"Appendage" = Secondary or accessory appendage of the upper antennæ.

In the peduncle of the antennæ the "first joint" is the ante-penultimate; in the limbs it is the basipodite, the propodos, or hand, thus being the 5th joint.

The measurements are from the tip of the uropods to the base of the antennæ when the Amphipod is laid straight.

When a joint is said to be as long as two or more it means as long as those joints united.

In the following classification the system used by Professor G. O. SARS in his 'Amphipoda of Norway' has been followed, except as to the position of the genus *Leucothoë*.

TRIBE: HYPERIIDEA.

FAMILY: HYPERIIDÆ.

Hyperia, LATREILLE, 1825.

Hyperia galba (MONT.).

Two from the Reef, Galle, the largest 7·5 millims.

The serration of the hind margin of the 1st gnathopod is simple, as figured by BOVALLIUS for *H. gaudichaudi*, M. EDW. (Hyperidea, Plate X., fig. 20). If *H. latreillei*, M. EDW., is to be united to *H. galba*, as proposed by SARS ('Amph. of Norway,' p. 7), there seems to be no reason why *H. gaudichaudi*, which BOVALLIUS (*loc. cit.*, p. 176) considers "a link between" these 2 species, should not also be included. The shape of the gnathopods in the present specimens is nearer to *H. galba* than to *H. gaudichaudi* as figured by BOVALLIUS.

Hyperia bengalensis (GILES).

Lestrigonus bengalensis, GILES, 'Journ. of Asiatic Soc. of Bengal,' 1887, p. 224.

Hyperia dysschistus, STEBBING, '"Chall." Amph.,' p. 1388, Plate 167, 1888.

There can be little doubt of the identity of the above; STEBBING, with his usual acuteness, observed the similarity, but was misled partly by the distance between the two stations (*H. dysschistus* was taken off Cape Howe, Australia) and partly by errors in GILES' description of the telson and uropods. As suggested by BOVALLIUS (*loc. cit.*, p. 200), GILES has mistaken the projecting hind margin of the urosome for the telson, which is unusually diaphanous and easily overlooked; while he has mistaken the 1st uropods for the 2nd owing to the former crossing the latter, as is common in a mounted specimen. As a matter of fact, the uropods are quite normal. The line of demarcation between the 2nd and 3rd urosome segments is also very difficult to see; it is correctly shown by STEBBING (*loc. cit.*, Plate 167) at the base of what was believed by GILES to be the telson. The posterior angle of the 3rd pleon segment is a sharp right angle as in *H. dysschistus*, and not rounded as drawn by GILES.

There is no doubt that our specimens are *H. dysschistus*, STEB., and, considering the localities and the deceptive nature of the characters in which Dr. GILES has erred, that they are also *H. bengalensis* (GILES).

The gnathopods agree well with the figures of *H. dysschistus* in BOVALLIUS (*loc. cit.*, Plate XI., figs. 1, 2).

This species presents a curious case of male dimorphism. The lower antennæ of the *smallest* males (2·25 millims.) have the very long and slender flagella generally considered characteristic of sexual maturity, while other males, with the antennæ imperfectly developed, measure 3·25 millims. Perhaps, as in the case of *Bathyporeia pilosa*, LIND., mentioned by BONNIER (' Travail du Lab. de Zoologie de Wimereux'), the males become sexually mature before they are full grown, and lose their nuptial appendages after copulation.

Several specimens from various localities at Ceylon.

Hyperia crucipes, BOVALLIUS.

In addition to the distinctive characters given by BOVALLIUS may be mentioned the great relative width of the 4th and the ciliate margin of the 5th joint in the 1st and 2nd peræopods.

Two, young, Station LXVI. Length 2·5 millims.

Hyperoche, BOVALLIUS, 1887.

Hyperoche cryptodactylus, STEBBING, ' "Chall." Amph.,' p. 1399, Plate 170.

One male, length 4 millims., Galle harbour.

The "Challenger" specimen was taken near the Cape of Good Hope.

Phrosina, RISSO, 1822.

Phrosina sp.

One, young—no locality. Length 2·5 millims.

Too young for identification.

Parascelus, CLAUS, 1879.

Parascelus parvus, CLAUS—Plate I., fig. 1.

One, male, length 3·5 millims.

The first (upper) antennæ have the 1st joint of the flagellum very wide and as long as the next two (fig. 1. ant.[1]).

The second antennæ have the last 3 joints subequal.

The gnathopods agree with STEBBING'S description ('"Chall." Amph.,' p. 1501); I could see no trace of the teeth shown on the carpus in CLAUS' figure ('Platysceliden,' p. 47, Plate VII., fig. 15); this is probably, from his description, exaggerated in the drawing.

Elsia, GILES, 1888.*

Elsia indica, GILES—Plate I., figs. 2.

Five or six male, female, and young. Length of male 5 millims., female with ova rather less.

Description of male (now found for the first time):—The head is produced and tumid in front, the eyes occupying the posterior half; it is fully as long as the first 4 segments.

Mesosome rather longer than pleon; the first 2 segments together as long as the 3rd, the 5th and 6th longest. The 1st segment of the pleon is longest, the 3rd shortest, the hinder angle of the latter is bluntly rectangular.

Upper antennæ attached to the extreme edge of the lower part of the front of the head, inflated, with the upper surface depressed and the lower convex. Flagellum minute, apparently 2-jointed (fig. 2. ant.[1]).

Lower antennæ of the usual form in males of this family, the 1st joint widened distally; the 3rd longer than the 4th and 5th, the latter very short.

No mouth organs or maxillipeds were found.

Gnathopods alike, small; 1st joint narrow, margin straight and parallel, longer than the remaining 5 joints; 2nd and 3rd subequal; hind margin of wrist extending nearly to the end of that of the hand, like a pair of shears with smooth inner margins; hand much shorter and narrower than the wrist, tapering slightly to the dactylus, which is very small (fig. 2. gn.[1]).

First and 2nd peræopods very slender, 1st joint as long as and scarcely wider than the 3rd and 4th; margins straight, parallel; 4th and 5th subequal; dactylus minute.

Third peræopods very powerful; 1st joint ovate, about as long as and but little wider than the 4th, narrowing distally; front margin obsoletely serrate; 3rd about two-thirds of the 4th, both widening distally; 4th and 5th subequal in length and width, the 4th rather wider at its distal end, both obsoletely serrate on both margins; dactylus very minute (fig. 2. pp.[3]).

Fourth peræopods like the third, but rather smaller.

Fifth peræopods small; 1st joint oval, widest near the base, and scarcely as long as the remaining joints; 3rd about twice as long as 4th; 5th as long as 3rd and 4th, narrowing distally; dactylus minute (fig. 2. pp.[5]).

* 'Journ. Asiat. Soc. of Bengal,' 1888, p. 250, Plate VI.

Uropods shortening progressively in extent, so that the 1st project the furthest; the inner ramus of the 1st is about half as large as the outer; the rami of the 2nd and 3rd pairs are subequal in length and breadth, and are all ciliate on the inner margins.

The telson is semi-oval, covering two-thirds of the rami of the 3rd uropods.

The only known species of the genus, and easily recognizable by the powerful 3rd and 4th peræopods.

Hyale, RATHKE, 1837.

Hyale nilssoni (RATHKE), var.

Station XLVII., 1 male; Station LVIII., 9 specimens.

This is the same form as that taken by Dr. H. O. FORBES on shore on the island of Abd-el-Kuri ('Nat. Hist. of Sokotra and Abd-el-Kuri,' 1903, p. 219). As there stated, it differs from the type in the length of antennæ (in the specimen from Station XLVII. not even in that); in the more rounded lobe of the wrist in the 1st gnathopod of the male and the 1st and 2nd gnathopods of the female; and in the 1st joints of the last 3 pairs of peræopods, which are serrate instead of smooth. I do not consider these differences sufficient to constitute a new species, but, if anyone wishes to do so, I suggest the name "*kuriensis*." They seem to me, however, quite as important as those that characterize some other species, such as *H. stebbingi*, CHEVREUX, and *H. grimaldii*, CHEV. ('Résult. des Camp. Sci. de "l'Hirondelle,"' pp. 8–10), but the genus appears to have been rather overworked.

Ichnopus, A. COSTA, 1853.

Ichnopus taurus, COSTA.—Plate I., fig. 3.

One male, Station XLI., about 100 fathoms.

The only point in which this species seems to differ from DELLA VALLE's description, &c. ('Gamm. d. Golfo di Napoli,' p. 802, Plate 27), is in the comparative squareness of the 1st joint and the greater width of the 3rd and 4th joints of the 3rd peræopods in our specimen (fig. 3, pp.[3]). I agree with DELLA VALLE that *I. spinicornis*, BOECK, and *I. affinis*, HELLER, can hardly be considered distinct species.

Socarnes, BOECK, 1870.

Socarnes schmardæ (HELLER).

> **Anonyx schmardæ**, HELLER, 'Amph. des Adriatischen Meeres.'
> **Ichnopus schmardæ**, HELLER, DELLA VALLE, *loc. cit.*

One male, Station VI.

Lateral angle of the head moderately produced, acute. Eyes occupying almost the whole head. Posterior margin of the 3rd pleon segment slightly convex, lower margin straight, angle rounded. The 1st urus segment is dorsally depressed.

The wrist of the 1st gnathopods is considerably wider at the distal end than the base of the hand; the latter has 2 or 3 spines on the posterior margin just beyond the widest part.

Socarnella, n. gen.

Upper antennæ with the 2nd and 3rd joints well developed, and the 1st joint of the flagellum like the succeeding joints.

Mandibles as in *Amaryllis*.

First maxillæ with a palp.

First gnathopod not subchelate.

Second gnathopod with hand long and widening distally.

Outer ramus of 3rd uropods without a terminal joint.

Telson small, emarginate at the tip.

Socarnella bonnieri,* n. sp.—Plate I., figs. 4.

One female; length 5 millims. Reef, Galle, with compound Ascidians (February 16, 1902). Head with the ocular lobe produced; convex on the upper side. Eyes large, oval, dark, with large crystalline facets.

Third segment of pleon with the hind margin convex, the lower margin straight, posterior angle rounded (fig. 4. pl.[3]); the 2nd segment has the posterior angle acute.

First 4 side plates rather deeper than the segments.

First segment of urus even.

Upper antennæ: 1st joint twice as long as wide, and as long as the 2 succeeding; 2nd rather longer than 3rd, which is subequal to the 1st joint of the flagellum. Flagellum setose, 9-jointed; the 1st joint like the succeeding, but twice as long as the 2nd. Appendage strong, 5-jointed, reaching to the 4th joint of the flagellum. The 1st and 2nd joints of the peduncle are acutely produced below, the 2nd more than the 1st (fig. 4. ant.[1]).

Lower antennæ: 2nd joint widening distally, rather longer than the 3rd, the two together about as long as the 7-jointed flagellum.

Mandible much as in *Amaryllis*, the palp placed near the proximal end, the 3rd joint about one-third of the 2nd, bent at a right angle (fig. 4. m.).

First maxillæ with a strong 2-jointed palp; outer plate with about 7 dentate spines; inner plate half as high as the outer, pointed, with 2 or 3 unequal setæ at the tip (fig. 4. mx.[1]).

Maxillipeds: inner plates reaching beyond the 1st joint of the palp, dentate at the ends, setose on the inner margin; outer plates broad, reaching the middle of the 3rd joint, margins smooth. Dactylus distinctly unguiform, acute (fig. 4. mxp.).

* I have much pleasure in dedicating this species to Mons. JULES BONNIER, who has contributed so much to a better knowledge of the Amphipoda.

First gnathopods: 1st joint with almost parallel margins, as long as the next 4; 2nd as wide, about one-fourth as long as the 1st and longer than 3rd or 4th; the 3rd overlapping the 4th, cordate, the point distal, hind margin very convex; wrist rather shorter than the hand, widening distally; base of the hand as wide as the wrist, narrowing to the dactylus; the latter short, curved, with a secondary tooth near the point. All the joints, except the 1st and 6th, have long setæ on the hind margin. Side plates subrectangular with rounded angles, wider than the next two (fig. 4. gn.[1]).

Second gnathopods: 1st joint about as long as the next 3, curved and widening distally; 2nd almost as long as the 4th, with 2 or 3 long stiff setæ in a depression on the hind margin near the distal end; 3rd very convex, with a group of erect setæ on the hind margin. Length of wrist to hand as 5 : 3, the former narrow, hind margin slightly concave, with short setæ and scanty fur at the distal end: the hand widens gradually to the end, furred on the hind margin, with short setæ on the front and a tuft of long setæ at the base of the dactylus; this is strong and overlaps the hind margin (fig. 4. gn.[2]).

First and 2nd peræopods slender, with few setæ and no spines.

Third peræopods: side plates wider than deep, lobes equal, larger than the 1st joint, which is suborbicular, flattened behind, margins smooth, a few setæ on the lower part of the front.

Fourth peræopods: the 1st joint flattened behind, the lower part of the front margin spinous; the upper part of the hind margin faintly serrate.

Fifth peræopods: the 1st joint rounded and more distinctly serrate behind, spinous on the lower part of the front margin.

First uropods spinous, the rather slender peduncle considerably longer than the subequal rami.

Second uropods: peduncle wide at the base, narrowing distally and about as long as the outer ramus, which is rather longer than the inner and spinous; the inner has one spine near the end (fig. 4. up.[2]).

Third uropods: peduncle longer than the rami, with 2 or 3 spines and a distal tooth on the outer margin; outer ramus rather the longer, *without a terminal joint*, with 2 spines dividing it into 3 equal parts (fig. 4. up.[3]).

Telson about half the length of the peduncle of the 3rd uropods, oval, deeply emarginate at the end, with a short spine on each of the lobes (fig. 4. ur.).

This genus differs from *Amaryllis* in the presence of a palp to the 1st maxillæ and in the smaller side plates of the first 4 segments. From *Socarnes* it differs in the mandibles, maxillipeds, 2nd gnathopods, telson, and 3rd uropods. It may be considered as connecting these two genera. The excavated point of the telson separates it from *Lysianax*, though DELLA VALLE (*loc. cit.*, p. 789, plate 25) has described a species under the name of *L. punctatus* with a similar telson. From this the present species differs in the antennæ, 1st maxillæ, &c.

Vijaya,* n. gen.

Upper antennæ in the male with the 1st joint of the flagellum much longer than any of the succeeding joints and very setose.

Mandibular palp set on in the middle of the trunk.

The remaining characters and the female antennæ as in *Amaryllis*, STEBBING, '"Chall." Rep.,' p. 699.

The curious difference in the male and female antennæ makes a new genus necessary.

Vijaya tenuipes, n. sp.—Plate I., figs. 5.

Coast of Ceylon, shallow water, 2 specimens, length 4 millims.

Head very deep, rostrum small, bent downwards; ocular lobe obtuse-angled. Eyes very large, long-oval.

Third pleon segment with the hind margin slightly convex, lower almost straight; the posterior angle acute, upturned, with a sinus above it, as in the other species of this genus (fig. 5. pl.[3]).

Antennæ in female subequal, reaching the hind margin of the 4th side-plates, which are very large.

Upper antennæ (female): 1st joint about twice as long and wide as the 2nd, produced below in a distal tooth; the 2nd the same proportion to the third; flagellum considerably longer than the peduncle, *the 1st joint resembling and rather shorter than the 2nd, quite naked;* appendage barely reaching the end of the 1st joint of the flagellum; 2-jointed, the 1st twice as long and wide as the 2nd (figs. 5. ant.[1]).

The upper antennæ in the male have the 1st joint of the flagellum as long as the next three and densely setose on the inner side, both flagella are broken, one at the 12th joint; the appendage is 3-jointed, the 1st joint twice as long as the 2nd, which is about in the same proportion to the 3rd: this is extremely narrow and reaches the end of the 2nd joint of the flagellum (fig. 5. ant.[1]).

Lower antennæ: the 1st joint very short, the 2nd half as long again as the 3rd (figs. 5. ant.[2]).

Maxillipeds: inner plates reaching beyond the middle of the palp, the ends cut into 3 teeth, sides setose; outer plates transparent, broad, reaching the end of the 3rd joint, dentate on the distal half, the indentations deeper towards the end. Second joint of the palp rather longer than the 1st or 3rd, which are subequal. Dactylus slender, with the inner margin finely denticulate and 2 or 3 setæ on the point.

First gnathopods: 1st joint as long as the remaining joints, about 5 times as long as wide; margins subparallel, 2nd longer than 3rd, which is irregularly triangular; wrist about two-thirds as long as the hand, with 3 fascicles of setæ on the hind

* VIJÁYA, an ancient king in Ceylon. See this Report, Part I., 'Introduction,' p. 1.

margin. The hand tapers gradually to the base of the dactylus without a palm, the hind margin finely pectinate with 4 spines and as many pairs of unequal setæ. Dactylus about one-fifth the length of the hand, curved. Side-plates small, oval below (fig. 5. gn.[1]).

Second gnathopods long and slender, the joints of almost uniform width throughout; the 1st slightly curved, about 6 times as long as wide; the 2nd twice as long as the 3rd; the wrist about equal to the two last named, margins straight, the hind margin setose; hand about two-thirds as long as the wrist, margins parallel, the hind margin with long setæ directed forwards. Side-plates nearly as long as the 1st joint, about twice as deep as wide, oval below (fig. 5. gn.[2]).

First and 2nd peræopods: 1st joint about as long as the next three: 2nd very short, 3rd, 4th, and 5th subequal; dactylus strong, about half as long as the preceding joint. Side-plate of the 2nd about as wide as one-fourth of the length of the whole body; hind margin excavated above and rounded below; *front margin with the lower angle produced and acute* (fig. 5. pp.[2]).

The remaining peræopods have the 1st joints expanded and serrate behind, the lower margins in the 3rd and 4th rounded, in the 5th almost straight; front margins spinous; 3rd joints spinous before and behind.

The uropods are damaged; the 1st pair extends the furthest, then the 2nd, which have the peculiar character shown by STEBBING in his figure of *A. macrophthalmus* ('"Chall." Rep.,' Plate 29). The rami of the 3rd pair are straight and lanceolate.

The telson reaches to about one-third of the length of the peduncle of the 3rd uropods, and is cleft for about one-third of its length, the cleft dehiscent.

This species may be distinguished by the acute anterior angle of the 4th side-plate, and by the straightness of the wrist and hand of the 2nd gnathopods. It may be identical with *Glycerina affinis*, CHILTON ('Trans. N.Z. Institute,' vol. xxiv., p. 2, Plate XLVII.), but the description of that species is not sufficient to determine the point.

Lysianax, STEBBING, 1888.

Lysianax cinghalensis, STEBBING.*—Plate I., fig. 6.

L. urodus, A. O. WALKER, 'Nat. Hist. of Sokotra,' &c., 1903, p. 220, Plate XIV., fig. 4.

Various localities round the coast of Ceylon.

This appears to be a variable species. Most of the specimens examined have a 4-jointed appendage to the upper antennæ, and, while in one male the 1st gnathopod resembles that of Mr. STEBBING's specimen, in another the hand is conical, with a straight dactylus continuous with the hand. The 1st joint of the 5th peræopods also varies, having the lower margin truncate in some and rounded in other specimens.

* 'Trans. Linn. Soc.,' Ser. 2, vol. 7, p. 28; Plate VII., A, 1896.

The apex of the telson is sometimes truncate. The small setiferous notch in the front margin of the side-plate of the 1st gnathopod, figured by STEBBING, is a constant character; it occurs also in *L. urodus*, which I consider identical with this species.

The mandibular palp has 1 or 2 spines in the middle of the concave side of the 3rd joint, which is rather more than half as long as the 2nd (fig. 6. mp.).

Length of male, 6 millims.; of female, 10 millims.

Lysianax cœlochir,* n. sp.—Plate I., figs. 7.

Stations LIII., LVIII.—about 16 specimens, males and females.

Head rather longer than the 1st segment; ocular lobe produced, subacute.

Epistome prominent.

Hind margin of the 3rd pleon segment rounded.

Anterior angle of 1st pleon segment rounded, posterior acute.

Upper antennæ subequal to the lower; 1st joint more than half as wide as long and rather longer than the next two. First joint of the 8-jointed flagellum subequal to and like the 2nd, shorter than the 3rd; appendage 4-jointed, the 2nd and 3rd the longest (fig. 7. ant.[1])

Mandibles normal, the 2nd joint of the palp nearly 3 times as long as the 3rd, which has no spine on the concave margin. Remaining mouth organs normal.

First gnathopods strong, the hand and dactylus in the same line; side plates large, much widened below with a small notch in the anterior margin near the lower angle, as in *L. cinghalensis* (fig. 7. gn.[1]).

Second gnathopods: 1st joint almost as long as the next 3; 2nd joint subequal to the 4th; 3rd much shorter and almost as wide as the wrist, which has the hind margin very convex and squamous, the front margin straight, with divergent setæ. The hand is about two-thirds the length of the wrist, the front margin rather convex and truncate at the end; the distal portion of the hind margin hollowed out, the whole very setose. Dactylus much curved, the base at the angle formed by the truncate end and the posterior sinus (fig. 7, gn.[2]).

Peræopods as in *L. cinghalensis.*

The 2nd uropods have spines on both the subequal rami and extend beyond the 3rd (fig. 7. ur.).

The 3rd uropods have the peduncles produced to a tooth at the outer angle and considerably longer than the rami, of which the outer is slightly the longer; the whole limb without spines (fig. 7. ur.).

Telson oval, barely reaching half the length of the 3rd uropods, not truncate.

Length 7·5 millims.

This species can hardly be distinguished from *L. cinghalensis*, except by the characteristic and peculiar hand of the 2nd gnathopods.

* From κοῖλος, hollow, χεὶρ, hand referring to the excavated palm of the 2nd gnathopods.

Orchomenella, Sars, 1894.

Orchomenella nana (Kröyer) = **O. ciliata**, Sars, 'Amph. of Norway.'

Cheval Paar; February, 1902; 30–40 specimens.

Length of male, 5·5 millims.

Tryphosa, Boeck, 1870.

Tryphosa cucullata,* n. sp.—Plate IV., fig. 8.

Kondatchi Paar; 17th November, 1902; one male. Length 5·5 millims.

Body compressed; first 4 side-plates twice as deep as the segments, the 4th deeply excavated behind; the 5th deeper than wide. The 3rd pleon segment has the hind and lower margins straight, the posterior angle bluntly rectangular; the upper margin produced in a subacute tooth behind. The 1st urus segment has a deep dorsal depression with a subangular carina behind it.

Head nearly as long as the 1st segment, produced in front; ocular lobe acute, produced to the 2nd joint of the upper antennæ. Eyes large, oval, red.

Upper antennæ: 1st joint tumid, projecting over the 2nd, which again completely overhangs and conceals the 3rd. First joint of the flagellum fully as long as the remaining 5, with about 10 rows of setules and a dense brush of long setæ. Appendage 5-jointed, not reaching the end of the 1st joint of the flagellum, the joints subequal (fig. 8).

Lower antennæ of the usual character of the males of this family, the flagellum reaching the urus.

Mouth organs and maxillipeds not examined.

First gnathopods as in *T. angulata*, G. O. Sars, the palm very oblique.

Second gnathopods: wrist much expanded below, without furring or setæ; lower margin of the hand produced; dactylus small.

The last 3 pair of peræopods are subequal and have the 1st joints wide, smooth, and rounded behind, spinous in front; the 3rd joints are much expanded behind, more so than in any of the species of *Tryphosa* figured by Sars.

The 3rd uropods have the rami widely lanceolate, rather longer than the peduncle, and spinous on their inner margins; they extend rather beyond the 2nd and as far as the 1st pair.

Telson convex on the upper side, long, reaching to the middle of the 3rd uropods, divided nearly to the base, with 2 or 3 submarginal spines and a larger apical spine on each division.

The single specimen was not dissected, but it is distinguished by the peculiar hooded character of the peduncular joints of the upper antennæ, in which respect it resembles the genus *Ambasia*, from which, however, it differs in the form of the 1st gnathopod.

* From the hood-like character of the first 2 joints of the upper antennæ.

Urothoë, Dana, 1852.

Urothoë spinidigitus,* n. sp.—Plate I., figs. 9.

Cheval Paar; November, 1902. One male, length 4 millims.

Body rounded, as deep as wide. Pleon segments all rounded behind.

Eyes very large, contiguous above, round, with large facets, red (fig. 9. c.).

Upper antennæ: 1st joint about three-fourths as long and twice as wide as the 2nd.

Lower antennæ: 1st joint very short, 2nd considerably longer than the 3rd; widening distally, setose on the upper and outer margins, and with an irregular row of spines (longer and sharper at the distal end) on the lower outer margin; 3rd joint swollen in the middle, with calceoli on the upper margin, and 7 or 8 long and weak setæ below. Flagellum very long and slender (fig. 9. c.).

Mandibles normal; the last joint of the palp with 6 setæ on the distal half and one or two very long setæ at the tip.

Maxillipeds: inner plates reaching half way up the outer, narrowed distally and crowned with 2 strong spine-teeth and one or two intermediate setules. Outer plates with curved spines and intermediate setæ; they barely reach the end of the 2nd joint of the palp, which is very broad.

First and 2nd gnathopods: side-plates very small, the 1st acutely angled in front, the 2nd rectangular, both without setæ. The limbs are similar in form and armature, the 2nd pair being rather the larger; the 1st joint is pyriform, as long as the hand and wrist; the 2 next short, with very long setæ on the hind margin of the 2nd, as also on the distal portion of the 1st. The wrist is rather longer than the hand in the 1st pair and subequal to it in the second—this joint and the hand are of the usual form, the hand being widest in the middle; the palm of the hand is defined by a peculiar rod-like spine, the end obliquely truncate with a setule at the tip; that of the 1st pair is half as long as the 2nd. The wrist is clothed with long setæ on the projecting portion, and the hand just below the palmar spine on the hind margin. Dactylus slender, with a setule on outer margin near the point (fig. 9. gn.[1]).

Side-plates of the 1st peræopods small, irregularly oblong; 1st joint rather longer than 3rd and 4th, the 3rd longer than the 4th, which has 4 blunt spines on the hind margin; 5th joint shorter and much narrower than the 4th, dilated and rounded at the end, where there are 4 spines of unequal length on the hind margin and 2 very short ones at the base of the dactylus. The dactylus is straight and slender, with 5 denticles on the inner side, the one nearest the point being the largest (fig. 9. pp.[1]).

Third peræopods: the 1st joint has the upper part projecting behind with 7 or 8 marginal setæ; front margin almost straight; 2nd joint very short; 3rd twice as long as 2nd, with a row of blunt spines just above the lower margin and 4 or 5 plumose setæ on the hind margin; 4th greatly expanded, with 2 parallel transverse ridges bordered with strong blunt spines and very long plumose setæ; 5th longer

* From the peculiar character of the dactylus of the 3rd peræopods.

and narrower than the 4th, with 3 irregular rows of similar, but more unequal, spines and setæ. Dactylus wide, with 4 long and 4 short spines in 2 parallel longitudinal rows on the front side (fig. 9. pp.[3]).

Fourth peræopods: 1st joint oblong, widening distally, and almost as long as the 3rd and 4th; a submarginal row of plumose setæ near the hind margin, which ends in a blunt right angle, and a few spines and simple setæ on the front margin; 2nd joint about half as long as the 3rd, which is about three-fourths of the 4th, and has 7 long plumose setæ on the hind margin; the 4th is nearly twice as long as the 5th, very spinous on the front and with simple setæ on the hind margin; 5th spinous in front and at the end; dactylus almost straight, slender, minutely and irregularly tuberculated with a denticle near the points (fig. 9. pp.[4]).

Fifth peræopods like the 4th, except the 1st joint, which is more than twice as long as wide, narrowing distally and rounded behind, without setæ or spines on either margin; the 3rd joint has no setæ on the hind margin except a distal tuft (fig. 9. pp.[5]).

First and 2nd uropods: peduncles with a distal spine at the outer and a seta at the inner angle; rami straight and subequal.

Third uropods as in *U. norwegica*, BOECK, as figured by G. O. SARS ('Amph. of Norway,' Plate 47), except that there are fewer spines on the outer margin of the outer ramus. Telson also as in *U. norwegica*.

A small male and female from the same tube, with well-developed lower antennæ, but only 2·5 millims. long, might, from observation of external characters only, be *U. elegans*, SP. BATE. I have long believed that differences of age would account for some of the species that have been established, and for which I would refer to Mr. STEBBING's valuable paper on the genus ('Trans. Zool. Soc. of London,' vol. 13, Part 1, 1891). The species described above may be distinguished by the curious spiny dactylus of the 3rd peræopods (Plate I., fig. 9. pp.[3]).

FAMILY: ARGISSIDÆ, nov.

First or upper antennæ in the males with the flagellum longer and more slender than in the females.

Gnathopods subequal and similar.

Last one or two pairs of peræopods much more powerful than the rest of the limbs.

Argissa, BOECK, 1870.

Argissa hamatipes (NORMAN).

Syrrhoë hamatipes, NORMAN, 'Brit. Assoc. Shetland Dredging Rep.,' 1868.
Argissa typica, BOECK, 'Crust. Amph. bor. and arct.,' 1870, p. 45.
Chimæropsis danica, MEINERT.
Argissa typica, G. O. SARS, 'Amphipoda of Norway,' p. 141, Plate 48.
Argissa hamatipes, NORMAN, 'Ann. and Mag. Nat. Hist.,' 7, vol. 10, p. 480, 1902.

Kondatchi Paar; 17th November, 1902; one female with ova.

Length 2·5 millims.

Platyischnopus, Stebbing, 1888.

Platyischnopus herdmani, *n. sp.*—Plate II., figs. 10.

Periya Paar Kerrai and E. Cheval Paar, November, 1902.

About 21 specimens. Colour in spirit, light brown.

Body compressed. Head nearly as long as the first 4 segments, produced to a point which is wrinkled or puckered, as in *P. mirabilis*, Stebbing, and surrounded with short spines (fig. 10. c. ♂). No eyes discernible.

The first 3 segments are subequal and shorter than the other mesosome segments, which increase in length successively.

The 3rd pleon segment has 2 dorsal and 1 or 2 dorso-lateral teeth just below the dorsal on each side on the hind margin, the posterior angle upturned, acute; the lower margin convex (fig. 10. pl.^{3}).

Upper antennæ placed considerably in front of the lower: in the female they are short, the 3rd joint of the flagellum reaching the end of the head; two joints only of the peduncle are visible, the 1st shorter than the 2nd; the flagellum 6-jointed; appendage barely reaching the end of the 2nd joint of the flagellum, 2-jointed, the 1st longer than the 2nd; the whole antenna without spines or setæ, except single ones at the ends of joints (fig. 10. ant.^{1} ♀).

In the male the upper antennæ are entirely different: the 1st joint of the peduncle is swollen and hemispherical, the 2nd twice as long as the 3rd, which has a dense fringe round the distal end: the flagellum is longer than the whole animal and very slender, the 1st joint as long as the next 3; appendage 2-jointed, about one-fourth the length of the 1st joint of the flagellum, which is more than twice as long as the 2nd (fig. 10. c. ♂).

Lower antennæ (female): the 2nd joint four times as long as, and but little narrower than the 1st, and one-third longer than the 3rd, with 4 nearly equi-distant spines on the front margin and 2 setæ at the end of the hind; otherwise the whole antennæ is naked; the flagellum is 9-jointed, as long as the last 2 joints of the peduncle (fig. 10. ant.^{2} ♀).

Mandibles as in *P. mirabilis* (fig. 10. m.).

Maxillipeds with the inner plate very small, and tapering, with a short spine and strong plumose setæ on the top; inner edge almost smooth. Palp with the 3rd joint shorter than the 2nd, widening distally.

First gnathopods: side-plates small and narrowly oval; 1st joint as long as the next two, much distended distally; wrist almost as long as the 1st joint, narrow; hand about half as long as the wrist, sub-triangular, the hind margin produced to form a chela as in *P. mirabilis* (fig. 10. gn.^{1}).

Second gnathopods like the first, but the wrist nearly twice as long (fig. 10. gn.^{2}).

First peræopods: side-plates rhomboidal, widening below. First joint as long as the next 3; the 3rd longer than the 5th, which is longer and narrower than the 4th; the 4th has a long and a short spine, and the 5th a group of strong spines on the postero-distal margin. Dactylus slender, slightly curved.

Second peræopods with the side-plates much produced behind, otherwise like the 1st (fig. 10. pp.^{2}).

Third peræopods: 1st joint narrow-oblong, widening distally, about as long and wide as the 4th, naked except a long spine on the produced end of the front margin, the remaining joints spinous, the 5th about half as wide as the 4th. Dactylus slender, straight (fig. 10. pp.^{3}).

Fourth and 5th peræopods: 1st joints broadly oval, with two teeth on the lower part of the hind margin; 2nd very small; 3rd much expanded behind, almost as wide as the 1st and considerably wider than the 4th; remaining joints as in the 3rd peræopods. The three last pairs of peræopods increase in length successively, the last two pairs being much the strongest, the 3rd hardly reaching below the 1st joints of the 5th (fig. 10. pp.^{5}).

The 1st and 2nd uropods are slender, the peduncles shorter than the equal rami, all spinous; the 1st are much longer than the 2nd. Third uropods: peduncle strong, cylindrical, with 2 or 3 teeth on the distal margin; outer ramus lamellar, spear-shaped; inner apparently wanting in all the specimens (fig. 10. up.^{3}).

Telson convex above, broad, cleft less than half its length; a tooth on the outer side, 2 upright spines near the middle and a group by the tooth of each division (fig. 10. t.).

This curious genus was first described by STEBBING in the '"Challenger" Report,' from two imperfect specimens of which only one, a female, had a head, so that he was not aware of the remarkable development of the *upper* antennæ in the male. He therefore placed the genus provisionally in the Pontoporeiidæ. I have thought it advisable to form a new family for it and the genus *Argissa*, which also has been placed by SARS, with hesitation, in the same family and, like *Platyischnopus*, is characterised by a similar development of the last peræopods and of the upper antennæ of the male. The present species has much the same general appearance as *P. mirabilis*, STEB., but differs in the sculpture of the last pleon segment, the absence of eyes, the proportions and armature of the antennæ, form of telson, &c. Subsequently ('Ann. and Mag. Nat. Hist.,' Ser. 6, vol. xix., 1897, p. 1, plate v.) Dr. C. CHILTON described another species (*P. neozelanicus*) from Otago, also from an imperfect female specimen, which differs in the gnathopods, and many other points from the other two species. It is to be hoped that specimens of the present species will be taken with perfect 3rd uropods; from the appearance of the peduncle I should expect the inner ramus to be long and easily detached as in the case of some of the Gammaridæ.

Leptophoxus, G. O. SARS, 1895.

Leptophoxus uncirostratus (GILES).

Phoxus uncirostratus, GILES, 'J. Asiat. Soc. Bengal,' vol. 59, Pt. II., 1890, p. 65, pl. ii., fig. 2.

Station XXXVII., one old female; length, 10 millims. Station LVIII., one young female.

Ampelisca, KRÖYER, 1842.

It will be useful to give here a synopsis of the following species of the genus:—

Upper antennæ extending beyond the peduncle of the lower by *more* than 3 joints of the flagellum.—*A. tridens*, n. sp.

Upper antennæ extending beyond the peduncle of the lower by *less* than 3 joints of the flagellum.

Lower antennæ reaching beyond the pleon.—*A. scabripes*, n. sp.

,, ,, not reaching beyond the pleon.—*A. brachyceras*, n. sp.

Upper antennæ not reaching the end of the peduncle of the lower.

Third uropods ovate; inner margin of outer ramus distinctly serrate.

Posterior angle of 3rd pleon segment acute, much produced, and upturned; head angular below.—*A. brevicornis*, COSTA.

Posterior angle of 3rd pleon segment scarcely produced or upturned; head rounded, narrow; one large red eye on each side of the head.—*A. cyclops*, n. sp.

Third uropods lanceolate, outer ramus not serrate.—*A. chevreuxi*, n. sp.

Ampelisca tridens,* n. sp.—Plate II., figs. 11, and Plate IV., figs. 11.

Generally distributed round the coast of Ceylon.

Head rather longer than the first 2 segments, not much produced, with a distinct but rounded lateral angle, just below which the lower and larger eye is placed; the other is close to the base of the upper antennæ (Plate II., fig. 11. c.).

Third pleon segment with the hind margin slightly convex; the posterior angle acute, scarcely upturned; the 2nd pleon segment has the hind margin more convex and the angle less produced.

First urosome segment with a deep dorsal depression, on which are 3 carinæ, each ending in a knob-like prominence. The 2nd segment is also dorsally depressed, with the sides elevated distally, forming a rounded prominence on each side of the base of the telson. The 3rd segment is hidden by the 2nd (Plate IV., fig. 11. ur.).

Upper antennæ reaching to about half the length of the flagellum of the lower, the peduncle to a little beyond the middle of the 2nd joint of its peduncle.

* From the three prominences on the 1st urosome segment.

Lower antennæ about as long as the body.

First and 2nd gnathopods normal; hind margins very setose. Side-plates wider below, with a strong curved tooth at the posterior angle.

First and 2nd peræopods: dactylus nearly twice as long as the 2 preceding joints. Side-plates of the 2nd with the upper posterior angle hollowed, leaving an acute angle below (fig. 11. $pp.^2$).

Third peræopods: 1st joint convex in front, with a rounded expansion behind; a submarginal row of 5 short spines on the 4th joint; 5th joint widening distally, with 3 short submarginal spines on the proximal half.

Fourth peræopods: 1st joint subquadrate.

Fifth peræopods: lower margin of the 1st joint slightly concave, reaching to the end of the 2nd joint, with many long setæ; 2nd joint subquadrate; 3rd joint shorter than 4th, front angle produced with 2 or 3 spines, hind angle slightly produced; 4th joint rather shorter than 2nd, front angle much produced, hind angle not at all; 5th joint oval, widest near the base, about one-fourth longer than the 2nd, a few short spines at the distal end. Dactylus as long as the 5th joint, tapering gradually to a long crooked point (fig. 11. $pp.^5$).

First uropods reaching the end of the peduncle of the 2nd; rami slender, curved, unarmed, about as long as the peduncle. Second reaching beyond the end of the peduncle of the 3rd, rami wider than those of the 1st pair, straight, subequal; a few short spines on their inner margins, the outer with a long serrate spine near the end of the inner margin.

Third uropods: the peduncle narrowed abruptly in the middle, where there is a curved spine and a setule; outer ramus narrower and a little shorter than the inner, with a long simple spine near the tip and a few plumose setæ on the distal half of the inner margin; inner ramus with the end slightly curved outwards, 3 slender spines near the end of the inner margin and 2 unequal setæ on the rounded point; both rami are widest at about one-fourth their length from the peduncle (fig. 11. ur.).

Telson divided to the base, without spines; a few setules on a median fold of each division; this is sometimes notched at the end with a setule in the notch (fig. 11. t.).

Length, 10 millims.

Distinguishable by the prominences on the urosome segments.

Ampelisca scabripes,* n. sp.—Plate II., figs. 12.

Areas (A), (C), (H): apparently not abundant.

Head as long as the first 2 segments, rounded below the upper antennæ. Eyes distant, with a crimson spot behind each, and a smaller one behind the uppermost (fig. 12. c.).

Hind margin of the 3rd pleon segment convex, the angle upturned but rounded (fig. 12. $pl.^3$).

* From the scabrous 4th joint of the 3rd and 4th peræopods.

First urosome segment with a dorsal depression, not carinate.

Upper antennæ reaching a little beyond the peduncle of the lower; the latter longer than the body.

First gnathopods strong; side-plates rounded before, straight behind. First joint widening distally; wrist and hand subequal, about twice as long as wide, setose.

Second gnathopods: 1st joint twice as wide at the distal end as any of the remaining joints; wrist half as long again as the hand.

First and 2nd peræopods: dactylus hardly as long as the two preceding joints (fig. 12. pp.[1]).

Third and 4th peræopods very short and much alike, except that the upper margin of the membranous posterior lobe of the 1st joint originates from the top of the hind margin in the 3rd, and from lower down in the 4th pair. The 4th joint is broad and produced behind in a truncate lobe, which is scabrous with minute spines, and terminates in a group of unequal spines, of which the longest reaches the end of the 5th joint and is denticulate (fig. 12. pp.[4]).

Fifth peræopods: hind margin of the 1st joint extending downwards to the end of the 2nd, a few short setæ on the lower part of the posterior curve and a long plumose one on the upward recurvature; 2nd joint the longest and the 3rd the shortest of the remaining joints, neither produced at the angles; 4th and 5th subequal in length and width, the latter ovate; last joint ovate, with a minute point and setule at the end (fig. 12. pp.[5]).

First uropods reaching the end of the 2nd pair; rami curved, rather shorter than the peduncle.

Second uropods with straight rami considerably shorter than the peduncle, inner ramus finely serrate on the outer, outer ramus on the inner margin.

Third uropods: rami* nearly twice as long as the peduncle, lanceolate, the inner the wider dentate along the distal half of its inner margin, the teeth increasing in size distally, and 3 or 4 setæ near the end of the outer; outer ramus minutely spinous near the end of the outer margin, with 3 or 4 fine submarginal and a pair of terminal setæ (fig. 12. ur.).

Telson divided to the base and covering a fourth of the length of the rami of the 3rd uropods; a notch and spine at the end of each division, a marginal spine just behind the end, and a seta behind the spine.

Characterized by the spinous 4th joints of the 3rd and 4th peræopods, the form and proportions of the joints of the 5th and the serrate and dentate 3rd uropods.

Length, 6 millims.

A. brachyceras,† n. sp.—Plate II., figs. 13.

Kondatchi Paar, 1; Cheval Paar, 1; both November, 1902.

* In the specimen figured the rami are double—probably the result of an imperfect moult.

† In allusion to the shortness of the antennæ.

Head of an unusual form in this genus, the lower antennæ originating immediately below the upper with a well-defined but rounded lateral angle. Eyes scarcely discernible (fig. 13. c.).

Third pleon segment with the hind margin slightly convex, the lower margin straight till turned up to meet the slightly produced angle (fig. 13. pl.[3]).

First segment of the urus with a small carina.

Antennæ short, the lower rather the longer, reaching the end of the 2nd mesosome segment. First joint of the upper about twice as long and as thick again as the 2nd; 3rd not distinguishable from the flagellum, which is 5-jointed without the above doubtful joint, with a long terminal seta. The lower have the first 2 joints subequal, the 3rd the longest, with 5 spines on the lower margin.

Gnathopods normal.

First and 2nd peræopods of the usual form, the dactylus about as long as the 2 preceding joints.

Third and 4th peræopods: 1st joint fully as wide as long; 4th joint has the posterior longitudinal half produced downwards for two-thirds of the length of the 5th joint, terminating in 2 long, unequal serrate spines. In the 4th pair the dactylus is rudimentary (fig. 13. pp.[4]).

Fifth peræopods: 1st joint with the front margin longer than the remaining joints; it is concave on the upper and convex on the lower part; the hind margin evenly convex, reaching downwards to the 5th joint; about 9 simple unequal setæ and 4 or 5 setules on the lower part; 2nd joint longer than any of the succeeding, 4th, 5th, and 6th subequal, the last lanceolate, acute. None of the joints have their angles materially produced (fig. 13. pp.[5]).

First uropods: peduncles almost twice as long as the subequal rami; 2 spinous and finely pectinate ridges on their upper sides; rami curved, unarmed, except a spine near the base of the inner.

Second uropods: peduncles rather longer than the subequal rami, sparsely spinous; rami straight, 5 spines on the inner margin of the inner (fig. 13. ur.).

Third uropods: rami rather longer than the peduncles, the outer having the outer margin very convex, the distal half beautifully ornamented with a double row of minute spines; the inner margins straight with a few long setæ; inner rami concealed by the outer—apparently as long and wide as these—with long and dense setæ at the tips (fig. 13. ur.).

Telson divided about three-fourths of its length, with long upright setæ along the margins of the cleft.

Length 4·5 millims.

Easily recognisable by the short antennæ, the peculiar structure of the 4th joints of the 3rd and 4th and the 1st joint of the 5th peræopods, and the curiously formed and ornamented 3rd uropods.

Ampelisca brevicornis (Costa, 1853).

A. lævigata, Lilljeborg, 1855.

For the synonomy of this species, see Norman in 'Ann. and Mag. Nat. Hist.,' Ser. 7, vol. V. (1900). p. 342.

Stations XXXIV., XXXV., and pearl oyster washings, Muttuvaratu Paar.

Length 5 7 millims.

Ampelisca cyclops,* n. sp. Plate II., figs. 14.

Galle, 14th February, 1902; Kondatchi Paar, 17th November, 1902.

Head as long as the first 3 segments, produced to the end of the 1st joint of the upper antennæ, where it is almost cylindrical. At the extreme end are 2 large confluent crimson spots in which are placed 1 or 2 (I could only see one, apparently between the 2 red spots) crystalline lens (fig. 14. c.).

The 2nd and 3rd segments of the pleon have a low dorsal carina, and the 1st urus segment a higher one, ending abruptly. The hind margin of the 3rd pleon segment is convex and hollowed out just above the acute posterior angle.

The upper antennæ are placed much in front of the lower and reach nearly to the end of the peduncle of these; the 1st joint twice as thick and more than half as long as the 2nd; the 3rd rather shorter than the 1st joint of the flagellum, which is 5-jointed and scarcely as long as the peduncle; this, in the adult, has 9 or 10 long plumose setæ on the lower side.

The lower antennæ reach to the pleon; the 1st joint does not reach the end of the 1st joint of the upper, though nearly twice as long; the 2nd joint is nearly twice as long as the 1st, the 3rd a little shorter than the 2nd.

Palp of the mandibles long and slender, the 1st joint about half as long as the 3rd, the two together about equal to the 2nd. *This is not dilated, the 3 joints being subequal in width* (fig. 14. m.).

Maxillæ normal, a single setule near the top of the inner lobe of the 1st.

Maxillipeds with the outer plate reaching the top of the 3rd joint of the palp and furnished with 6 disproportionately large oval spine-teeth.

First and 2nd gnathopods normal; the side-plates widened below and fringed with plumose setæ.

First and 2nd peræopods: 5th joint 3 times as long as the 4th, dactylus longer than the two united; side-plates of the 2nd with the upper posterior angle cut away and slightly hollowed; front and hind margin parallel.

Third peræopods: 1st joint wide, posterior lobe rather small, projecting; a long spine on the distal end of the front margin of the 4th joint.

Fourth peræopods: 1st joint subquadrate, 4th and 5th joints very spinous on the front margin. Dactylus like a bird's head (fig. 14. pp.[4]).

* From the apparently single eye.

Fifth peræopods: posterior lobe of the 1st joint reaching to the end of the 2nd, the anterior half of the lower margin fringed with long plumose setæ; 2nd and 3rd joints short, their angles hardly produced; anterior angle of the 4th joint produced one-third of the length of the 5th, spinous on the truncate end; 5th joint wide oval, truncate at the end; 6th as long as the 5th, tapering gradually to a long curved, very sharp point (fig. 14. pp.^{5}).

First uropods reaching to the middle of the rami of the 2nd; rami smooth, curved, subequal, considerably longer than the peduncle; 2nd pair longer than the 1st, peduncle longer than rami, which are subequal, straight and spinous, the spines slender and, at the distal end of both, very long (fig. 14. up.^{2}).

Third uropods: peduncle shorter than the rami in the proportion of 3 : 5, unarmed except 3 slender spines on the inner side; outer ramus a little longer than the inner, outer margin, with 4 small spines and plumose setæ, prolonged to a point beyond the inner, which is furnished with long plumose marginal setæ on the distal half; this ramus is narrow near the base and widest near the middle; the inner ramus is widest about one-third of the distance from its base and is naked except 2 or 3 slender spines near the rounded point and 3 slender spines and 2 plumose setæ on the tip (up.^{3}).

The telson is convex on the upper side, cleft rather more than half its length, the sides of the cleft contiguous almost the whole length; margins of the divisions parallel, the ends rounded with a terminal notch and 2 slender spines (fig. 14. t.).

The peculiar shape of the head and appearance of the eye distinguishes this species at once. In the form of the mandibular palp it differs from G. O. SARS' definition, but as one or two of Mr. STEBBING'S "Challenger" species differ in the same way, it would seem advisable to disregard that part of the definition.

Ampelisca chevreuxi,* n. sp.—Plate III., figs. 15.

Station LIII. One specimen. Length, 7 millims.

Head narrow and rounded in front, longer than the first 2 segments. Eyes large and prominent, one at the extreme end of the head, the other below the base of the upper antennæ.

Third pleon segment: the hind and lower margins rather convex, the posterior angle a little produced, obtuse (fig. 15. pl.^{3}).

Urus with a shallow carina on the 1st segment.

Upper antennæ reaching to about one-third of the last joint of the peduncle of the lower; 1st joint more than half as long as 2nd, 3rd shorter than the 1st joint of the flagellum, which is about 8-jointed.

Lower antennæ scarcely half the length of the body, the 3rd joint rather longer than the 2nd.

Gnathopods and 1st and 2nd peræopods of the usual form; dactylus of the latter rather longer than the 2 preceding joints.

* Named after that distinguished Amphipodist, Monsieur E. CHEVREUX.

Third peræopods: 1st joint wide, as long as the next 3, the posterior lobe projecting one-third of the length of the hind margin below the top of it; front margin with plumose setæ on the upper part and irregular spines on the lower; 4th joint considerably longer than the 5th, the hind margin produced in a spinous lobe (fig. 15. pp.[3]).

Fourth peræopods: 1st joint as wide as long, the front margin subangular, the part below the angle irregularly spinous; posterior lobe large, the margin evenly rounded and smooth; 2nd joint short, with an angular prominence behind and 2 or 3 short spines in front; 3rd joint longer than the 2nd, with 3 spines on the front margin; 4th joint twice as long as the 3rd, unevenly spinous on the front margin, which ends with 1 long and 2 short spines; the hind margin is naked, but ends in a cluster of unequal spines (one very long) on a truncate lobe; the 5th joint has 12 spines, increasing in length distally and a long terminal one on the front margin, and 3 short ciliate spines on the hind (fig. 15. pp.[4]).

Fifth peræopods: 1st joint produced behind to the end of the 2nd joint, with long plumose setæ on the lower margin; 2nd joint as long as the 2 next and much wider at the top than any of the succeeding joints—*the distal third of the front margin cut away;* 3rd joint about half as long as the 4th, somewhat produced in front; 4th as wide and more than half as long as the 5th, the front angle rounded off and spinous, hind angle slightly produced and spinous; 5th joint oval; 6th narrowed rather suddenly to a long crooked point (fig. 15. pp.[5]).

First uropods: rami curved, subequal, rather longer than the peduncle, inner margins of peduncle and inner ramus spinous.

Second uropods: rami straight, shorter than the peduncle, and spinous on their inner margins, the peduncle stout, with a strong spine at the end of the inner margin.

Third uropods: rami narrow, lanceolate, longer than the peduncle, subequal; the outer the narrower, with a few very small spines on the outer and plumose setæ on the inner margin: the inner has a few setæ on the outer margin near the end (fig. 15. ur.).

Telson divided almost to the base, the divisions pointed, with 3 spines before the point on the outer margin (fig. 15. ur.).

This species may be known by the form of the 2nd joint of the 5th peræopods, &c.

Amphilochus, Sp. Bate, 1862.

Amphilochus neapolitanus (?), Della Valle.

Muttuvaratu pearl oyster washings; 19th November, 1902.

One young and imperfect specimen, length 1·5 millims.

For the synonomy of this species see 'Jour. Linn. Soc.,' vol. 28 (Zool.), p. 300.

Gallea,* n. gen.

Body tumid, integuments strong; 3rd and 4th side-plates very large. Head with a deflexed rostrum. Antennæ subequal; the upper without an appendage and having the 2nd joint produced in a hood-like process over the 3rd. Mandibles with the molar tubercle obsolete; the palp long and slender, the 3 joints subequal.

Gnathopods stout, dissimilar, the 1st pair complexly subchelate as in *Leucothoë;* the 2nd pair rather less powerful, subchelate, as in *Amphilochoides.* Peræopods slender.

Second pair of uropods longer than the 3rd.

A carina runs along each side of the pleon and urus, uniting to form a pointed roof-like projection above the telson. Telson entire.

This is an aberrant genus resembling *Leucothoë* in its first and *Amphilochoides* in its second gnathopods. The length of the 2nd uropods is also unusual in this family, in which they are generally shorter than the 3rd; and the absence of a molar tubercle in the mandibles is inconsistent with G. O. Sars' definition of the family. It is a link between Amphilochidæ and Leucothoidæ.

Gallea tecticauda,† n. sp.—Plate III., figs. 16, and Plate VIII., fig. 16.

An abundant species in several localities round Ceylon.

Head with a small pointed and deflexed rostrum; no ocular lobe. Eye large, round, red, with many facets.

First and 2nd side-plates very small and hidden by the very large 3rd plate, which, with the still larger 4th plate, forms a complete cuirass (Plate VIII., fig. 16).

The 4th and 5th segments are subequal, and each of them as long as the 6th and 7th together; the latter have their lower part produced behind in an acute point; the 2nd pleon segment has the hind angle acute, and the 3rd is considerably produced behind, the convex hind and lower margins together forming a semi-oval.

Urus as long as the last 2 pleon segments, not counting the hood-like process; the 1st segment dorsally depressed, the 2nd produced in a roof-like process convex above and extending over half the telson (Plate III., fig. 16. ur.).

Upper antennæ: 1st joint shorter and wider than the 2nd, its upper and lower margins produced distally: 2nd with an elevated ridge produced above the short 3rd joint for half its length; flagellum 8 or 9-jointed, with 1 or 2 jointed (?) setæ at the end of each joint.

Lower antennæ: 1st joint contracted beyond the middle, the lower margin produced in a short tooth, about two-thirds the length of the 2nd; 3rd rather longer than the 2nd; flagellum 3-jointed, about as long as the 1st joint.

* From the port of Galle.

† From the roof-like projection over the telson.

Mandibles much hollowed below with a roughened portion, which probably represents the molar tubercle and spine row, in the concave part near the cutting edge; this is double in one mandible (in which the spine row also is more conspicuous), is expanded, and has 9 strong teeth (fig. 16. m.).

The palp is as long as the mandible, slender and tapering from the base to a point with a single seta, the joints subequal, the 2nd rather the longest.

First maxillæ: palp 2-jointed, the 2nd the longer; the outer plate is rather wide and crowned with simple spine-teeth; inner plate small, quadrate, with rounded corners and a few fine setules on the top (fig. 16. mx.[1]).

Second maxillæ normal.

Maxillipeds: inner plate hardly reaching beyond the base of the 1st joint of the palp, with 2 spine teeth a little below the upper margin; outer plate reaching half-way up the 1st joint, with a strong in-curved spine at the outer angle. First and 3rd joints of the palp subequal and longer than the 2nd; dactylus rather long and slender (fig. 16. mxp.).

First gnathopods: 1st joint about as long as the 4th and 5th; 2nd produced behind in a setose spur about half as long as the hind margin of the 3rd; the 3rd longer than the 2nd, produced at both angles; wrist with the hinder part produced in a pointed spur to the end of the hand as in *Leucothoë*, with a few stiff setæ on the inner margin. Hand oblong, with the palm at right angles to the hind margin, the angle rounded; hind margin finely serrate on the distal half, with an intra-marginal row of equidistant spinules; dactylus rather longer than the palm (fig. 16. gn.[1]).

Second gnathopods less powerful than the 1st; the 1st joint rather longer than the hand with a carina on the distal half of the front margin; wrist rather less than half as long as the hand, the hind margin prolonged in a setose spur along the hand for about one-third of its hind margin, and ending in a cluster of long spines; front margin of the hand straight, hind margin evenly curved, without a definite palm, the edge very minutely pectinate and with an intra-marginal row of spinules. Dactylus curved and slender, not reaching the end of the carpal spur, finely pectinate on the inner margin of the proximal half (fig. 16. gn.[2]).

First and 2nd peræopods: side-plates rounded below and obtusely angulated above, the 2nd larger than the 1st; limbs slender and naked, except a few spinules on the front margin of the 5th joint; 1st joint narrow (fig. 16. pp.[1 & 2]).

The remaining peræopods are like the first 2 pairs, but the side-plates are small and much wider than deep, those of the last pair produced behind to an acute angle.

First uropods: peduncle nearly twice as long as the smooth, styliform, equal rami.

Second uropods: peduncle longer than the rami, which are rather unequal, minutely pectinate, and spinulose on the inner margins.

Third uropods: peduncle shorter than the inner and about as long as the outer ramus; rami styliform, the margins minutely pectinate.

The 1st uropods extend beyond the 2nd, and these beyond the 3rd.

2 L

Telson entire, oblong-oval, concave above, reaching to the end of the peduncle of the 3rd uropods (fig. 16. ur.).

Length 4 millims.

Leucothoë, Leach, 1813.

Leucothoë spinicarpa (Abildgaard).

Generally distributed.

I can find no differences in the specimens examined to justify referring them to any later species. In a male, 7 millims. long, from Cheval Paar the distal half of the palm of the second gnathopod was more deeply toothed than in Sars' figure, while in smaller specimens from the same tube it agreed. The hind angle of the 3rd pleon segment varies from a blunt right angle to an acute angle in different specimens.

Leucothoë hornelli,* n. sp.—Plate III., figs. 17.

Various localities: in the branchial sacs of Tunicates, &c.

Head as long as the 1st body segment; ocular lobe square, with the upper and lower angles rounded.

Eyes large, dark, pyriform, with the small end lowest.

Segments of the mesosome subequal; first 4 side-plates scarcely deeper than the segments.

First and 3rd pleon segments respectively longer than the 2nd; posterior angle of the 2nd acute; the 3rd has the hind margin of the epimere at first straight, then abruptly incurved, forming a sinus above the acute and slightly upturned angle (fig. 17. pl.^{3}).

Antennæ, mouth organs, maxillipeds, and 1st gnathopods as in *L. spinicarpa*.

Second gnathopods: hand more than twice as long as wide; front margin almost straight or very slightly convex; hind margin with a deep sinus about one-third of its length from the base of the dactylus, followed by 2 smaller sinus, the 3rd being close to the base of the dactylus. In other respects the limb resembles *L. spinicarpa* (fig. 17. gn.^{2}). Peræopods as in *L. spinicarpa*.

Third uropods with the inner ramus almost as long as the peduncle, outer about one-fourth shorter (fig. 17. up.^{3}).

Telson reaching beyond the end of the peduncle of the 3rd uropods, tapering gradually to a very diaphanous blunt point, with 2 small spines on it (fig. 17. up.^{3}).

Length, 5 millims. to 6 millims.

This species resembles *L. spinicarpa* very closely, except in the sculpture of the hand of the 2nd gnathopods and the posterior angle of the 3rd pleon segment, which is nearer *L. lilljeborgii*, Boeck. In young specimens, 2 millims. long, "from *Rhabdocynthia*, Station XIX.," the characteristic indentation of the 2nd gnathopod is plainly

* Named after Mr. Jas. Hornell, F.L.S., now Marine Biologist to the Ceylon Government, by whom, when assisting Professor Herdman, many of the species of Amphipoda described in this work were taken.

to be seen. From *L. furina*, Savigny, it differs in the convex front margin of the hand of the 2nd gnathopod; in the 3rd uropods reaching beyond the 1st and 2nd; and in the quite different shape of the telson.

Leucothoë stegoceras,* n. sp.—Plate III., figs. 17A.

Three specimens from the branchial sac of an Ascidian (*Polycarpa*) from Singapore, sent by Dr. Hanitsch to Professor Herdman in 1898.

Head a little longer than the first segment, *produced in front to a hood-like projection over the base of the upper antennæ.* Ocular lobe rounded. Eyes round, colourless in spirit, probably red (fig. 17A, c.).

First 5 segments of the mesosome subequal, the remaining 2 longer.

Posterior angle of the 3rd pleon segment subrectangular.

Upper antennæ a little longer than the lower; the proximal third part of the 1st joint overlapped by the hood of the head; flagellum a little longer than the 2nd joint, 8–9-jointed.

Lower antennæ: flagellum about half as long as the 3rd joint, 6-jointed.

First gnathopods: side-plates securiform, the angles rounded. The rest of the limb as in *L. spinicarpa*, except the 1st joint, which is stronger.

Second gnathopods: side-plates subquadrate, angles rounded. First joint strong, two-thirds of the length of the hand. Carpal process about one-third of the hind margin of the hand, setose. Hand widest opposite the end of the carpal process, where the palm is obscurely defined by a small obtuse tooth; this is succeeded distally by a slightly concave space; then 2 deep sinus and a smaller one followed by a nodular tubercle near the base of the dactylus: this does not quite reach the palmar tooth (fig. 17A. gn.[2]).

The rest of the animal resembles *L. spinicarpa* so closely that further description is unnecessary. Length, 6 millims.

Easily distinguished by the form of the head.

Anamixis, Stebbing, 1896.†

Anamixis stebbingi, n. sp.—Plate III., figs. 18.

Muttuvaratu pearl oyster washings, 19th November, 1902. One imperfect specimen. Head produced in the middle. Ocular lobe rather deep, the lower angle produced and upturned. Eye round, colourless in spirit.

First body segment apparently coalesced with the head. Posterior angle of the 3rd pleon segment a rounded right angle.

First side-plates rudimentary and concealed by the 2nd, which are much deeper than the segments, pyriform, widest below the middle with a small tooth on each

* Στεγος = roof; κερας = horn; from the roof-like projection over the base of the antennæ.

† 'Trans. Linn. Soc.,' vol. 7, p. 35, Plate 11.

margin; 3rd similar in form, but narrower and without the teeth; 4th rather smaller, with a shallow emargination on the lower margin; remaining side-plates comparatively small.

Upper antennæ rising from the point of the hood-like projection of the head, the peduncle reaching to the end of the 2nd joint of the lower antennæ; the 1st joint much wider and rather longer than the 2nd, which is subequal to, but thicker than, the 3rd. Flagellum 6-jointed, about as long as the last 2 joints of the peduncle.

Lower antennæ apparently originating behind the articulation of the 2nd gnathopods to their side-plates; the 3 peduncular joints subequal. Flagellum 3-jointed, half as long as the last joint of the peduncle.

Mouth organs obsolete, except a pair of minute processes called by STEBBING "oral laminæ" in the form of 2 small plates below the head, which are probably rudimentary mandibles.

Maxillipeds: no inner or outer plates; palp apparently 5-jointed, including the dactylus, the joints subequal, but the 3rd rather the shortest and widest with a long spine on an angular projection on the inner margin; the 4th rather the longest and narrowest; the dactylus is slender, curved, and as long as the 4th joint.

First gnathopods very small and perfectly chelate; the 1st joint as long as all the rest, narrow at the top and widening suddenly a little below the middle; 2nd joint rather shorter than the 3rd; this takes the place of the wrist, which is obsolete, and supports the hand; this has the hinder part produced in an immovable finger as long as the rest of the hand, the end curved upwards and rounded at the point. The dactylus is a little shorter than the immovable finger and curved downwards, the ends of the fingers crossing; to complete the resemblance to the chelipede of a crab, the inner margin is furnished with blunt teeth. The entire limb extended is slightly longer than the hand of the 2nd gnathopods (fig. 18. gn.^{1}).

Second gnathopods: the 1st joint conspicuously articulated to the middle of the side-plate, as long as the hand, curved and widening distally; 2nd joint with a wide groove to receive the base of the wrist; 3rd joint oval, pointed, and articulating with the wrist at about one-fourth of its length from the base; wrist produced in a curved and pointed process almost as long as the hind margin of the hand, denticulate on the inner margin near the base. Hand widest near the base, front margin convex, hind rather concave beyond the middle. Dactylus about two-thirds of the length of the hand and meeting the end of the carpal spur, convex and denticulate on the proximal half (fig. 18. gn.^{2}).

First and 2nd peræopods: side-plates wide and irregularly angulated below; 1st joints reaching below the side-plates, widening distally.

Third and 4th peræopods: 1st joint expanded and rounded behind.

Fifth peræopods: 1st joint expanded behind with the margin subangular above and divided by a series of short transverse ridges into 10 or 11 irregularly angulated spaces (fig. 18. pp.^{5}).

Uropods: the 1st and 2nd have the inner ramus about twice as long as the outer, both styliform; the 3rd are wanting.

Telson entire, concave above, spoon-shaped.

Length 2 millims.

This curious genus was described by Mr. STEBBING from 2 specimens in the Copenhagen Museum, taken by Dr. H. J. HANSEN in the West Indies, and named *A. hanseni.* Mr. A. SCOTT, A.L.S., who was kind enough to dissect, mount, and draw the gnathopods of the very small specimen, informs me that there were 2 oral laminæ, Mr. STEBBING having only observed one. In their general appearance the two species resemble each other, but differ considerably in the structure of the 1st and 2nd gnathopods. I have taken the liberty of naming the present species after the distinguished naturalist, to whom all Amphipodists owe a deep debt of gratitude for the invaluable "Challenger" volumes.

Stenothoë, DANA, 1852.

Stenothoë marina (SP. BATE), var. **sinhalensis.**

Cheval Paar, 1st March, 1902. One female with young. Length 4 millims.

Differs from the type in its larger eye, in having the penultimate joint of the upper antennæ produced in an infero-distal tooth; the flagellum of the lower antennæ longer than the peduncle; and the absence of spines on the telson.

Stenothoë monoculoides (MONT.).

Tow-nets, Galle, 7th July, 1902, 3 specimens; Cheval Paar, February, 1903, 5 specimens. Length 2·5 millims.

The upper antennæ are about one-fourth longer than the lower; the 3rd joint of the latter is not longer than the 2nd; and the telson has 2 pairs of submarginal spines, but in other respects it agrees with G. O. SARS' description.

Stenothoë gallensis, n. sp.—Plate III., figs. 19.

An abundant species on the Ceylon coast.

Head scarcely produced in a rostrum. Ocular lobe truncate. Eyes round, rather large.

Segments of the mesosome increasing in length successively. Posterior angle of the 3rd pleon segment acute.

Upper antennæ a trifle longer than the lower; 1st and 2nd joints subequal in length, 3rd rather longer than the 1st joint of the flagellum, which has 22 joints in the female.

Lower antennæ: 2nd and 3rd joints subequal; flagellum longer than the peduncle, 18-jointed.

Mouth organs and maxillipeds as in *Stenothoë marina.*

First gnathopods: side-plates small, rounded below; wrist barely half as long as the hand, otherwise as in *S. marina* (fig. 19. gn.[1]).

Second gnathopods (male): very like *S. marina*, but the 3rd joint has the hind margin crenate, with a setule in each notch. Hind margin of the hand straight and densely hirsute; near the base of the dactylus a double-pointed tooth, the proximal point the highest, the irregular distal one with 6 intra-marginal setules. Dactylus as in *S. marina* (fig. 19. gn.² ♂). In the female the posterior margin of the hand is convex, even, with the palm quite undefined, but 4 nearly equidistant spines and some setæ near the middle (fig. 19. gn.² ♀).

First and 2nd peræopods as in *S. marina*.

Third peræopods: side-plate small, produced and rounded behind; 1st joint oval, about half as wide as long, longer than the next 2; 3rd joint but little produced behind; 5th joint nearly as long as the 2 preceding; dactylus strong (fig. 19. pp.³).

Fourth and 5th peræopods as in *S. marina*, hind margin of the 1st joint obscurely crenate.

First uropods reaching to the end of the 3rd; peduncle longer than the rami; rami subequal, a spine in the middle of the inner and 2 or 3 spines in the middle of the outer (fig. 19. ur. ♂).

Second uropods shorter than the 1st and 3rd.

Third uropods: the peduncle longer than the 2 remaining joints, with 5 or 6 spines on the upper margin; the last joint bent upwards in the middle and finely denticulate on the upper margin (fig. 19. ur.).

Telson concave above, oblong, with 4 spines increasing in size distally on the proximal half of each side (fig. 19. ur.).

Length of adult male, 6 millims.; female, with ova, 5 millims.

This species is undoubtedly very near *S. valida*, DANA, 1852, but the dentition of the hind margin of the hand in the male is somewhat different in that species as figured, and the same part in the female is described and figured as having "the palm nearly straight and armed with a stout tooth towards the apex." From *S. marina* it may be distinguished by the relatively short wrist of the 1st gnathopods and the different dentition of the 2nd; the wider 1st joint of the 3rd peræopods; the peculiar structure of the last joint of the 3rd uropods, and the oblong truncate form and armature of the telson.

Perioculodes, G. O. SARS, 1894.

Perioculodes serra,* n. sp.—Plate IV., fig. 20.

Kondatchi Paar and Cheval Paar, November, 1902.

Head as long as the first 3 segments. Rostrum deflexed to the level of the rounded ocular lobe and reaching the end of the 1st joint of the upper antennæ.

First segment of the mesosome twice as long as the 2nd, which is the shortest.

Pleon segments obscurely carinate.

* From the saw-like character of the 1st uropods.

First uropods not reaching the end of the 2nd, outer rami half as long as the inner, *the upper margins of the rami in adults strongly serrate;* 2nd and 3rd uropods subequal in extent, denticulate on the inner and spinous on the outer margins (fig. 20. up.[1]).

Length of adult male, 5 millims.

This species much resembles *P. longimanus* (Sp. Bate), the details above indicating the principal points of difference. As is usual with its congener on sandy coasts in the British Seas and Mediterranean, it is found associated with a *Synchelidium.*

Synchelidium, G. O. Sars, 1894.

Synchelidium brevicarpum (Sp. Bate).

Kroyera brevicarpa, Bate and Westwood, 'Brit. Sess. Crust.,' App., p. 508.

Cheval Paar, November, 1902, 1 specimen. Length 3 millims.

Agrees with British examples even to the dark brown blotches on the 5th and 6th segments of the mesosome.

Tiron, Lilljeborg, 1865.

T. thompsoni,* n. sp.—Plate IV., figs. 21.

Kondatchi Paar, 17th November, 1902, 1 specimen; Station LXVI.; 1 female with ova.

Head rounded above, almost as long as the first 3 segments; the front deflexed; ocular lobe rounded; eyes obliterated.

First mesosome segment almost as long as the next 2 and subequal to the 4th. Segments of the pleon and first 2 of the urus slightly carinate, the carinæ produced to teeth which are very conspicuous on the urus, as in *Tiron acanthurus,* Lillje.

Upper antennæ reaching the end of the peduncle of the lower; 1st joint twice as wide and long as the 2nd, with a long distal spine; 3rd much narrower and almost as long as the 1st; flagellum 6-jointed; appendage reaching the end of the 2nd joint of the flagellum, 3-jointed, the first 2 subequal, the last minute (fig. 21. ant.[1]).

Lower antennæ: 1st joint thick, about half as long as the 2nd, which is subequal to the 3rd; flagellum 6-jointed, shorter than the 2 last joints of the peduncle (fig. 21. ant.[2]).

Maxillipeds: inner plate reaching a little beyond the end of the 1st joints of the palp, the top rounded with plumose submarginal setæ; outer plate membranous, the surface concave, margins irregular and setose; 1st joint of the palp shorter than the 2nd, which is swollen and about as long as the 3rd; dactylus slightly curved, acute (fig. 21. mxp.).

First gnathopods: side-plates widened below, rounded in front, with about 6 submarginal setæ on the lower margin; 1st joint shorter than the next 3, widening distally; wrist rather longer and considerably wider than the hand to which it

* Named after my late friend and fellow-worker, Mr. Isaac C. Thompson, F.L.S.

tapers, 4 pectinate spines and a few long setæ on the hind margin. Hand slightly tapering, with 5 or 6 pectinate spines on the hind margin. Dactylus continuous with the hand and about one-fourth as long, contracting to a curved point beyond the middle (fig. 21. gn.[1]).

Second gnathopods are rather longer than the 1st; the wrist has 4 pectinate spines on the distal half, of which the 2nd and 3rd are longer than the others and have a shorter spine at the base.

First and 2nd peræopods are much shorter than the gnathopods, the 1st joint as long as all the rest; 3rd, 4th, and 5th subequal. Dactylus small and curved, with a seta in the middle of the front margin; a curious strong curved spine rises from the distal end of the anterior margin of the 5th joint and appears to duplicate the dactylus (fig. 21. pp.[1]).

Remaining peræopods are alike; the 1st joint oval; the 3rd much longer and wider than the subequal 4th and 5th, which have the anterior margin spinous and minutely pectinate. Dactylus with a supplementary point.

First uropods extending beyond the 2nd, rami shorter than the peduncle, subequal

Second uropods extending a little beyond the end of the peduncle of the 3rd, outer ramus the shorter.

Third uropods: rami narrow, lanceolate, considerably longer than the peduncle, subequal in extent; the outer spinous on the distal half of the outer margin and with a central row of spines; the inner with the tip truncate and emarginate, with a spine at each angle (fig. 21. up.[3]).

Telson not quite reaching the end of the 3rd uropods, cleft almost to the base, the divisions pointed, tips spinous, a submarginal spine near the distal end of the inner margins (fig. 21. up.[3]).

Superficially very like *T. acanthurus*, LILLJE., but differs in the single dorsal tooth instead of the serrate hind margin of the pleon segments, and in the structure of the maxillipeds, gnathopods, antennular appendage, 3rd uropods, &c.

Eusiroides, STEBBING, 1888.

Eusiroides cæsaris, STEB. var.—Plate IV., fig. 22.

Various localities round Ceylon.

Agrees with the type except as regards the pleon segments, which are not dorsally produced, and the 3rd has the hind margin only slightly convex, with but 3 teeth on the lower third part; the posterior angle is a rounded right angle (fig. 22. pl.[3]). The telson is divided more than half its length.

Length of female with ova 8 millims.

Eusiroides orchomenipes, n. sp.—Plate IV., figs. 23.

In a tube marked "Cheval Paar, February, 1902," with 2 large normal specimens of the last form, was an ovigerous female 5 millims. long. This has the entire hind epimeral margin of the 3rd pleon segment faintly crenate (fig. 23. pl.³), a dorsal carina on the 1st urus segment; the 3rd joint of the last 3 pairs of peræopods about as wide as long and very convex behind; the rami of the 3rd uropods unequal, the outer being much the longer and *with a terminal joint* (fig. 23. ur.). In spite of these very considerable differences, I am disposed to think that sexual maturity has here preceded that of the integument and limbs, which probably require another moult or two to bring them to the fully adult form. I believe this to be a not uncommon condition in the Amphipoda, and one that accounts for a good many so-called species. At the same time it must be admitted that the changes required to make this form identical with *E. cæsaris* are great, and it would almost seem as if it were passing through a Lysianassid form; the 3rd peræopods with their bi-lobed side-plates larger than the wide 1st joint (fig. 23. pp.³); their shortness compared to the next 2 pairs, and the structure of the 3rd uropods reminding one of *Orchomene*. On the other hand, the fore part, including head and mouth organs, is distinctly *Eusiroides*. On the whole, I have thought it advisable to record this as a new species, which I would call *E. orchomenipes*.

Paratylus, G. O. Sars, 1894.

Paratylus granulosus, n. sp.

Cheval Paar, 8 specimens.

Body moderately compressed, *the whole integument granulose*. Second pleon segment with a shallow carina slightly produced behind; 3rd segment with a deeper carina produced in an acute tooth.

First segment of the urus as in *P. vedlomensis* (Sp. Bate), *i.e.*, with a small setiferous tooth, a deep depression, and a large arched and pointed hood-like process. Second segment elevated behind. Third peræopods with the 1st joint considerably wider than in *P. vedlomensis*.

Length of male, 4 millims.; female, with ova, rather smaller.

In other respects the animal closely resembles *P. vedlomensis*.

Dexamine, Leach, 1814.

Dexamine serraticrus, n. sp.—Plate IV., figs. 24.

Cheval Paar, 1; Talaivillu Paar, 1. Length 3 millims.

Head as long as the first 3 segments, with a distinct rostrum. Eyes very large, roundish oval, dark; ocular lobe rounded.

Mesosome segments increasing in length successively. Pleon segments carinate, the carinæ produced behind as in *D. spinosa* (Mont.). Hind margin of the 3rd segment concave, the angle produced and upturned. First segment of urus with a prominent carina.

Antennæ subequal, not half as long as the body, like *D. spinosa*.

First and 2nd gnathopods almost alike, the wrist as long as the hand, which is subtriangular, the palm almost rectangularly transverse (fig. 24. gn.[1]).

Peræopods as in *D. spinosa*, *except the last pair, which have the 1st joint expanded behind and coarsely and irregularly toothed or serrate* (fig. 24. pp.[5]).

Telson divided nearly to the base; the divisions truncate at the tips, the outer margin acutely produced, then a spine and 4 minute spinules (fig. 24. t.).

Very near *D. spinosa*, from which it differs in the more transverse palms of the gnathopods, the coarsely serrate and expanded 1st joint of the last peræopods, and the armature of the telson.

Tritæta, Boeck, 1876 (= **Polycheria**, Haswell, 1880).

Tritæta antarctica, Stebbing*—Plate IV., fig. 25.

> **Polycheria tenuipes**, Haswell, 'Proc. Linn. Soc. N.S. Wales,' vol. 4. (For further remarks on the synonomy of this species, see "Challenger Report," pp. 451, 512, 945.)

Station XLIX., 7 specimens. Talaivillu Paar, 1. Length of ovigerous female, 3·5 millims.

I have no doubt that these specimens are identical with Mr. Stebbing's species. It is a question, however, whether, owing to the different structure of the terminal joints in the peræopods, this can properly be included in the genus *Tritæta*. In the type, *T. gibbosa* (Bate), the clasping by these limbs is effected by the point of the dactylus meeting the prominent hind margin of the *carpal* joint, and G. O. Sars, in his definition of the genus, says that "the 2 outer joints are modified for grasping," so that unless one may consider the dactylus as one of the 2 joints (in which case the definition is insufficient as regards the type), it does not apply to *T. antarctica*, in which the short dactylus and the somewhat expanded and transverse palm of the propodos form the grasping part (fig. 25. pp.[1]). Haswell's genus *Polycheria* might be revived if thought desirable.

This species exactly resembles *T. gibbosa* in two respects: its extreme dirtiness and its habit of carrying the antennæ flexed at a right angle from the 2nd joint of the peduncle.

Guernea, Chevreux, 1887† (= **Helleria**, Norman, 1868‡).

In his definition of the genus *Helleria*, Canon Norman writes: "Superior antennæ . . . with secondary appendage"; but his figure of the head and antennæ does not show one.§ Chevreux also, in his definition of *Guernea*, writes: "*Antennæ*

* 'Ann. and Mag. Nat. Hist.,' Ser. 4, 1875, vol. 15, p. 184, Plate XVA.

† 'Bull. de la Soc. Zool. de France,' vol. 12, 1887.

‡ 'Ann. and Mag. Nat. Hist.,' December, 1868, p. 418, Plate XXII., XXIII.

§ Canon Norman informs me that the words "with secondary appendage" are an accidental error, Monsieur Chevreux no doubt took his description from Norman's. See also Stebbing, 'Ann. and Mag. Nat. Hist.,' Ser. 6, vol. 5 (1890), p. 192.

superiores flagello appendiculari instructæ": but neither does he show any appendage in his figure (which in my copy is accidentally misplaced and numbered as fig. 1, p. 5). I have not been able to find one either in the species to be described or in British specimens of *G. coalita* (NORMAN). DELLA VALLE ('Gam. d. Golfo di Napoli,' p. 570, Plates 31 and 58) neither figures nor mentions one.

Guernea lævis, CHEVREUX.*—Plate IV., figs. 26.

Station LXVI., Cheval Paar, February; Shoal Buoy, Karativo, February.

Description of female :—

Body tumid. Head longer than the first 2 segments, which are much shorter than the rest, the 5th and 6th being the longest; first 4 side-plates as deep as the segments. Pleon not much longer than the 3 last segments of the mesosome. Urus rather shorter than the last 2 segments of the pleon, the segments coalesced and carinate, *the edge of the carina not denticulate.*

Ocular lobe rather deep, flattened in front, rounded below. Eye large, round; colour red.

Upper antennæ rather longer than the head; 1st joint twice as long as and much wider than the 2nd; 3rd about half as long and thick as the 2nd. Flagellum 4-jointed.

Lower antennæ about as long as the head; 1st joint very short, 2nd longer than the 1st and 3rd united; flagellum very small, about half as long as the 3rd joint. (In the male the 2nd joint is convex below, setose above; the flagellum long and slender, reaching the pleon.)

Mandibles without palps; these organs were not clearly distinguished owing to their small size, but they appear to be of a more complex structure than is shown by DELLA VALLE in *G. coalita.* The remaining mouth organs and maxillipeds seem to agree with DELLA VALLE's figures.

First gnathopods: side-plates oblong, rounded below: the 1st joint much swollen distally, as long as the 3rd, 4th, and 5th together; 2nd and 3rd subequal; wrist as long and almost as wide as the hand, with 4 spines on the hind margin; hand with subparallel margins, a few fine setæ on the hind margin, palm obliquely truncate, defined by 3 long spines, the margin straight, spinous and setose. Dactylus scarcely as long as the palm, with a secondary tooth; a tuft of long setæ at the base (fig. 26. gn.^{1}).

Second gnathopods very like the 1st, but rather longer and more slender in all the parts; the 1st joint with 3 long setæ on the hind and about 6 short setules on the front margin.

First and 2nd peræopods: side-plates oblong, rounded below; 1st joint with subparallel margins, about as long as the next 3; 4th joint with 4 spines on the hind margin, increasing in length distally.

* 'Crust. Amph. de S. O. Bretagne,' p. 41 (separate copy), Note.

Third peræopods: side-plates broad; 1st joint expanded before and behind, as wide as the side-plate, the front margin setose; 3rd joint longer and twice as wide as the 4th; 5th about as long as the 3rd (fig. 26. pp.[3]).

Fourth peræopods like the 3rd.

Fifth peræopods: side-plates much smaller than the 1st joint, which is much expanded behind, straight in front; 3rd joint widening somewhat distally and produced at the posterior angle; 4th shorter and narrower than the 3rd, oblong, narrowing distally; both these joints densely setose and spinous on the front and sparsely on the hind margin; 5th joint as long as the 4th, very slender, naked. Dactylus small, in a straight line with the 5th joint. The setæ on the 3rd and 4th joints are simple, *i.e.*, not plumose (fig. 26. pp.[5]).

First uropods extending beyond the 2nd and these beyond the 3rd: rami of the 1st hardly as long as the peduncle; inner ramus of the 2nd shorter than the outer; rami of the 3rd pair wider than the others, about twice as long as the peduncle, without setæ or spines.

Telson divided almost to the base with a setule at the tip of each division.

Length of female with ova 2 millims.

The most conspicuous difference between this species and *G. coalita* is the smoothness of the dorsal surface of the urus, but there are also differences in the form and armature of the limbs. Both NORMAN and DELLA VALLE have described male specimens; besides the shorter lower antennæ and absence of plumose setæ on the 3rd uropods, there is a curious difference in the relative proportions of the mesosome segments in the 2 sexes of both species.

Hornellia,* n. gen.

Body rather tumid. Segments of pleon and urus with postero-dorsal teeth.

Head not rostrate or vaulted in front. Eyes distinct, not coalescent.

Upper antennæ with an appendage; flagellum slender, much longer than the peduncle.

Mandibles with well-developed molar tubercle, spine-row, and toothed cutting edges; palp long, 3-jointed, 2nd and 3rd joints subequal (fig. 27. m.).

First maxillæ with the 2nd joint of the palp widened towards the obliquely truncate end, which is crowned with spine-teeth and setæ alternately (fig. 27. mx.[1]).

Maxillipeds well developed in all parts; 4th joint of palp dactyliform (fig. 27. mxp.).

Gnathopods subequal and similar, like those in *Halimedon*.

Third uropods of moderate length, with subequal rami.

Telson long and deeply cleft.

This genus will probably find a place in the as yet undefined family Melphidippidæ, STEBBING.

* See footnote, p. 258.

Hornellia incerta, n. sp.—Plate IV., figs. 27.

Station LIII., 4 or 5 : off Chilavaturai. 4 ; Cheval Paar.

Description of female with ova.

Head as long as the first 2 segments, which, as well as the head, are shorter in the male. Eyes large, wide-oval, red.

Second and 3rd pleon and 1st and 2nd urus segments postero-dorsally dentate, the teeth subequal. Hind margin of the epimere of the 3rd pleon segment rather concave, the angle produced and acute.

First segment of the urus dorsally depressed, twice as long as the 2nd or 3rd.

(In the male the teeth on the hind margins of the segments and the dorsal depression are more conspicuous than in the female.)

Upper antennæ more than half as long as the body, the peduncle scarcely half the length of the flagellum ; the 1st joint considerably wider and longer than the 2nd, which is more than twice as long as the 3rd ; flagellum slender, 14-jointed ; appendage 2-jointed, the 1st the longer.

Lower antennæ imperfect in all the specimens. In the male the 2nd joint is as wide as the 1st of the upper antennæ, and reaches to the 3rd joint of the upper flagellum ; it is densely setose above.

Mandibular palp projecting beyond the end of the 1st joint of the upper antennæ.

First gnathopods : side-plates oblong, deeper than wide, expanding below with marginal setules and intramarginal setæ. Wrist as long and wide as the hand, being much widened behind : hand oval, widest near the base ; palm scarcely defined by 2 sets of spines ; the 3rd, 4th, and 5th joints are furnished with many long spines, of which many are pectinate ; dactylus slender, about two-thirds the length of the hind margin of the hand (fig. 27. gn.[1]).

Second gnathopods nearly resembling the 1st, but rather larger ; the spines fewer and simple. The coxopodite is remarkably large and distinct in both the gnathopods.

First and 2nd peræopods : side-plates of the 1st as in the gnathopods ; of the 2nd much wider below and sloped away behind ; 1st joint rather longer than the 2 next, narrow, slightly curved ; 3rd joint somewhat dilated behind, subequal to the 5th, the 3rd shorter. Dactylus strong, slightly curved. A few slender spines on all the joints.

Remaining peræopods imperfect : the 1st joint about twice as long as wide, sub-ovate : the 3rd joint about as long as the 1st.

First uropods long, slender, and spinous ; rami and peduncle all subequal.

Second uropods : outer ramus as long as the peduncle, the inner about one-fourth longer : both spinous.

Third uropods : narrow, lanceolate ; the inner ramus rather longer than the outer and twice as long as the peduncle.

Telson cleft almost to the base, each division notched at the tip, the outer angle of the notch longer and wider than the inner (fig. 27. t.).

Length of female with ova. 3 millims.

Melita, Leach, 1813.

Melita obtusata (Montagu).

Stations V., XVII., XXIII., XLIII., LIII., LXIV.

Females only.

Melita anisochir (Kröyer).—Plate IV., figs. 28.

Gammarus anisochir, Kröyer, 1845.

Melita cotesi, Giles, 'Journ. Asiatic Soc., Bengal,' 1890, vol. 59, p. 64, Pl. ii., fig. 1.

It is probable that the following species ought also to be referred to *M. anisochir*, viz., *M. valida* (Dana), *M. setipes* (Dana), and *M. australis*, Haswell. According to Della Valle all these should be referred to *Gammarus fresnelii*, Audouin and Savigny, 1825.

This is an abundant species all round Ceylon.

Description of female :—

Head longer than the first 2 segments of the mesosome, which increase in length progressively. Eyes large, round, red.

Pleon segments with dorsal teeth on the hind margin, the teeth increasing in size posteriorly ; the 1st has 4 subequal teeth, the 2nd and 3rd 6 unequal ; the epimeral hind margin of the last is concave, with marginal setules, the posterior angle produced and acute (fig. 28. pl. & ur.).

The 1st urus segment has a small central tooth, with a large and a small one below it ; there is a dorsal indentation on the anterior part ; the 2nd segment, which is the shortest of the three, has a small central tooth, with a long spine and 2 minute subdorsal teeth on each side ; the 3rd segment has a conical tooth just above the base of the telson. The number and proportions of the teeth, especially in the pleon segments, vary considerably (fig. 28. pl. & ur.).

Upper antennæ nearly as long as the body, the 1st joint twice as wide and two-thirds as long as the 2nd, lower margin convex, with 2 or 3 subcentral and a distal spine ; 2nd joint 4 times as long as the 3rd. 1st joint of the flagellum as long as the next 2. Appendage varying in the number of joints, generally 3 subequal, with a minute terminal, reaching beyond the end of the 3rd joint of the flagellum.

Lower antennæ about two-thirds of the length of the upper and stouter than these, except the 1st joint.

Mouth organs normal ; the 3rd joint of the mandibular palp is rather longer than the 2nd.

First gnathopods : side-plates oblong, with rounded angles, wider below, with marginal setules ; 1st joint widening distally, as long as the next 3 ; wrist longer than and fully as wide as the hand, with many short and a few long setæ on the hind margin ; hand widely oval, palm undefined, hind margin very convex and setose like the wrist. Dactylus about half as long as the hand (fig. 28. gn.¹).

Second gnathopods larger than the 1st ; side-plates oblong, not wider below ;

1st joint subequal in length and width to the hand, which is rather longer than the wrist, front and hind margins subparallel, slightly convex; palm oblique, well defined, uneven and setose (fig. 28. gn.[2] ♀).

First and 2nd peræopods: 1st joint widening abruptly. Dactylus strong, with a secondary tooth on the outside and a short spine on the inside (fig. 28. pp.[1]).

Third peræopods: 1st joint oblong and subequal in length to the 5th.

Fourth and 5th peræopods much more powerful than the 3rd, and reaching backwards much beyond the ends of the uropods; the joints spinous. All the peræopods have the secondary tooth on the dactylus.

First uropods extending a little beyond the 2nd, slender; peduncles and rami subequal, spinous; 2nd pair resembling the 1st.

Third uropods with the outer ramus about twice as long as the peduncle, with 3 "whorls" of spines between the base and the extremity; inner ramus quite rudimentary.

Telson not unlike that of *M. palmata* (Mont.), but the divisions are sharply pointed without terminal spines, but with a long upright one at the angle on the inner side, and a horizontal one between it and the point.

Length 5 millims.

The male has been described and figured by Dr. Giles (*loc. cit.*). It is remarkable for the large size and peculiar form and colouring of one of the 2nd gnathopods. I think there can be little doubt, from its resemblance to a bit of broken shell, that its use is protective, the animal covering itself with it as it lies partly buried in the sand. Dr. Herdman informs me that he has seen them in this position.

Mæra, Leach, 1813.

Mæra othonides, n. sp.—Plate V., figs. 29.

Stations V., LIII., LXIV., Cheval Paar.

Very near *M. othonis* (M. Edwards), from which it differs as follows:—

The ocular lobe is *rounded*.

The 3rd pleon segment has *no teeth on its lower* and from 1 to 3 teeth on the hind margin (fig. 29. pl.[3]).

The appendage of the upper antennæ is 3-*jointed*.

The palp of the mandibles has the 3rd joint *considerably shorter than the 2nd*.

The side-plates of the gnathopods are *not serrated* below; there is a single tooth at the posterior angle of the 1st pair. In the hand of the 2nd pair in the female the palm is concave.

The 3rd uropods have their ends *truncate* with a group of spines (fig. 29. up.[3]).

The telson has a *second notch* above the terminal one on the inside of each division (fig. 29. t.).

Length 8 millims.

Of the above characters the least valuable is that of the 3rd pleon segment, as the number and position of the teeth vary considerably.

Mæra rubro-maculata (STIMPSON).—Plate V., fig. 30.

Gammarus rubro-maculatus, STIMPSON, 'Proc. Acad. Nat. Sci.,' Philadelphia, 1855.

M. rubro-maculata (STIMPSON), '"Challenger" Amphipoda,' p. 1008, Plates XCV., XCVI.

Ceradocus rubro-maculatus (STIMPSON), DELLA VALLE, 'Gamm. d. Golfo di Napoli,' p. 720.

From Kodramallai Point southward to Galle.

Length of adult male 10 millims.

In the specimen dissected, the mandibular palp was set far back, the 1st joint produced forward in a sharp point; the 2nd widened abruptly near the base, then narrowing gradually (fig. 30. m.).

Mæra tenella (DANA).—Plate V., figs. 31.

Gammarus tenellus, DANA, 'U.S. Explor. Expn.,' p. 952, Plate 65, fig. 7.

Mæra tenella, SP. BATE, 'Cat. Amph. Crust. Brit. Mus.,' p. 193, Plate XXXV., p. 3.

Cheval Paar, 10th November, 1902. One male, length 6 millims.

Head about as long as the first 2 segments. Eye nearly round, rather small.

Mesosome and pleon without dorsal teeth; epimere of the 3rd pleon segment with 6 or 7 unequal teeth on the hind margin, the posterior angle acute and somewhat upturned (fig. 31. $pl.^3$). First segment of the urus with 3 small postero-dorsal teeth and a dorsal depression; 2nd segment with 1 tooth.

Upper antennæ reaching to the end of the pleon; 1st joint twice as thick and nearly as long as the 2nd; 3rd very short; flagellum rather shorter than the first 2 joints of the peduncle, 13-jointed; appendage 8-jointed, two-thirds of the length of the flagellum.

Lower antennæ scarcely reaching beyond the end of the peduncle of the upper; the flagellum about as long as the 3rd joint.

Both upper and lower antennæ are sparsely setose, except the flagellum of the lower, which is more hairy.

First gnathopods: side-plates small, produced in front to an acute angle; wrist longer than the hand, the hind margin densely setose; hand with the palm ill-defined, and transverse rows of setæ on the hind margin (fig. 31. $gn.^1$).

Second gnathopods: side-plates small, quadrate, with rounded angles; 1st joint stout, two-thirds of the length of the hand and nearly twice as long as the next 3 joints together; wrist transverse; hand large, widening distally; hind margin as long as the front, straight, with a few setæ, and ending in a strong curved tooth which defines the palm; this is transverse, convex, uneven, and spinulose (fig. 31. $gn.^2$).

First and 2nd peræopods slender, slightly longer than the 1st gnathopods; 1st joint narrow, subequal to the next 2; 5th longer than 4th and not so long as 3rd; 2 distal spines on the hind margin of the 4th and a row of 4 on that of the 5th joint. Dactylus with a strong tooth behind the point (fig. 31. pp.[2]), giving it the appearance of being bifid (fig. 3K, SP. BATE, *loc. cit.*).

The rest of the peræopods are altogether wanting.

The 1st and 2nd uropods are subequal in extent, not quite reaching the middle of the outer ramus of the 3rd pair; the rami are subequal; in the 1st they are rather shorter and in the 2nd rather longer than the peduncles; all spinous on both margins, with groups of terminal spines.

Third uropods: peduncle little more than half as long as the outer ramus, which is but little longer than the inner and has 4 deep notches with fascicles of long spines on the outer margin; both are truncate, with groups of long spines at the ends (fig. 31. up.[3]).

Telson small, cleft to the base, and widely dehiscent, each division ending in a double point with 2 long and 2 or 3 short spines (fig. 31. t.).

DANA's specimen was from the Fiji Islands. This species has a strong general resemblance to the next, from which, however, it differs in the toothed epimeres of the 3rd pleon segment; the relatively longer and more equal 3rd uropods; the different form of the dactyli of the 1st and 2nd peræopods, &c. It is unfortunate that the specimen had lost the last 3 pairs of peræopods, as these have a very distinctive character in *M. scissimana*.

Mæra scissimana (COSTA)—Plate V., fig. 32. pp.[1].

Gammarus scissimanus, A. COSTA, 1853.

Mæra truncatipes (WHITE), DELLA VALLE, *loc. cit.*, p. 725, Plate 22.

West Coast of Ceylon.

Length 5 millims.

This species forms a connecting link between the genera *Mæra* and *Elasmopus*. The fore part, including the 3rd peræopods, is typical *Mæra*, while the massive and very spinous 4th and 5th peræopods (a character that is much more marked in Ceylon than in Mediterranean specimens), and the comparatively short rami of the 3rd uropods, resemble *Elasmopus*. Another peculiarity of the species is that the size and shape of the hand of the 2nd gnathopods is much the same in males and females.

Mæra tenuicornis (DANA)—Plate V., figs. 33.

Melita tenuicornis, DANA, *loc. cit.*, p. 963, Plate 66, fig. 5.

Mæra tenuicornis, SP. BATE, 'Cat. Amph. Crust. Brit. Mus.,' p. 195, Plate XXXV., fig. 6.

Tow-net off Marichchikadi, 1st February, 1903. One male, and one young.

Segments of the mesosome and pleon without carinæ or dorsal teeth. Hind margin of the 3rd pleon epimere concave, smooth; lower margin rather convex, obscurely toothed; posterior angle acute (fig. 33. pl.[3]). First segment of urus with a double carina produced backwards in 2 points; 2nd segment with a small tooth and a long upright spine (fig. 33. ur.).

Upper antennæ: 1st joint stout, two-thirds as long as the 2nd and about twice as long as the 3rd. Flagellum long and slender, broken at the 18th joint. Appendage small, with 2 subequal joints and a minute terminal one, barely reaching the end of the 1st joint of the flagellum.

Lower antennæ: peduncle reaching a little beyond that of the upper; 1st joint short, 2nd and 3rd subequal in length, but the 2nd much the wider; flagellum shorter than the last 2 joints of the peduncle.

Mandibles as in *Elasmopus subcarinatus* (*vide* '"Challenger" Amph.,' Plate 98, *E. persetosus*), but the 2nd joint of the palp is subequal to and rather wider than the 3rd; very few setæ (fig. 33. m.).

First maxillæ: the inner plate oblong, with 7 plumose terminal setæ (fig. 33. mx.[1]).

Maxillipeds as in *E. persetosus*, but the outer plate reaching the end of the 2nd joint of the palp.

First gnathopods: side-plates subtriangular, with rounded angles; 1st joint stout, margins parallel, as long as the 3rd and 4th united; 2nd and 3rd subequal. Wrist nearly twice as long and about as wide as the hand. Hand widening distally, the hind margin straight, the front convex and bent at the distal end at a right angle round the base of the dactylus in a tooth-like process reaching beyond the middle of the dactylus, and having the appearance of a 2nd dactylus; the hind margin ends in a densely spinous lobe. The dactylus is very small, crooked, and deeply sunk in the hand. The whole limb is setose and recalls the 2nd gnathopod of a *Lysianax* (fig. 33. gn.[1]).

Second gnathopods: side-plates deeper than wide, oblong, rounded and a little wider below, about as long as the 1st joint; this is rather longer than the next 3 joints, but shorter than the hand; 2nd and 3rd joints subequal. Wrist triangular, about as wide as long; the hind margin with about 8 setiferous ridges. Hand long-oval, widest about one-third of its length from the base; palm undefined, the hind margin densely clothed on the distal half with incurved plumose setæ. Dactylus fully half as long as the hind margin (fig. 33. gn.[2]).

First and 2nd peræopods: side-plates fully as deep as the segments, rounded below; hind margin of the 2nd pair concave. The entire limb is as long as the last 2 pairs of peræopods, in which respect they differ from DANA's description and figure; 1st joint as long as the 3rd and 4th united; 3rd longer than 4th; 4th and 5th subequal, a few small spines on their hind margins; the rest of the limb has only a few scattered setæ (fig. 33. pp.[2]).

Remaining peræopods of similar form, the 3rd rather the shortest; 1st joint wide-oval, the width more than half the length, the hind margin smooth, front margin with small spines; 2nd joint short; 3rd joint very wide, 3 times as wide as the 4th, with long spines on setæ, before and behind; 5th joint three-quarters of the length of the 3rd and 4th together. Dactylus rather small, curved at the point (fig. 33. pp.[1]). In the 3rd pair the hind margin of the 1st joint is straight, in the 4th and 5th convex.

First uropods: rami subequal, shorter than the peduncle; all spinous.

Second uropods like the 1st, but the rami rather longer than the peduncle.

Third uropods wanting.

Telson cleft almost to the base, the divisions pointed with an angle on the inside.

Length 5 millims.

There are certain discrepancies between our specimens and DANA's description and figures of the New Zealand form, as given by SP. BATE. I attach no importance to the omission of the antennular appendage, as this is small and not easy to see. But if we are to take the proportions of the first 2 and last 3 pairs of peræopods shown in the figure as even approximately correct, they are quite different from ours. On the other hand, the 1st gnathopods are so peculiar and the description and figures of both pairs agree so well, that I feel justified in considering them identical. The species requires a new genus, but the absence of the 3rd uropods makes a satisfactory definition impossible.

Elasmopus, COSTA, 1856.

The mandibular palp in this genus is of two distinct forms; the one (A) with the 3rd joint slender, its hind margin straight, and its front margin rather sparsely setose or naked, approaching the same appendage in *Mæra*, *e.g.*, *M. obtusata* (MONT.); the other (B) as in *E. rapax*, COSTA, with the 3rd joint strong, the hind margin convex and the front margin pectinate.

To (A) belong, of the species under consideration,

E. subcarinatus (HASWELL) = *E. persetosus*, STEBBING.

To (B) belong the new species *E. serrula*, *E. spinimanus*, and *E. dubius*.

(A) **Elasmopus subcarinatus** (HASWELL)—Plate V., figs. 34.

Megamæra subcarinata, HASWELL, 'Proc. Linn. Soc. N.S.W.,' vol. 4, p. 335, Plate XXI.

E. subcarinata (HASWELL) (**E. persetosus**, STEBBING), '"Chall." Amph.,' p. 1019, Plate XCVIII.

Abundant and occurs all round Ceylon.

Length of adult male 7·5 millims.

The antennular appendage is 2-jointed instead of 6, otherwise it agrees with the "Challenger" description, except in the sculpture of the hand of the 2nd gnathopods of the male, which varies considerably. In the smaller specimens there is generally a single flat-topped lobe near the base of the dactylus; in the larger this is divided in two by a sinus. In the largest of all there is hardly a trace of a lobe or tooth on any part of the hind margin, which is densely setose in all (figs. 34. gn.[2] ♂ and ♀). None are quite like the "Challenger" drawing. The 3rd joint of the mandibular palp is distinctly longer than the 2nd.

(B) **Elasmopus dubius**, n. sp.—Plate V., figs. 35.

One male from pearl oysters, East Cheval Paar, 8th November, 1902.

Body smooth, without dorsal teeth.

Head: ocular lobe rounded, with an acute, re-entering angle and a narrow rounded lobe below, as in *E. rapax*. Eyes large, wide-oval, dark.

First 4 side-plates about as deep as the segments.

Upper antennæ of moderate length; the 1st joint as long and twice as thick as the 2nd and about one-third longer than the 3rd. Flagellum 16-jointed, a little shorter than the peduncle. Appendage 2-jointed, the 2nd rather the longer, a little longer than the 1st joint of the flagellum.

Lower antennæ reaching the end of the peduncle of the upper, 2nd and 3rd joints subequal; flagellum 8-jointed, rather longer than the last joint of the peduncle.

Mouth organs as in *E. rapax*.

Maxillipeds as in *E. rapax*.

First gnathopods: side-plates irregularly rhomboidal, the anterior angle rounded, with a few setæ on the lower margin. First joint about as long as the next 3; wrist rather shorter than the hand, the hind margin densely setose; hand with the palm rounded off into the hind margin, but defined by a spine (fig. 35. gn.[1]).

Second gnathopods: side-plates rounded below, not reaching half-way down the 1st joint; this is longer than the next 3; 3rd joint produced behind in a narrow lobe with 5 or 6 setæ; wrist very short and wide, hind margin with a dense tuft of setæ. Hand nearly twice as long as the 1st joint, margins subparallel and subequal, the front slightly the longer and smooth, except 2 or 3 setules; the hind margin has 9 or 10 fascicles of setæ and ends in a strong tooth which defines the palm; this is transverse, not oblique, narrow, with a central tubercle; the hinge of the dactylus is as wide as the palm. *Dactylus peculiar, bulbous at the base and very strong, with a curved blunt point which meets the defining tooth of the hind margin* (fig. 35. gn.[2]).

First and 2nd peræopods almost as long as the 4th and 5th; 1st joint narrow, as long as the 3rd and 4th together; 4th and 5th spinous on the hind margin.

Third peræopods wanting.

Fourth and 5th peræopods subequal and similar, stout; 1st joint five-sixths as wide as long, hind margin serrate, front spinous; 3rd joint produced downwards *in front;* otherwise subequal to 4th and shorter than 5th; all the joints spinous. Dactyli strong (fig. 35. pp.[5]).

First uropods: rami subequal, shorter than the peduncle; all spinous.

Second uropods short and stout; outer ramus shorter than the inner and subequal to the peduncle; all spinous.

Third uropods wanting.

Telson reaching beyond the middle of the 2nd uropods, divided nearly to the base, the divisions notched at the tip with a long and a short spine in each notch.

Length 5 millims.

This species is certainly very near *Mæra festiva*, CHILTON, 'Proc. Linn. Soc., N.S.W.,' vol. 9, Part 4, p. 3, Plate XLVI., fig. 2. As, however, Professor CHILTON has only described the antennæ and gnathopods, and as both of these differ somewhat from the specimen described above (considering also the distance between Sydney and Ceylon), it seems better to consider them as distinct. It is unfortunate that, in both cases, the 3rd uropods, so important in this family, should be wanting.

Elasmopus spinimanus, n. sp.—Plate V., figs. 36.

Reef, Galle, Station XXXVIII.

Very near *E. rapax*, from which it differs in the following points :—

The hind margin of the epimere of the 3rd pleon segment is slightly concave, the lower margin convex with submarginal spines, the posterior angle upturned, acute (fig. 36. pl.^{3}).

The 1st gnathopods have the hand longer than the wrist, the palm very oblique and only defined by a spine. The anterior angle of the side-plates is rounded.

The hand of the 2nd gnathopods in the male has no tubercle, except near the base of the dactylus; *this is flat-topped and crowned with 7 or 8 spines; below this is a row of 6 spines on the distal third of the hind margin*, with rather scanty fascicles of setæ below this. The side-plates are rounded below (fig. 36. gn.^{2}. ♂). In the female the limb nearly resembles that of *E. rapax*, female.

The last 3 pairs of peræopods are more slender than in *E. rapax*; the 1st joint with the hind margin obscurely serrate, and in the 3rd pair concave.

The 3rd uropods have the rami subequal in length and breadth, and considerably longer (as 5 : 3) than the peduncle, the outer with 4 fascicles of spines on the outer margin (fig. 36. up.^{3}).

The divisions of the telson are narrower at the end and more deeply notched.

Length 5 millims.

From *E. affinis*, DELLA VALLE, it differs in the absence of the median tubercle and the presence of the 6 spines on the hind margin of the hand of the 2nd gnathopods.

Elasmopus serrula, n. sp.—Plate VIII., figs. 37.

Galle; basket hung to buoy, 9th May, 1902, 1 male; from pearl oyster washings, Cheval Paar, several.

This species resembles *E. rapax* in the form and character of the body, the head, antennæ, mouth organs, peræopods (so far as relates to their proportions), and uropods.

The 3rd pleon segment has the hind margin almost straight, the lower convex and the posterior angle a little produced and upturned.

The side-plates of the first gnathopods have the front margin concave and the angle rounded; the limb as in *E. rapax*.

The 2nd gnathopods in the male have the hand of similar form to *E. rapax*, but *the hind margin is without spines or dentiform projections, except the large flat-topped one* (as in the last species) *at the base of the dactylus;* it is densely clothed with long setæ rising from numerous transverse ridges (fig. 37. gn.[2]). In the female the hand resembles *E. rapax.*

The 3rd peræopods are very short and stout, the hind margin of the front joint almost straight, narrowing distally, and obscurely toothed.

The 4th and 5th peræopods are subequal; the 1st joint, which is rather wider and more convex in the 5th, *has the greater part of the hind margin elegantly cut into flat-topped teeth* of a peculiar form (fig. 37. pp.[4]).

The telson has the end of the divisions rather deeply notched, with the angles equally produced; 2 unequal spines and 2 spinules in each notch (fig. 37. t.).

Parelasmopus, STEBBING, 1888.

Parelasmopus suluensis (DANA).—Plate VI., figs. 38.

> **Gammarus suluensis**, DANA, 'U.S. Exploring Expedition,' 1852.
> **Megamæra suluensis**, SP. BATE, 'Cat. Amph. Crust. Brit. Mus.,' 1862.

Cheval Paar, Gulf of Manaar.

The palm of the 2nd gnathopod in the male is much less oblique than in the "Challenger" figure.* In the female this limb resembles the 1st gnathopods, except in being rather longer and more slender. The hand is considerably longer and narrower than the wrist, with 5 fascicles of setæ on each margin; palm very oblique (fig. 38. gn.[2]).

The 3rd uropods (wanting in the "Challenger" specimen) have the rami half as long again as the peduncle, subequal in length and width, the outer slightly the longer, with 4 spiniferous notches on the outer edge; the inner has 4 pairs of submarginal spines on the inner side (fig. 38. up.[3]).

The telson reaches to the end of the peduncle of the 3rd uropods.

The length of a female (tube 94) is 13 millims.

Cheirocratus, NORMAN, 1865.

A single female with ova from Periya Paar Kerrai, November, 1902; length 4 millims. There was only one postero-dorsal tooth on the urus and that on the 1st segment. A description without the male would be useless.

Megaluropus, NORMAN,† 1889.

Megaluropus agilis, NORMAN.

> **Cheirocratus drechselii**, MEINERT, 'Crust. Malacostr. Daniæ,' 1890.
> **Megaluropus agilis**, NORMAN, DELLA VALLE, *loc. cit.*, p. 695, plates 3 and 34.

Kondatchi and Cheval Paars, November, 1902. About 30 specimens.

Notwithstanding the following differences between the Ceylon and English speci-

* In this respect our specimens resemble *P. setiger*, CHEVREUX ('Mém. de la Société Zool. de France,' t. xiv., p. 412, fig. 32, 1901), as also in some other small details.

† 'Ann. and Mag. Nat. Hist.,' Ser. 6, vol. 3 (1889), p. 446, Plate XVIII., and vol. 4, p. 123.

mens, I consider them to be substantially identical. In the former the denticulation of the hind margin of the 3rd pleon segment is finer; the flagellum of the upper antennæ is 9-jointed and considerably *longer* than the peduncle in the female; the last 3 pairs of peræopods have the 1st joint narrower, the hind margin concave, obscurely serrate, and produced downwards.

Length barely 4 millims.

To illustrate the difficulties one has to contend with in determining species from specimens sent from abroad in spirit, I may mention that of the 30 odd specimens only one had the lower antennæ, and perhaps 5 or 6 the broad 3rd uropods. It would be far better if specimens, when picked out, were sent home in *pure* glycerine.

Lilljeborgia, Sp. Bate, 1862.

Lilljeborgia pallida, Sp. Bate.

L. pallida, Bate, Norman, 'Ann. and Mag. Nat. Hist.,' Ser. 6, vol. 4 (1889), p. 116, plate x.
L. pallida, Bate, G. O. Sars, 'Amph. of Norway,' p. 530, plate 187.
Nicippe pallida (Bate), Della Valle, *loc. cit.*, p. 658, plate 19.

Stations XIX., LI. Length 4·5 millims.

Lembos,* Sp. Bate, 1857 (= **Autonoë**, Bruzelius, 1859, in part).

Lembos podoceroides, n. sp.—Plate VI., figs. 39.

Coast of Ceylon, under 100 fathoms, generally distributed.

Head as long as the first 2 segments; ocular lobe as in *L.* (*Autonoë*) *websteri*, Bate. Eye round-oval, dark.

Third segment of the pleon, with the hind and lower margins of the epimere convex, the posterior angle subacute and produced; a diagonal line running forward and upward from it (fig. 39. pl.[3]).

First segment of the urus almost as long as the remainder, including the telson.

Upper antennæ reaching to the pleon, peduncle reaching about the middle of the last joint of that of the lower; 1st joint about 3 times as wide and three-fourths as long as the 2nd, and 3 times as the 3rd. Flagellum about 22-jointed in the male, the joints lengthening distally. Appendage 7-jointed, the last minute, reaching the 7th joint of the flagellum.

Lower antennæ reaching to the middle of the flagellum of the upper; 2nd and 3rd joints subequal; flagellum in female 5-jointed, shorter than the last joint of the peduncle. Both pair of antennæ very sparsely setose.

Mandibular palp large and projecting, the 3rd joint as long as the 1st and 2nd united; the 2nd expanded distally (fig. 39. m.).

First gnathopods in the female (fig. 39. gn.[1] ♀):—

Side-plates rhomboidal, shorter than the 1st joint, the anterior angle blunt; 1st joint stout, rather longer than the next 3; wrist about half the length of the

* For the reasons for re-instating this genus see Stebbing, 'Ann. and Mag. Nat. Hist.,' Ser. 6, vol. xvi., 1895, p. 206.

hand, hind margin convex and setose. Hand wider than the wrist and widening distally, the palm about half as long as the hind margin, oblique, with a shallow sinus above the palmar angle, below which is a strong spine; the hind margin, palm, and sides of the hand and wrist are furnished with fascicles of setæ. The dactylus has the inner margin serrate and reaches below the strong spine mentioned above.

In young male: side-plates with the anterior angle acute; the first 4 joints very stout, the 1st about half as long as the hand and longer than the next 3; wrist about one-fourth of the length of the hand; the front margin of this is convex and naked; the hind margin has near the base a strong, somewhat everted tooth, above which is an angular sinus; above this is a flat-topped projection, with a rough edge and submarginal setæ, and a small sinus near the base of the dactylus: this has a central projection on the inner side which corresponds with the flat-topped one; the point reaches slightly beyond the basal tooth; the outer margin is rough with minute granules, as also is the lower margin of the basal tooth (fig. 39. gn.[1] ♂ jr.).

In adult male: the first 4 joints as in the young male, except the 1st joint, which is wider, being half as wide as long. The hand has the base produced backwards in a long pointed spur, above which the hind margin is straight, with a small semicircular sinus near the hinge of the dactylus; the latter is relatively much longer than in the young male, evenly curved like a sabre, without the central projection, and with a row of 7 or 8 setules along the inner margin (fig. 39. gn.[1] ♂ adult).

The 2nd gnathopods are as usual in this family small and alike in both sexes, except that in the female the wrist is rather shorter and in the males subequal to or slightly longer than the hand; of this the margins are subparallel, the palm obliquely transverse. This limb and the rest of the animal so closely resemble *L.* (*Autonoë*) *websteri*, SP. BATE, that I refer my readers to Professor G. O. SARS' excellent description and figures ('Amph. of Norway,' p. 547, plate 194).

Length 8 millims.

The resemblance between the *first* gnathopods of the young and old males of this species and the *second* gnathopods of the same in *Jassa* (*Podocerus*) *falcata* (MONT.) is very striking (*conf.* SARS, *loc. cit.*, plate 212, p^2 ♂–p^2 ♂′).

Lembos chelatus, n. sp.—Plate VI., figs. 40.

One specimen from north end of Chilaw Paar, 2nd February, 1902.

Head longer than the first 2 segments. Ocular lobe prominent, angular. Eye roundish, large, dark.

Third pleon segment rounded behind.

Upper antennæ: peduncle shorter than that of the lower; 1st joint twice as thick and more than half as long as the 2nd; the 3rd rather shorter than the 2nd; 1st joint of the flagellum almost as long as the last of the peduncle; appendage very small, 2-jointed, about one-third of the 1st joint of the flagellum. The flagellum was broken at the 2nd joint.

Lower antennæ reaching the 4th body segment; the 2nd joint rather shorter than the 3rd; flagellum subequal to these united.

Mandibular palp with the 3rd joint shorter and wider than the 2nd, sub-oval, widest near the distal end, which is truncate; 1st joint very short (fig. 40. mp.).

First maxillæ: inner plate minute, with a single setule near the rounded top.

Palps of the maxillipeds more slender than in *L. websteri*, the outer plates reaching about the middle of the 2nd joint, armed with spine-teeth which increase in length distally.

First gnathopods: side-plates fully as deep as the segments, wider below, the angles rounded; 1st joint about twice as long as the next 3, rather shorter than the hand; 3rd joint rounded behind; wrist small, triangular, almost coalescent with the base of the hand; this has the front and hind margins subparallel and sparsely setose; the latter produced in a strong tooth beyond the base of the dactylus to the point of which it is opposed, forming a chela; a smaller tooth between this and the base of the dactylus; this has a prominent rounded tooth on the inner margin (fig. 40. gn.[1]).

Second gnathopods: side-plates irregularly rhomboidal, with rounded angles; 1st joints stronger than in the 1st pair, wider than any of the other joints, and about as long as the hand; this is a little longer than, and subequal in width to, the wrist, margins parallel, setose; palm small, oblique. Dactylus reaching much beyond the palm (fig. 40. gn.[2]).

First and 2nd peræopods: side-plates rounded below, deeper than the segments; 1st joint relatively wide, 3rd nearly twice as long as the 4th, and wider at the distal end; the whole very sparsely setose (fig. 40. pp.[1]).

Third peræopods but little longer than the 2nd; 1st joint widely oval and about as long as the next 3; 3rd longer than 4th, the two together rather longer than the 5th, which is slender, and has 2 or 3 spines on the front margin.

Fourth and 5th peræopods are subequal, the latter shorter than is usual in this genus, only reaching the 2nd urus segment; they are but little longer than the 3rd pair, which they resemble, except the 1st joint, which is relatively shorter and narrower (fig. 40. pp.[5]); the 3 pairs are almost entirely without setæ.

The 3rd uropods extend a little beyond the 2nd, and these beyond the 1st; the outer ramus of the 3 pairs is shorter than the inner; in the 3rd the inner ramus is as long as the peduncle, with a spine near the middle and 3 unequal terminal spines; the outer has 2 or 3 short and 2 or 3 long terminal spines (fig. 40. up.[3]).

Telson rounded at the end, with a spine and a seta at each side.

Length 2·5 millims.

The characteristic features of this species are the angular ocular lobes, resembling *Gammaropsis*, the chelate hand of the 1st gnathopods, and the comparative shortness of the last peræopods. It is, however, very possible that the specimen was immature.

Another species of *Lembos* from Cheval Paar has the 1st gnathopods very like

L. websteri. Another from East Cheval Paar appears to be a *Lemboides*, STEBBING, 'Ann. and Mag. Nat. Hist.,' Ser. 6, vol. 16 (1895), p. 209, plates ix. and x., but both are too imperfect for description.

Aora, KRÖYER, 1844.

Aora gracilis (?), SP. BATE.

Pearl oyster washings, Gulf of Manaar.

A very small (2 millims.) and imperfect male from Muttuvaratu had the characteristic gnathopods of this species, and a female, with ova, length 2·5 millims., from East Cheval Paar may possibly belong to it.

Gammaropsis, LILLJEBORG, 1854.

Gammaropsis zeylanicus, n. sp.—Plate VI., figs. 41.

Generally distributed round the coast of Ceylon.

Head as long as the first 2 segments. Ocular lobe produced to more than one-third of the length of the 1st joint of the upper antennæ, subangular; the extremity generally entirely occupied by the eye, which is dark and variable in size and shape.

Hind margin of the 3rd pleon segment rounded. Urosome about as long as the last pleon segment, its 1st segment dorsally depressed.

Upper antennæ more than half as long as the body and longer than the lower, the peduncles subequal; 1st joint twice as thick and two-thirds as long as the 2nd, which is longer than the 3rd; flagellum subequal to the peduncle, with about 14 joints; appendage reaching the middle of the 5th joint of the flagellum, 5-jointed, the last joint the longest.

Lower antennæ: 2nd and 3rd joints subequal, longer than the 11–12-jointed flagellum. Both pairs of antennæ are sparsely setose.

Mouth organs and maxillipeds normal.

First gnathopods (female): side-plates rhomboidal, front not produced, angles rounded; 1st joint subequal to the next 3; wrist subequal to the hand in length and width, very setose on the side and hind margin; hand oval, palm undefined, with setiferous ridges on both margins; dactylus rather long, serrate. In the immature male from the same tube as the female (Station LVIII.) the 1st joint is stronger and has 3 strong curved pectinate setæ at the end of the hind margin; these were not seen on the female or the adult male. In this last the front margin of the side-plates is considerably produced to a rounded acute angle and the 1st joint is very stout, with scattered setæ along the hind margin (fig. 41. gn.[1] ♀).

Second gnathopods (female): side-plates as in the 1st pair, but rather wider; 1st joint strong, the margins subparallel, considerably longer than the next 3 joints; wrist triangular, about half as long as the hand; this is oval, palm only defined by a blunt spine a little beyond the middle of the hind margin, which, as well as that of the wrist, is very setose; the dactylus reaches a little beyond the spine and is not serrate (fig. 41. gn.^{2} ♀).

In the young male the side-plates are oblong, about twice as wide as deep, the angles rounded; 1st joint very stout (width to length as 3 : 5) and longer than the next 3, a number of long setæ on the outer side; wrist short and triangular; hand subovate, margins to the palmar angle subparallel; palm very oblique, uneven, defined by a small blunt tooth, and occupying nearly half of the hind margin, which is setose; the front margin is naked; the dactylus reaches to the palmar tooth and is not serrate (fig. 41. gn.^{2} ♂ jr.).

In the adult male the anterior angle of the side-plates is less rounded. The palm of the hand is deeply sculptured with a double tubercle in the middle. The dactylus has an obtuse tooth in the middle of the inner side (fig. 41. gn.^{2} ♂ adult).

First and 2nd peræopods: 1st joint rather longer than and twice as wide as the next 2; 3rd joint much longer than the 4th and rather longer than the 5th, which tapers to the base of the dactylus. The whole very sparsely setose.

Third peræopods much shorter than the 4th, the 1st joint wide-oval with smooth margins; 3rd and 4th much wider, but together scarcely longer than the 5th, on which there is a row of spines.

Fourth and 5th peræopods like the 3rd, but longer; the 3rd pair reaches the 4th joint of the 4th pair, and the 4th pair to the same joint of the 5th.

The uropods are subequal in extent, the peduncles of the 1st and 2nd subequal to the rami, with a row of spines on the outer margin; rami also spinous. The 3rd pair have the peduncle considerably longer than the rami, of which the inner is the shorter and pointed with 3 small spines on the outer margin and a terminal spine; the outer has a short spine on the upper side near the middle, with 3 or 4 short and 2 long spines on the tip (fig. 41. up.^{3}).

Telson as in *G. erythrophthalmus* (Lillje.).

Length 6 millims.

Cheiriphotis, n. gen.

Body very slender, scarcely compressed laterally; side-plates very small.

Head slightly produced in front, ocular lobes more so, angular or cuspidate.

Upper and lower antennæ subequal, the latter stronger; appendage well developed.

Mandibles with the palp long, 2nd and 3rd joints subequal, the whole as in *Gammaropsis*.

Second gnathopods of moderate size in the female, but immensely developed and peculiarly formed in the male; urus small; the 3rd uropods with the outer ramus very short, without a terminal joint, and the inner rudimentary.

This genus is nearly allied to *Microprotopus*, from which it differs chiefly in the smallness of the side-plates.

Cheiriphotis megacheles (Giles).—Plate VI., figs. 42.

Melita megacheles, Giles (male), 'Journ. Asiatic Soc. Bengal,' 1885, vol. liv., p. 70, pl. iii.

Eurystheus hirsutus, Giles (female), 'Journ. Asiatic Soc. Bengal,' 1887, vol. lv., p. 227, pl. viii.

Rather abundant along the West Coast from Colombo northwards.

Third pleon segment rounded behind; lower margin straight, hind margin convex.

Head not quite as long as the first 2 segments, of which the 1st is the shorter; ocular lobe moderately produced, angular, the angle obtuse and apiculate (fig. 42. o.l.).

Upper antennæ: peduncle subequal to that of the lower; 1st joint shorter and wider than the 2nd, longer than the 3rd; flagellum rather variable in length, generally subequal to the last 2 joints of the peduncle, about 13-jointed. Appendage (in female) reaching the end of the 4th joint of the flagellum, 4-jointed, the first 2 joints together subequal to the 4th. In the males the appendage is 3-jointed, the 1st joint shorter than the 2nd, the 2nd and 3rd subequal; the whole reaching to the end of the 2nd joint of the flagellum; the appendage has, in addition, a minute terminal joint in both sexes.

Lower antennæ rather stronger than the upper, the 1st joint about one-third of the 2nd; 2nd, 3rd, and flagellum subequal, the last 9-jointed. Both pairs of antennæ are rather thinly clothed on the under side with long setæ.

Mouth organs as in *Gammaropsis*, except the inner plate of the 1st maxillæ, which is round-oval, with 4 setules on one side.

Maxillipeds as in *Gammaropsis*.

First gnathopods: side-plates acutely produced in front and fringed round the blunt point and below with long setæ, especially in the female. The 1st joint is as long as the wrist, which is longer than the hand and has the hind margin rather flattened and very setose; the hind margin of the hand is evenly convex, with no definite palm, and is setose on the middle part. Dactylus about half as long as the hind margin, with a row of setules on the inner margin (fig. 42. gn.[1]).

Second gnathopods (female): Side-plates small subquadrate, angles rounded, lower margin fringed with long setæ. First joint very strong, subequal to the hand, with long setæ on the front margin; wrist half as long as the hand, triangular, produced and setose behind; hand subovate, palm oblique, uneven, defined by a strong tooth just below the point of the dactylus (fig. 42. gn.[2] ♀).

The young male has the hand much wider than the female, though less so than the adult male; the palm is somewhat obliquely transverse, defined by a strong pointed tooth; near the middle is a double pointed tooth and a single one near the base of the dactylus; the latter is wider in the middle than in the adults. The wrist is produced towards the *front* margin of the hand and cannot be seen behind (fig. 42. gn.[2] ♂ jr.).

In the adult male the 1st joint is shorter, the width being three-fourths of the length, which is subequal to the next 2 joints. The wrist has disappeared or can only be seen in a reduced form through the wall of the 3rd joint. The hand is subquadrate, as long and wide as the first 3 segments united; the proximal part of the front margin is very convex and fringed with long plumose setæ; the palm is rectangularly transverse, defined by a sharp tooth with 5 equidistant, irregular teeth between it and the hinge of the dactylus. The hind margin is almost straight and about two-thirds as long as the front, with a few setæ below the palmar angle. Dactylus slightly curved, narrow, with subparallel margins, the point meeting that of the defining tooth (fig. 42. gn.^{2} ♂). Dr. GILES' specimen had only 3 teeth on the palm, but this is a feature that doubtless varies with age.

First peræopods rather longer than the first 3 joints of the 2nd gnathopods in the male, and as long as the whole limb in the female; 1st joint curved in the male, straight in the female, rather stout; 3rd and 5th subequal in length, the 3rd widened distally with a group of long stiff setæ at the anterior angle. Dactylus rather slender and recurved (fig. 42. pp.^{1}). In the female this limb is much more setose than in the male.

Second peræopods in the female like the 1st pair; in the male smaller and with the 1st joint straight.

Third peræopods about as long as the 2nd pair in the male: 1st joint much expanded behind and fringed on both margins; next 3 joints subequal in length and width; 5th longer and narrower, with 5 or 6 spines on the hind margin. All the joints have long plumose setæ on the front margin and the 3rd and 4th joints have a group at the posterior angle as long as the next joint. Dactylus rather short, recurved, and reversed as in *Photis* (fig. 42. pp.^{3} ♂).

The remaining peræopods increase in length successively, the last pair extending beyond the uropods and having the 1st joint broader than the 4th pair. Both pairs are densely hirsute.

The first uropods extend a little beyond the 2nd, and these beyond the 3rd; in the 1st and 2nd the rami are subequal and shorter than the peduncles, all the parts being spinous.

The 3rd uropods have the outer ramus shorter than the peduncle, without a terminal joint, but with 3 short spines and some stiff setæ at the tip; inner ramus a spiniferous tubercle (fig. 42. up.^{3}).

Telson as in *Microprotopus*, squarely truncate when seen from above mounted, with 3 or 4 setæ in each angle; it does not quite reach the end of the peduncle of the 3rd uropods.

Length of male, 4 millims.

Incubatory lamellæ elongate-triangular, the apex below.

The great size and resemblance in shape and colour to a broken piece of shell in the hands of the 2nd gnathopods of the male suggest, as in *Melita anisochir*, KR., a protective purpose. It is, however, not easy to see why, in both species, the males only should be protected. There can, I think, be little doubt that *Eurystheus hirsutus*, GILES (*loc. cit.*), is the female of this species.

Photis, Kröyer, 1842.

Photis longicaudata (Sp. Bate).—Plate VI., figs. 43.

West Coast of Ceylon, from Galle northwards; generally abundant.

Length of female with ova, 3·5 millims.

I have referred the specimens examined to the above species chiefly on account of the prominence of the ocular lobe (fig. 43. c.). In other respects it is equally near the other two species described by G. O. Sars, the limbs in some specimens being as robust and hairy as in *P. reinhardi*, Kr., while the hand of the 2nd gnathopods resembles that of *P. tenuicornis* (fig. 43. gn.^{2}). It is a question whether these 3 species and *P. pollex*, A. O. Walker, ought not to be merged in the oldest recorded form, *P. reinhardi*. The Ceylon specimens are remarkably variable. The colour in spirit is dark yellowish-green spotted with black or brown.

One of the forms has the hind margin of the outer ramus of the last 2 pairs of pleopods expanded near the base and furnished with peculiar longitudinally-striated, tapering plumose setæ radiating symmetrically from the curved margin (fig. 43. plp.). In this form the side-plates and gnathopods are setose.

Photis longimanus, n. sp.—Plate VII., figs. 44.

From pearl oysters, East Cheval Paar, 8th November, 1902; 5 specimens.

Male.—Head about as long as the first two segments.

Ocular lobe reaching almost to the end of the 1st joint of the lower antennæ. Eye large, occupying almost the whole lobe, dark.

Hind angle of the 3rd pleon segment rounded.

Upper and lower antennæ subequal, scarcely reaching to the pleon, sparsely setose; 1st joint of the upper twice as thick as, but shorter than, the 2nd, and subequal to the 3rd; flagellum 6-jointed, subequal to the 2nd and 3rd joints of the peduncle together.

First joint of the lower antennæ about half as long as the second, which is subequal to the 3rd; flagellum 6-jointed, rather shorter than the last 2 joints of the peduncle.

Mouth organs and maxillipeds normal.

First gnathopods: side-plates oblong, much wider than deep, angles rounded; 1st joint as long as the 3rd and 4th and at least as wide as the hand; wrist as wide as, and considerably longer than, the hand, which is oval; the palm undefined (fig. 44. gn.^{1}).

Second gnathopods: side-plates small, rounded-oblong; the first 4 joints very short and stout. *Wrist brought round the base of the hand on the outside and produced beyond it in an oval lobe.* Hand long, narrowing distally, a strong blunt tooth near the base on the *inner* surface, the hind margin divided into 3 nearly equal concave spaces by this and 2 other teeth, the middle one being the smallest. Dactylus strong, reaching the basal tooth (fig. 44. gn.^{2} ♂).

The peræopods do not differ materially from those of *P. reinhardi*, Kr., except in being less setose; the last pair extends to the end of the 3rd uropods.

The segments of the urus decrease successively in length; the 1st has a dorsal depression.

The uropods are subequal in extent, short and stout; the outer rami in the 1st and 2nd rather shorter than the inner and about half as long as the peduncles, without terminal spines or setæ. The 3rd pair has the inner ramus almost rudimentary, the outer curved, rather longer than the peduncle, with a minute terminal joint and 1 or 2 slender spines on it. With the exception of 2 or 3 setules on the telson, the urus appears to be entirely destitute of setæ.

Telson not quite reaching the end of the peduncle, of the usual form.

Length 3 millims.

Colour in spirit yellowish, with a few dark-red blotches on the body and limbs. No female was observed. The species may be distinguished by the peculiar form of the wrist and hand of the 2nd gnathopods.

Photis nana, n. sp.—Plate VII., figs. 45.

Pearl oyster washings, Muttuvaratu, 19th Nov., 1902. Two females with ova.

Head longer than the first 2 segments. Ocular lobe distinct, but not prominent. Eye round, rather small.

Posterior angle of the 3rd pleon segment rounded.

Antennæ subequal in length and width, except the 1st joint of the upper, which is at least twice as wide as any of the other peduncular joints; both pairs are almost naked. In the upper pair the 3 joints of the peduncle are subequal in length, the 1st with a group of setæ at the distal end; the flagellum about as long as the last 2 joints of the peduncle, with 3 rather long subequal joints and a minute terminal one which, as well as the 2 preceding, has one or two strap-shaped setæ at the end. The lower antennæ have the 1st joint very short; the 2nd shorter than the 3rd; the flagellum as long as the peduncle.

First gnathopods: 1st joint curved, as long as the next 3; wrist about two-thirds as long as, but wider than, the hand, with a group of setæ on the convex hind margin. The hand narrows distally to the base of the dactylus, the distal half of the hind margin setose (fig. 45. gn.[1]).

Dactylus with a spine and 2 setules on the inner margin, which is finely pectinate.

The 2nd gnathopods resemble the 1st in size and form, but the 1st joint is less curved and the 3rd has the end of the hind margin squarely truncate (fig. 45. gn.[2]).

First and 2nd peræopods: 1st joint pyriform, longer than the next 3, the hind margin convex and setose at the distal end (fig. 45. pp.[1]).

Third peræopods as in *P. reinhardi*, but without setæ, except one at the end of the hind margin of the 4th joint and one at the base of the dactylus.

Fourth and 5th peræopods as in *P. reinhardi*, except the 1st joint, which is more oblique and the whole less setose.

The uropods are without spines or setæ, except at the ends of the joints. The 3rd pair extends slightly beyond the 2nd; the inner ramus very small, the outer almost as long as the peduncle, curved, with a minute terminal joint, no spines or setæ (fig. 45. up.[3]). Telson obtusely pointed.

Length 2 millims.

The peculiar gnathopods of this small species seem to indicate that a new genus will be required for it when the male is found.

Chevalia, n. gen.

Body laterally compressed.

Head without a rostrum.

Antennæ subequal, the upper with an appendage.

Mandibles small; palp long and slender, 3-jointed.

First and 2nd maxillæ as in *Cerapus*, but relatively smaller.

Palp of the maxillipeds with the last joint blunt.

First gnathopods slender, as in *Gammaropsis*.

Second gnathopods with large wrist and hand alike in both sexes.

The last 3 pairs of peræopods with the dactyli inverted, as in *Cerapus*.

First and 2nd uropods with dissimilar rami; 3rd with 2 well-developed rami.

Telson, as in the Photidæ.

This curious genus is intermediate between the Photidæ and the Corophiidæ. It resembles the former in the form of the body, head, antennæ, gnathopods, and telson; and the latter in the inverted peræopods and the dissimilar rami of the 1st and 2nd uropods, though in the new genus the dissimilarity is greater. Notwithstanding these points and the similarity of the 2nd gnathopods in the males and females, I have placed this form under the Photidæ as the family with which it has the greatest affinity.

Chevalia aviculæ, n. sp.—Plate VII., figs. 50, and Plate VIII., fig. 50).

Pearl oyster washings, East Cheval and Muttuvaratu paars: about 20 specimens

Body smooth, without dorsal spines or teeth; much curved; speckled with red.

Head as long as the first 2 segments; ocular lobe subangular, not very prominent.

Eyes oval—colourless in spirit.

Segments of the mesosome increasing in length successively, the 7th twice as long as the 1st.

Pleon segments with a pair of upright setæ on their postero-dorsal margins; the epimere of the 3rd rounded behind and below.

First 2 segments of the urus coalesced and subequal to the last pleon segment; 3rd segment about half as long.

Antennæ about two-thirds of the length of the body, subequal in the female; the upper rather the longer in the male; in the upper the 1st and 2nd joints are subequal, about one-third longer than the 3rd; flagellum 7-jointed; appendage 1-jointed, as long as the 1st joint of the flagellum.

Lower antennæ: 1st joint about half as long as the 2nd, which is rather longer than the 3rd; flagellum 6-jointed, subequal to the last 2 peduncular joints. Both pairs are similarly fringed below with long curved setæ.

Mandibles small, shorter than the 2nd joint of the palp; cutting edge double; molar tubercle rather large, but not prominent, palp projecting to the middle of the 2nd joint of the lower antennæ; 1st joint very small, 2nd and 3rd subequal (fig. 50. m.).

Maxillipeds: inner plate reaching the end of the 1st joint of the palp, spinous on the angle: outer narrow, reaching the middle of the 2nd joint, with slender curved spines near the top: 1st and 3rd joints of palp subequal; 2nd about twice as long; 4th rather more than half as long as the 3rd, the apex rounded and setose.

First gnathopods: side-plates small, front angle acute, with a setule on the point; 1st joint subequal to the wrist, curved; wrist subequal to the hand in length and width, the hind margin setose; hind margin of the hand convex and setose, the palm undefined. Dactylus half as long as the hind margin (fig. 50. gn.^{1}).

Second gnathopods: side-plates as in the 1st, but smaller; 1st joint stout, subequal to the next 3; wrist subequal in width to the hand, along the anterior margin of which it is carried for about one-third of its length. Hand longer than the wrist, subquadrate, the palm almost rectangular to the hind margin, convex, and defined by a strong tooth, behind which is a notch which receives the point of the dactylus (fig. 50. gn.^{2}).

First and 2nd peræopods are rather longer than the 2nd gnathopods and strongly built; the side-plates alike small and triangular, the angles rounded. The 1st joint is subequal to the next 3, about twice as wide as the 3rd joint, and widening distally; the front margin distally convex in the 1st pair and straight in the 2nd; the 3rd joint as long as the 2nd, 4th, and 5th together, and twice as wide as the last 2. Dactylus short (fig. 50. pp.^{2}).

Third peræopods hardly reaching the end of the 1st joint of the 2nd pair; 1st joint almost as wide as long, the front margin very convex; the 2nd subequal to the 4th and the 3rd to the 5th, which is the narrowest; the 3rd and 4th are obcordate. Dactylus reversed, with a secondary tooth on the outer side (fig. 50. pp.^{3}).

Fourth peræopods like the 3rd, but longer.

Fifth peræopods rather longer than the 4th; the 1st joint with the hind margin almost straight and ending in a rounded right angle; otherwise as in the preceding pairs (fig. 50. pp.^{5}).

The last 3 pairs of peræopods are feeble, the last pair hardly reaching the 3rd pleon segment, and neither as long or strong as the first 2 pairs of peræopods; they are almost devoid of spines or setæ.

First uropods: peduncle rather shorter than the upper ramus, which is styliform, curved and spinulous on the proximal half of the inner margin; the lower ramus is about one-fourth shorter than the upper, obliquely truncate at the end, where there is a crowded group of short blunt spines; the inner margin has a row of microscopic ciliæ (fig. 50. up.[1]).

Second uropods of similar structure to the 1st, but shorter in extent.

It is very difficult to determine which is the "inner" or the "outer" ramus, as, in fact, the one lies immediately above the other in these 2 pairs.

Third uropods: peduncle subequal to the inner ramus, which is rather longer than the outer; both are alike and simple, with obliquely truncate setose ends (fig. 50. up.[3]).

Telson as in *Gammaropsis*.

Length of ovigerous female 4 millims.

Probably a tubicolous species, from the structure of the last 3 pairs of legs. So far it has only been obtained from the washings of pearl oysters.

Amphithoë, Leach, 1813.

Amphithoë intermedia, n. sp.—Plate VII., figs. 46.

West Coast of Ceylon, from Colombo northwards.

Head shorter than the first 2 segments. Ocular lobe slightly produced, subangular. Eye round, red.

Third pleon segment: lower and hind margins convex, angles rounded.

Upper antennæ: 1st joint stout, almost as long as the slender 2nd; the 3rd barely one-third of the 2nd; flagellum slender, 30-jointed.

Lower antennæ: 1st joint very short, 2nd and 3rd subequal, but the 2nd the wider; *flagellum subequal to the last joint of the peduncle, 9-jointed.*

Mandibles normal, the palp scarcely as long as the mandible; 1st joint about half as long as the 2nd, which is subequal to the 3rd; this widens distally and is obliquely truncate, with 7 pectinate setæ on the truncate part and 1 below (fig. 46. m.).

First maxillæ: inner plate with 3 setæ (fig. 46. mx.[1]).

Remaining mouth organs and maxillipeds normal.

First gnathopods in the female as in *A. rubricata* (Mont.), the side-plates rather wider below, with a few setæ on the rounded posterior angle. In the male the whole limb is more robust; the hind margin of the wrist straight, crenate, setose, and ending in an acute angle; the hand scarcely as wide as the wrist, oblong; the dactylus strong and serrate (figs. 46. gn.[1] ♀ and ♂).

Second gnathopods in the female very like and but little larger than the 1st; the side-plates oblong, with setæ as in the 1st; the wrist is produced behind in a truncate lobe which is densely setose; the hand is about half as long again as the wrist, *the palm slightly convex, defined by a spine, but rounded off into the hind margin,* which is rather the longer; the whole hind margin setose. Dactylus reaching a little beyond the palmar spine, serrate (fig. 46. gn.[2] ♀).

In the male the side-plates are suborbicular, the diameter less than the length of the 1st joint, which is subequal to the next two; the front margin of the wrist is about half as long as that of the hand, and has a few unequal spines near its proximal end; the hind margin is a small, rounded, setose lobe. The hand has its anterior surface furnished with numerous setiferous ridges, the setæ very long; this part is produced in a rounded lobe beyond the base of the dactylus. The hind margin is subparallel with the front for about half its length, where it forms a strong tooth* which forms a deep V-shaped sinus with the palm. The point of the dactylus just meets that of the tooth (fig. 46. gn.[2] ♂).

The peræopods resemble those of *A. rubricata*, but are rather more slender.

The 1st and 2nd uropods have their outer rami subequal to the peduncles, the inner rather longer; all the parts are spinous.

The 3rd uropods have the inner ramus slightly longer than and subequal in width to the outer, the end rounded with a group of unequal spines at the end and 4 along the inner margin; the outer as in *A. rubricata*.

Telson as in *A. rubricata*.

Length of female with ova, 4 millims.

This species appears to connect *A. rubricata* with *A. vaillanti*, LUCAS; the female agreeing with the former, but differing from the latter in the hand of the 2nd gnathopods, while the reverse is the case in the male. The form described by DELLA VALLE as *A. rubricata* is, as pointed out by CHEVREUX ('Amphipodes des campagnes de "l'Hirondelle,"' 1885–8, p. 100,† who also gives the synonomy of that species), *A. vaillanti*.

The incubatory lamellæ of the 2nd gnathopods are narrow; the branchial pyriform broader at the lower end than in *A. rubricata*.

Amphithoë vaillanti, LUCAS.

Station LVIII., two females with ova; length 6 millims.

Ischyrocerus, KRÖYER, 1838.

Ischyrocerus anguipes, KR. (?).

Coast of Ceylon, under 100 fathoms, exact locality not known.

One male and 1 female with ova; length 2·5 millims.

I should not hesitate to refer these specimens to KRÖYER'S species were it not for the entire absence of their antennæ, their very small size (neither of these characters being, however, of much importance in this genus), and the fact that the species has not been recorded south of the Kattegat. The shape of the hand of the 2nd gnathopods in the male agrees exactly with SARS' figure of *I. anguipes*, differing in the concave hind margin from its nearest and more southern ally, *I. minutus*, LILLJEBORG. With the latter species I am well acquainted, having formerly described it under the name of *Podocerus isopus*.

* In a male from Station LVI. (tube 43) this tooth becomes a lobe.

† "Résultats des Campagnes scientifiques du Prince de Monaco," 1900.

Jassa, Leach, 1813 (= Podocerus, Auct.).

Jassa falcata (Montagu) (?).—Plate VII., fig. 47.

Muttuvaratu Paar, 19th November, 1902. One female without ova; length 4 millims.

In the absence of a male it is impossible to be sure of the species, but in its principal features this agrees with the above. The limbs and antennæ are more robust: the flagellum of the upper antenna is 6-jointed, about as long and half as wide as the last joint of the peduncle, the 1st joint as long as the next 3; appendage 1-jointed, about one-third of the 1st joint of the flagellum. The terminal joint of the palp of the maxillipeds is oblong, not pointed. The 2nd gnathopods are very robust, but of much the same form as in *J. falcata.* The 1st joint is about half as long as the hand; the separation of the 2nd and 3rd joints is not very distinct, and the wrist appears to be entirely coalesced with the hand. The dactylus is apparently encased in a sort of sheath to within a short distance of the point, the lower margin being studded with minute equidistant denticles.

Erichthonius, Milne Edwards, 1830.

Erichthonius abditus (Templeton).

Abundant from a basket hung to a buoy in Galle Harbour, 9th May, 1902; also from other localities along the coast.

Length of female with ova, 7 millims.

Erichthonius macrodactylus (Dana). -Plate VII., figs. 48.

Pyctilus macrodactylus, Dana, 'U.S. Exploring Exp.,' p. 974, plate 67.

Station LIII., north part of Gulf of Manaar; a few specimens.

Head as long as the first 2 segments, of which the 1st is very short, the remainder subequal. Ocular lobe moderately produced. Eye medium sized, dark, roundish-oval.

Upper antennæ reaching the middle of the flagellum of the lower; the 1st joint little more than half the length of the 2nd, which is rather longer than the 3rd; flagellum 13-jointed, subequal to the last 2 joints of the peduncle.

Lower antennæ: peduncle longer than that of the upper, the 2nd joint shorter than the 3rd, a red blotch upon both; flagellum rather longer than these two together.

Mouth organs normal except the palp of the mandible, which, both in this species and in *E. abditus*, differs from the European form of the latter in having the 3rd joint rather narrower than the 2nd and less expanded towards the tip (fig. 48. m.).

Maxillipeds normal.

First gnathopods as in *E. abditus.*

Second gnathopods as in *E. abditus* in the female. In the male it is very near to *E. difformis*, M. Edw., *but the thumb-like process of the wrist has the outer margin* *quite straight, while the inner is parallel to the outer for half its length, and thence tapers to a very sharp point*, with a tuft of setæ on the outer margin; the distal half of the proper hind margin of the wrist is quite straight. The hand is narrow and curved, *the margins parallel without any prominence on the inner.* Dactylus fully as long as the hand (fig. 48. gn.² ♂).

First and 2nd peræopods as in *E. abditus.*

Third peræopods: in the male the 1st joint has the hind margin produced downwards in a narrow rounded (not "acute," as described by DANA, though figured rounded) lobe reaching beyond the end of the 2nd joint; the 3rd joint is longer than the next 3, curved and expanded at the end (fig. 48. pp.³ ♂). In the female the 1st joint is without the lobe, and the 3rd joint is straight and shorter than the next two.

The 4th pair are slender and much longer than the 3rd, the 3rd and 5th joints subequal.

The 5th pair are longer than the 4th and extend considerably beyond the uropods; *the 5th joint is as long as the 3rd and 4th together.*

First uropods: peduncle considerably longer than the rami, the inner margin with 5 or 6 spines, rounded off and pectinate or finely serrate at the end; inner ramus a little shorter than the outer, both spinous and minutely pectinate.

Second uropods like the 1st, except the inner margin of the peduncle, which is not rounded or pectinate on the inner margin.

Third uropods as in *E. abditus*—two unequal spines near the middle of the outer margin and a small one near the base of the peduncle.

Telson as in *E. difformis*, with an obtuse central tooth.

Length 5 millims.

The colour of the specimens (in spirit) was lighter than in *E. abditus*, with dull red blotches and transverse bars on the body and limbs. This species may be considered as the eastern form of *E. difformis*, from which the male differs in the even hind margin of the hand, the somewhat differently formed wrist of the 2nd gnathopods, and, still more, in the peculiar construction of the 3rd peræopods. The female can only be distinguished from *E. abditus* by its greater slenderness generally, and especially by the great length of the 5th joint of the last peræopods.

Cerapus, SAY, 1817.

Cerapus calamicola (GILES).

Cyrtophium calamicola, GILES, 'Journ. Asiatic Soc. Bengal,' vol. liv., 1885, p. 54, pl. ii. ♂.

Cerapus flindersi, STEBBING, '"Chall." Amph.,' p. 1163, plate cxxv. ♀.

Cerapus flindersi, STEB., CHILTON, 'Rec. Aust. Mus.,' vol. ii., p. 1 (separate copy), pl. 1. ♂.

Station LIII., Periya Paar Kerrai, many, with tubes. East Cheval Paar.

A female from Station LIII. measured 6 millims.; those from Periya Paar Kerrai only 3 millims.

Siphonœcetes, Kröyer, 1845.

Siphonœcetes orientalis, n. sp.—Plate VII., figs. 49.

Station V., several; Station LIII., two; and Station LVIII., two specimens.

Rostrum acute deflexed, as long as the ocular lobes, which are almost rectangular, narrowing distally. Eyes small but distinct, with about 6 lenses.

First 4 side-plates acutely angled and fringed with rather long setæ.

Upper antennæ reaching beyond the middle of the 3rd joint of the peduncle of the lower, the 1st and 3rd joints equal; flagellum shorter than the peduncle, 14-jointed.

Lower antennæ almost as long as the whole body, the 1st joint about half as long as the 2nd, which is a little longer than the 3rd; flagellum about half as long as the last joint of the peduncle, 3-jointed, the 2nd one-fourth as long as the 1st, the 3rd minute. The whole of the flagellum is armed with a row of 5 or 6 strong recurved spines on each margin of the lower side. The lower side of the 2nd joint of the peduncle is sparsely, and that of the 3rd densely, clothed with long plumose setæ (fig. 49. ant.^{2}).

First gnathopods: 1st joint, hand, and wrist subequal, the hand throughout narrower than the wrist, and narrowing gradually from the base to the end with 4 spines on the hind margin; both hand and wrist setose on both margins. Dactylus with a row of spines on the inner margin, increasing in size distally (fig. 49. gn.^{1}).

Second gnathopods: much as in *S. colletti*, Boeck, but the hand narrower, the widest part near the base, from which point to the dactylus the hind margin is slightly concave, with 5 spines increasing in size distally (fig. 49. gn.^{2}). Dactylus as in the 1st gnathopods.

The rest as in *S. colletti*.

Length 5 millims.

The narrowness of the hands of the gnathopods distinguishes this species from the others, but I confess that I am inclined to agree with Della Valle (*loc. cit.*, p. 362), that the points of difference between *S. typicus*, Kröyer, the original Arctic species, *S. colletti*, Boeck, and *S. pallidus*, Sars, are not greater than can be accounted for by age, &c., so that both these species, as well as the present one, might well be united to *S. typicus*.

Corophium, Latreille, 1807.

Corophium crassicorne, Bruzelius.

Periya Paar Kerrai, 9th November, 1902. Two males, one female.

Length 2·5 millims.

The only difference observed between this and the European form was that there are 2 spines on the 3rd joint of the lower antennæ in the female instead of one.

Platophium, Dana, 1852.

Platophium læve (Haswell).—Plate VII., figs. 51.

> **Dexiocerella lævis**, Haswell, 'Proc. Linn. Soc., N.S. Wales,' vol. x., 1886, p. 111, pl. xviii.
> **Cyrtophium haswelli**, Chevreux and De Guerne, 1888.

Stations V., XLVII., LVIII., all in Gulf of Manaar.

The first 5 segments of the mesosome with a median transverse depression, the last segment and the first 2 of the pleon carinate, the carinæ not produced behind.

Head considerably longer than the 1st segment. Lower angle of the ocular lobe bluntly rectangular. Eyes wide-oval, dark in the centre.

Upper antennæ about as long as the head and first 2 segments; 2nd and 3rd joints of peduncle subequal, the flagellum the same length, 4-jointed in the females, 5-jointed in the males, the 1st joint much the longest. Appendage about one-third of the 1st joint. The whole setose below.

Lower antennæ are longer and less setose in the male than in the female, the 2nd joint considerably shorter than the 3rd and subequal to the 3-jointed flagellum.

First gnathopods: side-plates rhomboidal; 1st joint rather shorter than the next 3; hind margin of the wrist almost straight, setose. Hand subtriangular, longer than the wrist in the male, widest near the base, the palm occupying two-thirds of the hind margin and defined by a group of spines. Dactylus barely reaching the palmar spines; a row of spines on the inner margin and an obscure denticulation on the outer near the point, which has a secondary tooth, giving it a split appearance. In the female the hand is proportionately shorter than in the male, being only about as long as the wrist (figs. 51. gn.^{1}).

Second gnathopods, female (fig. 51. gn.^{2} ♀): the whole limb short and stout; the 1st joint subequal to the next 3; 3rd joint produced behind to a point tipped with a spine; wrist triangular, cup-shaped, with spines round the margin, about one-third as long as the hand; this is widely oval, the palm about 3 times as long as the rest of the hind margin, from which it is defined by a spine; about 6 spines and 4 long setæ on the palmar edge, and 4 marginal and 3 submarginal spines on the front margin; dactylus rather longer than the palm. In the male the hand is 4 times as long as the wrist, about 3 times as long as the hand in the female and proportionately narrower; the palm occupies nearly the whole of the hind margin, is defined by a small tooth, and is spinous, with a few short setæ throughout its length; there are 5 groups of spines (1 long and 2 short spines in each) along the front margin (figs. 51. gn.^{2}).

First and 2nd peræopods: the 1st joint narrow and as long as the next 2; the 3rd joint expanded distally, the front margin subangulate; 5th joint almost as long as the 3rd and 4th; all the joints spinous (fig. 51. pp.^{1}).

Third peræopods: 1st joint with a projecting lamina behind narrowing distally; 3rd and 4th joints subequal, 5th nearly twice as long; dactylus strong (fig. 51. pp.^{3}).

Fourth and 5th peræopods like the 3rd, except the 1st joint, which is wider and rounded behind.

The outer rami of the 1st and 2nd uropods are shorter than the inner and are terminated by a long spine, as also the inner ramus of the 2nd pair; the inner ramus of the 1st pair has 3 shorter and unequal spines and the inner margin finely pectinate and spinulose (fig. 51. ur.).

The 3rd uropods are uni-ramous, oval, acuminate, with a setule at the tip, about two-thirds covered by the telson (fig. 51. up.[3]).

The telson seen in profile is triangular, with 2 spines on the summit and the margin of the extended base upturned (fig. 51. t.).

Length of female with ova, 3·5 millims., but the females appear to become sexually mature very young in this genus, as much smaller females are full of ova.

In 1888, CHEVREUX and DE GUERNE referred HASWELL'S genus *Dexiocerella* to *Cyrtophium*, DANA, and as the specific name *læve* was preoccupied by *C. læve*, HELLER, they re-named HASWELL'S species *C. haswelli*. As, however, the species belongs to *Platophium*, I have reverted to HASWELL'S name, HELLER'S species having no antennular appendage.

It is possible that this species is identical with *Cyrtophium orientale*, DANA, in which, however, no antennular appendage is figured or described.

Platophium synaptochir,* n. sp.—Plate VIII., figs. 52.

Galle Harbour and Bay, very abundant. Kondatchi Paar, Periya Paar Kerrai, East Cheval Paar. All taken from May to November, 1902.

Male:—The first 4 segments of the mesosome are subequal, the 5th rather shorter, the 6th longer; the 7th the longest; all, as well as the pleon segments, have a transverse dorsal depression, and are elevated behind, but not carinate or produced behind. Urus with 3 distinct segments. Head longer than the 1st segment; ocular lobe subangular. Eye large, round, dark red.

Upper antennæ reaching to one-third of the last joint of the peduncle of the lower; the 1st joint twice as thick and more than half as long as the 2nd, which is about one-fourth longer than the 3rd. Flagellum as long as the 3rd joint, 5-jointed, the 1st joint as long as the remaining 4. Appendage 1-jointed, nearly half as long as the 1st joint of the flagellum; the whole rather sparsely clothed below with long, simple setæ.

Lower antennæ as long as the mesosome; the 1st joint less than half as long as the 2nd, which is much shorter than the 3rd. Flagellum shorter than the 2nd joint, 4-jointed, the 1st longer than the remaining 3; the whole sparsely furnished with short setæ.

* From συνάπτω, to join, and χειρ, hand, in allusion to the coalescence of the hand and wrist in the 2nd gnathopods of the male.

Palp of the 1st maxillæ with the 2nd joint not wider than the 1st and not expanding distally (fig. 52. mx.[1]).

Other mouth organs as in *P. inconspicuum*, STEB. ('Chall. Amph.,' p. 1194, pl. cxxxi.).

First gnathopods: side-plates small, produced to a blunt point with a setule. First joint short and stout, longer than the next 2; wrist shorter than the hand, but fully as wide, the front margin with curved spines, the hind margin flattened and densely setose; the hand has the hind margin concave near the base, with a straight and very setose palm; the front margin convex (fig. 52. gn.[1] ♂).

Second gnathopods of male: side-plates oblong, wider than deep, rounded in front. First joint about half as long as the hand, 3rd joint convex and setose, with the hind margin produced distally. Wrist merged in the hand, which is narrow-oval, with the hind margin slightly concave and densely setose; the palm is undefined. The front is convex, with groups of spines. Dactylus reaching rather beyond the middle of the hind margin (fig. 52. gn.[2] ♂).

The gnathopods in the female much resemble those of *P. inconspicuum*, STEB., but the wrist of the 1st pair is as wide as the hand, and the point of the dactylus is not divided as in that species. In the 2nd pair the 3rd joint is more produced behind, and the wrist, which is quite distinct, though small, is not produced at all (fig. 52. gn.[2] ♀).

First and 2nd peræopods: first joint narrow and subequal to the 4th, with long spines on the front margin: the 5th the longest, its hind margin, with 5 spines, increasing in length distally (fig. 52. pp.[1]).

Third peræopods: side-plates bilobed, the front lobe the larger. First joint with the lamina projecting beyond the proximal part of the hind margin, the distal part fringed with slender, unequal spines; 3rd joint acutely produced behind; 5th joint rather shorter than the 3rd and 4th together; the whole limb spinous (fig. 52. pp.[3]).

Fourth and 5th peræopods resembling the 3rd, except in the 1st joint, in which the posterior lamina is continuous along the hind margin (fig. 52. pp.[5]).

Uropods: the outer ramus of the 1st as long as the inner of the 2nd, the peduncles shorter than the inner rami; the whole spinous (fig. 52. ur.).

The 3rd pair small and spoon-shaped, with a setule on the inner margin, barely reaching beyond the end of the telson.

Telson as in the last species, but with 2 groups of 3 or 4 spines on each side.

Length of adult male, 6·5 millims. Female, with ova, 3·5 millims.

Platophium zeylanicum, n. sp.—Plate VIII., figs. 53.

From pearl oysters, East Cheval Paar, November, 1902; several.

Segments of mesosome and pleon dorsally depressed in the middle, not carinate or dentate. Urus with 3 segments, the division between the 2nd and 3rd somewhat indistinct. Head shorter than the first 2 segments. Ocular lobe little produced. Eyes round and prominent.

Upper antennæ: the 1st joint half as long and twice as wide as the 2nd, which is equal to the 3rd; flagellum subequal to the 3rd joint, 3–4-jointed, the 1st as long as or longer than the remainder; appendage about half as long as the 1st joint of the flagellum, 1-jointed (fig. 53. ant.[1]).

Lower antennæ: the 1st joint sub-globose, more than twice as wide as the 2nd, which is considerably shorter than the 3rd and subequal to the flagellum; this is 3–4-jointed.

First gnathopods: side-plates much produced in an acute angle, with a seta at the tip; the rest of the limb much like the last species (fig. 53. gn.[1] ♂).

Second gnathopods of female: side-plates small, subquadrate, with rounded angles. First joint rather shorter than the hand; 3rd more than twice as long as the 2nd, and produced beyond the wrist as in the last species; wrist small and triangular; hand wide-oval, both margins convex, especially the front, and setose; palm hardly defined, but a spine within the point of the dactylus, which is slender; the setæ are stiff and spine-like. Incubatory lamellæ very large, sub-oblong, the upper part spotted with red (fig. 53. gn.[2] ♀).

Second gnathopods of male: 1st joint expanded distally, longer than the next 3, with a channel in front to receive the hand; 3rd joint twice as long as the 2nd, the hind margin rectangular; the wrist very small and almost concealed by the 3rd joint; hand much longer than all the preceding joints united, oval, a strong tooth near the middle of the hind margin defining the palm, between which and the base of the dactylus are two tubercles with concave interspaces, the whole clothed with unequal plumose setæ. Dactylus barely reaching the palmar tooth, with a row of denticles on the inner margin. The sculpturing of the palm is somewhat variable (fig. 53. gn.[2] ♂).

First and 2nd peræopods: the 1st joint subequal to the 4th joint, with a laminar expansion of the front margin which is rounded and furnished with a group of stiff setæ; 3rd joint shorter than the 4th, produced and spinous in front; 5th joint almost as long as the 3rd and 4th united (fig. 53. pp.[1]).

Third peræopods: 1st joint shorter than the 4th, with a semicircular membranous expansion behind (fig. 53. pp.[3]); the rest as in the preceding pairs.

Fourth and 5th peræopods: 1st joint wider above, but otherwise like the 3rd pair: the 5th pair reaches far beyond the ends of the uropods (fig. 53. pp.[5]).

First uropods: peduncle subequal to the outer ramus, reaching beyond the telson; inner ramus about one-fourth longer and wider (fig. 53. ur.).

Second uropods shorter in extent than the 1st; peduncle reaching to the end of the telson, shorter than the outer ramus, which is one-third shorter than the inner. In both pairs the rami are spinous, the terminal spines about one-fourth of their length.

Third uropods not reaching beyond the end of the telson.

The telson has the form of a truncated cone, the apex directed backwards, with a long terminal and 2 shorter subterminal spines (fig. 53. t.).

Length of male, 4 millims.; of female, with ova, 2·5 millims.

The males of this species may be distinguished by the 2nd gnathopods; the females in the genus *Platophium* are very much alike, but in this case may be known by the triangular expansion of the 1st joint of the 1st and 2nd peræopods.

Colomastix, GRUBE, 1861.

Colomastix pusilla, GRUBE.

Cratippus tenuipes, SP. BATE.

Exunguia stilipes, NORMAN.

Pearl oyster washings, Muttuvaratu Paar—2 specimens.

EXPLANATION OF PLATES.

LIST OF ABBREVIATIONS USED WITH THE FIGURES.

c. and *ceph.* = cephalon, head.
o.l. = ocular lobe.
ant^1., *ant*^{2}. = upper and lower (1st and 2nd) antennæ.
m. = mandible.
mp. = mandibular palp.
mx^1. = 1st maxillæ.
l. = posterior lip.
mxp. = maxillipeds.
gn^1., *gn*^{2}. = 1st and 2nd gnathopods.
pp. 1–5 = peræopods, 1st to 5th pairs.
up. 1–3 = uropods, 1st to 3rd pairs.
t. = telson.
pl^3. = 3rd segment of the pleon.
ur. = urus, last 3 abdominal segments.

PLATE I.

Fig. 1. *Parascelus parvus*, CLAUS.
,, 2. *Elsia indica*, GILES.
,, 3. *Ichnopus taurus*, COSTA.
,, 4. *Socarnella bonnieri*, n. gen. et sp.
Fig. 5. *Vijaya tenuipes*, n. gen. et sp.
,, 6. *Lysianax cinghalensis*, STEBBING.
,, 7. ,, *cœlochir*, n. sp.
,, 9. *Urothoë spinidigitus*, n. sp.

PLATE II.

Fig. 10. *Platyischnopus herdmani*, n. sp.
,, 11. *Ampelisca tridens*, n. sp. (see also Pl. IV.).
Fig. 12. *Ampelisca scabripes*, n. sp.
,, 13. ,, *brachyceras*, n. sp.
Fig. 14. *Ampelisca cyclops*, n. sp.

PLATE III.

Fig. 15. *Ampelisca chevreuxi*, n. sp.
,, 16. *Gallea tecticauda*, n. gen. et sp. (see also Pl. VIII.).
Fig. 17. *Leucothoe hornelli*, n. sp.
,, 17A. ,, *stegoceras*, n. sp.
,, 18. *Anamixis stebbingi*, n. sp.
Fig. 19. *Stenothoe gallensis*, n. sp.

PLATE IV.

Fig. 8. *Tryphosa cucullata*, n. sp.
,, 11. *Ampelisca tridens*, n. sp. (see also Pl. II.).
,, 20. *Perioculodes serra*, n. sp.
,, 21. *Tiron thompsoni*, n. sp.
,, 22. *Eusiroides cæsaris*, STEBBING.
Fig. 23. *Eusiroides orchomenipes*, n. sp.
,, 24. *Dexamine serraticrus*, n. sp.
,, 25. *Tritæta antarctica*, STEBBING.
,, 26. *Guernea lævis*, CHEVREUX.
,, 27. *Hornellia incerta*, n. gen. et sp.
Fig. 28. *Melita anisochir* (KRÖYER).

PLATE V.

Fig. 29. *Mæra othonoides*, n. sp.
,, 30. ,, *rubro-maculata* (STIMPSON).
,, 31. ,, *tenella* (DANA).
,, 32. ,, *scissimana* (COSTA).
Fig. 33. *Mæra tenuicornis* (DANA).
,, 34. *Elasmopus subcarinatus* (HASWELL).
,, 35. ,, *dubius*, n. sp.
,, 36. ,, *spinimanus*, n. sp.

PLATE VI.

Fig. 38. *Parelasmopus suluensis* (DANA).
,, 39. *Lembos podoceroides*, n. sp.
,, 40. ,, *chelatus*, n. sp.
Fig. 41. *Gammaropsis zeylanicus*, n. sp.
,, 42. *Cheiriphotis megacheles* (GILES).
,, 43. *Photis longicaudata* (SP. BATE).

PLATE VII.

Fig. 44. *Photis longimanus*, n. sp.
,, 45. ,, *nana*, n. sp.
,, 46. *Amphithoe intermedia*, n. sp.
,, 47. *Jassa falcata* (MONT.).
Fig. 48. *Erichthonius macrodactylus* (DANA).
,, 49. *Siphonœcetes orientalis*, n. sp.
,, 50. *Cheralia aricula*, n. gen. et sp. (see also Pl. VIII.).
Fig. 51. *Platophium læve* (HASWELL).

PLATE VIII.

Fig. 16. *Gallea tecticauda*, n. gen. et sp. (see also Pl. III.).
,, 37. *Elasmopus serrula*, n. sp.
Fig. 50. *Cheralia aricula*, n. gen. et sp. (see also Pl. VII.).
,, 52. *Platophium synaptochir*, n. sp.
Fig. 53. *Platophium zeylanicum*, n. sp.

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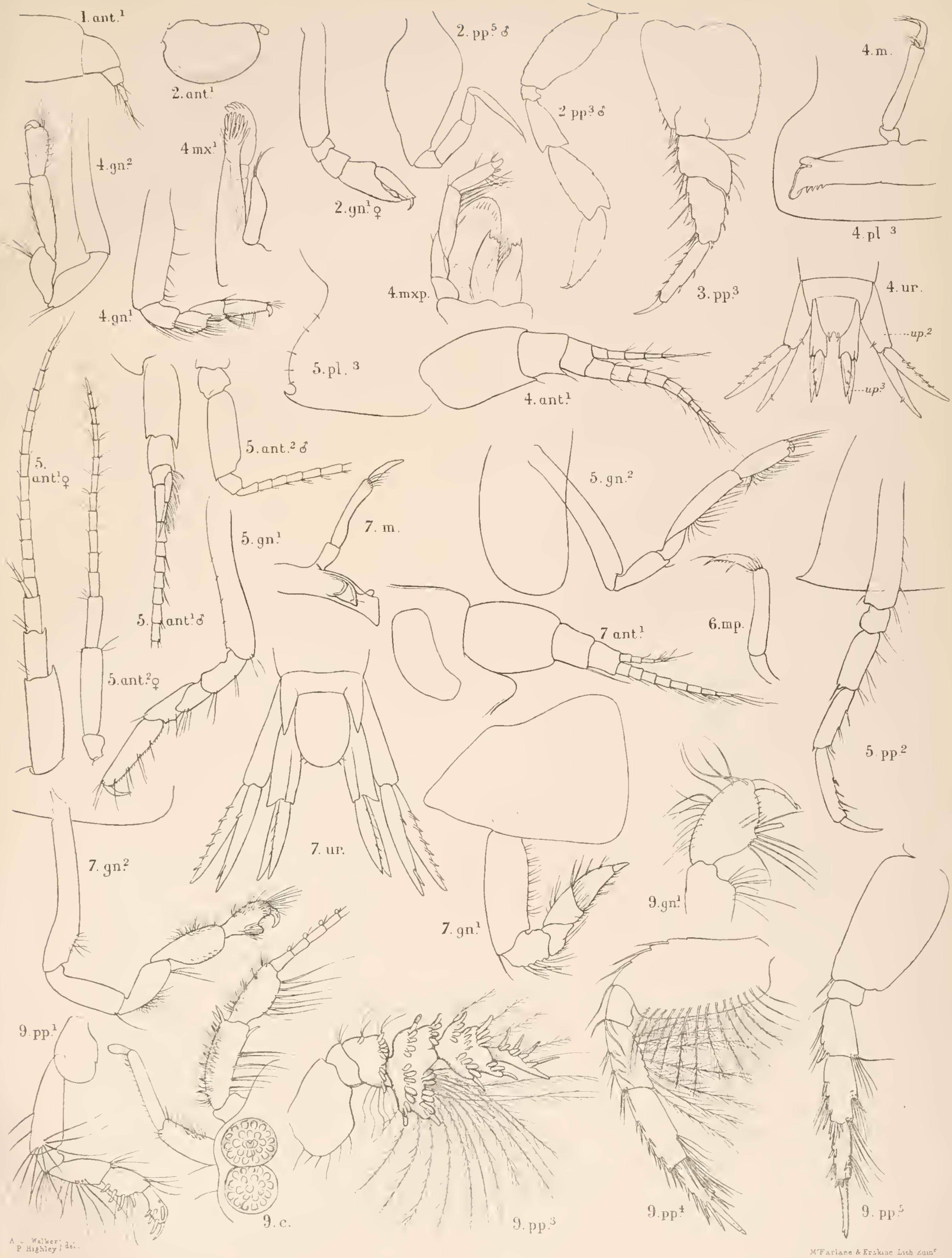

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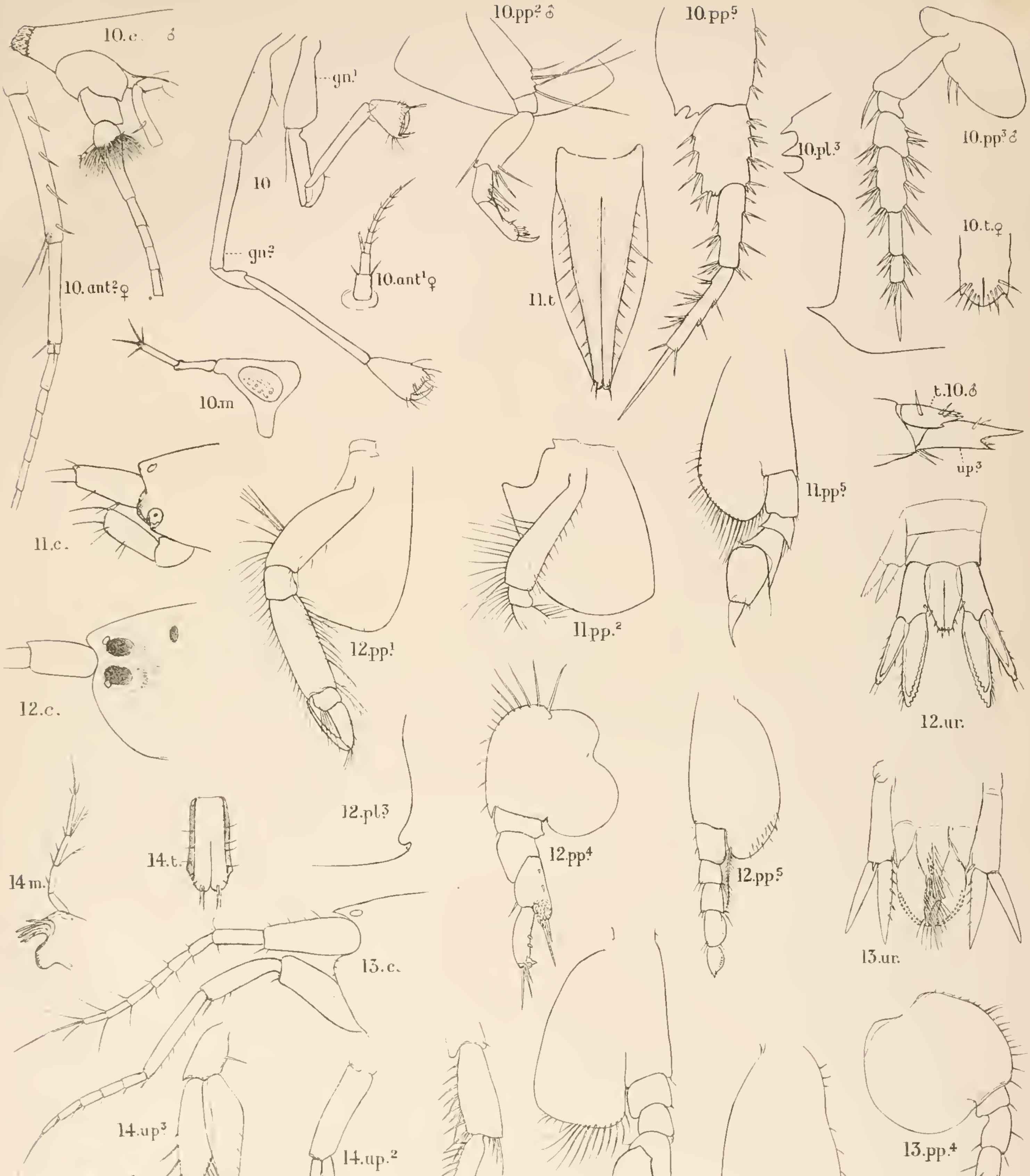
1. Parascelus parvus. 2. Elsia indica. 3. Ichnopus taurus. 4. Socarnella bonnieri. 5. Vijaya tenuipes. 6. Lysianax cinghalensis. 7. Lysianax cœlochir. 8. (see Plate IV). 9. Urothoë spinidigitus.



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10. PLATYISCHNOPUS HERDMANI. 11. AMPELISCA TRIDENS. 12. AMPELISCA SCABRIPES.
13. AMPELISCA BRACHYCERAS. 14. AMPELISCA CYCLOPS.

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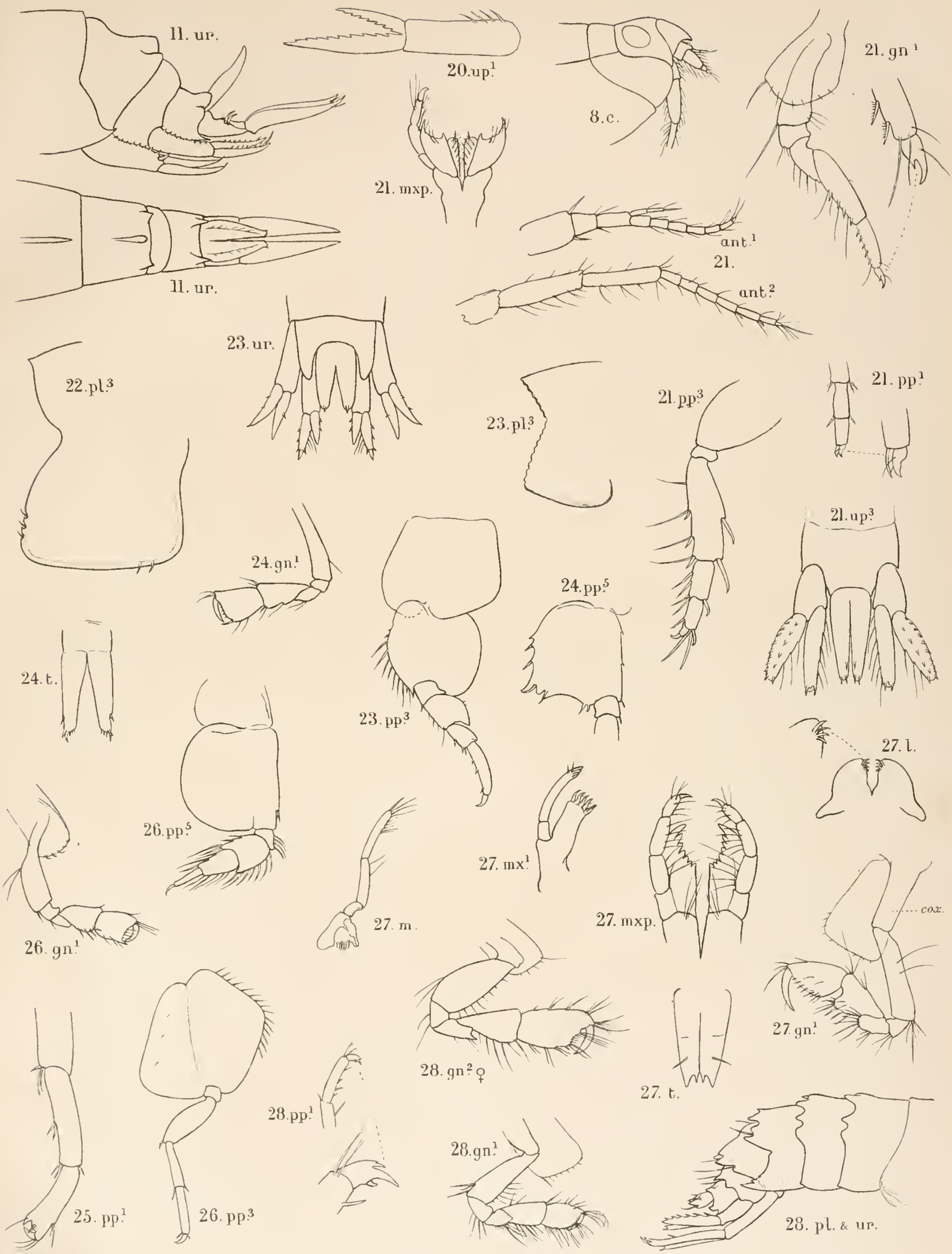
15. Ampelisca chevreuxi.
16. Gallea tecticauda.

17 Leucothoë hornelli.
17.A. L. stegoceras.

18. Anamixis stebbingi.
19. Stenothoë gallensis.



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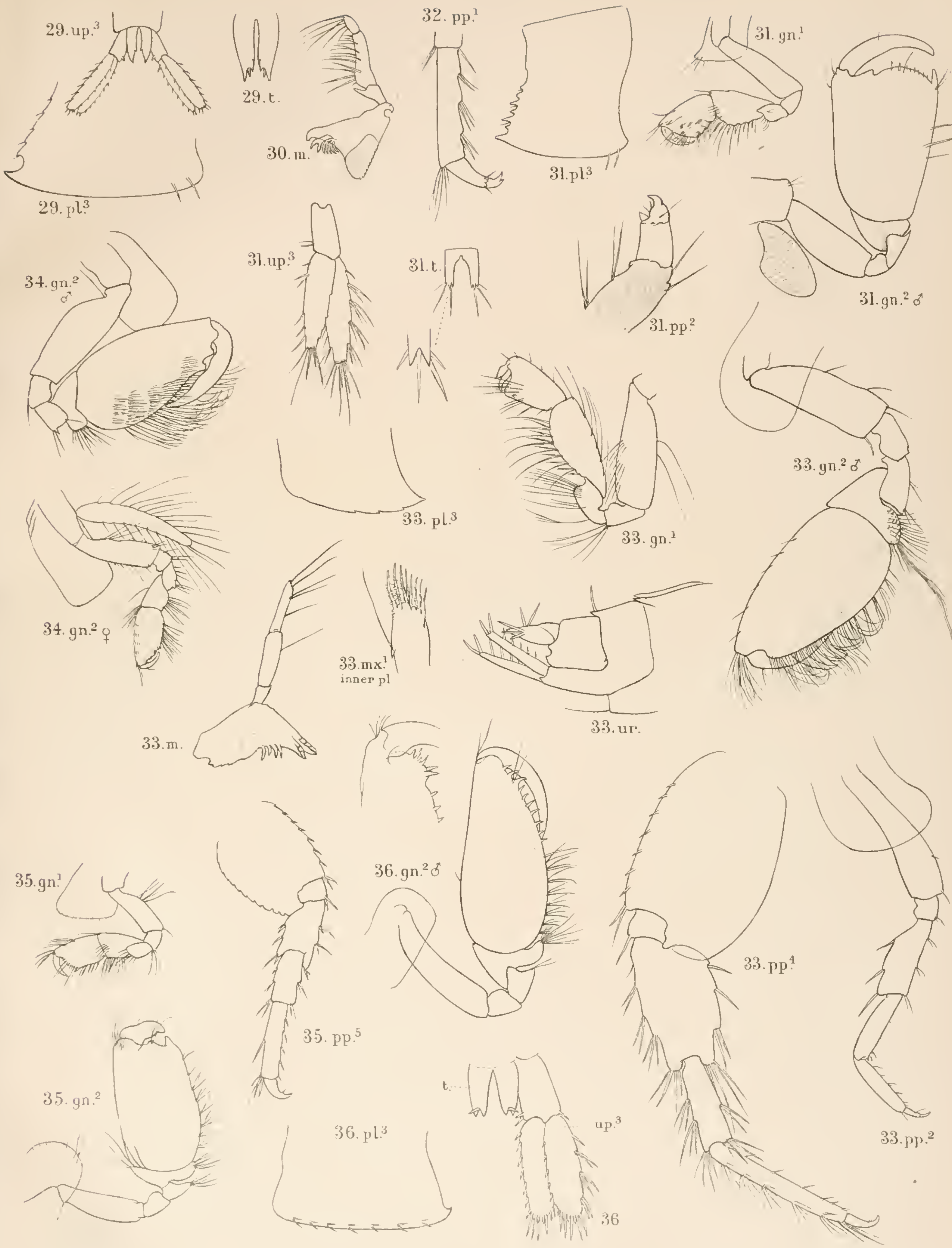
8. Tryphosa cucullata. 20. Perioculodes serra. 22. Eusiroides cæsaris. 24. Dexamine serraticrus.
11. Ampelisca tridens. 21. Tiron thompsoni. 23. E. orchomenipes. 25. Tritæta antarctica.
26. Guernea lævis. 27. Hornellia incerta. 28. Melita anisochir.



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29. MÆRA OTHONIDES. 30. M. RUBROMACULATA. 31. MÆRA TENELLA. 32. M. SCISSIMANA. 33. MÆRA TENUICORNIS. 34. ELASMOPUS SUBCARINATUS. 35. ELASMOPUS DUBIUS. 36. E. SPINIMANUS.

A. O. Walker, P. Highley del.

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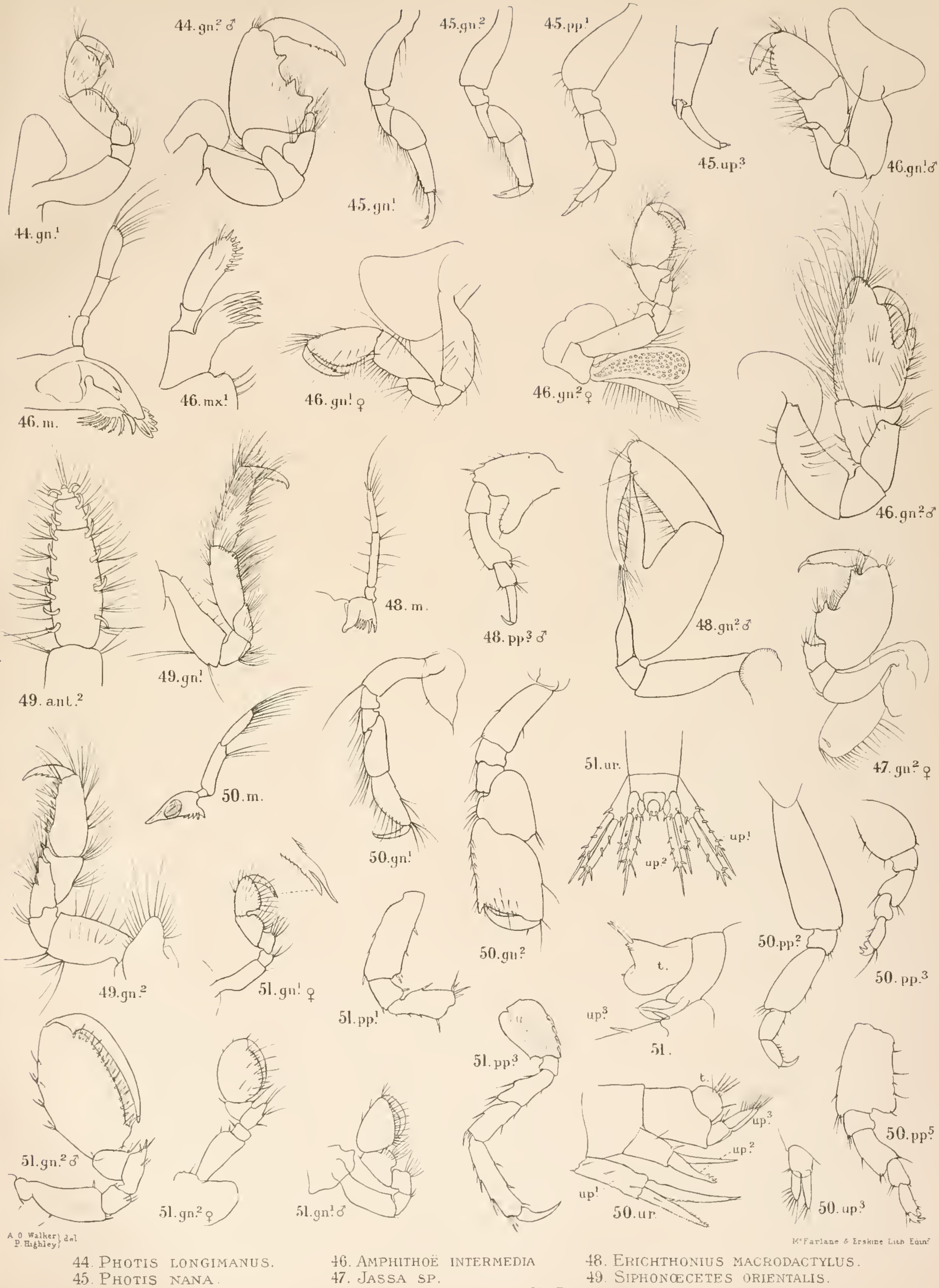
38. Parelasmopus suluensis.
39. Lembos podoceroides.
40. Lembos chelatus.
41. Gammaropsis zeylanicus.
42. Cheiriphotis megacheles.
43. Photis longicaudata.



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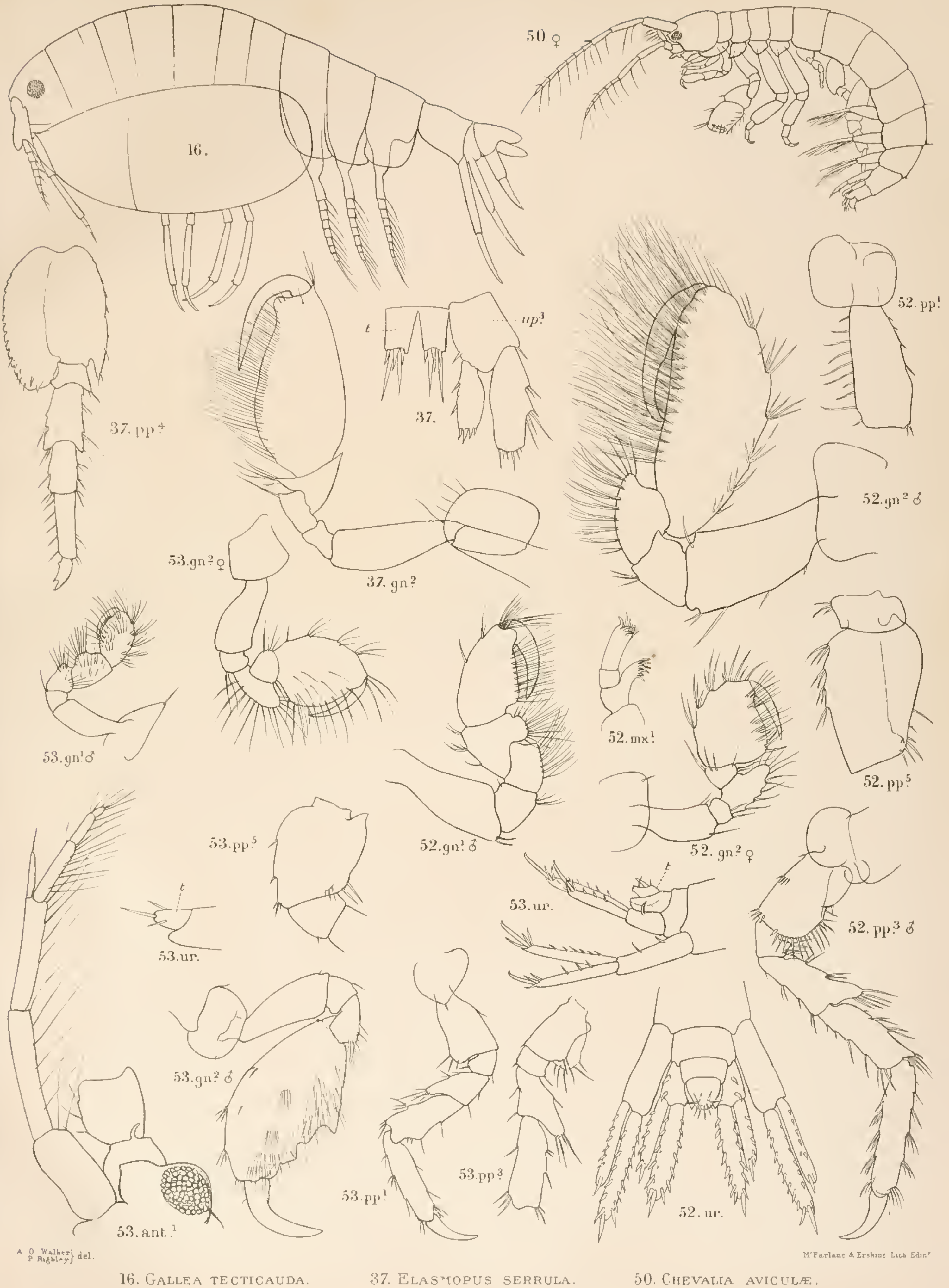
44. Photis longimanus. 45. Photis nana. 46. Amphithoë intermedia. 47. Jassa sp. 48. Erichthonius macrodactylus. 49. Siphonœcetes orientalis. 50. Chevalia aviculæ. 51. Platophium læve.



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16. GALLEA TECTICAUDA. 37. ELASMOPUS SERRULA. 50. CHEVALIA AVICULÆ.
52. PLATOPHIUM SYNAPTOCHIR. 53. PLATOPHIUM ZEYLANICUM.

1077

REPORT

TO THE GOVERNMENT OF CEYLON

ON THE

PEARL OYSTER FISHERIES

OF THE

GULF OF MANAAR,

BY

W. A. HERDMAN, D.Sc., F.R.S., P.L.S.
Professor of Natural History in the University of Liverpool.

WITH SUPPLEMENTARY REPORTS

UPON THE

MARINE BIOLOGY OF CEYLON,

BY OTHER NATURALISTS.

PART III.

PUBLISHED AT THE REQUEST OF THE
COLONIAL GOVERNMENT
BY
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LONDON:
1905.

1078

CONTENTS OF PART III.

PEARL OYSTER REPORT.

SUPPLEMENTARY REPORTS.

PREFACE.

In this Part III., I have thought it best to place proportionately more of the Supplementary Reports and less of the Pearl-oyster work than was the case in Parts I. and II., for the following reasons:—

1. The Supplementary Reports here printed were ready and it might have been unfair to the authors and unfortunate for Science if there had been avoidable delay in publication by excluding any from this Part.

2. Those sections of the Pearl-oyster work which were completed, or nearly so, are of such a nature that the results can be communicated in writing to the Authorities in Ceylon, and a delay of a few months in making them known to the public seemed comparatively unimportant.

3. It seemed advisable, for obvious reasons, to have as much of the Pearl-oyster work as possible placed together in Part IV., which will, I hope, be the final volume of the series. This plan, moreover, presents the further advantage of allowing of observations and conclusions to be drawn from the coming fishery in the spring of 1905—probably the last which will be available for the purposes of this Report.

Consequently the sections on Pearl-formation and Pearl-distribution and on the different kinds of pearls and their natural classification have been postponed, and I have inserted in this Part only (1) a discussion of the recent fishery (1904) based on a report sent to me by Mr. Hornell, (2) a statement as to the present condition and future prospects of the beds of oysters on the Banks, based on Mr. Hornell's letters and other documents, and (3) a further account of the internal Parasites of the Pearl Oyster, by Mr. Shipley and Mr. Hornell, in which several new species of Cestode, Trematode and Nematode worms are described and figured.

The Supplementary Reports now issued deal with the Sponges, the Alcyoniidæ and the other Alcyonarians, the Opisthobranchiate Mollusca and the Ostracoda.

The very considerable collection of Sponges (146 species, of which 77 were new to science) has enabled Professor Dendy to make an extensive report, which is a notable contribution to the taxonomy of the group. At least two of the Ceylon sponges are of economic importance. The sponge of commerce, found in abundance at Trincomalee, is of good form and consistence and might prove worth further cultivation; and one of Professor Dendy's new species, *Cliona margaritiferæ*, is the boring sponge which ruins the shell of the pearl oyster and occasionally causes great mortality. Other sponges from the Gulf of Manaar must probably be regarded as enemies, from the damage they do in smothering the pearl oysters they encrust and surround.

Another report of a comprehensive nature, dealing with about 77 species, is that by Professor J. ARTHUR THOMSON and Mr. W. D. HENDERSON on the Alcyonaria —with the exception of the family Alcyoniidæ, reported on by Miss E. M. PRATT. Professor THOMSON has kindly provided the beautiful coloured drawings, by Mr. G. DAVIDSON, from which his plates have been produced. But I am really much indebted to *all* the authors for the careful and excellent drawings with which they have illustrated their reports. Mr. FARRAN'S report deals with a considerable number of species of a group (the Nudibranchiata) which I had hoped to have been able to examine myself. Consequently, when collecting in the Gulf of Manaar, I made some colour notes and sketches from the living animals which Mr. FARRAN has been able to make use of in his descriptions. Mr. ANDREW SCOTT records 77 species of Ostracoda, 35 of which are new to science. To all these authors I am very much obliged for their kindness in undertaking the work and for the skill they have exercised in carrying it out.

It may be well to indicate here the Supplementary Reports that remain. They are all, I think, well advanced, and ought to be ready for publication some time in the summer:—Corals, by Mr. G. C. BOURNE; Medusæ, by Mr. E. T. BROWNE; Antipatharia, by Professor J. ARTHUR THOMSON; Polyzoa, by Miss L. R. THORNELY; Polychæta, by Dr. ARTHUR WILLEY; Schizopoda and Stomatopoda, by Mr. W. TATTERSALL; Macrura, by Mr. J. PEARSON; Brachyura, by Mr. D. LAURIE; Isopoda, by Rev. T. R. R. STEBBING; Molluscan Shells, by Mr. R. STANDEN and Mr. A. LEICESTER; Marine Insects, by Professor G. CARPENTER, and the Tunicata, by myself The remaining sections of the Pearl-oyster work, and our Summary of Results and Recommendations as to the Conservation of the Banks, should then complete the Report.

The records of observations sent to me by Mr. HORNELL during the latter part of 1904, and especially his detailed reports upon the great spring fishery and the November inspection—upon which I have based the two first articles in this volume (see p. 1 and p. 37)—show that very considerable changes have taken place in regard to the condition of the beds of oysters on the paars and the prospects of fisheries during the next few years. Under the heading "CONCLUSIONS," in the article on the "History of the Principal Pearl Banks" in the last volume (Part II., p. 36) it was stated:—"Finally, there are prospects of good fisheries both next year and in 1906 on the Modragams and several divisions of the Cheval Paar—possibly also on the Muttuvaratu and the Dutch Modragam in the latter year. The results in 1907 and the immediately succeeding years will, so far as we can now see, depend upon whether large measures of transplantation are adopted without delay." In writing of the Cheval Paar (p. 20), also, I recommended that young oysters be transplanted there from the Periya Paar "at the earliest opportunity and in sufficient quantities."

Following upon that recommendation, Mr. HORNELL was authorised by the Ceylon Government to make preparations for transplanting young oysters in quantity from the Periya Paar to the Cheval Paar in November, 1904, should it still be found necessary. This was the only wise course to take. A great part of the Cheval Paar was denuded, and there was no certainty that a fresh fall of spat would occur.

It is essential that the Inspector of the Pearl Banks should have the power, and the means, of ordering transplantation to be carried out whenever it may be required. In the present instance, however, the necessity has been obviated. In the late summer, or early autumn, an abundant deposit of spat has fallen over the greater part of the Cheval Paar, clothing the barren sandy wastes and covering the patches of old oysters and the rock alike, so that they are said to be indistinguishable to the diver. These young oysters, now about 4 months old, cover an enormous area, and must be present (judging from the samples examined) in numbers that run to thousands of millions. No doubt the vast majority of them will die off from natural causes during the next few years, but a fair proportion should remain to yield fisheries in 1908 and succeeding years. In the meantime, the barren areas of the Cheval Paar denuded by the two last fisheries are once more occupied. Transplanting is, for the moment, unnecessary, but cultching of some parts of the ground is urgently required. The position of affairs and the work necessary to improve the condition of the banks are fully discussed in the articles that follow.

The other change in conditions which has to be announced is that, of the various beds of adult oysters on the Cheval and Modragam paars, some are now dying off, or will probably do so during the coming year, while others are apparently healthy and undiminished. Under these circumstances certain beds (detailed in the article on the Present Condition of the Pearl Banks, p. 44) are clearly indicated for fishing first, and fortunately there seem to be sufficient adult oysters in sight to yield at least two and possibly three successive good fisheries. But, although the prospects are so good, it is the Biologist's duty to point out that now—when there are so many beds of oysters of different ages living together on the Banks—is especially the time when vigilance and effort must on no account be relaxed, when inspections must be frequent and complete and the scientific examination of sample oysters must be thorough, when cultching of sandy ground must be extensively undertaken, when thinning out of overcrowded beds should be carried out, and when the Inspector should be authorised to dredge up and transplant young oysters whenever it may seem desirable.

Next after the healthy development of beds of oysters comes the question of infection with the parasites necessary for pearl production. In the preface to Part II. the further work that lay before us in tracing the Fish-host upon which this infection must depend was pointed out, and Mr. HORNELL has continued to take every opportunity to get information and specimens bearing on the matter. Since the November inspection he has devoted some time to work amongst the fishermen on the shores of Dutch Bay (between Colombo and the Pearl Banks) with the view of obtaining for dissection some of the larger Elasmobranch fish caught by the natives. In this he has been very successful, and recent letters inform me (1) that he has now determined the Trygon-Rays which eat the oysters as being the "Walwadi tirikkai" of the Tamils, *Rhinoptera javanica*, and the still larger "Mundakanni tirikkai," *Rhinoptera adspersa ;* and (2) that amongst the Entozoa he obtained from the former species was a Tetrarhynchid agreeing in the armature of its proboscides with the larval *Tetrarhynchus unioniformis* from the Pearl oyster. As the result of this work with the fishermen, Mr. HORNELL has recently made a large and varied collection of parasites which will be the subject of a final report by Mr. SHIPLEY and himself in PART IV.

W. A. HERDMAN.

THE UNIVERSITY, LIVERPOOL,
January, 1905.

REPORT ON THE PEARL OYSTER FISHERIES OF THE GULF OF MANAAR.—PART III.

THE PEARL FISHERY OF 1904.

[*Based on a Manuscript Report and Letters from Mr.* JAMES HORNELL, *F.L.S., Marine Biologist and Inspector of Pearl Banks.*]

SINCE this present investigation was commenced in the spring of 1902, the Government of Ceylon, after an interval of eleven barren years, has held two most successful pearl fisheries—the last of which, that in the spring of 1904, yielded over forty-one millions of oysters, and established a record from having given receipts amounting to well over a million of rupees. This is, however, by no means the whole of the value of the fishery, since the divers carry off as their share one-third of the spoil, and the benefits conferred directly and indirectly upon thousands of attendants and traders may be said to affect the prosperity of a large district. But, dealing only with nett proceeds, these two last fisheries combined have brought in to the Government of Ceylon considerably over £100,000. The prospects for another good fishery in the spring of 1905 are now excellent, and the adult oysters at present known to us on various parts of the Cheval Paar ought, if no unforeseen calamity occurs, to yield fisheries in 1906 and 1907. If cultching of the barren parts of the Cheval Paar and transplantation of young oysters from the Periya Paar, as recommended in the earlier parts of this Report, be carried on with vigour there is every reason to believe that still other fisheries will follow. Spat may fall naturally upon suitable ground at any time, or it may be prevented from so falling, for a series of years, by natural causes beyond the control of man. It cannot be trusted to come when and where it is wanted and we must not depend upon it.* But if a continuity of profitable fisheries, or even a fairly constant succession, can be ensured by the

* Since the above was written, Mr. HORNELL'S report on the November inspection shows that a fall of spat has taken place on the Cheval Paar; but I leave my words unaltered, as I believe them to be generally applicable, and their truth is not affected by this unexpected, somewhat exceptional, but very welcome, occurrence.—W. A. H., January 2nd, 1905.

expenditure of a few thousand pounds annually in cultching the banks and transplanting the young oysters, it is evident that the proceeding will be economically a sound one.

Mr. HORNELL, since I left him on the pearl banks in April, 1902, has kept me supplied with frequent letters and occasional longer reports—constituting, in fact, a journal of his doings and a discussion of his observations. He has now furnished me with a very full report upon the record fishery of 1904, and from this, supplemented by the letters received from him during the progress of the fishery, I have drawn up the following account. This Report upon our pearl oyster investigation would, I feel, have been incomplete without some description of the conditions under which a great fishery is held and of the methods adopted, both administrative and scientific, on the occasion.

Mr. HORNELL's MS. report, though giving most valuable information, was not in a form intended for publication. It was sent to me as *material to make use of*. Parts of it, such as details of the "Racial types represented among the divers," are more or less irrelevant to our present purpose; other parts, such as discussions of the value of "Beacon marks," lists of "Casualties," and record of "Services of Staff," are of purely local interest from the administrative point of view. Consequently a good deal has been omitted and much has been re-cast. I have frequently, however, as will be seen from the quotation marks, employed Mr. HORNELL's own words. Elsewhere his account has been used as the basis of the statements, or as the text which has called forth remarks or upon which an argument has been founded. From the knowledge which I gained of the locality and of the conditions of life during my visits to the pearl banks in 1902, on the "Lady Havelock" and the "Rangasami Puravi," I find it easy to follow and to realise the changes in the oyster beds; and I have no hesitation, in the light of the fresh evidence, in pressing my former recommendations that the "paars" be cleaned, thinned and improved by dredging and cultching, and that deficiencies in spat deposit be made good on all possible occasions by the transplantation of young oysters.

THE PREPARATORY INSPECTION OF THE NORTHERN PEARL BANKS.

From the 26th January, 1904, on which date Mr. HORNELL was appointed Inspector of Pearl Banks in addition to his duties as Marine Biologist, until the 18th of the following month, his time was largely occupied with the multifarious preparations necessary before sailing for the pearl banks. Boats had to be repaired and painted, old stores overhauled and new ones procured, and at the same time a general supervision given to the fitting up of the steamer "Ready," which was to serve as an oyster-dredger. However, by February 18th, the last stores were on board, inclusive of over 6900 gallons of fresh water for the 70 men (divers, munducks, boatmen, &c.)

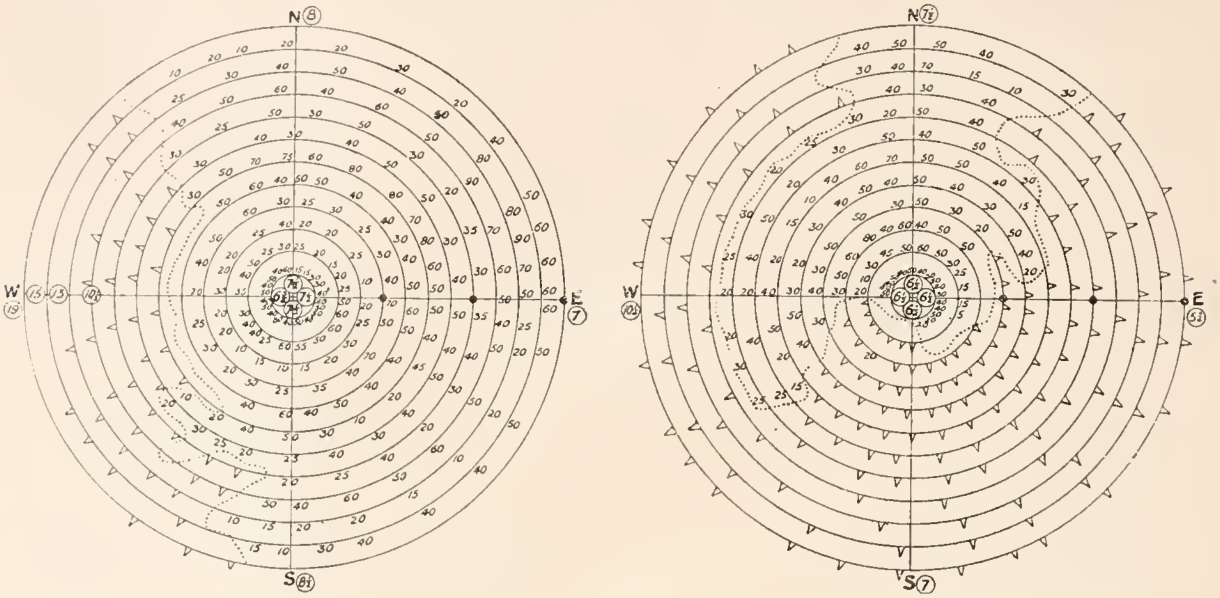
for whom provision had to be made, and the Inspector left Colombo in the native barque "Mohideen Bux" in tow of the steam dredger.

On arrival at Marichchukaddi, near the mouth of the Modragam River, the place selected as the centre of the pearl fishery and the site of the camp, on the morning of February 20th, it was found that—"no Government divers had arrived. The next day, seven Manaar men having put in an appearance, I resolved that the urgency of immediate inspection was too great to permit waiting longer for the laggards and left at 6.40 A.M. to do the best possible with these few divers—half the usual complement. The first step was to locate Captain DONNAN's sunken tanks marking the 'shoal buoy' position on the tail of Karativo shoal, and I was so fortunate as to find them within 10 minutes after anchoring on the place where I reckoned them to be according to the bearings of landmarks ashore. After laying down a large beacon buoy, as is usual at the beginning of inspections, I proceeded to take up my first inspection position at the centre of the South-west Cheval Paar."

Although the banks have been inspected on the previous November, it is always necessary to make an inspection of the beds of oysters which it is proposed to fish immediately before a fishery opens, so that the Inspector may be in a position to mark off the ground and regulate the number of boats and days allotted to particular areas. The method of inspection adopted was that introduced by Captain DONNAN (who was Inspector of the banks during our visit in 1902), modified in some details. The essential features are as follows:—Three flag-buoys are laid out by the attendant launch or tug-boat in the direction of each cardinal point of the compass, at distances apart of $\frac{1}{4}$ mile, the innost buoys taking their distance from the inspection vessel, which is anchored to serve as a pivot mark in the centre of the circular area to be inspected (see fig. 1, p. 4).

Four inspection boats (modified whaleboats), each manned by a crew of six, together with three divers and two munducks, under the charge of an experienced coxswain, take up equidistant positions between the ship and the first flag-buoy on the north radial line, and row slowly round the ship, retaining with wonderful accuracy their relative positions the while. At regular intervals the crew rest on their oars to allow the divers opportunity to make descents and bring up oysters if any are present. The result of each dive is reported to the coxswain of the boat, who records the condition of bottom and oysters upon a diagram form with which he is provided. The oysters are retained in the boat for the Inspector to examine. The four boats, having each made a complete circuit, are next ranged in line abreast in the same manner as before, between the $\frac{1}{4}$-mile and the $\frac{1}{2}$-mile flag-buoys, and each then makes a second circuit. The day's work is completed by a third and last series of circles, in this case between the buoys distant respectively $\frac{1}{2}$ mile and $\frac{3}{4}$ mile from the ship. The four boats thus make a total of twelve concentric circuits, each boat making three. The results shown upon the coxswain's diagrams—each of which has three concentric circles drawn upon it representing the three circular paths covered—

are transferred by the Inspector to a final diagram or plan furnished with twelve concentric circles. When this has been done, the distribution of old and of young oysters is graphically shown for a circular area having a diameter of $1\frac{1}{2}$ miles (fig. 1 represents two such inspection areas on the Muttuvaratu Paar in 1902).



A. B.

Fig. 1. Inspection charts of (A) northern and (B) southern parts of Muttuvaratu Paar in November, 1902. There are four concentric circles made by the divers' boats between the centre and the $\frac{1}{4}$-mile buoy, four between that and the $\frac{1}{2}$-mile buoy, and four from that to the $\frac{3}{4}$-mile. Each complete area is therefore $1\frac{1}{2}$ mile in diameter. The numbers enclosed in rings indicate depths in fathoms. The numbers on the concentric circles give the quantities of oysters brought up at a dive on that spot. The cones indicate dives on a rocky bottom with no oysters. The dotted line therefore surrounds the oyster-bearing area.

After calculating in square yards the area occupied by oysters, the approximate number of oysters thereon may be estimated by taking the average number of oysters per dive (ascertained by examining the divers' results) in conjunction with the average amount of ground which a diver is credited with being able to clear at one descent. Usually this area is considered, on normal ground, to be from $2\frac{1}{2}$ square yards to 3 square yards. By assuming the area per dive to be 3 square yards, the danger of an overestimate is avoided. Inspection estimates are usually less than the total number of oysters obtained at the ensuing fishery. "Thus, at the 1904 fishery, I estimated the number of mature oysters to be 35,000,000, whereas the number actually fished from the area in question was roughly 37,000,000 (41,000,000 minus the amount of immature oysters fished on April 2nd)."

The North and South Modragam Paars were examined on March 5th, and in addition a series of diving and dredging traverses was made further north, in the region of the Vankali Paar, in fruitless search for the oysters found there during our visit in 1902. "The absence of good landmarks in the Aripu district made the inspection of this paar difficult, and I had to rely almost entirely on biological data, such as the nature of the bottom and the fauna, for the verification of my position. Without this help I could not have arrived at any certain conclusion."

How the Valuation Sample of Pearls is Procured.—Before a fishery it is also necessary to obtain samples of the oysters to be fished in order that their pearls may be officially valued for purposes of advertising the fishery. Consequently, during intervals in the inspection, three large samples of oysters of fishable age were collected from the three western blocks of the Cheval Paar, partly by means of divers and partly by the use of dredges. The results obtained showed the sample

Fig. 2. Valuation sample of pearl oysters from the Cheval Paar, being brought on board the "Rangasami Puravi," from the inspection boats—from a photograph by Mr. Hornell.

of the South-west Cheval to be well ahead of the other two lots in the weight and the number of pearls to each 1,000 oysters; the Mid-west was extremely poor in both respects. The washing of the sample oysters and the sifting and subsequent valuation of the pearls was carried out in the usual way, the two former processes by the Government divers and munducks, the latter by three Mohammedan pearl merchants; all under the constant supervision of Mr. Hornell, assisted by Mr. V. Vraspillai, the able Adigar of Musali.

"When the samples are brought into the Government Kottu, a palisaded enclosure, the sacks of oysters are emptied into dug-out canoes or 'ballams,' and covered carefully with mats. In this state they are left under guard for a period of from

7 to 10 days. Bacterial putrefaction alone is not relied upon to get rid of the flesh, the maggots of a species of blow-fly being the agency most in evidence and most desired. Under favourable conditions, at the end of 7 to 10 days, the so-called rotting period, the fly maggots should have eaten their way through everything, and have left nothing but empty shells and pearls behind. When the oysters are rotted in sacks, the time for washing is rendered evident by the pile of brown chrysalis cases—full and empty—that litter the ground immediately around the pile of sacks as well as encrust the sacks themselves.

"The time to wash having arrived, the covers are removed from the ballam, and coolies fill it to the brim with water. As the water level rises to the edge, a mad race for the points above the flood ensues among the maggots which float up in myriads from the lower recesses. The washers range themselves in line along either side, squatting on anything convenient—a canoe outrigger, an overturned tub, empty kerosine tins, and the like. They are stripped to the loin-cloth, and are not allowed to take their hands out of the water save to drop out the empty shells. The first process is to rinse the shells thoroughly, to separate the valves, and, by rubbing the outside of one valve against that of the other, to remove any detritus in which a pearl might lodge. The men scrutinize the nacreous lining for attached or shell pearls, placing any found in a special basket. The other shells, after a final rinse, are dropped outside the ballam at the washers' feet.

"After the quantity is reduced somewhat, the floating maggots are skimmed off, lifted by hand, and some of the water is baled out through a sieve, any material that remains therein being carefully returned to the ballam lest a pearl might be contained or entangled in the dirt. More water is then added, and the process of washing the shells is continued. At last all the shells have been removed and the men are then free to stand up and stretch their cramped limbs.

"A fresh supply of water is now poured in till the ballam overflows—a rough method of elutriation. Time after time this is repeated till the bulk of the lighter filth is got rid of. Then the remainder of the water is decanted, and the heavy *débris* in which the pearls are mingled is exposed on the bottom. More water is repeatedly poured in, the detritus or 'sarraku' the while being kneaded and turned over and over again.

"When this apparently interminable cleansing process comes eventually to an end, every scrap of sarraku is removed with scrupulous care to a cotton cloth and bundled up. One ballam full of oysters will usually furnish from two to three such bundles of pearl-containing dirt. The bundles of sarraku are opened later and spread to dry in the sun, undergoing a preliminary search at the beginning, and if wished at intervals during the drying. These early searchings yield usually the largest and therefore the most conspicuous of the contained pearls.

"When dry, the material is sifted out into several grades, and each is gone over time after time by the men employed (fig. 3). The final search—after it appears that even the dust-pearls, the 'masi-tul,' have been removed—is carried on by women and children, and it is amazing to see what a large quantity of small pearls their keen eyes and fine touch enable them to obtain. After the pearls are picked out it is

Fig. 3. Government divers picking out pearls from oyster washings.—Photo. by Mr. HORNELL.

the custom to offer the apparently exhausted dirt for sale, and ready buyers can always be found."

After the valuation was completed, and the results had been telegraphed to the Colonial Secretary for the purpose of advertisement, Mr. HORNELL utilized the few remaining days, prior to the advertised opening of the fishery on the 14th March, in an examination of the Karativo and Dutch Modragam Paars.

Method of Marking out the Fishing Ground.—On the 13th March Mr. HORNELL returned to the Cheval Paar and took up a position on the south-west corner of the south-west section, and marked out the ground for fishing in the following manner:—

"As the plan adopted was a novel one, the Government Agent kindly acceded to my request to notify the method by beat of tom-tom in the divers' quarters, intimating that the boundaries of the fishing ground would be marked by buoys bearing red flags, while a series of white flag buoys would be placed wherever fishable oysters were present. The divers were instructed to cluster their boats round the various white flags.

"These oyster buoys were placed according to the distribution of oysters mapped out after the inspection, but to guard against the possibility of mistake I verified the abundance of oysters at selected spots by preliminary dives before anchoring the buoys in position. The system proved a success, as by placing but a few white flags down at a time I was able to control the movements of the fleet and ensure the bank being fished in a methodical manner. At the next fishery I propose to introduce further improvements in this flag system, among others the marking of the flags individually with distinctive numbers and signs.

" **Discovery of Brood Oysters on the Periya Paar.**—The advertised date of opening the fishery found but a handful of divers assembled at the Fishery Camp at Marichchukaddi. The commencement being in consequence postponed, I took the opportunity afforded to examine the Periya Paar, and ascertained that over an area measuring at least 5 miles in length by $1\frac{1}{2}$ miles in width the bank bore its accustomed brood of young oysters.* As oysters have but once come to maturity upon any part of this paar during the past century, and that but a small patch, I hastened to recommend to Government a wholesale transplantation to the Eastern Cheval—the area cleared of oysters during the 1903 fishery—requesting the use of the dredging steamer for the purpose. This was granted, and I inspected a likely area on the East Cheval and laid down on the selected ground a set of five mark buoys for the guidance of the Master of the 'Ready' when engaged upon the distribution of the dredged oysters. Unfortunately for these plans, the dredger, by reason of rough weather, was able to put in but $2\frac{1}{2}$ days at this work prior to April 9th, on which date I received instructions to place the 'Ready' at Mr. Dixon's disposal for the purpose of dredging mature oysters, and when, later on, the vessel again reverted to me, continuous bad weather had set in, rendering it impossible to work upon the exposed Periya Paar. As a consequence I had to cancel the cultching arrangements I had made to prepare the ground, and transplanting operations are in consequence postponed probably for at least a year.

" With regard to the future need of transplantation, I can but endorse Professor Herdman's reiterated statement that *in this lies the true salvation of the pearl banks.* This being so, if Government approves of such recommendation, it will be absolutely necessary, in order to ensure success, to give me permission to arrange for and carry out an extensive programme of transplantation and cultching and to provide me with adequate means for the purpose, that is to say, I should have a dredging steamer at my disposal from the very date of finding young oysters fit for transplanting, and this steamer should be devoted solely to this work for the whole of the fine weather available and suitable for dredging. Only by transplantation on the greatest possible scale can success be assured. We have to remember the largeness of the object in view—nothing less than the formation of a bed of oysters of sufficient extent to allow for extensive wastage, due to a dozen different causes, and after such wastage to give a fishery of mature oysters calculable in millions.

" **Necessity for Extensive Cultching.**—Our observations show that the sections of the Cheval and Modragam paars giving the finest oysters and the most valuable pearl-yield are those possessing a well-cultched sandy surface, with somewhat restricted rocky outcrops. Unfortunately such areas are comparatively limited in extent, and

* The condition of these oysters will be discussed further on.

the major part of the Cheval, the north, north-east, mid-east and part of the south-east and south-west, with all the three central sections, consists of sandy bottom inadequately supplied with material suitable to serve as foothold to oysters.

"We now have sufficient knowledge of our local conditions to see that transplantation must go hand in hand with extensive cultching if we are to obtain a full return for the labour and money expended on the former operation—indeed we may go further and say that the transplantation of young pearl oysters will be labour wasted unless adequate cultching operations be carried out concurrently. Appreciation of the vital importance of this fact caused me to apply for authority to obtain several hundred tons of broken rubble for cultching purposes as soon as transplantation was seen to be advisable last March. The proposal was at once sanctioned, and while waiting to begin transplanting I arranged, by the kindness of the Public Works Department, for the preparation of a trial shipment of 100 tons of broken calcareous sandstone from Kalpitiya. The stone was to be roughly broken to the size of the fist—about $3\frac{1}{2} \times 3\frac{1}{2} \times 2\frac{1}{2}$ inches. The full quantity had been prepared when the transplanting scheme was arrested and now lies ready for shipment whenever it be next required.

"It may be useful to add here that whenever good prices cannot be obtained for the pearl oyster shells accumulated during a fishery, the best purpose they can be put to is to relay them upon the depleted banks, where the ground is in need of cultch.

"I calculate that at the very lowest estimate 1 ton of shells will furnish as much cultch as 3 tons of Kalpitiya stone or rubble. As this quantity of the latter costs Rs. 11.25 (three tons at Rs. 3.75 per ton) I believe that it will be more economical for Government to refuse to sell the shells at any less price than Rs. 10 per ton, and to use them as cultch unless this minimum price be obtained.

"**Clean Banks Essential to Successful Cultivation.**—In this, as in the matter of cultching, we may with great advantage profit by the experience of European oyster culturists. They find it necessary to check the growth of many other organisms upon the banks, not only those that are active enemies of the oyster—star-fishes, whelks and the like—but also such animals as curtail the area which oysters may occupy or which consume food that would otherwise fall to the oyster. Seaweeds, too, are for the most part weeded out. As a consequence much can be done in cleaning 'foul' beds by means of the dredge. If the beds are in preparation to receive spat, all harmful matter is taken ashore—both direct enemies, such as star-fish, whelks, mussels, and also the various other animals that compete for food and so may be termed the indirect enemies of the oyster.

"Fortunately the Ceylon pearl banks are comparatively 'clean.' No fact struck me so forcibly when first I began to make diving descents as the paucity of injurious life on the better quality of the oyster-bearing paars. Wherever oysters were found thriving, wherever they were seen in vigorous growth and perfect health, the bank appeared to be comparatively free from deleterious matters.

"Where 'foul' areas are found, *i.e.*, where Sponges, Corals, Alcyonarians, Echinoderms and Ascidians abound, as on many parts of the Western Cheval and Muttuvaratu paars, the oysters, while numerous enough, are stunted and poor, suffering by competition with the host of creatures living upon the same diet of microscopical organisms. The only means of cleaning such a bed is to dredge it thoroughly, separating and removing the materials brought up."

On the Ceylon pearl banks the beds are too extensive to permit of dredging being undertaken with this sole object in view, but as this cleaning can and should go on concurrently with the dredging of spat for transplantation or of mature oysters for sale, we have herein an additional argument in favour of taking up dredging on a scale of considerable magnitude. We must not lose sight of the fact that dredging has a fourfold utility, namely, (*a*) in fishing oysters, (*b*) in cleaning the ground and removing enemies, (*c*) in thinning out overcrowded beds, and (*d*) in spat transplantation. Its value is not properly assessed if account be taken of the first item alone, or even of the first and the last. Every live coral removed and replaced by a fragment of clean cultch may mean the addition of three oysters at the next fishery; every star-fish destroyed probably means scores of oysters saved from destruction; every *Cliona*-riddled block of coral bleached on the shore will tend to reduce the widespread havoc this inconspicuous sponge causes amongst the oysters. The immense advantage that accrues from keeping the banks in a state of thorough cleanliness can well be appreciated by an agriculturist, who knows how his crops fall off if weeds be left unchecked, and if fungoid and insect pests be ignored.

Beacon Marks.—Sir WILLIAM TWYNAM has pointed out the need of fixed, well-defined landmarks from which bearings may be taken at all parts of the banks; and he states his belief (p. 20 of his 1902 Report) that this want of adequate landmarks resulted in the wrong bank being fished in 1836—two beds of young oysters being fished instead of the one proposed. Again he states that the fishery of 1860 on the Modragam was all but lost for the same reason—a long continued search of 3 days being necessary before the bed was re-discovered.

A notable advance was made this year by the erection of a permanent beacon on the tail of Karativo shoal, immediately to the south of the South Cheval Paar, to serve as the point of departure at the inspection of the whole Cheval area. Many years ago (1878) Captain DONNAN sank an iron tank close to this spot and subsequently (1883) he added a second. It was his custom at the beginning of each inspection to locate these tanks by bearings taken from Kudiramalai and by means of the inspection divers, and, when found, to mark the position temporarily during the inspection by a large beacon buoy—the so-called shoal buoy.

Captain DONNAN'S successor, Captain LEGGE, appreciating both the loss of time involved in the oft recurrent hunt for sunken tanks, and the danger of taking incorrect bearings when these tanks could not be located, requested sanction to have a permanent beacon erected. This was granted, but all efforts to erect it last year were rendered futile by unfavourable weather. Before leaving for inspection this year, Mr. HORNELL pressed upon the attention of Government the importance and urgency of another effort being made to place the beacon in position. Accordingly it was sent up once more under the care of Mr. LINDSAY, the general foreman of the Harbour Works Department, who, after very great difficulties due to the heavy ground swell always present on the shoal, eventually completed the erection successfully. One great safeguard has thus been created against the loss, by oversight, of oyster patches in the Cheval region, and valuable time will also be saved at inspections. "This Karativo shoal beacon consists of four iron piles driven 6 feet into the sand, braced together securely and bearing an iron telegraph pole secured by four wire stays. The apex of the pole bears two circular metal discs set vertically at right angles, the top being 43 feet 6 inches above sea-level, and therefore visible at a distance of $11\frac{1}{2}$ miles to an observer whose eye is 12 feet above sea-level. The depth of water where and when it was erected was 25 feet 6 inches at low tide. The position of the sunken tanks is latitude 8° 39′ 15″ N., longitude 79° 45′ 0″ E.; and the new beacon is distant therefrom 233 feet N., 3° W."

Mr. HORNELL states:—"My experience during the last two years, and especially during the last inspection, makes clear to me that a beacon in the Aripu district, together with an improvement by heightening of the present Kudiramalai beacon, is essential to efficient inspections. With respect to the cost of these, I would point out that whatever it might be, the amount would be as nothing compared with the loss of revenue entailed by the loss of a bank of fishable oysters through lack of proper beacon marks—a mischance which has occurred in the past probably oftener than we imagine. At a later date the scheme of land-marks might be completed and perfected by the erection of a beacon at the Doric and by the raising of Kallar Tower another 20 feet. For the present, however, urgency centres in the raising of Kudiramalai Tower and the erection of a beacon on Aripu Reef."

PARTICULARS OF THE FISHING OPERATIONS.

The news that a pearl fishery is advertised to take place in the Gulf of Manaar is conveyed throughout India and other parts of the coast of the East with amazing rapidity, and at the appointed time a heterogeneous population of from 20,000 to perhaps 40,000 natives gathers in a few days on what is usually an uninhabited desert—a bare sandy coast with jungle extending for miles inland. A temporary town, covering a site of about one square mile, and having streets (Main Street, Old and New Moor Street, Tank Street, Divers' Street, Chetty Street, Muttu Bazaar, and the like) of houses and shops, Government buildings, such as court house, prison, hospitals, markets, and offices of various kinds, is rapidly run up. 'Camp Town' is erected under the supervision of the Adigar of Musali, largely of bamboos and palm leaves (fig. 4), and is a prosperous and very busy centre of industry and trade during the few weeks of its existence. In the neighbourhood large water-tanks are constructed, some for the drinking supply, others for washing and for the divers to

Fig. 4. Beachmaster's (Muttutamby) house, tom-tom beater and other natives. Pile of cadjans (palm-leaf mats) for building in foreground.—Photo. by Mr. HORNELL.

bathe in when they return from the day's work. At the same time the fleet of some 200 fishing boats assembles on the shore (fig. 5), and a port with the necessary officials is constituted. The whole organisation is under the Government Agent of the province.

Fig. 5. Part of the pearl-divers' fleet at Marichchukaddi.—Photo. by Mr. HORNELL.

"Four distinct racial types were represented among the divers both at last year's fishery and at this—Coast Tamils, chiefly from the Madras Presidency; Moormen, or

Lubbais, drafted largely from Kilakarai and the neighbouring villages on the Madura Coast of the same Presidency; Malayalam men, from the southern portion of the Malabar Coast (Travancore principally), and lastly a compact body of some 250 so-called Arabs from Colombo and Jaffna. The first two groups comprised the bulk of the diving community (including both divers and munducks), accounting for 1989 and 3732 respectively out of a total of 7408 who attended at last year's fishery (*vide* ' Report on Fishery of 1903,' by Mr. R. W. Ievers, C.M.G.)."

Most extravagant statements are current in regard to the time a diver can remain under water. The Arabs are far ahead of all the others in endurance, their time under water being generally from 70 to 85 seconds. The Tamil and other divers have a lower average, varying from 35 to 50 seconds. The maximum for the best divers, in our experience, is not over 90 seconds. The diving goes on from daybreak (about 6 A.M.) to noon, and the divers' boats set sail for the banks soon after midnight, taking advantage of the land wind which then blows off shore, so as to be ready to start work with the light.

" On the 15th March, twelve Colombo and Jaffna boats, manned entirely with Arab divers, had taken up positions by daybreak around the barque. As is the habit of Arabs, these men fished quietly and methodically, and with great energy. By noon they were tired and satisfied with their catch, an average of 22,811 oysters per boat, and, hoisting sail, made for the camp. The next day a number of Tamil and Moorish divers appeared, and on the 5th day of the fishery the number of boats actually at work had increased to 148, while for several days in the height of the fishery just over 200 boats (202) were employed.

" The boats used by the divers at this fishery were of at least five distinct types—narrow single-masted canoes, with an outrigger, from Kilakarai on the Madura Coast; larger 3-masted canoes, from the Tanjore Coast; large ' Dhoneys,' from Jaffna and the north of Ceylon; large sailing lighters, from Tuticorin; and ' luggers,' with square sterns, from Paumban. Some of the large boats accommodated as many as 30 divers, and with the ' munducks ' (the men who attend to the divers' ropes) and crew must have had about 65 men on board.

" Fishing on the South-west Cheval went on methodically and in a perfectly satisfactory manner for 17 days, by which time the bank proper was practically cleared of oysters. On the 18th day of the fishery the fleet, instead of settling down to glean over the fished ground, flocked to a patch of mixed oysters on the north-east corner of the south-west section, and as a heavy swell was rolling in from the south-west I did not judge it advisable to attempt to move them away. This day's catch of oysters proved phenomenal, totalling close upon 4,000,000 (3,919,712), of which the Government share, 2,609,445, sold for Rs. 39,058.79, being at an average rate of nearly Rs. 15 per 1,000. The oysters on this patch lay extremely thickly strewn in bunches upon a sandy bottom ; I had not included them in my estimate of the south-west bed, considering it preferable to leave them for next year's fishery. However, the thinning out which this day's fishing entailed will have excellent results and conduce to more rapid growth during the intervening 12 months.

"Judging it time to abandon the south-west region, I moved the ship to the bed upon the North-west Cheval on the 3rd April, laying out a series of red flag buoys along the boundary and white flag buoys as fishing centres, as upon the South-west, and accordingly the fleet began work there upon the following day. A break in the hitherto excellent fishing weather unfortunately coincided, and from the 5th April more or less unfavourable weather prevailed steadily and practically without intermission, rendering fishing increasingly difficult. As a consequence the north-west bed was not exploited in the thorough manner characteristic of the fishery on the south-west section, and whereas 26,000,000 5-year-old oysters were taken from the latter bed as against an estimate of 19,500,000, upon the north only 4,500,000 were fished as against the estimate of 9,000,000. This less satisfactory result was, however, not due entirely to rough weather; many large patches were so thinly furnished with oysters that 5, 7, and 10 oysters per dive were the best possible—a condition of matters ill-suiting men who had been accustomed for over a fortnight to averages of 25 and 35 per dive.

"It became expedient therefore to open the last section—the mid-west—to fishing on April 12th, and on that date the boats lifted 1,244,070 oysters from this bed. From this date the wind increased greatly in force and, being accompanied by a heavier swell, it became impossible to set definite limits to the ground to be fished upon. The number of the boats at work began to diminish rapidly, and by April 16th the fishery terminated, so far as the fleet as a whole was concerned.

"From the 16th to the 18th April the weather was too boisterous to permit of any fishing. On the latter date, some of the Arab divers being willing, it was arranged that they should be sent out aboard the steamers 'Ready' and 'Serendib' to carry on diving from these vessels. In all 44 responded to this emergency call, and I superintended their work on April 19th, beginning fishing at 10.10 A.M. and ceasing at 3 P.M. During the whole time the weather conditions were the worst possible, a heavy sea running, accompanied by a chill, cutting wind. The men worked most pluckily and with the utmost good humour. The majority did not touch food all the time they were aboard, from 5.30 A.M. to nigh on 6 P.M. This day's work by these 44 Arabs stirred up emulation in the breasts of their co-religionists, the Kilakarai Moormen, and enabled the fishery to be carried on in spite of the boisterous character of the weather for 4 days longer and with a gain to Government of Rs. 15,580.

"By this time the great majority of the divers' boats had left Marichchukaddi, and on the 23rd April it was seen to be impossible to attempt to further prolong the fishery, which thus expired, after a nominal length of 33 fishing days; on 7 days, however less than 200,000 oysters fell to Government share, owing to the unfavourable nature of the weather on these days; so under these circumstances the grand total of just over 41,000,000 oysters was an extremely satisfactory result. Last year's fishery produced an almost identical number, 41,169,637, spread over 38 fishing days of continuously fine weather. Had similarly favourable conditions prevailed this year the divers would certainly have fished another 8,000,000 oysters, and would probably have raised the grand total to 50,000,000."

It is said that even the large amount of pearls obtained from these oysters is not the total number fished up, as during the 3 or 4 hours' sail home from the banks opportunity is given to the divers and their boats' crews to abstract some of the finest from an occasional gaping shell. These illicit pearls, concealed it may be in the eyes, or in the cavities of the nose, are often discovered by the official searchers before the men leave the Government kottus. So there is some ground for supposing that the divers really carry off a good deal more than the one-third of a fishery to which they are entitled. The kottus where the oysters are received from the boats and separated into piles are large enclosures close to the beach, surrounded by high fences of wattling (fig. 6) and having sheds thatched with palm leaves. Here the

Fig. 6. Government divers and munducks picking out pearls in the kottu.—Photo. by Mr. HORNELL.

Government officials and clerks assign a separate compartment to each boat's crew as it arrives with a load of oysters. The first proceeding is for the divers to divide their oysters into three heaps, one of which is destined to be their own, and there can be no doubt that they make these piles as nearly equal as they possibly can, since they have no means of knowing which one the official will presently point out as their share. The divers now carry off their own oysters and emerge from the kottu on the landward side after running the gauntlet of the searchers. They are at once surrounded by a crowd of natives anxious to buy oysters in small quantities, by the dozen or even singly. The diver usually disposes of his whole stock in this way in a very short time, and then spends the remaining hours of the day in bathing and resting.

Inside the kottu the clerks are now counting the millions of oysters left as the Government's share; and about sunset the Government Agent puts them up for sale by auction at the Court House. The prices bid are per thousand, and may vary from 20 to 80 rupees, and the buyer can take one or more thousands at the price he bids. The kottu with its valuable contents is closed and guarded during the night, and in the morning the buyers remove the oysters to their own enclosures, and then the lengthy and unpleasant process of washing the rotting oysters begins. Some of our figures (fig. 3 and fig. 6) show the examination of the "sarraku" or residue for pearls, while fig. 7 shows Tamils, outside the kottu, searching for attached or blister

Fig. 7. Tamils searching the washed shells.—From a photograph by Mr. Hornell.

pearls amongst the piles of shells thrown out after washing. Fig. 8 shows two pearl merchants, who sit all day ready to buy or sell, weighing, discussing and playing with their gems. They have basket-like sieves for grading the pearls, and curious little scales with scarlet seeds for certain weights. These capitalists (many of them Moormen and Bombay merchants) are an important section of the population of "Camp Town." There are also the pearl-cutters and "fakers," who carry on their business in the street at little three-legged wooden work-tables and with simple bow-drills, by means of which they pierce the pearls for stringing. All these workers who have some definite connection with the fishery or the pearl require others to

Fig. 8. Pearl merchants.—From a photograph by Mr. HORNELL.

supply them with the necessaries and the luxuries of life, and so is brought together the large heterogeneous population. But as soon as the fishery closes the whole town appears to dissolve in a day, the people separate in all directions as rapidly as they gathered, and Marichchukaddi is again a solitary sandy waste.

THE OYSTER DREDGING EXPERIMENT.

At the 1904 fishery, amongst other new departures, some of which have already been noted, oyster dredging from a steamer was tried for the first time with a view to supplement the work of native divers.

The experiment was, however, carried on with imperfect apparatus and under difficulties which will certainly disappear as further experience is gained. The steamer "Ready," engaged for this work during the greater part of the fishery, was found to be unsuitable in several particulars, and Mr. HORNELL has made a number of recommendations in regard to the deck fittings and gear, which will lead to greater efficiency and economy of time by working a larger number of dredges simultaneously.

Mr. HORNELL has kept an exact record of the dredging results day by day, which, however, considering the imperfect nature of the experiment on this first occasion, need not be published. After a discussion of the results he concludes as follows:—"At 70,000 to 80,000 oysters per day I should consider the steamer to be giving very satisfactory results, but I wish to emphasize the fact that the best results can be hoped for only from a few of the banks, *i.e.*, the North Modragam, certain large regions of the Cheval, and some of the smaller and less important paars. The South Modragam and the remainder of the Cheval occupy a somewhat doubtful position, and further working experiments are necessary before we can pronounce a definite verdict regarding the prospects of commercial success in fishing by means of the dredge. I believe, however, the advantages of dredging to be greatest in regard to spat transplantation—as has been explained elsewhere in this Report. Dredging is also of great assistance in the preliminary or prospecting inspections—when it is necessary to ascertain the presence or the absence of oyster patches on grounds too extensive for detailed examination by means of divers."

Details of the Oysters Found.

The oysters found during the recent inspection were of two distinct generations, the older being from $4\frac{1}{4}$ to $4\frac{3}{4}$ years old, the younger from $2\frac{1}{4}$ to $2\frac{1}{2}$ years. The former were of the same brood as those fished on the Eastern Cheval in 1903, and were therefore of a very satisfactory age for fishing this year (1904). Those of the younger brood will hereafter be termed "immature," not in the sense of sexual immaturity, but in regard to pearl-yield.

The fishable oysters lay as a discontinuous north and south band along the seaward or western side of the Western Cheval. Save for a scattered remnant left over from last year's fishery (1903) on the Eastern Cheval, and for occasional individuals forming the nuclei of bunches of younger oysters on the parts covered by the immature generation, no other oysters of fishable age were found. Those present last year on the Periya Paar Kerrai and Vankali Paar were gone, and the huge bed upon the Muttuvaratu Paar, estimated by Captain Donnan, in 1902, at a total of 277,000,000 oysters, and which would have been fishable this year, had also disappeared, being partially replaced by a later brood of $2\frac{1}{2}$-year-olds. On the Karativo Paar, also, none of the 25,000,000 oysters, $1\frac{1}{2}$ to 2 years old, found there in April, 1902, remained, the bank being bare save for a few handfuls of 2-year-olds. A small bed of this fresh generation of oysters was also discovered on the Dutch Modragam Paar.

The details respecting the number and distribution of the oysters present may be summarized thus:—

Number, Distribution, and Sizes of the Fishable Oysters.

The beds of $2\frac{1}{2}$- to 3-year-old oysters on the Western Cheval (comprising the south-west, mid-west, and the north-west sections), which we saw for the first time during our visit to the banks in February, 1902, were found to have the same general disposition, but to have largely decreased in area and to be represented by several detached patches thickly covered with $4\frac{1}{2}$- to 5-year-olds on the South-west Cheval, by a large area of more thinly spread oysters of the same age on the north-west section, and by a third of rather smaller extent on the mid-west, the southern end of the last named joining the north-west patch on the south-west section.

"The south-west patches covered in the aggregate an area of 2,754,021 square yards, with an average of 22 oysters per dive on 1,778,676 square yards and of 21 on the remainder. As each dive is estimated to account for an area of 3 square yards, I estimated the total number of oysters on this section to be 19,500,000, sufficient to give daily loads of 10,000 oysters per boat to a fishing fleet numbering 100 boats for a period of $19\frac{1}{2}$ days, each boat being presumed to have a complement of 10 divers.

"The oysters on the north-west section amounted to 9,000,000, covering an area of 1,685,460 square yards, a number based upon an average of 20 oysters per dive on 716,100 square yards and 13 per dive on 969,360 square yards. Although apparently sufficient to give fishing for 100 boats for 9 days at an average load per boat of 10,000 oysters, the result of the fishery showed that the number of oysters per dive on certain portions of this bed was too low to give profitable results, with the consequence that the fleet had to be moved off after only five days' fishing and the removal of a little over 4,000,000 oysters—rather less than half of those present.

"The bed on the mid-west had an area of 992,250 square yards, whereon I estimated there were 6,500,000 oysters, being at the rate of 20 per dive. These oysters were smaller for their age than those of the south-west and most of those on the north-west sections.

"The total number of fishable oysters on the three sections of the Western Cheval I estimated at 35,000,000, equal to 35 days' fishing for 100 boats. By far the most important of the beds found in respect of numbers as well as condition were the patches on the south-west section, for here not only were the oysters splendidly grown for their age, but they were absolutely free from mixture with young. Everywhere else there was more or less admixture of young of 2 to $2\frac{1}{2}$ years of age, especially upon the eastern margin of the ground where they adjoined the beds of the immature generation.

"Over those parts of the South, South-east, and South-central Cheval, and North Modragam occupied by oysters, the older oysters, while nearly universally present, were in a very small minority, averaging not more than 1 to 6 of those $2\frac{1}{2}$ or 2 years old. Here and there on the northern edge of the South-east Cheval were small patches of little mixed $4\frac{1}{4}$- to $4\frac{3}{4}$-year-old oysters, the remnants of the bed fished last year.

"As was to be expected, the Periya Paar Kerrai, ravaged by ray-fish (Trygonidæ) in March, 1903, gave no results, and but a few oysters of no fishery value were found on the Kondatchi Paar, ground that is utterly bad for oyster growth under present circumstances (*infra*).

"The sizes of average samples from the three sections of the West Cheval are as follows :—

Name of Bank.	Height of oyster.	Length.	Breadth.
	millims.	millims.	millims.
South-west Cheval . . .	76·20	69·20	32·32
Mid-west ,, . . .	72·30	65·25	31·70
North-west ,, . . .	72·87	66·50	31·57

"Some exceptionally fine oysters from a patch at the extreme south end of the Mid-west, a patch lying upon sandy bottom, rose to the high average dimensions of 76·56 millims. by 69·16 millims. by 34·44 millims. If we exclude the last-mentioned oysters as being exceptional, we get as the general average of the $4\frac{1}{4}$ to $4\frac{3}{4}$-year-old oysters fished this year 73·79 millims. by 66·98 millims. by 31·86 millims.

"During the course of last year's fishery (1903) I found the average size characteristic of oysters on the Eastern Cheval to be 75·51 millims. by 69·18 millims. by 31·18 millims. Both lots originated from the same brood, and it is significant that, although this year's oysters are a full year older, their size, except in respect of breadth, is decidedly inferior to the average of those fished last year from the Eastern Cheval. This marked character, due to stunted growth, has long been associated with oysters from this particular region, and has frequently been referred to by Sir WILLIAM TWYNAM and by Captain DONNAN. Occasionally this stunted growth has been so extreme that the divers and merchants have referred to such oysters as being of the 'Kottapakku' variety, a form which is undoubtedly correlated with overcrowding on extensive stretches of rocky bottom."

Number, Distribution, and Sizes of the Immature Oysters.

"Immense quantities of immature oysters varying from $2\frac{1}{4}$ to $2\frac{1}{2}$ years old covered practically the whole space on the eastern half of the Mid and North-west sections, extending eastwards into the North-central, Central, and South-central areas. The South and the South-east Cheval also bear very large quantities, as do also the North and South Modragams.

"A fair-sized bed, plentifully covered with oysters, is at present on the Dutch Modragam Paar, but they are too young to fish for at least a year, as the age of the majority varies from 2 to $2\frac{1}{2}$ years. These oysters represent the young spat which was noted as abundant in November, 1902 ; their growth has been at the expense of the older oysters that were present that year, and which have been killed off by the more vigorous and numerous young.

"The size of those on the North and South Modragam paars and those on the South, South-east, and South-central Cheval, is greater than that of those upon the remaining sections, including also the Dutch Modragam, indicating more vigorous growth and a better food supply. Indeed, many of the oysters have a superficial appearance of being from 3 to $3\frac{1}{2}$ years old. The general superiority of these oysters is well brought out in the following tabulation of the average size of representative oysters from each of the localities named:—

Locality.	Height of oyster.	Length.	Breadth.
	millims.	millims.	millims.
South-central Cheval	$67\frac{3}{25}$	$61\frac{4}{25}$	$27\frac{6}{25}$
North-west ,,	56	$51\frac{4}{5}$	$23\frac{13}{15}$
North-west ,, (another part)	$61\frac{1}{3}$	$57\frac{1}{2}$	$23\frac{3}{4}$
Mid-west ,,	$56\frac{3}{5}$	$52\frac{3}{5}$	$24\frac{3}{5}$
South Modragam	$68\frac{17}{25}$	$64\frac{4}{25}$	$27\frac{7}{25}$
Dutch ,,	$58\frac{19}{25}$	$53\frac{18}{25}$	$25\frac{11}{25}$
Karativo Paar	$58\frac{19}{25}$	$55\frac{8}{25}$	$24\frac{4}{5}$

"There are few oysters of an age less than 2 years mixed with these—an important favourable factor, as the fall of abundant spat upon a bed of oysters approaching maturity is one of the most serious dangers that beset the fruition of an oyster bed, and one that is most difficult to combat."

Summary of the Past History of the Oysters Found.

The oysters fished this year were first seen in March, 1900, by Captain Donnan, who reported that over the whole of the Western Cheval, an area nearly $5\frac{1}{2}$ miles long by 1000 to 4000 yards wide, young oysters 3 to 9 months old were thickly spread. The area actually covered was estimated at 5800 acres. During the 12 months following a great decrease took place in the number of oysters present and in the acreage covered, the Inspector reporting that the solid phalanx of 1900 had been broken up into three detached beds totalling only some 1685 acres bearing 80,000,000 of oysters.

A year later (February and March, 1902), during our visit to the banks in the "Lady Havelock" and with Captain Donnan in the "Rangasami Puravi," we saw these oysters and noted the marked inferiority of their size to that of oysters of similar age upon the Eastern Cheval. Captain Donnan's estimate of their numbers was 123,357,000 oysters, spread over an area of 2170 acres. At the same time it was noticed as a disquieting feature that the fresh fall of spat so generally distributed over the banks had invaded the Western Cheval—a large proportion of the older generation bearing each several young attached to the valves. These young oysters, upon which we now rely for the next immediate fisheries, appeared when first seen (February, 1902) to be from 2 to 6 months old. Besides having invaded the Western Cheval, immense quantities were found on the South and North-central, South and South-east Cheval regions, and also upon the two Modragams, as well as upon many of the southern banks extending from Negombo to Karativo.

In November, 1902, the numbers on the Western Cheval bank were given by Captain LEGGE as 57,605,000, occupying 936 acres, but, owing to bad weather, the whole of the bank was not surveyed. No other numerical estimate was made till Mr. HORNELL'S inspection of this year, when a very careful estimate placed the number remaining at 35,000,000 upon 1122 acres. Tabulation of the above facts shows this history clearly.*

Date.	Number estimated.	Age in years.	Acreage.	Number per dive.
March, 1900	Too great for calculation	$\frac{1}{4}$ to $\frac{3}{4}$	5800	—
„ 1901	80,000,000 (?)	$1\frac{1}{4}$ „ $1\frac{3}{4}$	1685	21 to 30
„ 1902	123,357,000	$2\frac{1}{4}$ „ $2\frac{3}{4}$	2170	27 „ 40
November, 1902 (inspection incomplete)	Over 57,605,000	3 „ $3\frac{1}{2}$	Over 936	—
February, 1904.	35,000,000	$4\frac{1}{4}$ „ $4\frac{3}{4}$	1122	13 to 22

The discrepancy between the estimates for 1901 and March, 1902, appears largely explicable by the estimate of oysters per dive having been either too low for the former year or too high for the latter, estimates being liable to variation with every condition that affects a diver's powers of working. Divers have been known to bring up from one particular spot only 10 oysters per dive when the weather conditions were unfavourable, and yet the following day, the sea being calm and warm, the same men would report double the number. To arrive at accurate estimates, the weather conditions, if adverse, should be allowed for, and the total number increased accordingly.

In November, 1902, the encroachment of the younger generation had markedly increased, and with the growth of the smaller ones many portions of the Western Cheval bank—the parts where they were most abundant—had to be transferred from the category of regions bearing maturing oysters to those monopolised by the younger generation.

"In February, 1903, no regular inspection was made of these latter regions, but by means of numerous descents in a diving dress I was able to obtain a fair knowledge of the distribution of the younger oysters. On the Cheval and the North and South

* See also Part II. of this Report (1904), p. 15, and figs. 9 to 14.

Modragam the young already noted were found well grown and flourishing, and, while their actual age was only $1\frac{1}{4}$ to $1\frac{1}{2}$ years, many, especially upon the Modragams and South Cheval, had the appearance of being 2 years old. On the Muttuvaratu and Dutch Modragam the older oysters had made no increase in size, and were in an unhealthy and miserable condition. Mixed with them were considerable numbers of a younger generation, apparently over 1 year old. This year, as already stated, the older generation proved to have died off upon the Karativo, while the younger generation found last year had made fair progress and appeared moderately healthy. Similar conditions, I believe, characterise the Muttuvaratu this year, judging from the rather meagre data at my command."

Rate of Increase in Size.—So little is known with exactitude concerning the rate of growth of oysters, that the following tabulation by Mr. HORNELL of the observed increase in size of these younger oysters has considerable value.

TABLE showing Rate of Growth of Oysters aged $2\frac{1}{4}$ to $2\frac{1}{2}$ Years, March, 1904.

Date.	Age in years.	Size in millimetres.
I. SOUTH-EAST AND SOUTH-CENTRAL CHEVAL :—		
March, 1902	$\frac{3}{12}$ to $\frac{6}{12}$	35·00 × 32·00 × —
November, 1902	$\frac{11}{12}$ „ $1\frac{2}{12}$	50·57 × 47·52 × —
March, 1903	$1\frac{1}{4}$ „ $1\frac{1}{2}$	54·41 × 49·75 × 20·38
„ 1904	$2\frac{1}{4}$ „ $2\frac{1}{2}$	67·12 × 61·16 × 27·24
II. MODRAGAM PAARS :—		
March, 1902	$\frac{3}{12}$ „ $\frac{6}{12}$	37·15 × 33·20 × —
„ 1903 (North) . . .	$1\frac{1}{4}$ „ $1\frac{1}{2}$	61·17 × 54·50 × 24·28
„ 1904 (South) . . .	$2\frac{1}{4}$ „ $2\frac{1}{2}$	68·68 × 64·16 × 27·28
III. NORTH-WEST CHEVAL :—		
March, 1902	$\frac{3}{12}$ „ $\frac{6}{12}$	33·50 × 30·75 × —
November, 1902	$\frac{11}{12}$ „ $1\frac{2}{12}$	47·64 × 44·36 × —
March, 1904	$2\frac{1}{4}$ „ $2\frac{1}{2}$	56·60 × 52·60 × 24·56
„ 1904 (another locality)	$2\frac{1}{4}$ „ $2\frac{1}{2}$	61·33 × 57·40 × 23·70

When these records are extended over the remaining life-period of these oysters we shall have, for the first time, reliable data as to the relative rate of growth from year to year upon three of the most important of our oyster banks.

The respective increases during the first two annual intervals are as follows :—

	South-east and South Cheval.	North-west Cheval.	Modragams.
	millims.	millims.	millims.
12 months from age 3 to 6 months.	19·41 × 17·75 × —	—	24·02 × 21·30 × —
12 months from age $1\frac{1}{4}$ to $1\frac{1}{2}$ years	12·71 × 11·41 × 6·86	—	7·51 × 9·66 × 3·00
Total for two years .	32·12 × 29·16	25·46 × 24·25 (average)	31·53 × 30·96

It will be noted that while the growth of the Modragam and of the South-east and South Cheval oysters has been greater and more rapid than that of those upon the Western Cheval, the Modragam oysters, growing more quickly than those of the South-east and South Cheval up to the age of $1\frac{1}{4}$ to $1\frac{1}{2}$ years, and thereby attaining larger size, suffered retardation in the rate of increase thereafter, making but 7·51 millims. × 9·66 millims. × 3·00 millims. increase, whereas the South-east and South Cheval oysters made 12·71 millims. × 11·41 millims. × 6·86 millims. in the same period, and so reduced the disparity in size caused by the more rapid growth of the Modragam individuals at the earlier age—so much so that the difference between them at the age of $2\frac{1}{4}$ to $2\frac{1}{2}$ years is but 1·56 millims. × 3·00 millims. × 0·04 millim.

This lends support to our previous statement (this Report, Part I., 1903, p. 136) that shell growth is most vigorous during the first two years of life, or, as we may now put it, up to the size of about 60 millims. × 54 millims. × 24 millims., and that thereafter it slackens to a very slow rate, actually coming to a stand, or even retrograding as regards height and length in the case of the stunted oysters of the Muttuvaratu and the Mid-west Cheval.

As examples of this slowness of growth in older oysters we may take those fished this year from the South-west Cheval. These were the most vigorous and freely grown as regards the general average, and yet the increase made from November, 1902, to March, 1904, was but 5·31 millims. in depth by 3·77 millims. in length, *i.e.*, between the ages of say $3\frac{1}{2}$ to $3\frac{3}{4}$ and $4\frac{1}{2}$ to $4\frac{3}{4}$ years (size in November, 1902, was 71·25 millims. × 65·39 millims.). Contrast with this the increase *within the same period* (16 months) when the oyster is younger, say between the ages of $\frac{11}{12}$ to $1\frac{2}{12}$ and $2\frac{1}{4}$ to $2\frac{1}{2}$ years. In the case of oysters of this age from the South Cheval, the increase has been, as shown above, as much as 16·55 millims. × 13·64 millims., and in the case of the North-west Cheval 13·69 millims. × 13·04 millims.—a remarkable difference indeed.

Again we see that the disparity of growth is most marked during early life—up to the age of 2 years—so that oysters situated in exceptionally favourable conditions attain such dimensions that they are liable to be credited with greater age than knowledge of their origin will warrant. This circumstance may account for some of the differences of opinion as to the ages of young oysters in the past (see, for example, the oysters attached to the Karativo buoy in 1866, described by Mr. HOLDSWORTH and discussed by Sir W. C. TWYNAM—Report, &c., Colombo, 1900).

CAUSES OF DECREASE AMONG THE FISHABLE OYSTERS SINCE MARCH, 1902.

The factors which tend to reduce the number of oysters, both old and young, have been treated of at some length in former parts of this Report, and it is only necessary here to discuss the causes which have led to great decrease since 1902 in the old oysters that were fished this year on the Western Cheval and the disappearance of the same generation from the Muttuvaratu, the Dutch Modragam and the Karativo paars. The decrease appears to have arisen from two chief causes, overcrowding and sand disturbance, the ill-effects of which have been intensified by several other influences of subsidiary importance. The former affected the beds in the North-west and Mid-west of the Cheval sections, with the Muttuvaratu and Karativo paars; the latter those of the South-west Cheval.

Sand Disturbance did the greatest harm upon the South-west Cheval, as this area has but few stretches of exposed rock surface, while "cultch" is not sufficiently abundant. When first seen by Captain DONNAN in 1900, the whole area was thickly spread with oysters on the sand as well as on the rock and on the cultch-strewn areas. With every recurrent period of stormy weather since that time these oysters have suffered thinning by encroachment and overwash of sand, till eventually they were cleared from off the sandy uncultched areas and only those were left that lay on rocky ground and on sufficiently cultch-covered bottom.

A subsidiary cause of destruction was the ravages of the boring sponge, *Cliona margaritiferæ*, which appeared specially active on this section, riddling the valves and apparently sapping the vitality of the oyster by the drain it caused upon nacre-secretion. Out of 400 individuals examined 310 were affected by *Cliona*—less than 23 per cent. were free from the infection.

Apart from this the oysters of the South-west Cheval were the healthiest, the bodies being plump and well developed, whereas a considerable proportion of those from the Mid-west and North-west sections were thin and of poor appearance.

The Effects of Overcrowding.—Sand disturbance produced comparatively little numerical reduction upon the North-west and Mid-west sections, these regions possessing more extensive stretches of rocky bottom than any others in this neighbourhood. The reduction here was due primarily to the effects of overcrowding, not, perhaps, so much because of their own numbers, great as these were originally, but rather because of deposits of spat which fell in July and December of 1901 upon the older oysters along the eastern part of these sections. For the first year the effects were little marked, but as the myriads of new-comers flourished and increased in size the well-being of the older generation was affected, a result that showed itself first by arrest of the growth of the shell and then, later, by starvation, lowered powers of vitality and reproduction, and wide-spread mortality.

Regarding the arrest of growth, we noted that the older oysters on the Mid-west Cheval measured 69·42 millims. × 64·54 millims. in March, 1902, when they were $2\frac{1}{2}$ to $2\frac{3}{4}$ years old, while survivors on less thickly populated parts of the bank were only 72·30 millims. × 65·25 millims. in March, 1904, an increase in size of but 2·88 millims. in height by 0·71 millim. in length in 2 years, a growth so slight as to justify the conclusion that oysters from the Western Cheval practically attain their maximum height and length upon reaching the age of 3 years, increasing thereafter in no appreciable extent save in thickness, which is due to deposits of nacre upon the inner surface of the valves.

In the case of the Muttuvaratu, the Karativo and the Dutch Modragam paars, the disappearance of the oysters has been total, caused not so much by the competition introduced by the presence of myriads of vigorous young—though this also existed and no doubt had some effect—as by the overcrowding and diseased condition set up by the immense number of adults. This has had such baneful effect that when Mr. Hornell saw them in March of last year they showed marked deterioration upon their condition 4 months previously, while their average size showed actually a decrease in height and length (58·84 millims. × 54·32 millims. in November, 1902, as against 57·54 millims. × 54·00 millims, in March, 1903). These oysters are in a shrunken, poorly nourished condition, and out of 227 examined, 25, or over 11 per cent., were affected with the "yellow" disease—a malady marking the imminence of wide-spread mortality, and characterised by the invasion of most of the tissues by immense numbers of leucocytes crowded with yellow granules.

That the Muttuvaratu oysters should have been entirely cleared away, while a relatively large number of the same generation is left upon the Western Cheval, is undoubtedly due to the overcrowding having been less acute and less wide-spread in the latter case.

Subsidiary Causes.—The general enemies of the pearl oyster were present as usual, such as star-fish, boring molluscs and the smaller oyster-eating fishes (*Balistes*, &c.). The two former, the star-fishes especially, do much harm, and their reduction in number is one of the benefits to be derived from dredging on a large scale. The smaller oyster-eating fishes have not been excessively numerous upon the Cheval and are not at present a destructive agency, seeing that the oysters are now too large and too strong to be crushed by the small jaws of these fishes. Their ravages are only to be feared when a bank is covered with spat; then these fishes gather from all quarters and, if the deposit is limited and the nature of the bottom sufficiently smooth, the attack may involve partial or even entire annihilation of the bed. The boring-annelid, *Polydora* sp., was markedly abundant on the South-west Cheval, but comparatively few bad cases could be traced to its tunnelling. Far otherwise was it with the inroads of the boring sponge, *Cliona margaritiferæ*, already alluded to. Hundreds of valves were examined where not only was the substance of the shell riddled by its honeycomb-like tunnels (see fig. 9), but, a more serious matter, the

Fig. 9. Pearl-oyster shell honeycombed by *Cliona margaritiferæ*, DENDY.

insertion scar of the adductor muscle was tuberculated and diseased, a condition due to the inferior powers of nacre-production of the epidermal layer in this region. "So great indeed was the nacreous tuberculation in some cases, that I have seen the natives save these shells with a view to cutting the tubercles off to use in the manufacture of native pearl jewellery." Whenever the inroads of *Cliona* were extensive, the sub-epidermal tissue in particular, and the other tissues in general, were thin and diseased-looking. A fairly large proportion of the dead shells found during the fishery on the South-west Cheval was badly affected; *Cliona* must undoubtedly be included among the more destructive agencies with which we have to contend.

"There was no evidence of any depredations on the part of Ray fishes this year, like the destruction of the Periya Paar Kerrai oysters last year. Rays were, however, several times seen; on the 27th February a large shoal, heading south, passed the ship at anchor on the North-west Cheval. The sight was a remarkable one, the sea for over 20 yards square being one patchwork of yellow disk-like bodies. Fair-sized examples of *Trygon walga* were caught from time to time. None of them furnished direct incriminating evidence, the stomachs being filled with crustacean *débris* and fragments of lamellibranch shells other than those of the pearl oyster. Like the trigger fishes, these smaller rays would appear to find the present size and strength of the oysters too great for the power of their teeth and jaws."

No sharks were seen on the fishing grounds. Mr. HORNELL says: "During all the months I have spent upon the pearl banks during the last $2\frac{1}{2}$ years, I have never had a glimpse of a shark dangerous to man. Several times the boatmen have caught 'basking-sharks'* of considerable size, but all were of a species that lives almost entirely upon small fishes and mollusca."

Condition of Spat on the Periya Paar in 1904.

"March 14th was devoted to an inspection of the Periya Paar, with the result that an immense bed of oyster spat† was there discovered. The young oysters were incredibly abundant, spread densely over an area fully 5 miles in length by from 1 mile to $1\frac{1}{2}$ miles in width. The age was under 3 months, so that they must have been spawned not earlier than December of 1903, more probably towards the end of the month. Alike on sandy and on rocky ground was this profusion seen, but on the rock the numbers were notably greater. On the sandy stretches the oysters formed bunches often of large size, the individuals attached in most cases to one another, but generally having a nuclear fragment of small cultch which most frequently was a cockle shell, a nullipore ball (*Lithothamnion*) or a small fragment of 'paar.' The spinning mussel (*Modiola barbata*), 'Suran' as it is called by the Tamil divers, was in places abundant, especially upon the sandy ground, but not sufficiently so to constitute a grave danger to the bed. This discovery of spat paralleled in extent and nature that made by Professor HERDMAN in February, 1902, when he estimated approximately the numbers of the young oysters at 100,000,000,000, and which, it will be remembered, had all disappeared when I next examined the bank in November of the same year.

"A very remarkable fact was that some of the largest of these young oysters when last seen, 3rd April, had already developed gonads filled with reproductive products fully formed and ready to be shed. The average size of these sexually mature individuals was $25\frac{1}{2}$ millims. $\times$ $26\frac{1}{2}$ millims. $\times$ 9 millims. The smallest was $24\frac{3}{4}$ millims. $\times$ 25 millims. $\times$ $8\frac{3}{4}$ millims. The extreme age of these cannot be more than $3\frac{1}{2}$ months, and we are fully warranted in considering that sexual maturity is reached by the pearl oyster soon after the age of 3 months. Previous to this record, the age of 6 months was the earliest at which reproduction had been observed."

Sexual maturity at such a small size and early age, in itself remarkable, has a practical bearing upon the replenishing of the banks from time to time—a subject to be treated of again.

Principal Spawning Seasons.—The gonads of this year's fishable oysters were nearly all in a spent condition during February and March, and this taken in conjunction with the presence of enormous multitudes of very young oysters—so young indeed that they could not have been set free earlier than the middle of the December

* The sketch of one of these which Mr. HORNELL has sent home has been identified by Mr. G. A. BOULENGER as *Stegostoma tigrinum* (GMEL.).

† The term "spat" is used in these pages in a wide sense to comprise all sizes of attached oysters under the age of 4 months.

preceding—points to December and January as being the period ot one of the maxima of reproductive activity in the pearl oyster of Ceylon.

In April the gonads began to show signs of increase, and a small quantity of spat was seen. It now seems that the two maxima do not coincide, as we at first supposed, with the intervals of fine weather and variable winds between the monsoons, *i.e.*, November in the one case, March and April in the other. This year's observations point distinctly to the chief spatting seasons having December and January, and June. July or August, as the central periods respectively—times when the monsoon winds are blowing steadily and strongly. It may be noted that a wide dispersal of the embryos can be more effectually attained during these boisterous periods of strong currents than if they were expelled during the inter-monsoon lulls, characterised by light winds and erratic surface drift.

Prospects of Future Fisheries.*

"The prospects of a large fishery, both next year and in 1906, upon the Cheval and Modragam paars are excellent; the immense quantities of young, 2 to $2\frac{1}{2}$ years old, occupying the Modragams, the South-east, South, Mid-west, North-west, and the greater part of the three central blocks of the Cheval Paar being ample for 2 years' fisheries. Those on the Modragams, and on the South, South-east, and South-central Cheval will, I hope, be fit to fish next March, being more advanced in growth than those on the Mid-west and North-west Cheval. Apart from this reason it will be advisable to fish the former at as early a date as the valuation of samples may show to be profitable, because, as many of the oysters on the beds named lie loose in bunches on a sandy bottom, they are thereby exposed to the danger of destruction by currents of exceptional force—a contingency infrequent but not unknown (*e.g.*, fishery of 1888). By March of 1905 these oysters will be about $3\frac{1}{2}$ years old, and, judging from the rapidity of their growth and their present large size, by that date they should be sufficiently matured to give a profitable fishery. They will then be practically of the same age as those of the 1903 fishery, which realised just under Rs. 30 per 1000, average price.

"If the fishery be postponed till 1906, the pearl yield would be greater, but if this were done, even supposing the oysters remained in safety till March, 1906, upon the banks, there would then be too great a quantity to fish in one year, and a portion would be left for the succeeding year, 1907. But in 1907 the remainder would be $5\frac{1}{2}$ years old, and under the conditions prevailing on the Western and Median Cheval, where these oysters are, it is most improbable that they would be still alive. A definite decision cannot be arrived at till the next valuation has been made† in November of the present year.

* I give this as Mr. Hornell's opinion in the Summer of 1904. It must be read in conjunction with the next article (p. 37) based upon the inspection of last November.

† See below, p. 43.

"The oysters at present on the Muttuvaratu and the Dutch Modragam paars should also be ready to fish in 1906, but I do not build confidently upon this; even now these oysters are extremely stunted and sickly looking, and are certain to decrease very much before they are ripe for fishing.

"Beyond 1906, or at latest 1907, there is likely to be a break in the fishery sequence, a more or less prolonged blank* whereof the duration will be to some extent dependent upon whether or not large measures of transplantation are resorted to, seeing that there has been no fall of spat upon the Cheval, Modragam, or Muttuvaratu paars within the last two years, that is to say, since June, 1902. The only other hope lies in the possibility that a younger generation may be growing up on some of the paars that have not been inspected of recent years. I therefore trust that I may be given the opportunity to make exhaustive inspections during the next 2 years. The more I learn at first hand about the banks and the more I read of the old records, the more convinced I am that limited and narrow-compassed inspections have been the cause of the loss of many valuable fisheries. To give a concrete instance of the essential need for thorough periodical examinations of the whole pearl-bank area, the following extract from Captain DONNAN's Report of the 1878 inspection furnishes significant reading:—

" 'While inspecting the Cheval I discovered oysters on a new bank, $2\frac{1}{4}$ miles to the 'westward of the Cheval, where it has generally been considered that there was 'nothing but an extensive sandy flat. I saw it recorded in the diary of inspection 'by Captain LAUGHTON, in March, 1802, that he found oysters of 4 or 5 years in 'abundance in 9 fathoms, rocky bottom, Kudiramalai bearing S.E. $\frac{1}{4}$ E.; and being 'anxious to test if rocky bottom really existed in that neighbourhood, I took all the 'inspection boats in tow of the launch out to the verge of the bank of soundings, 'and directed them to dive all the way back to the inspection vessel, so as to cross 'the position noted by Captain LAUGHTON, and they came upon rocky ground and 'oysters, where they placed a buoy. On subsequent examination this bed of oysters 'proved to be about $1\frac{1}{2}$ miles in its longest direction N.N.W. and S.S.E., and about '$\frac{3}{4}$ mile broad at its broadest part, having a depth of water over it of from $8\frac{1}{4}$ to '$9\frac{1}{4}$ fathoms, and a sandy flat of 9 fathoms between it and the Cheval. I believe it 'to be an extension of the Periya Paar in a S.E. direction. I have duly recorded 'its position in my diary. The superficial area of the bed is 3,845,935 yards, and 'the oysters on it average 22 to a dive. I estimate the total number of oysters on 'it at 3,500,000, sufficient to give 10 days' fishing for 50 boats with loads of '7000 oysters each. I found, however, 13 per cent. of dead shells, which is an 'unfavourable sign, and a large quantity of seaweed growing on the oysters. I have 'been much puzzled about the age of these oysters, as they appear to be old, although 'of small size. I believe them to be of the description known to the natives as

* The position of affairs is now altered by a great fall of spat on the Cheval Paar (see below, p. 37).

' "kottapakku," which are said to be a small class of oyster but rich in pearls. They ' resemble the oysters of the Chilaw banks, which I know to be 4 years old now, and ' therefore they ought to be fit for fishing in March next. I can find no record of ' this bed having ever been inspected since 1802, and it is a curious coincidence that ' what was then recorded of its condition might be recorded now on its most probably ' first examination since that time.' "

The oysters referred to in the above extract were fished the following year, 1879, and the question is at once suggested, "How many times between 1802 and 1878, the interval during which this paar received no attention, did oysters mature unknown upon this ground; and, further, how many other oyster-bearing patches have been left unnoticed for want of more extended inspections?"

Parasites of the Pearl Oyster.

"Entozoa were plentiful in the oysters fished this year, both nematode worms and encysted cestode larvæ being found; the former especially were more numerous than I had before seen, and many oysters contained two individuals. A solitary example of the trematode *Aspidogaster margaritiferæ* was found, located as usual in the pericardium. Cestode larvæ were particularly abundant in the oysters from the North-west Cheval, and this fact will be referred to when we come to treat of the relative pearl yield of the three sections.

"More specimens are still needed to enable us to complete our knowledge of the life-history of the pearl-inducing parasite, and till I have an opportunity to dissect a number of individuals of the large oyster-eating sting-rays, the Walwadi tirikkai of the Tamils, there can be no hope of filling up this important gap in our investigation. No opportunity offered to obtain one of these rays at the late fishery, my position 12 miles from land precluding access to the fishermen of Pukkulam and Marichchukaddi, the only possible places where I could hope to procure specimens. Several small individuals of *Trygon walga* were caught by the inspection boatmen. This species does not, however, possess teeth sufficiently powerful to destroy oysters more than a few months old and no parasites belonging to the species found in the pearl oyster were discovered when these fish were dissected. Besides pearl oysters a large number of fishes were dissected in search for the adult stage of the pearl-parasite, and a continuation of such work will form the subject of a detailed report in the future."

The Yield and Character of Pearls from Different Regions.

During the inspection of the Cheval Paar representative samples of mature oysters were collected from the South-west, Mid-west and North-west beds respectively, and from the 7th to the 9th of March Mr. Hornell was engaged superintending the washing of these samples and the valuation of the pearls picked out. The results showed that the South-west oysters were the richest in pearls, the North-west following closely, with the Mid-west unmistakably much poorer in yield.

The following table will make clear the relative returns:—

Bed.	Quantity.	Total weight of pearls.		Weight per 1000.		Valuation per 1000.	Size of oysters in millimetres.
		Kalanchu.	Manchadi.	Kalanchu.	Manchadi.	Rs. cts.	
South-west Cheval	12,000	7	13·25	—	12·76	36.01	76·20 × 69·20 × 32·34
North-west Cheval	7,200	2	17·00	—	7·91	33.75	72·67 × 66·50 × 31·50
Mid-west Cheval	6,000	2	0·88	—	6·81	20.25	72·30 × 66·50 × 31·57

"The weight of pearls per 1000 oysters was very high in the case of those from the South-west, which fact may be correlated with the size of these oysters being considerably greater than that of the other two lots. In regard to the quality of the pearls, the North-west oysters, while yielding a less weight, contained a much greater proportion of 'cyst pearls' of excellent quality than those from the South-west, which owed their greater proportionate weight of pearls to a noteworthy abundance of 'muscle pearls.'

"External characteristics give the most meagre indication of what the pearl yield may be—in regard to 'cyst pearls' the abundance, or otherwise, is connected with the factors which control the relative abundance of the pearl-inducing cestode and those which conduce to its death during encystment in suitable localities within the tissues—problems as yet obscure. The fact, however, is to be noted that dissection showed the oysters from the North-west Cheval to be more extensively infested with cestode cysts than those from the other districts, while the valuation sample showed that cyst-pearls were much more abundant in these oysters than in those from either the Mid-west or South-west Cheval sections. With regard to muscle pearls the general fact stands out, deduced from my experience of two fisheries, that the more vigorous and well grown are the oysters the more abundant are the muscle pearls."

Shell-pearls.

"At the close of the inspection, when the valuation samples of oysters had been washed, I seized the unique opportunity thus afforded to examine over 30,000 pairs of separated valves of the pearl oyster. I did this chiefly to see if any considerable proportion of shell-pearls were induced by the irritation caused by perforation of the shell by boring parasites—sponges, lamellibranch molluscs and annelids. The result negatived this idea and showed that these animals have little or no influence upon pearl production; the sponge, *Cliona margaritifera*, causes occasional roughening, or even rugged tuberculation (fig. 10), at the insertion scar of the adductor muscle, and the annelid, *Polydora*, may produce an occasional discoloured internal excrescence, usually sharp-pointed: more rarely a parasitic nematode, free or encysted, is cemented to the nacre and sealed up in a pearly sarcophagus.

Fig. 10. Inside of pearl oyster shell, showing adductor impression affected by *Cliona* borings on the outside. × ½.

" By far the larger number of shell-pearls, fully 90 per cent. of the whole number, are due to the attachment of cyst- and muscle-pearls to the nacreous lining of the shell, consequent upon fusion of the pearl-forming sac with the epidermal layer outside, and rupture of these tissues caused by the pressure of the growing pearl, thus placing the pearl in actual contact with the nacre and converting its closed pearl-secreting sac into a pouch or ampulla, the open neck directed outwards and in continuity with the general epidermal layer upon the exterior of the mantle.

" Shell-pearls originating in this manner are at first pedunculated, and at this stage may be detached readily. The peduncle tends, however, to become obliterated, and eventually the pearl may be entirely lost in the substance of the shell nacre. Such shell-pearls are in most cases affixed singly, without definite arrangement. Examples may be located anywhere, the largest, however, being usually either in the peripheral region of the nacre, or in the central region, corresponding with the lateral surfaces of the visceral mass.

Fig. 11. Diagram showing comparative frequency of cyst pearls in the various parts of the mantle.

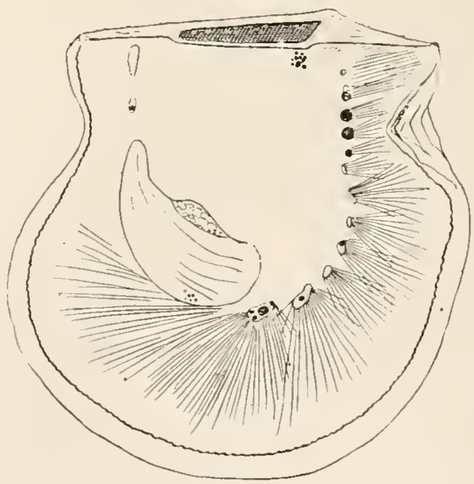


Fig. 12. Diagram showing the positions most frequently occupied by muscle pearls.

" Smaller attached pearls are not infrequently either singly or in a serial line of from two to five along the pallial line, each pearl coinciding in position with a muscle scar. Very rarely small ones may be seen along the edge of the adductor. Most frequent of all are pearl masses of irregular or even botryoidal form attached at or adjacent to the levator insertions. Decalcification of these pearls reveals no organic nuclei, whereas the pearls irregularly disposed have cestode embryos as nuclei, exactly as 'fine' pearls have.

"Examination of these 30,000 shells gives, therefore, strong confirmatory evidence in support of the theory set forth by Professor HERDMAN and myself* associating such pearls as have no organic nuclei (cestode or other platyhelminthian embryos) with the attachment surfaces of those muscles which are inserted on the shell, especially the small and comparatively weak levator and pallial muscles. Figs. 11 and 12 show the distribution in the body of cyst pearls and muscle pearls respectively, and fig. 12 is very instructive in showing the perfect way in which the positions of the shell pearls there depicted coincide with the series of pallial muscle scars.

"PHOSPHORESCENT AND OTHER PHENOMENA.

"On the evenings of April 9th, 10th, 11th, and 12th, when at anchor on the Western Cheval, we beheld a repetition of the strange phosphorescent phenomenon witnessed by Professor HERDMAN on March 13th, 1902 (see this Report, Part I., 1903, p. 81). The display began at about the same hour each evening, varying from 8.45 to 9.30 P.M., the sea being dotted with large isolated flashing lights that pulsated and vanished ghost-like at regular and frequent intervals.

"The rhythmic and progressive blotting out and rekindling of these phosphorescent fires was as if the sea were swept by regularly recurring search-light rays. The beginning of each successive light-wave appeared to lie to the south; the intervals were approximately of two seconds' duration. All the four nights were dark, but the weather was variable, one night tempestuous, another fairly calm, a moderately strong swell prevailing the whole time. The displays lasted approximately for an hour each evening. The cause remains undetermined.

"**Trichodesmian calm.**—During several days in March vast quantities of the red-brown scum of *Trichodesmium erythræum* lay profuse and filthy upon the surface of the sea. So abundant was this scum that twice did it extend the period of noontide calm, acting precisely as a film of oil does. At midday when the first puffs of the sea-breeze came out of the north-west, while the breeze was evident enough otherwise, yet it failed for sometime to disturb the surface where lay this scum. Where it was absent, or where the progress of the launch broke a lane through the film, the wind raised ripples and wavelets which little by little spread and encroached upon the Trichodesmian calm. This with the gradual freshening of the wind finally scattered the particles, driving them downwards.

* 'Brit. Assoc. Report,' Southport, 1903, p. 695.

" **Surface drift.**—Nothing can be done towards the solution of this question without the employment of bottle-drifters, except to note the direction of the current from day to day, when at anchor on the banks. This was attended to from 19th February to 19th April, the result being to show that during February the current set in the main to the south and to the south-west in dependence upon the general direction of the wind which at this period was mostly north-east. The following month, March, distinguished for its alternate land and sea breezes, showed a to-and-fro motion of the water upon the banks, the current altering with every change of wind and never attaining any strength. In April, consequent upon the continuous south-west wind and swell, the current ran strongly northwards, frequently at a rate of from 2 to 3 knots per hour."

Finally, Mr. Hornell has sent me a series of "Recommendations" in regard to the further exploitation and conservation of the pearl banks. Some of his paragraphs deal with matters treated of above, while others are better left over for discussion in the Final Part of the Report. I give here the following headings of the chief points in his recommendations :—

Synopsis of Recommendations.

(*a.*) Improved and extended inspection.

(*b.*) The provision of a beacon on Aripu reef and the improvement of Kudiramalai Tower.

(*c.*) Transplantation on an extensive scale by means of steamer dredging whenever blank spaces occur upon the Cheval, coincident with the presence of young oysters in the neighbourhood, within a radius of 20 miles.

(*d.*) Cultching to go on concurrently with transplantation. If these operations can be carried out within the next twelve months, 500 tons of oyster shells and 300 tons of Kalpitiya stone to be provided for this purpose.

(*e.*) The thinning out of overcrowded beds by means of the dredge.

(*f.*) The cleaning of the oyster banks by means of the dredge.

(*g.*) Further investigation of the life-history of the pearl-inducing Cestode.

(*h.*) A series of drift-bottle experiments in conjunction with the Madras Presidency officials.

(*i.*) The establishment of a chank fishery on Government account and under Government management in the neighbourhood of the Aripu pearl banks.

TABLE showing the Principal Facts relating to the Oyster-population on the Pearl Banks in November, 1904—to illustrate "The Present Condition of the Pearl Banks" (p. 37).

Name of Paar.	Estimated number of oysters on the bank.	Valuation per 1000 oysters.	Age (November, 1904).	Condition.	Prospects.
South Cheval . . . South-east Cheval .	40,000,000 23,600,000	Rs. 24.65 10.76½	years $2\frac{2}{3}$ to $3\frac{1}{6}$ $2\frac{2}{3}$,, $3\frac{1}{6}$	Healthy and vigorous	Should live through two more seasons without excessive diminution in numbers.
Mid-east and South-central Cheval	13,750,000	13.21	years $2\frac{2}{3}$ to $3\frac{1}{6}$	Healthy, but smothered in young oysters	The majority will die off within the next year owing to the smothering effects of the myriads of young oysters present.
South-west Cheval .	3,500,000	—	years $5\frac{1}{2}$	Healthy for their age	Too old to live beyond 1905.
The remainder of the Cheval	Thousands of millions	—	months $1\frac{1}{2}$ to $2\frac{1}{2}$	Healthy	Good. Should furnish fisheries in future years.
North Modragam . South Modragam .	4,700,000 21,000,000	— 17.86½	years $2\frac{2}{3}$ to $3\frac{1}{6}$ $2\frac{2}{3}$,, $3\frac{1}{6}$	Unhealthy, shells and bodies diseased; those on the south smothered in young oysters	Dying off rapidly.
Periya Paar . . .	Thousands of millions	—	months $1\frac{1}{2}$ to $2\frac{1}{2}$	Healthy	Will probably disappear during the next South-west Monsoon.
Muttuvaratu . . .	20,000,000	3.16½	years $2\frac{2}{3}$ to $5\frac{1}{2}$	Stunted and diseased	Dying off gradually.

THE PRESENT CONDITION OF THE PEARL BANKS.

[*Based on Mr.* Hornell's *Inspection in November, 1904.*]

Mr. Hornell left Colombo for the Pearl Banks on October 25th, 1904, with the inspection barque "Rangasami Puravi" and the dredging steamer "Violet"—a trawler recently acquired by the Government for pearl-fishery purposes. I have received a detailed MS. report from him which has furnished the quotations and facts that form the basis of the present section.

"The actual examination of the banks was begun on the morning of October 29th and lasted with but one day's partial interruption, caused by heavy rain squalls, until November 17th, when I brought the inspection to a close and went ashore [at Marichchukaddi] to superintend the washing of the samples obtained."

This last inspection of the Cheval, Modragam, Periya and Muttuvaratu paars was evidently unusually extensive and thorough for a November inspection, and examination of the valuation records since the year 1854 shows that the number of oysters (87,500) lifted by the divers was by far the largest ever collected.

The size of these samples affords a better opportunity than usual of ascertaining the true average value of the oysters upon the different banks.

The result of the inspection is briefly as follows (see also Table opposite, p. 36) :—

1. Mature oysters, aged from $2\frac{2}{3}$ to $5\frac{1}{2}$ years, were found in quantity upon the North and South Modragam and Muttuvaratu paars, and upon the South, South-east, South-central and Mid-east sections of the Cheval Paar, together with a small and thinly covered patch remaining from last year's fishery (1904) upon the South-west Cheval.

2. Very young oysters, aged from $1\frac{1}{2}$ to $2\frac{1}{2}$ months at the beginning of November, cover the whole area of the Cheval excepting the South-west, South and South-east sections, and are also found equally abundant on the Periya Paar and the South Modragam Paar. If we estimate their age from the average size it is evident that a fall of spat covering an immense extent of ground and quite unusual in numbers must have occurred between the middle of August and the middle of September. This is a most important occurrence which, though hoped for, was not expected and could not have been foreseen. It greatly improves the fishery prospects for some years to come and diminishes the need for any immediate transplantation from the Periya to the Cheval Paar.

Details of the Condition of Each Bank.

On the South and South-east sections of the Cheval Paar (see fig. 13) is a large and continuous bed of excellently grown oysters from $2\frac{2}{3}$ to $3\frac{1}{6}$ years old. The area covered with oysters Mr. Hornell computes at 6,705,000 square yards, but as the bed extends in one direction beyond the limit surveyed we may safely calculate upon a fishable area in this one locality alone of fully 7,000,000 square yards. But even taking the former figure and reckoning the population at an average of from 16 to 26 per dive, it is estimated that this bed has a total of 63,820,000 oysters. Mr. Hornell reports that "these oysters are extremely well grown for their age and while they contain but a small proportion of cyst-pearls and therefore yield, at present, but few pearls of high individual value, they give a remarkably heavy weight of muscle-pearls, so much so that the valuation of the sample pearls ranges from Rs. 10.76 per 1000 oysters in the case of the South-east to as much as Rs. 24.65 per 1000 in the case of those from the South section —a fact accounted for by the ready sale which comparatively low-class pearls meet with locally and in India."

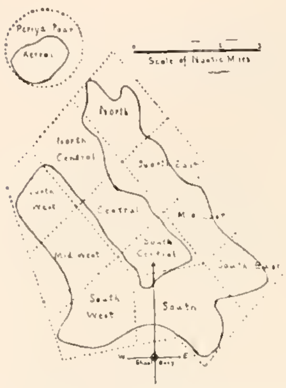


Fig. 13. Proposed culture areas recommended for the Cheval Paar and Periya Paar Kerrai.

Scarcely any young oysters are mixed with the mature individuals in this bed—a fact of some importance when considering the rotation of fishing operations. This point will be considered later on.

On the eastern part of the South-central and over the South-west quarter of the Mid-east Cheval another extensive bed of oysters occurs, continuous along the southern margin with the South Cheval bed. In area it contains about 2,300,000 square yards, bearing oysters averaging 15 to a dive, from which we estimate the number of oysters present to be fully 13,750,000. The bulk of this ground was fished, but imperfectly, in 1903, and, as a consequence, there are occasional patches of oysters nearly $5\frac{1}{2}$ years old, intermingled here and there with the younger generation, $2\frac{2}{3}$ to $3\frac{1}{6}$ years old, which forms the greater part of the bed (fig. 14). The presence of a proportion of older oysters might be thought to make the quality and value of the pearls from this locality higher than that of those from the South Cheval, but actually the valuation is only Rs. 13.21 per 1000 as against Rs. 24.65 per 1000 in the case of the latter bed. The difference seems due to a less vigorous growth upon the Mid-east Cheval, a character correlated with inferior power of nacre-secretion and consequent inferiority in the yield of pearls.

Over the whole of this bed of oysters, and extending west and north upon those portions of both sections (South-central and Mid-east) which are bare of mature oysters, myriads of the very young oysters before mentioned (now a few months old) occupy every available point of hard ground. Where older oysters are present the young ones crowd thickly upon the valves, ranging from 20 and 30 up to actually (and frequently) counted totals of 96 to 99 upon each individual. Where cultch and unoccupied outcropping rock occur every inch is crowded, the little oysters seeming to shoulder each other in their fight for vantage ground. Mr. HORNELL goes on to state: "Towards the west, upon the sandy cultch-barren stretches of the South-central Cheval, the struggle for existence among the young oysters is already intense; clusters of individuals are grouped round nuclei of absurdly small and inadequate dimensions, and often I have counted from 30 to 50 oysters in a bunch having for its centre a fragment of stone or shell no larger than a pea in size. In other cases even this may be wanting, the oysters adhering to one another."

The danger to these unstable clusters is obvious; a strong current or under-tow will sweep them hither and thither, and while this may have a certain value in possibly bringing about the stocking of bare stretches of the bank elsewhere, the dangers that these young oysters run of being swept into unsuitable localities far outweigh the advantage to be gained by wider dispersion.

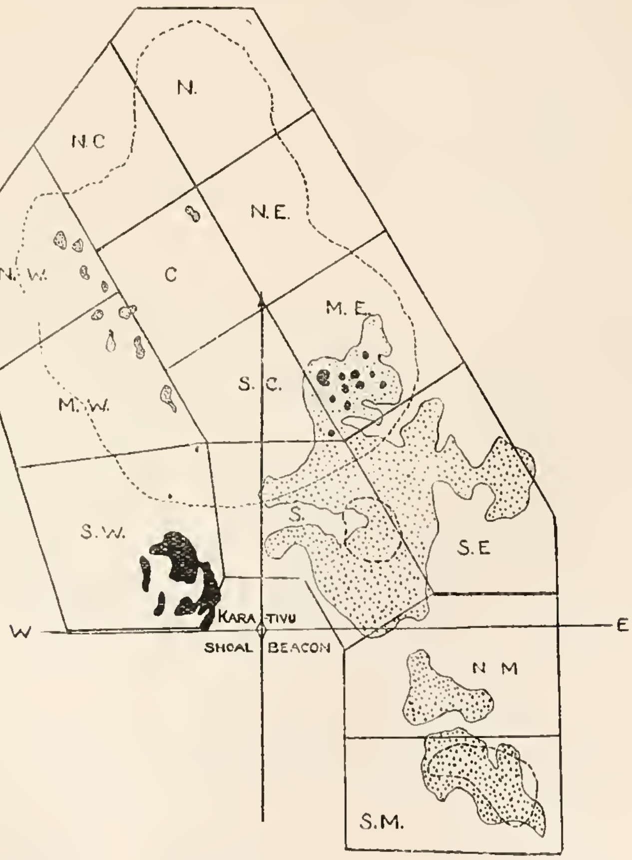


Fig. 14. Sketch-plan of the Cheval and Modragam paars, showing the distribution of pearl oysters in November, 1904. Scale: Half an inch to one nautical mile. The broken line surrounds the areas covered with spat a few months old, the dotted areas are those with oysters about 3 years old, the solid black indicates those beds of oysters over 5 years old.

No other fishable oysters in any quantity are to be found on the Cheval Paar, with the exception of an irregular and sparsely populated patch on the south-west corner of the South-west Cheval—a remnant left from the last fishery. The quantity is just under 3,500,000, reckoning the area at 1,150,000 square yards and the number of oysters per dive as 9. No spat is here present, and as there is no admixture of a younger generation, these oysters, which will be nearly 6 years old in March next, should give a high valuation in pearls. They are too unevenly distributed to permit of being dredged to any advantage. The native divers should, however, find the patch remunerative, and it will probably be found advisable to begin next year's fishery on this ground. The rest of this area (south-west) is blank, without even a trace of the very young oysters found elsewhere (see fig. 14).

The whole of the remaining sections without exception—the Mid-west, the North-west, the North-central, the Central, the North and the North-east—were everywhere packed densely in the beginning of November with very young oysters of from $1\frac{1}{2}$ to $2\frac{1}{2}$ months of age, healthy in condition, vigorous in growth, and too abundant to estimate in numbers. Indeed, so great is the profusion that Mr. HORNELL reports that "the remainder of the $2\frac{1}{4}$- to 3-year-old oysters that abundantly stocked much of this region in the early part of the present year are so masked by the covering of spat as to be unrecognisable by sight. The divers cannot distinguish between rock and old oysters; both are submerged in this young brood of oysters, and till the masses are brought to the surface the differences are not seen. Even if the quantity of old oysters were considerable, fishing under such circumstances would be well nigh impossible; but, as it is, we are saved having to face this difficulty by the fact that the North-west, Mid-west, and North-east sections have been ravaged by ray-fish (Trygonidæ) during the last few months, and the numbers of mature oysters so thinned that these regions, for all practical purposes, may be considered blank so far as concerns a fishery during the next 2 years. The prospects for an extensive fishery 4 years hence are on the other hand excellent; by that time the present spat will be old enough to be fished on those regions where growth progresses most rapidly."

On the North Modragam there is a small bed of 700,000 square yards in extent, covered with oysters of $2\frac{2}{3}$ to $3\frac{1}{6}$ years old, ranging in density from 16 to 24 per dive. This bed should yield at least 4,700,000 oysters if fished in March next. Spat is absent from the whole of this section.

The South Modragam bears a much larger bed, fully 2,200,000 square yards in area. At 24 oysters per dive the present population is estimated to be about 21,000,000. Unfortunately for fishing operations, very young oysters (spat) are extremely abundant, and may prove somewhat troublesome to the divers, as practically every old oyster will have to be, at the least partially, stripped of its load of young. Mr. HORNELL recommends that "fishing operations should be hastened as much as possible so far as this bank is concerned, as the health of the fishable generation is far from satisfactory. The oysters are thin and the shells of a large proportion are so diseased that if not fished within the next 4 months I shall expect to find the bank cleared of this generation in March, 1906. The age is the same as of those on the North Modragam."

The only other bank where, from our previous observations, there was the remotest possibility of finding fishable oysters is the Muttuvaratu Paar, lying off Dutch Bay (see Map. Mu., fig. 15). Three days were devoted to the inspection of this, with the

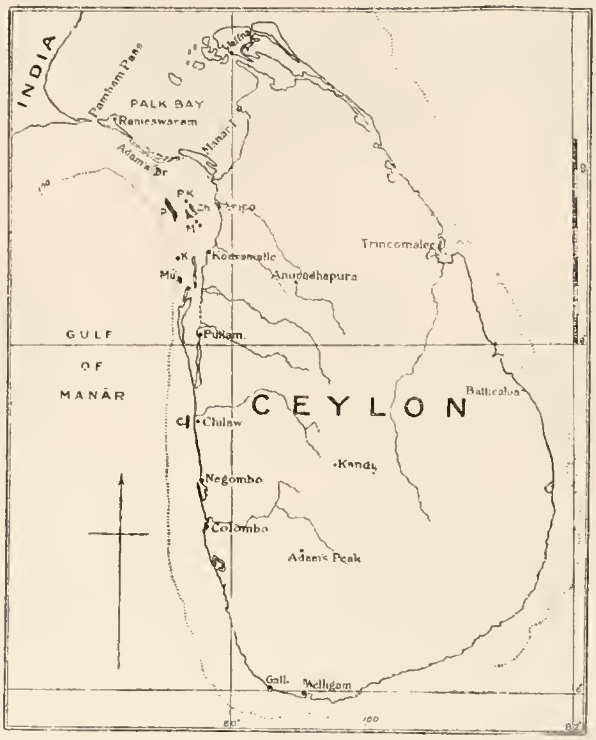


Fig. 15. Sketch-map showing the principal pearl-oyster banks in the Gulf of Manaar. C., Chilaw Paar; Ch., Cheval Paar; K., Dutch Modragam and Karativo paars; M., Modragam Paars; Mu., Muttuvaratu Paar; P., Periya Paar; P.K., Periya Paar Kerrai.

result that Mr. HORNELL estimates the number of oysters thereon, aged from $2\frac{2}{3}$ to $5\frac{1}{2}$ years, to be about 20,000,000. "All are stunted in outward appearance, the shells both small and unhealthy, covered and distorted in many cases with a parasitic growth of coral, while the substance is riddled and tunnelled by boring sponges, molluscs, and worms. The soft parts are in like condition, miserably thin and sickly, and many are obviously diseased." It is therefore not surprising to find that the sample of 10,000 average individuals which was collected by the divers on November 11th yielded only a very small quantity of pearls, valued at Rs. $3.16\frac{1}{2}$ per 1000 oysters.

The valuation of the same bank of oysters in the previous November (1903) gave Rs. 1.50 per 1000, so, as the value has more than doubled in the twelve months, there is the possibility that a remnant might provide a small fishery in 1906 if oysters be then scarce elsewhere. The only remaining bank inspected was the

Periya Paar. An examination of this remarkable region during the progress of the fishery of 1904* showed the entire extent to be densely packed with untold millions of young oysters from $1\frac{1}{2}$ to 3 months old. At the present time but a few handfuls of these survive; the others have, as usual, disappeared, having been no doubt swept from the bank into deep water or buried in sand during the turmoil of the south-west monsoon. Their place is, however, now taken by a new generation of young oysters of the same age as those so plentiful upon the Cheval Paar. They will be of excellent size for transplantation in March next, if there be then need of such an operation. If not utilised they must inevitably share the usual fate of oysters on this bank, and will without doubt disappear during the next south-west monsoon.

Enemies of the Pearl Oyster.

Mr. Hornell reports that "Oyster-eating fishes are at present abundant on the banks. Numbers of 'Kilati' (*Balistes mitis*, chiefly) and of 'Vellamīn' (*Lethrinus nebulosus* and other species) were caught by the crew whenever we anchored upon spat-covered ground, and unmistakable evidence of their diet was given by the stomach contents. In the stomach of one *Balistes* which I examined there was found a minute pearl."

The quantity of young oysters is, however, sufficient to afford ample margin of safety from such dangers, and with another 6 months' growth the shell will be sufficiently strong to give protection against these particular enemies. "Greater danger threatens from the huge ray called 'Walwadi tirikkai' by the Tamil fishermen (*Rhinoptera javanica*). This fish can destroy the strongest-shelled oyster, and so great is its appetite and the capacity of its mouth and stomach that a shoal is capable of destroying an entire bed of oysters within a few weeks or even days, as witness the destruction of the fine bed of oysters on the Periya Paar Kerrai, which was found to be in progress at the time of the fishery of 1903.† During the recent inspection traces of widespread havoc from this cause were much in evidence over the northern sections of the Cheval Paar, and this enemy is responsible for the greater part of the reduction in numbers of the younger generation of oysters so abundant on this area in March last."

The region of the bank in question is notably deficient in natural cultch, and till this defect is remedied this and other similar parts of the Cheval and Modragam paars must always be more or less subject to ravages and losses, even to the extent of occasional total destruction of a bed and the consequent failure of expected fisheries.

The boring sponge, *Cliona margaritiferæ*, Dendy, is doing great harm to the oysters of the Modragam paars. On these banks there is also an excessive abundance of

* See this volume, p. 28.

† See this Report, Part II., p. 25.

shell-tunnelling annelid worms (*Polydora*), of boring molluscs (*Lithodomus*), and of encrusting and enveloping sponges. This combination of parasites has induced in the oysters a weakly condition which doubtless predisposes to disease. "As a consequence the oysters here are sickly, the rate of mortality is increasing, and comparatively few are likely to survive to 1906. Star-fishes are also abundant on this bank and are aiding in the destruction of this bed of oysters."

On the Periya Paar, where very young oysters are plentiful, small carnivorous gastropod molluscs (*Sistrum* and other genera) are unusually abundant, and are causing, by boring through the shell, the death of considerable numbers of the young oysters. On the Cheval Paar they are less numerous, and, speaking generally, there is, saving for the great rays, no special or dangerous abundance of oyster enemies upon this the most important bank.

Valuation Results.

The exceptionally great number of oysters collected at this inspection was made up as follows :—

40,000	from the	South Cheval Paar.
15,000	,,	Mid-east Cheval Paar.
6,000	,,	South-east Cheval Paar.
1,500	,,	North-west Cheval Paar.
15,000	,,	South Modragam Paar.
10,000	,,	Muttuvaratu Paar.
87,500		

Mr. Hornell reports that "One-half (20,000) of the South Cheval sample was given to Mr. G. G. Dixon to be treated by his oyster-washing machine for comparison with the other half, which was to be hand-washed and hand-picked in the ordinary manner.* In addition, one bag containing 750 of the South-east Cheval oysters was handed by mistake of the landing boatmen to Mr. Dixon, who will account for it. All the rest of the samples which I collected were washed in the ordinary way by the divers and munducks."

The result shows that the two highest valuations were yielded respectively by the South Cheval and the South Modragam, the former being worth Rs. 24.65 per 1000 oysters, the latter Rs. 17.86½ per 1000. In the case of the former (higher) valuation the result is due to the great *weight* of pearls present, in the latter to the comparatively high value of the individual pearls. The one gives quantity, due to an unusual abundance of muscle-pearls, the other quality, owing to fine cyst-pearls being present in a higher ratio than in the former case.

* See this volume, p. 6.

Regarding the 40,000 oysters from the South Cheval Paar washed for comparison, half by hand and half by Mr. DIXON in his machine, Mr. HORNELL reports that "the half washed by hand gave a valuation of Rs. 24.65 per 1000 oysters as against Rs. 16.79 in the case of the machine-washed. The weight of pearls from the machine-washed oysters was also markedly inferior, being but 7 manchadi per 1000 as against a weight of a little over $11\frac{1}{20}$ manchadi in the case of the hand-washed."

Mr. HORNELL adds: "Lest it should be thought that the two lots might have been taken from different localities, I wish to state that the whole 40,000 oysters were lifted on the same days and from the same parts of the bank. They were originally all piled on the deck of the inspection vessel, bagged under my supervision, and sent ashore in one lot. The final division after being landed was carried out by Mr. SAUNDERS, Assistant Government Agent, Manaar, and by Mr. G. G. DIXON conjointly, I not being present."

FISHERY PROSPECTS AND RECOMMENDATIONS.

As the result of this inspection in November, 1904, Mr. HORNELL reports that at the present time there are available for fishing the following oysters, all yielding a pearl valuation above Rs. 10 per 1000, the minimum at which it is considered profitable to fish a bank, viz.:—

Paar.	Estimated number of oysters.	Value per 1000.	Age next March.
		Rs.	years.
South Cheval	40,220,000	24.65	3 to $3\frac{1}{2}$
South-east Cheval	23,600,000	$10.76\frac{1}{4}$	3 ,, $3\frac{1}{2}$
Mid-east and South-central Cheval	13,750,000	13.21	3 ,, 6
South-west Cheval	3,500,000	—	$5\frac{1}{2}$,, 6
North Modragam	4,700,000	—	3 ,, $3\frac{1}{2}$
South Modragam	21,000,000	$17.86\frac{1}{2}$	3 ,, $3\frac{1}{2}$
Total	106,770,000		

The highest recorded number of oysters landed at any one fishery has been 44,311,441 in 1891. At the utmost we could not hope to lift above 50,000,000 at the next fishery and this would therefore leave rather more than half the number to fish in 1906. Thus the number of fishable oysters appears amply sufficient to give two large fisheries in 1905 and 1906 respectively and possibly a small one in 1907. This can probably be brought about, if a careful watch be kept upon the banks and if we take note of the various biological contingencies likely to menace the different beds of oysters during the next 18 months. Mr. HORNELL recommends that the order in which the banks should be fished be as follows, provided the inspection of

February next shows the position of matters to be much the same as at present, viz. :—

In 1905—(*a.*)	3,500,000	oysters	on the	South-west Cheval,
(*b.*)	21,000,000	,,	,,	South Modragam,
(*c.*)	4,700,000	,,	,,	North Modragam,
(*d.*)	13,750,000	,,	,,	Mid-east and South-central Cheval.
Total . .	42,950,000	oysters,		

leaving for 1906 and 1907 the unmixed oysters now aged between $2\frac{2}{3}$ and $3\frac{1}{6}$ years upon the South and South-east Cheval.

The 40,000,000 oysters on the South Cheval are, with the exception of the small patch of $5\frac{1}{2}$-year-olds on the South-west Cheval, the richest in pearls at the present moment, and it might be thought that Mr. HORNELL was assuming a grave responsibility in advising the postponement for a whole year of a fishery upon this bank. It must be remembered, however, that the section of the Cheval in question is very reliable, and has scarcely ever disappointed the hopes of the authorities. There are also the following special reasons for the course recommended :—

(*a.*) The Modragam oysters are unhealthy and liable to die off in great numbers within the next 12 months.

(*b.*) The South-west Cheval oysters, being nearly 6 years old, have all but reached the span of oyster existence, and, though as yet fairly healthy, cannot be expected to survive to 1906, when they would be nearly 7 years of age.

(*c.*) The oysters on the Mid-east and South-central Cheval are so densely covered with very young oysters, a few months old, that, judging from the results of similar competition seen repeatedly elsewhere during the last 3 years, the inevitable consequence will be that in a year's time, or even less, the growth of such enormous numbers of young will smother and kill off so large a proportion of the old that the bed will cease to be one of mature or fishable oysters. Fishing on this bed will, therefore, only be possible if carried out within the next 3 or 4 months. If fished within this time the bulk of the young oysters could be returned to the sea, and the bank will then be one of young oysters holding out good prospects of a fishery in 1908 or 1909.

The above are arguments in favour of fishing certain banks first. Those against immediate fishing on the South Cheval and the South-east Cheval are :—

The oysters on these two beds are at present in a healthier condition than those on any of the others; their growth is vigorous and they are not overcrowded with young oysters. The oysters are clean and wholesome in appearance, food is plentiful, and, so far as we know, no harmful agencies are present in a marked degree. These oysters offer every prospect of being able to survive till 1906—which cannot be said of any other bed of mature individuals now known.

In the case of the South-east Cheval there is also the obvious additional argument against fishing in 1905, derived from the small pearl yield given by the present valuation sample; a year's growth would, no doubt, result in an enhanced pearl value.

On the other hand, there is, of course, always a certain risk in leaving a fishable bed of oysters unfished, and, once the biological facts given above have been stated, it lies with the Government to decide what risk can be run and what course should be taken. If the 40,000,000 oysters on the South Cheval Paar, or a considerable number of them, can be fished in addition to the 43,000,000 which certainly ought to be secured first, there will, no doubt, be a large additional profit now—a present certainty in place of the prospect of a possibly much greater result next year.

Summary of the Prospects of Fisheries from 1905–1909.

The following forecast assumes (*a*) the adoption of the suggestion made above as to the order in which the banks be fished; (*b*) that extensive cultching operations be undertaken next year to improve the purely sandy areas; and (*c*) that no exceptional catastrophe happens, such as an inroad of rays or abnormal weather conditions.

1905.—A fishery numerically as extensive as that of 1904, to be held on the North and South Modragam paars, South-west Cheval Paar, Mid-east Cheval Paar, South-central Cheval Paar. [Possibly also the South Cheval Paar.]

1906.—A fishery of large extent upon the South and South-east sections of the Cheval Paar. [Unless the South be fished in 1905.]

1907.—A small fishery on the same grounds and possibly upon some small patches elsewhere.

1908.—A portion of the Northern and Central thirds of the Cheval Paar now covered with young oysters, if the pearl yield be then found sufficiently high to give a remunerative return.

1909.—A fishery upon the remainder left from the preceding year's fishery.

That accounts for all the beds of oysters, old and young, now in sight. During these five years other deposits of spat may fall upon reliable paars such as the Cheval. If not, young oysters for future fisheries must be transplanted from the Periya Paar, where they will no doubt be present in abundance from time to time.

Culture of the Banks.

In various parts of this Report Mr. Hornell and I have urged the necessity of transplanting large quantities of young oysters by means of a dredging steamer, in the event of no fall of spat occurring in the immediate future upon the unoccupied sections of the Cheval Paar. Accordingly, on setting out upon the past inspection, Mr. Hornell was authorised to employ the dredging steamer "Violet" for this purpose if, upon examination of the banks, he still considered this procedure necessary, and provided the conditions on the Periya and Cheval paars respectively were found suitable. Nature, however, proved unexpectedly generous; the last spatting season (August to September, 1904) must have been unusually bountiful, and the currents favourable, as the result has been that all the great blanks on the Cheval Paar and elsewhere have been filled up with young oysters in profusion.

The need for transplantation in consequence of this quite exceptional spat-fall has ceased to be urgent for the present season. The Government has been saved the considerable outlay which transplantation on the scale contemplated would have entailed. The dredging steamer consequently became available at the inspection for fishing mature oysters, and means were thus provided to supply Mr. G. G. DIXON with large numbers of oysters for experimental washing in the machine devised by him for this purpose. It must not be thought, however, that the necessity for transplanting has disappeared altogether. It is only postponed for a season, and might become urgent again at the next inspection if, for example, it were found that any catastrophe had occurred to the young oysters over any large section of the Cheval Paar. The Inspector of the Pearl Banks should be authorised to transplant from the Periya Paar whenever he may find it necessary.

The spat-fall has taken place equally upon sandy and upon rocky ground. That upon the latter may for the present be safely left without special attention, but the deposit upon the sandy areas requires careful nursing if it is to be brought to maturity and yield a fishery. The prime necessity is extensive cultching operations, the enriching of the surface of the sandy wastes of the South-central and North-east Cheval especially with large quantities of fragmentary hard material in order to furnish foothold to a few, at least, of the many millions of young oysters now existing there in a very precarious condition. These young oysters have upon such sections of the bank but few opportunities to make attachment to any fragments of a size and weight sufficient to resist the strength of the bottom currents during even moderately severe monsoon weather. They are liable at such times to be swept from the banks, more especially during the first two years of existence, when the shells are still light in comparison with their bulk, and when the small bunches into which they are aggregated are of just the right form to permit of their being readily rolled along the level stretches of the sandy areas till they finally perish.

Time and opportunity did not permit of the adoption during this last inspection of active measures for the protection of these young oysters upon anything approaching an adequate scale. All that Mr. HORNELL could do was to take from the beach at Marichchukaddi a quantity of nullipore balls (*Lithothamnion*, see fig. 16), dead coral and broken calcrete ("paar-rock") and spread that hard material over a small portion of the South Cheval area. He also directed the Master of the dredging steamer to instruct his crew to break up all large masses of rock and coral that came up in the dredge and to return the fragments to the sea. This is being done at present, and if carried out consistently will go some little way towards effecting what is desired. Much more active measures must, however, be taken to ensure an immediate improvement of the ground, and to save the spat now on the sand a great deal of cultching work must be done during the next three months.

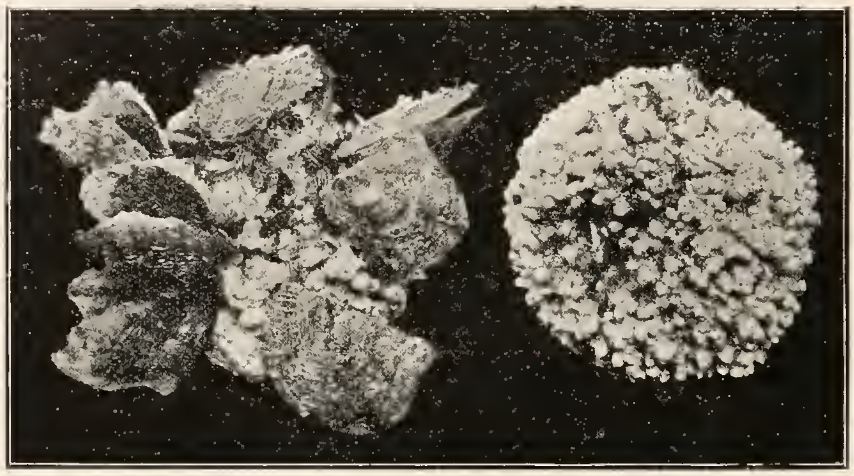


Fig. 16. Natural cultch (*Lithothamnion*) and, to the left, a similar Nullipore ball with a dozen young pearl oysters attached.

The cultching operation which Mr. Hornell has recommended to the Ceylon Government, and which I entirely approve of, is the disposal annually, for the next few years, of a quantity amounting to not less than 500 tons of rubble, carefully broken to a standard size of $3\frac{1}{2}$ inches $\times$ $3\frac{1}{2}$ inches $\times$ $2\frac{1}{2}$ inches, upon the South-central and North-east sections of the Cheval Paar. If it be possible to get any broken or waste tiles and bricks, such material is preferable to stone rubble and should be utilised so far as obtainable. The cost delivered on the banks of the above quantity should not exceed Rs. 1500, an insignificant sum compared with the enormous return in the form of oysters saved from destruction which we should reasonably expect to receive from this outlay. This quantity should, however, be regarded as the minimum annual amount; a much larger deposit of cultch would probably well repay the increased expenditure.* The ravages of ray-fish have been great during recent months upon some parts of the Cheval Paar, and it should be mentioned that the efficient strewing of rubble over the ground is probably one of the most feasible methods of stopping their depredations.

This section may appropriately end with a reference to the tabular statement on p. 36, drawn up by Mr. Hornell to show the present condition of the beds of oysters on the principal pearl banks.

* As this goes to the printer, I have received the information that the Ceylon Government has very wisely decided upon the larger measure of cultivation. Rs. 5000 in place of Rs. 1500 has, I understand, been placed upon the estimates to meet the expense of this year's cultching operations.

FURTHER REPORT ON PARASITES

FOUND IN CONNECTION WITH THE

PEARL OYSTER FISHERY AT CEYLON.

BY

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[WITH ONE PLATE.]

THE following short Paper is based on material collected by Mr. HORNELL largely from Elasmobranchs which frequent the Pearl Beds of Ceylon. The specimens unfortunately arrived too late for our account of them to be incorporated in the article on the "Parasites of the Pearl Oyster," published in the second volume of this Report, but as some of the forms are new and the Cestodes may possibly, though perhaps not probably, be the parent form of the pearl-producing larvæ, it has seemed advisable to publish this further instalment. Unfortunately our further researches throw no direct light on the problem of the *provenance* of the pearl-producing parasite.

I. CESTODA.

Staurobothrium ætiobatidis, n. gen. et sp.—Plate, figs. 1 and 2.

A considerable number of tapeworms, with large cruciform heads, were taken from the intestine of the Bird or Cockle-eating Ray, *Ætiobatis narinari*, MARCG., at Marichchukaddi, the centre of the recent pearl fishery.

The head has the form of a cross with very short broad arms (Plate, fig. 1). Each arm ends in a sucker which, however, does not penetrate far into the arm, and whose lumen is rather shallow. From the centre of the cross posteriorly arises the trunk, whilst anteriorly the centre bears usually a slight papilla with rings round it; the distinctness and size of this latter varies, however, greatly with the state of contraction of the specimen (Plate, fig. 2). In some specimens the head was swollen, and then its longitudinal diameter equalled its greatest transverse diameter, but, as a rule, the transverse axis is three times the length of the antero-posterior. There is no armature. Also there is no neck, the strobilization commencing immediately behind the head. The proglottides are at first many times as broad as long, but these proportions alter as we pass backward, and at the posterior end of the body they are perhaps one and a half times as long as they are broad. Each proglottis has a very well marked salient posterior border, and their shape and relative size at different regions of the body are well shown in fig. 1. Altogether there are about 100 proglottides, and the whole tapeworm measures on an average 1·5 centims. in length, and about 0·5 millim. to 0·7 millim. in breadth where it is broadest. These tapeworms were, when preserved in formalin, stout and stiff, with well cut outlines.

In transverse sections the proglottides are circular, and the genital pore opens for, at any rate, some consecutive proglottides on the same side, if one may speak of the side of a cylindrical body. It was not possible to make out details of the sexual organs beyond this fact, and that the uterus in the posterior proglottides is follicular.

As it has been impossible to find any figures or descriptions which correspond at all closely with this animal, we have ventured to establish a new genus which we propose to call *Staurobothrium*, and since it is found in the Bird Ray, I suggest the specific name of *ætiobatidis*. The name *Staurocephalus* would better have fitted the facts, but unfortunately it has been used before.

The formal definition is as follows:—

Staurobothrium, n. gen.

Cestode with large cruciform head, without hooks, genital pore lateral, no neck.

Staurobothrium ætiobatidis, n. sp.—Head without hooks or any armature, it consists of four well marked arms projecting from a centre, like the arms of a Maltese cross; each arm ends in a shallow sucker; anteriorly where the arms meet is a low annulated papilla representing the rostrum, but, as said above, there are no hooks. There is no neck. Each proglottis overhangs the one which succeeds it by salient angles forming a funnel-shaped skirt. The genital opening is on one side. The uterus, when full of ova, is follicular. The average length of the worm, with about 100 proglottides, is 15 millims., the average width from 0·5 millim. to 0·7 millim.

The systematic position of this Cestode is obscure. In structure the head superficially resembles that of *Cylindrophorus*, Dies., but it bears no hooks. Very little change would be required in the architecture of the head to turn *Staurobothrium* into the *Calyptobothrium* of Monticelli, but the terminal sucker of the latter is absent in the new genus. In this respect it differs also from Linton's genus *Crossobothrium*. On the whole I think we are justified in placing *Staurobothrium* in the family Phyllobothriidæ, and not very far from the genus *Phyllobothrium*, van Ben.

Tetragonocephalum trygonis, n. gen. et sp.—Plate, figs. 3, 4, 5, 6, 7 and 8.

A number of very minute Cestodes were found in the alimentary canal of *Trygon walga*. It frequently happens that most delicate tapeworms are found in the most powerful and voracious Elasmobranchs, and nothing could be more delicate and fragile than the Cestodes in question. The worms are fragile, and very limp when preserved in formalin. They do not lie stiff and distinct as do those described above from *Ætiobatis narinari*, but they are entangled together and form a mass like a knot of chewed fine white cotton thread (Plate, fig. 3).

The head forms a distinct knob, hardly more than visible to the naked eye, borne on the slender neck. Its diameter is some 0·03 millim. and its antero-posterior axis is nsually rather less than its diameter from side to side. In some specimens, as in the one shown in fig. 3, the head is swollen, and its longitudinal axis is longer than its transverse. It is a cnrious cushiony-looking head, consisting of two distinct parts. Anteriorly there is a circular and rounded knob, about twice as broad as it is long and resembling in shape the stones which are used in the Scottish sport of cnrling. This probably corresponds with the rostellum of other forms. It is quite unarmed (Plate, fig. 4). This rounded rostellum rests on a second region like a crown upon a cushion. This second region is square in outline, and at each of its corners it carries a small bnt distinct sncker, the orifice of which is minute. From these suckers small papillæ protrude, passing through their orifice. The rostellum is separated from the sqnare sucker-bearing portion by a thick basement membrane, and it is traversed by many muscle bundles. Similar bundles are attached to the hinder surface of this basement membrane and run down into the neck, where they soon fade away.

The neck is short, and the narrow strictures separating the nascent proglottides commence close behind the head. The constrictions between the proglottides always remain slight; the older proglottides somewhat resemble those of *Dipylidium cucumerinum*, but are less distinct and, except for the slightest possible thinning between adjacent proglottides, the posterior part of the Cestode, after it has attained a certain dimension, remains the same width throughout. At the same time, every here and there there are constrictions which do not seem to correspond with the divisions between proglottides. These are well shown in Plate, fig. 3.

The reproductive apertures are lateral, and the penis lies concealed in a spacious recess (Plate, fig. 6). The pores irregnlarly alternate, some four being in the left followed by one or two on the right, then a few on the left and again perhaps four on the right. At its first appearance the nterus seems double, an anterior and a posterior part lying one in front and one behind the genital pore; the two are, however, in communication by a narrow channel (Plate, figs. 5, 6 and 7). The whole uterus in the ripe proglottides is thus somewhat dumb-bell-shaped, the narrow part being pinched in by the cirrus bulb. The ova are slightly oval.

At first it might be thought that we had to do with a tapeworm of the same genus as LINTON'S *Lecanicephalus*, but on referring to his description* and figures it is evident that this can hardly be the case. LINTON describes the head as "consisting of two disciform plates," but he figures a round anterior part lying in the foremost plate. The figure is very poor and we may be wrong in this interpretation, which, however, is strengthened by his comparison of *Lecanicephalum* with the *Discobothrium* of VAN BENEDEN, for in this genus the head is divided into three distinct parts. The disks of *Lecanicephalum* are nearly circular, and the posterior bears four suckers, but there is no mention of any papillæ projecting from them. VAN BENEDEN'S genus *Discobothrium* found in *Trygon pastinaca* is figured, but not described by him.† It has two distinct circular disks, corresponding with the rounded anterior part and the first disk of *Lecanicephalum*, and then a thicker somewhat cruciform disc with very salient angles which terminate in suckers. Our specimen has the anterior round part—the curling stone as we have described it—resting on a quadrangular cushion with suckers at the angles. On the whole it seems that we must describe it as a new genus, and this we do under the name *Tetragonocephalum*, from the square cushion which forms the larger part of the head.

Tetragonocephalum ætiobatidis, n. sp.—Plate, figs. 9 and 10.

A single specimen of another Cestode of apparently the same genus was found with those described above in *Ætiobatis narinari*. Its length was 1·3 centims., and its breath, which was remarkably uniform behind the head, was 0·5 millim. (Plate, fig. 9). The head was three times this breadth and consisted of a rostellum, long and conspicuous and unarmed, and of a swollen base, squarish in cross-section, with four small suckers at the anterior angles (Plate, fig. 10). Posteriorly the basal portion overlapped the anterior proglottides. There is no neck, but the proglottides appear immediately after the head, at first very narrow but with marked constrictions; as they increase in size the posterior angle becomes salient, less so, perhaps, than in *Staurobothrium ætiobatidis*, but more so than in *Tetragonocephalum trygonis*. The last three proglottides are twice the length of those which immediately precede them and this growth is somewhat sudden.

The head, though it differs greatly in its proportions, resembles in essentials the head of *T. trygonis*. The marked saliency of the posterior edge of the proglottides separates off the species in question from the species which inhabits *Trygon walga*. As there was but a single specimen, it did not seem advisable to cut it, and as it was preserved in osmic it was not possible to make out anything of the internal anatomy.

The definition of this genus is as follows:—

* 'U.S.A. Commission of Fish and Fisheries,' 1891, p. 802.

† 'Mem. Ac. Belgique,' xxxviii., 1871.

Tetragonocephalum, n. gen.

Head unarmed, consisting of an anterior knob-like portion arising from a cubical base; the four posterior corners of the cubical base have minute suckers, each with a papilla.

This genus would be a member of the family Lecanicephalidæ, and would probably come not very far from the genus *Lecanicephalum*, LINT., in BRAUN'S classification given in BRONN'S "Thierreich."

The species above described may be formally defined as follows:—

Tetragonocephalum trygonis, n. sp.—Fragile, minute, head hardly visible to the naked eye; length of body 2–4 centimetres: in section the head is circular and the proglottides almost so, their greater diameter being 0·03 millim.; head consisting of a curling-stone-shaped anterior portion resting on a square cushion with suckers at each corner from which a papilla protrudes; neck short; furrows between contiguous segments very slight and in some places invisible; reproductive pores lateral and irregularly alternate; genital recess large, and the remains of this constrict the ripe uterus into a dumb-bell-shaped structure.

Tetragonocephalum ætiobatidis, n. sp.—Minute head not much more than visible to the naked eye; length of body and head 1·5 centims.; head consists of an elongated rostellum, unarmed, which projects freely from an almost cubical base, this base is as long or longer than it is broad; at its anterior angles it bears four small suckers; there seems to be no, or at most a very short, neck; the proglottides overlap.

II. TREMATODA.

In the following account of two Trematodes, one from *Balistes* sp. and the other from either a species of *Carcharias* or *Rhinodon typicus*, the "basking shark"* of tropical waters, we are much indebted to Mr. NORMAN MACLAREN both for notes on the structure of the animals and for the drawing of fig. 11 on our Plate.

Distoma palleniscum, n. sp.—Plate, fig. 11.

This Trematode comes very near *D. pallens*,† but differs from it in having certain peculiarities which seem of specific rank. *D. pallens* was found in *Chrysophrys aurata*, CUV., by the authors mentioned in the footnote, and by LINTON in *Alutera*

* There is some doubt as to the host represented by the "basking-shark." The "basking-shark" of the Indian Ocean, according to the books, is the rather rare *Rhinodon typicus*, but Professor HERDMAN'S recollection is that the term was applied by the sea-going men to a *Carcharias*. A drawing of one of these sharks caught on the pearl banks has, however, been identified by Mr. BOULENGER as *Stegostoma tigrinum*.

† RUDOLPHI, 'Entozoorum Synopsis,' 1819, pp. 111 and 410; DUJARDIN, 'Hist. Nat. d. Helminthes,' pp. 457 and 458; DIESING, 'Syst. Helm.,' vol. 1, p. 348; STOSSICH, 'Saggio di una Fauna Elmint. di Trieste,' p. 47; 'LINTON, 'Proc. Nat. Museum,' vol. 20, pp. 526 and 527, plate xlvii., figs. 8 and 9.

schæpfii. The present species is from the intestine of *Balistes* sp., the File- or Trigger-fish found on the Ceylon pearl banks (Plate, fig. 11). The distoma is characterised as follows:—Length 5 millims.; perfectly smooth skin; anterior sucker almost globular, with a relatively small mouth; the pharynx does not directly abut on the anterior sucker; œsophagus wide; digestive cæca reach to posterior end; yolk-glands extraordinarily prominent, arranged in 2 rows, one on each side and behind the testes; the shell glands and receptaculum seminis not easy to distinguish, but they lie anterior to the ovary; the termination of the vas deferens is apparently eversible and is probably used as a penis; a definite penis is absent; numerous glands surround the terminal parts of both the male and the female ducts.

This species seems to differ from the *Distoma pallens* of RUDOLPHI in the facts (i.) that the ventral sucker is not twice the size of the oral, (ii.) the aperture of the ventral sucker is rounded and is not a transverse slit, (iii.) the ovary is not globular, (iv.) the yolk-glands are prominent and arranged in two rows.

Distomum richiardii, LOPEZ.

Many specimens of this elegant little Trematode were taken from the perivisceral cavity of *Rhinodon typicus.* The species has recently been described by MONTICELLI,* who has found it in the body-cavity of *Acanthias vulgaris* and more rarely in *Mustelus vulgaris* and *Myliobatis aquila*, in the Bay of Naples.

III. NEMATODA.

Cheiracanthus spinosissimus, n. sp.—Plate, figs. 12 and 13.

Length 13·7 millims., breadth 0·45 millim.; œsophagus $\frac{1}{15}$, and the conical tail, which is round quite at the end, is $\frac{1}{31}$ of the whole body-length; cuticle 0·022 millim. thick, tough, transversely wrinkled; head end rounded like the mouth of a Turkish pipe (Plate, fig. 12); four tongue-like projections pointing backwards in the intermediate areas; 30 to 33 transverse rings, each consisting of some hundreds of spines; six lips around the mouth; four neck glands of $\frac{2}{3}$ to $\frac{3}{4}$ the length of the œsophagus, in front these are thin, with two swellings, but they thicken behind and contain spiral muscles; intestine dark brown; the tail has on each side two præ-anal and four post-anal papillæ, arranged as shown in fig. 13; the papillæ in outline resemble a skittle; cirri equal and 0·7 millim. long.

This Nematode was obtained from *Myliobatis aquila*, in the Gulf of Manaar.

This above definition has been furnished by Dr. VON LINSTOW, who kindly undertook to investigate the *Cheiracanthus.* He adds that this new species differs from *C. unicinctus* both in its head and in its neck glands.

* 'Zool. Jahrb. Syst.,' vi., Supplement, 1893.

LIST OF PARASITES WITH THEIR HOSTS.

The species described in this and the previous Paper are as follows :—

PARASITE.		HOST.
CESTODA :—		
Small Cestode larvæ	from	*Margaritifera vulgaris.*
Tetrarhynchus unionifactor	,,	,, ,,
,, *balistidis*	,,	*Balistes mitis*, *B. undulatus*, and *B. stellatus.*
,, *pinnæ*	,,	,, ,, ,,
,, *minimus*, v. LINS	,,	*Tæniura melanospilos.*
Staurobothrium ætiobatidis	,,	*Ætiobatis narinari.*
Tetragonocephalum trygonis	,,	*Trygon walga.*
,, *ætiobatidis*	,,	*Ætiobatis narinari.*
TREMATODA :—		
Muttua margaritiferæ	,,	*Margaritifera vulgaris.*
Musalia herdmani	,,	,, ,,
Aspidogaster margaritiferæ	,,	,, ,,
Distomum palleniscum	,,	*Balistes* sp.
,, *richiardii*	,,	*Rhinodon typicus.*
NEMATODA :—		
Ascaris meleagrinæ	,,	*Margaritifera vulgaris.*
Cheiracanthus uncinatus	,,	,, ,, larva, and *Balistes mitis* and *B. stellatus.*
,, *spinosissimus*	,,	*Myliobatis aquila.*

EXPLANATION OF PLATE.

Fig. 1. *Staurobothrium aetiobatidis.* × 12.

,, 2. Anterior end of the same more highly magnified.

,, 3. *Tetragonocephalum trygonis.* × 24.

,, 4. Another head of the same, showing different dimensions. × about 75.

,, 5. Some mature proglottides of the same more highly magnified, showing the dumb-bell-shaped uterus.

,, 6. Transverse section through the same, showing the penis, the genital recess, and the narrow part of the uterus.

,, 7. Another transverse section, showing the opening of the genital recess to the exterior.

,, 8. A third transverse section nearer the end of a proglottis, showing the uterus taking up almost all the space.

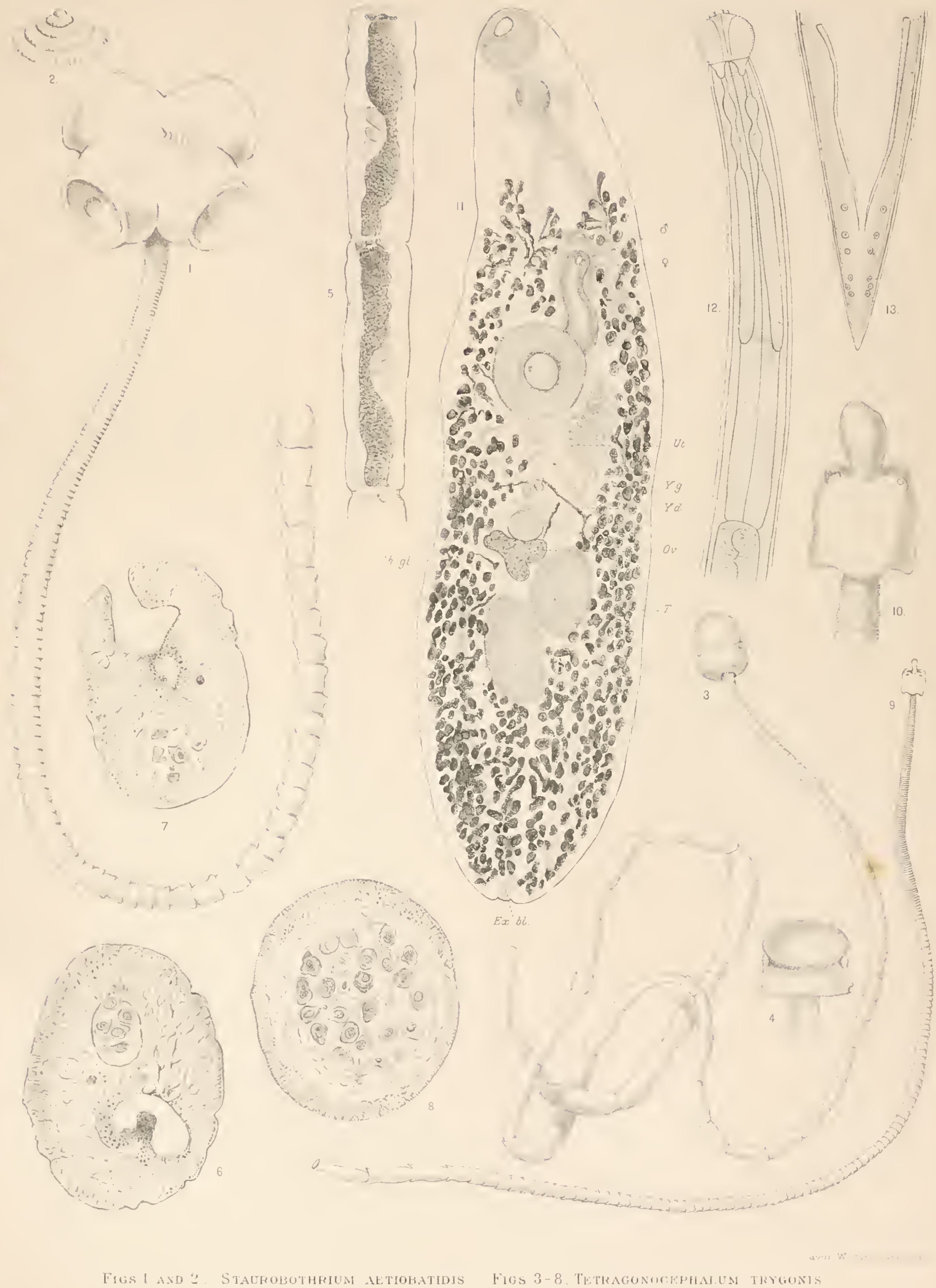
,, 9. *Tetragonocephalum aetiobatidis.* × about 20.

,, 10. The head of the same. × 75.

,, 11. *Distomum pallenisœum.* *Ex.bl.*, excretory vesicle; *Ov.*, ovary; *Sh.gl.*, shell glands; *T.*, testis; *Ut.*, uterus; *Y.g.*, yolk glands; *Y.d.*, yolk ducts; ♂, male, and ♀, female, reproductive pores.

,, 12. *Cheiracanthus spinosissimus*, head end.

,, 13. The same, tail end.



Figs 1 and 2. Staurobothrium aetiobatidis Figs 3-8, Tetragonocephalum trygonis
Figs 9 and 10. Tetragonocephalum aetiobatidis. Fig. 11, Distomum palleniscum
Figs. 12 and 13, Cheiracanthus spinosissimus.

REPORT

ON THE

SPONGES

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH PLATES I. TO XVI.]

INTRODUCTION.

CONSIDERING the frequent opportunities for collecting which have been afforded by the Pearl Fisheries of Ceylon, it is remarkable that our knowledge of the Sponge-Fauna of this locality, rich and varied as it is, should so long have remained in so backward a condition. In 1887, Mr. RIDLEY and I (1)* called attention to this fact in our Report on the Monaxonida collected by H.M.S. "Challenger," but as the "Challenger" unfortunately did not visit Ceylon, the results of that memorable voyage did nothing towards improving matters in this respect. In the same year, however, as that in which our "Challenger" Report was published, I was able to report (2) also upon a collection of sponges from Madras, made by Mr. EDGAR THURSTON, the Superintendent of the Government Central Museum, and again in 1889 I reported (3) on a second collection of sponges made by the same Zoologist in the Gulf of Manaar. In this way considerable additions were made to our knowledge of the Sponge-Fauna of Ceylon and Southern India, but Mr. CARTER's papers (4, 5) on the sponges collected in the Gulf of Manaar by Captain W. H. CAWNE WARREN still remained the principal works on the subject; a very remarkable fact, when we remember the extraordinarily

* The numbers in brackets refer to the List of Literature at the end of the Report.

small bulk of the material which he investigated and amongst which he found altogether something like 70 species—a notable addition indeed to the 13 or so previously described from the same neighbourhood by Esper (**6**), Haeckel (**7**), Bowerbank (**8**), and Holdsworth (**9**).

The collection of sponges (146 species) made by Professor Herdman is, however, far more extensive than any previously obtained in Ceylon waters, and includes not only a large proportion of the species already described by the authors mentioned, but also a considerable number (77 species) of new ones, some of which are of very great interest. With the exception of the Calcarea, which are singularly few in number, and of the Hexactinellida, which are, of course, a deep-water group and not likely to be met with in the neighbourhood of the pearl banks, the collection contains representatives of practically all the important sub-divisions of the Phylum. In dealing with so large a mass of material, the question of classification has assumed a very formidable aspect, and I have found it desirable to make certain modifications in this respect which I hope may be regarded as improvements. These modifications will be duly explained, and I hope justified, in the proper place.

Since, in spite of the enormous advances which have been made during the last twenty years in our knowledge of the sponges, our ideas as to taxonomy are not yet by any means in a settled condition, I have considered it desirable to give brief diagnoses of the various sub-divisions with which I have to deal, in order that there may be no mistake as to the sense in which I employ them. We are, undoubtedly, progressing rapidly towards a satisfactory and natural classification of the group, but the problem is an extremely difficult one, and every new collection of any considerable extent, such as the present, must for a long time to come necessitate more or less modification of existing views. The classification which I have adopted may at present be regarded as the latest of these modifications, based principally upon the writings of Sollas, Ridley, Lendenfeld, Topsent, and myself. Topsent, in particular, has done much in the last few years both in arranging and classifying the chaotic mass of information left by earlier writers, and in making notable additions to our systematic knowledge of this difficult but interesting group.

In order to facilitate reference to the type specimens by future workers and to make the systematic portion of this report as precise as possible, I have adopted the system, already employed in my Catalogue of Non-Calcareous Sponges collected by J. Bracebridge Wilson, &c. (**10**), of giving at the end of the description of each species the Register Number (R.N.), which I have attached to each specimen. This method also has the great advantage of enabling one to refer readily to individual specimens in the text.

At the conclusion of the Report I propose to give as complete a list as possible of the Sponge-Fauna of Ceylon and to discuss the problem of Geographical Distribution. In the meantime I append a list of the principal memoirs dealing with the subject arranged in chronological order.

Special Bibliography of the Ceylon Sponge-Fauna.*

1798–1806. Esper.—"Fortsetzung der Pflanzenthiere," Part 2.

1870. Ehlers.—"Die Esper'schen Spongien." (In this memoir the author re-describes two Ceylon species.)

1872. Haeckel.—"Die Kalkschwämme." (This work includes descriptions of half a dozen species of Calcareous Sponges collected by Wright in Ceylon waters.)

1873. Bowerbank.—"Report on a Collection of Sponges found at Ceylon by E. W. H. Holdsworth, Esq.," 'Proc. Zool. Soc. Lond.,' 1873, p. 25. (This paper contains descriptions of only four species. It was criticized by Gray in 'Ann. and Mag. Nat. Hist.,' Ser. 4, vol. XII., p. 266.)

1873. Holdsworth.—"Note on the Occurrence of *Xenospongia patelliformis*, Gray, on the Coast of Ceylon," 'Proc. Zool. Soc. Lond.,' 1873, p. 32.

1880. Carter.—"Report on Specimens dredged up from the Gulf of Manaar and presented to the Liverpool Free Museum by Captain W. H. Cawne Warren," 'Ann. and Mag. Nat. Hist.,' Ser. 5, vol. V., p. 437; vol. VI., p. 35 and p. 129. (In this paper the author describes fifty-four species, the great majority new, from material which he tells us would hardly fill a quart measure, the largest of the specimens being not more than three inches in its longest diameter.)

1881. Carter.—"Supplementary Report on Specimens dredged up from the Gulf of Manaar, &c.," 'Ann. and Mag. Nat. Hist.,' Ser. 5, vol. VII., p. 361. (A considerable number of species are added to the previous list.)

1884. Ridley.—"Zoological Collections of H.M.S. 'Alert,'" British Museum. (The author refers incidentally to the Sponge-Fauna of Ceylon.)

1887. Dendy.—"The Sponge-Fauna of Madras. A Report on a Collection of Sponges obtained in the neighbourhood of Madras by Edgar Thurston, Esq.," 'Ann. and Mag. Nat. Hist.,' Ser. 5, vol. XX., p. 153.

1888. Sollas.—"Report on the Tetractinellida collected by H.M.S. 'Challenger.'" (In this work the author deals critically with the Tetractinellida described by Carter from the Gulf of Manaar.)

1889. Dendy.—"Report on a Second Collection of Sponges from the Gulf of Manaar," 'Ann. and Mag. Nat. Hist.,' Ser. 6, vol. III., p. 73. (The list of the Ceylon Sponge-Fauna is herein considerably extended, and the report contains records made by Mr. Thurston of the colours of many of the species when alive.)

1889. Lendenfeld.—"Monograph of the Horny Sponges," 'Royal Society.'

* This list includes only works which deal directly with Ceylon species, and was inserted here on account of its historical interest. In the course of the Report I shall have occasion to refer to many other memoirs, and, in order to conform with the system adopted in the other Reports of this series and to save space, I have decided to give a full list of the literature cited at the end of the work and to refer to it by means of numbers.

SYSTEMATIC DESCRIPTION OF THE GENERA AND SPECIES OF SPONGES IN PROFESSOR HERDMAN'S COLLECTION.

Phylum PORIFERA.

Class: NON-CALCAREA.

Porifera without calcareous spicules.

The non-calcareous sponges are divisible into four natural groups, for which I propose to use the names Myxospongida, Triaxonida, Tetraxonida, and Euceratosa respectively, and which may be conveniently regarded as of ordinal rank.

Order: MYXOSPONGIDA.

Non-calcarea which are primitively destitute of spicules and horny fibre; with simple canal system and usually large flagellate chambers.

In this order I include the genera *Halisarca*, *Bajalus*, *Hexadella*, and *Oscarella*, all of which appear to me to be nearly related to one another, so that it is hardly necessary to divide them, as is usually done, into two families, Halisarcidæ and Oscarellidæ. All of them are, I believe, primitive forms, and should therefore stand at the bottom of the series of non-calcareous sponges.

It is quite possible that Lendenfeld's "Hexaceratina" may be closely related to the "Halisarcidæ," as supposed by that author; but, if so, it appears to me that the Halisarcidæ are the more primitive forms, from which both Hexactinellida and Hexaceratina have been derived. Lendenfeld, on the other hand, appears to regard the Halisarcidæ as being derived from the Hexaceratina by loss of horny fibres, and in this opinion he is followed by Topsent (**11**), who observes "Dépourvu à la fois de spicules et de fibres cornés, le genre *Hexadella* est vraiment le dernier chaînon de la chaîne des Hexaceratina et doit occuper la place qu'on a parfois assignée, sans raison valable, aux *Halisarca*."

The Myxospongida may therefore be regarded as representing a common starting point, from which have originated the Triaxonida, the Tetraxonida, and the Euceratosa, and I cannot agree with Professor Minchin (**12**) in placing this order at the end of the siliceous series instead of at the beginning. The primitive character of the canal system argues strongly against the belief that they are forms in which the skeleton has been lost by gradual reduction, and the case is obviously quite different from that of *Chondrosia*, whose highly specialized canal-system, strongly developed cortex, and evident relationship to *Chondrilla*, afford good grounds for regarding it as a reduced siliceous sponge in which the absence of skeleton is a secondary and not a primary character.

Hexadella, Topsent.

Myxospongida with large, sac-shaped flagellate chambers and a distinctly differentiated, tough ectosome.

The description given by Topsent (*loc. cit.*, p. 119) of this genus and of the two species which he includes in it is evidently of a preliminary character and is unfortunately without illustrations. His own diagnosis of the genus runs, "Hexaceratina revêtantes, molles, sans spicules ni fibres cornés; un peu plus épais que dans les genres voisins, l'ectosome jouit seul de quelque consistance et sert, dans une certaine mesure, de squelette externe à la masse."

As the genus is as yet so little known, I shall postpone the discussion of its relationship until I have described in some detail the anatomy of the Ceylon species.

Hexadella indica, n. sp.—Plate I., figs. 1–3.

Sponge thin, encrusting; spreading extensively over masses of calcareous Polyzoa and other organisms, but usually only about 1 millim. in thickness. Colour in spirit, grey (in life, red?). Surface smooth, glabrous, minutely reticulate. Vents few, minute, scattered. Consistence (in spirit) rather tough and membranous (owing chiefly to the ectosome), so that the sponge can be stripped off from the substratum like a skin.

The ectosome (Plate I., fig. 1, *Ect.*) forms a tough pellicle about 0·08 millim. thick, which can be stripped off from the underlying choanosome. The choanosome evidently consists of a thin lamella (fig. 1, *Ch.L.*, fig. 2), very much folded upon itself. The lamella itself is little, if any, thicker than the ectosome, and contains a single layer of large, sac-shaped flagellate chambers (figs. 1, 2, *F.C.*), whose arrangement, of course, follows the curvature of the lamella. The structure of the choanosome thus reminds one very strongly of what occurs in *Oscarella*, but there is no extensive internal portion free from flagellate chambers as in that genus.

Between the folds of the choanosomal lamella lie the primary inhalant (*P.I.C.*) and exhalant (*P.E.C.*) canals. The former expand at their outer ends into large, irregular crypts (fig. 1, *Cr.*), roofed over by the ectosome, which merges insensibly into the choanosome at the points of contact. These crypts, resembling subdermal cavities, may sometimes be seen from the surface, ramifying horizontally beneath the ectosome. The primary exhalant canals open at their inner ends into larger exhalant channels (fig. 1, *L.E.C.*).

Owing to the development of the ectosome, the water does not enter the primary inhalant canals directly, as in *Oscarella*, but by means of numerous well-developed "chones" (fig. 1, *Ch.*), which penetrate the ectosome at right angles to the surface. Each chone expands somewhat at its outer end in a trumpet-like manner, and is covered over by a membrane (fig. 3, *Mem.*) which doubtless contains the inhalant pores, but the pores are now all closed and cannot be recognised. I have, however, seen indications, in the form of fine, slit-like canals in the closing membrane, of the existence of several minute pores in the roof of each chone.

From the primary inhalant canals the water reaches the flagellate chambers by fine, sometimes branching canaliculi of considerable length (fig. 2, *I.Ca.*). The chambers themselves (figs. 1, 2, *F.C.*) are sac-shaped, unbranched (at any rate usually) and up to about 0·098 millim. long, though usually less (say about 0·065 millim.). They open into the primary exhalant canals either directly (eurypylous) or through short exhalant canaliculi.

The mesoglœa, both of the ectosome and choanosome, is abundantly developed and chiefly collenchymatous, with a profusion of small connective-tissue cells (fig. 2, *C.T.C.*) with much-branched processes. The mesoglœa of the ectosome passes insensibly into that of the choanosome at the points of contact; the former, however, stains rather more darkly than the latter, and is often distinctly, though very finely, fibrillated.

In the mesoglœa we also find embedded a large number of small, darkly staining, spherical cells (figs. 1, 2, 3, *Sy.A.*), about 0·006 millim. in diameter, sometimes apparently with small central nuclei. These cells are most abundant around the various parts of the inhalant canal-system, and are congregated in immense numbers in the inner portion of the ectosome. They sometimes appear to be broken up into groups of smaller cells. They are in all probability symbiotic algæ, such as are known to occur frequently in sponges, a conclusion which is rendered almost certain by the fact that, when treated with iodine and sulphuric acid, they give a distinct purple coloration (although it must be admitted that when tested for starch with SCHULTZE'S solution, only negative results were obtained). These bodies are probably closely comparable to the "cellules sphéruleuses" to which TOPSENT (*loc. cit.*, p. 120) attributes the red colour of his *Hexadella racovitzai*, and which are also (in my opinion) probably symbiotic algæ. Unfortunately, I have no information as to the colour of *Hexadella indica* in life, but if, as seems just possible, it is identical with CARTER'S *Halisarca rubitingens*, it is also red, and the colour may likewise be attributable to the symbiotic algæ.

This very interesting sponge appears to form a connecting link between the three genera *Oscarella*, *Halisarca*, and *Hexadella*, to which latter genus I have referred it only after long hesitation. It resembles the first in the distinctly folded character of the choanosomal lamella and the arrangement of the flagellate chambers, which are, however, much larger and usually (though not always) eurypylous, while a more important distinction is introduced by the strong development of the ectosome. The structure of the ectosome, the absence of the curious connective-tissue fibres, and the unbranched character of the flagellate chambers, together with the less extensive development of the mesoglœa, separate it from *Halisarca*. The mesoglœa appears, however (as far as one can judge from TOPSENT'S description), to be a good deal more extensively developed than in his species of *Hexadella*. TOPSENT says nothing about the existence of a distinctly folded choanosome lamella, or of inhalant chones, in his species, and it is quite possible that a new genus may be necessary for the reception of the Ceylon sponge, but this is a point which cannot be decided until we have more information as to the European species.

Hexadella indica may, as I have already suggested, possibly be identical with CARTER's *Halisarca rubitingens* (5), which was described from *dry* material from the Gulf of Manaar and referred to the genus *Halisarca* provisionally by its author. Having examined one of Mr. CARTER's original preparations of *Halisarca rubitingens*, now in my possession, I have come to the conclusion that we cannot say for certain what that organism was, and that it will be best to abandon the name altogether.

R.N. 26, 46 (Gulf of Manaar), 254 (south of Adams Bridge, 5 fathoms).

ORDER: TRIAXONIDA (HEXACTINELLIDA).

Non-calcarea in which the skeleton is composed of siliceous spicules whose fundamental form is triaxonid and hexactinellid.

Owing, doubtless, to the collecting operations having been confined to comparatively shallow water, there are no representatives of the Hexactinellida in the collection. There are, however, a few specimens of the so-called Hexaceratina which may be found ultimately to belong here. As, however, I do not consider that their systematic position is yet definitely settled, I have decided to deal with them later on, in connection with the other horny sponges (see below, p. 200).

ORDER: TETRAXONIDA.

Non-calcarea in which the fundamental form of the spicule is tetraxonid and tetractinellid. The spicules may, however, be more or less reduced, and also to a greater or less extent replaced by spongin or even sand.

It will be seen that I use the term Tetraxonida in a wider sense than that in which it is employed, for example, by MINCHIN, in his admirable article in LANKESTER's 'Zoology.' It appears to me necessary to do this in order to bring out the most fundamental character of the group, viz., the primitively tetraxonid and tetractinellid character of the spicule, in contrast with the triaxonid and hexactinellid character of the spicule in the Triaxonida.* The term Tetractinellida may be reserved for those non-Lithistid Tetraxonida which retain to a greater or less extent the primitive spicule-form, a form which doubtless characterised the ancestors of all the Tetraxonida, but has been lost by reduction in many of the existing members of the group.

The Lithistida have evidently developed along special lines of their own, and

* The occurrence of triods in the most primitive family of the Tetraxonida (viz., Plakinidæ) suggests a triaxonid (and triradiate) precursor of the tetraxonid and tetractinellid spicule. The triaxonid spicule of the Plakinidæ is, however, a fundamentally different form from that of the Triaxonida (Hexactinellida).

include both tetractinellid and monaxonellid forms, they may therefore be most conveniently regarded as constituting a separate "grade." By this exclusion of the Lithistida, the term Tetractinellida is confined to SOLLAS's group "Choristida," a sense in which it has already been employed by LENDENFELD in his work on the Tetractinellida of the Adriatic (13).

Recent researches, however, have shown that the Tetractinellida, Lithistida, Monaxonellida, and certain horny sponges which I propose to call Pseudoceratosa, are so closely related to one another that they must certainly be included in one and the same order. Indeed, it is difficult to draw a hard and fast line between these sub-divisions, which merge very gradually into one another. It is certain that the Monaxonellida have been derived (probably polyphyletically) from ancestral Tetractinellida, and the Pseudoceratosa (or, at any rate, the great majority of them) from ancestral Monaxonellida (probably polyphyletically), while the Lithistida may also be of polyphyletic origin and are closely related to the Tetractinellida on the one hand and to the Monaxonellida on the other.

The sharp separation of these four groups is, therefore, to a large extent artificial, but must be retained as a matter of convenience till we know a good deal more about their phylogeny. It must, however, be clearly recognised that the groups Tetractinellida, Lithistida, Monaxonellida, and Pseudoceratosa simply represent stages in a complex evolutionary series, commencing with the first-named group, and that each of the later stages may possibly have been reached along more than one line of descent.

GRADE: TETRACTINELLIDA.

Tetraxonida in which the primitive tetraxonid and tetractinellid condition (or a possibly still more primitive triaxonid and triradiate condition) is retained by some at least of the spicules, while no desmas are developed.

SUB-ORDER: HOMOSCLEROPHORA.

Tetractinellida in which microscleres and megascleres are not yet sharply differentiated from one another and no triænes are developed.

I venture to propose the name Homosclerophora to replace the old name Microsclerophora of SOLLAS. The latter is very misleading in that it does not indicate the primitive undifferentiated character of the spicules as regards size, and leaves it to be inferred that microscleres, as distinct from megascleres, are present.

TOPSENT (14), followed by MINCHIN (12), associates the Homosclerophora (Microsclerophora) with the "Microtriænosa" and the "Oligosilicina" in one group, to which he gives the old name "Carnosa." This appears to me a most undesirable proceeding, for while the Homosclerophora (especially the Plakinidæ) are evidently primitive forms, as SOLLAS (15) long since pointed out and as is clearly shown by their anatomical characters, the "Microtriænosa" are what MINCHIN terms "a heterogeneous collection of sponges of divers affinities," and the "Oligosilicina" ("Chondrosidæ," of SCHULZE) are simple only by the reduction of the skeleton and not primitively. I therefore consider that TOPSENT'S revived "Carnosa" should be again abandoned, the "Microtriænosa" placed amongst the other triæne-bearing Tetractinellida, and the "Oligosilicina" placed near the Tethyidæ, to which they are evidently allied by their corticate character, the general arrangement of their canal-system, and the astrose microscleres of Chondrilla.

The Homosclerophora are thus left as the natural starting point of the Tetraxonid series, a position already clearly indicated for them by LENDENFELD in his work on the Tetractinellida of the Adriatic. TOPSENT, it is true, fully recognises the artificial character of his "Carnosa" and places them after his "Tetractinellida." MINCHIN, on the other hand, places them first, a diversity of opinion which clearly indicates the impracticability of associating together such widely different forms as are included in the group.

Owing to their primitive character, the Homosclerophora form a very important and interesting sub-order, and it is here that we must seek for the origin, not only of the various types of canal-system, but also of the almost innumerable types of both micro- and megascleres met with amongst the Tetraxonida.

FAMILY: PLAKINIDÆ.

Homosclerophora in which no distinct cortex is developed.

This appears to be the most primitive family of the Tetraxonida. The genus *Plakinastrella*, formerly included herein, but possessing more or less well-developed triænes, finds a more natural position amongst the Pachastrellidæ.

Dercitopsis, n. gen.

Plakinidæ with calthrops, triods and smooth oxea, but no candelabra. The oxea vary greatly in size, and some of the smaller ones form a special dermal layer, in which they are commonly arranged at right angles to the surface.

It is, perhaps, doubtful whether this genus ought to be separated from *Plakortis*, but the species for which it is founded differs from the type species of *Plakortis* (*P. simplex*) in three respects:—(1) Calthrops are present as well as triods; (2) some of the oxea are so large as to deserve the name of megascleres, although they pass gradually into the smaller forms (microxea); (3) some of the microxea form a special dermal layer, in which they are commonly arranged at right angles to the surface.

In this genus we have a refutation of SOLLAS'S statement that "megascleres are absent" from the so-called "Microsclerophora" (including the Plakinidæ), and we see very clearly how oxeote megascleres may be derived directly from primitive triaxon or tetraxon spicules by suppression of one or two actines (see Plate II., fig. 1). From the same source are derived microxea, and these, being frequently curved, have probably given rise to the sigmata and toxa and, perhaps, other curvilinear microscleres of higher groups. Increase in the number of actines of the primitive spicule, on the other hand, accompanied by other modifications, has probably given rise to the astrose series of microscleres. Thus *Dercitopsis* and its allies may be regarded as representing at the present day the common ancestors of both Astrophora and Sigmatophora.

Dercitopsis ceylonica, n. sp.—Plate II., fig. 1.

This species is represented in the collection by two small, flat pieces which have probably been encrusting and may have formed parts of the same specimen. One is about 22 millims. in length, 13 millims. in greatest breadth, and 7 millims. in greatest thickness. The other is about 26 millims. in length, 16 millims. in greatest breadth, and 7 millims. in greatest thickness. The surface is smooth but rather uneven. Colour in spirit, dark slate grey on the outside, dull yellow internally. Vents minute, scattered singly, with a tendency towards marginal arrangement or grouping on prominent parts. Inhalant pores dispersed abundantly over the surface, not in sieves.

Skeleton very dense, for the most part quite confused and irregular, but with the smallest microxea forming a thin dermal crust, in which they are commonly arranged at right angles to the surface.

Spicules.—(1.) Calthrops and triods (Plate II., fig. 1, *a–h*); rays smooth, sharply and gradually pointed, commonly about 0·033 millim. long by 0·005 millim. in maximum diameter, but subject to considerable variation, and occasionally exhibiting monstrous forms such as twins.

(2.) Oxea (fig. 1, *i–o*); varying enormously in size, but in such a perfectly graduated series between the smallest and the largest that they cannot be divided into mega- and microscleres. The dermal microxea measure only about 0·025 millim. by 0·002 millim., while the oxea in the deeper parts of the sponge frequently measure as much as 0·42 millim. by 0·012 millim. Both large and small oxea are smooth, gradually and finely pointed at each end, and frequently centrotylote. They often exhibit a curvature, which may be sigmoid or toxoid, and thus strongly support the conclusion arrived at by Sollas (*loc. cit.*, p. 109) to the effect that the toxa of *Dercitus* are probably microxea which have acquired a curvilinear growth. The same author has also pointed out that the spinose microrhabds of *Dercitus* originate as smooth centrotylote microxea, which he regards as diactinal asters. From a similar origin we get, in the case of *Dercitopsis ceylonica*, comparatively large oxeote megascleres, which seems to indicate that this common type of spicule may also have been derived from an aster. It also seems probable that the well-known sigmata, so widely distributed in certain tetractinellid and monaxonid groups, may have originated from such microxea as we find here, in other words, from diactinal asters.

The distinction between ectosome and choanosome is not well-marked, and there is no properly defined cortex. The ectosome is, however, fairly thick (about 0·27 millim.), and much more densely spicular than the choanosome; it contains numerous small brown pigment cells (which are also met with in the outer part of the choanosome). There is no fibrous tissue in the ectosome, and what little mesoglœa there is between the densely packed spicules is probably collenchymatous. The mesoglœa of the choanosome is very finely and uniformly granular.

The dermal pores lead into short inhalant canals which penetrate the ectosome more or less vertically and, after uniting together to a greater or less extent, open beneath the ectosome into spacious "crypts," from which the inhalant canals of the choanosome take their origin. The flagellate chambers are rather large, pouch-shaped, about 0·04 millim. in longer diameter; eurypylous, or with short, wide exhalant canals.

R.N. 139, 235 (? Parts of the same specimen. From Station XLI., 12 miles off Galle, 100 fathoms).

Sub-order: ASTROPHORA.

Tetractinellida with triænes and with astrose microscleres; without sigmata.

Family: PACHASTRELLIDÆ.

Astrophora without long-shafted triænes and without sterrasters. Calthrops, in addition to short-shafted triænes resembling calthrops, may be present.

Plakinastrella, Schulze.

Pachastrellidæ with calthrops and (or) short-shafted triænes and oxea for megascleres; and oxyasters and microxea for microscleres; the microxea forming a special dermal skeleton.

This genus occupies an intermediate position between the Plakinidæ and the Stellettidæ, and probably indicates the first stage in the evolution of the long-shafted triæne from the calthrops. The relationship to the Plakinidæ is clearly shown by the form of the oxea, and the differentiation between megascleres and microscleres is not yet by any means complete.

Plakinastrella intermedia, n. sp.—Plate I., fig. 4; Plate II., fig. 2.

Specimen (Plate I., fig. 4) irregularly branched and shortly stalked; branches short, thick, irregularly nodose, spreading more or less horizontally, rounded at the extremities. Surface smooth but uneven, minutely porous in parts. Texture firm and incompressible, with many relatively large foreign bodies embedded in the substance of the sponge and sometimes projecting beyond the surface. Vents small and few, on rounded ends of branches. Pores scattered in irregular groups; many in each group, easily visible under a pocket lens. Colour in spirit, greyish brown. Total height, 20 millims.; greatest breadth, 26 millims.

The skeleton is for the most part very confused. The choanosome is densely strewn with large oxea lying in every direction and occasionally aggregated in loose bundles; with these are mingled oxea of smaller size and a few tetract spicules, while the interspaces are filled in with immense numbers of oxyasters, uniformly and thickly scattered through the soft tissues. On the surface of the sponge is a dense layer of small oxea, tangentially disposed, and for the most part lying so close together as to touch one another and form a continuous crust, perforated by the numerous circular inhalant pores where these occur. Beneath this dermal crust are extended horizontally a number of the large oxea and the heads of the dichotriænes.

Spicules.—(1.) Dichotriænes (Plate II., fig. 2, *a–d*), with cladi extended beneath the dermal crust and shaft projecting inwards at right angles to the surface. The shaft is short, stout, and fairly gradually sharp-pointed, only about as long as the radius of the cladome (or even shorter), measuring, say, about 0·37 millim. by 0·055 millim. The protocladi are short and stout, about 0·092 millim. by 0·055 millim. The deuterocladi are about two and a half times as long as the protocladi, but variable; fairly gradually and sharply pointed, commonly slightly curved and often unequal. Boiled-out preparations show various monstrous forms of this spicule, *e.g.*, one with one cladus unbranched, another with one deuterocladus itself branched, another with the shaft branched, and also a number of very much slenderer forms of the same spicule which are probably not fully developed. Although these dichotriænes are essentially characteristic of the sub-dermal skeleton, yet we find a good many branching spicules scattered through the deeper parts of the sponge, which evidently belong to the same type.

(2.) Oxea (Plate II., fig. 2, *e–p*). *a*, large; more or less curved or even angulated in the middle; fusiform; usually gradually and fairly sharply pointed; size about 1·2 millims. by 0·037 millim. Occasionally a slightly curved stylote spicule may be observed, with one end broadly rounded; apparently derived from an oxeote by suppression of one ray. *b*, small; found chiefly in the dermal crust; fusiform, gradually and sharply pointed, slightly curved; varying very much in size; averaging, say, about 0·18 millim. by 0·01 millim., but ranging from about a third of these dimensions through intermediate sizes to the large forms.

(3.) Rather large oxyasters (Plate II., fig. 2, *q–v*), abundantly strewn through the choanosome; with usually about five long, slender and gradually sharp-pointed rays, which are smooth and up to about 0·025 millim. in length; there is no centrum.

Stained sections show that the ectosome is rather thin, apparently consisting only of the dense spicular crust and with no fibrous tissue except a little around the oscular tubes. The choanosome is gelatinous (collenchymatous). Both ectosome and choanosome contain numerous pigment cells full of brown granules, especially in the walls of the canals. The material is not sufficiently well preserved to show the characters of the flagellate chambers. The inhalant pores, about 0·13 millim. in diameter, are the single openings of short cylindrical chones which penetrate the spicular dermal crust and are provided with well-developed sphincters near its inner limit; but there are no extensive subcortical crypts.

(A fragment of a large, massive anatriæne was found in a boiled-out preparation of the spicules of this sponge, but I could find no others, either in boiled-out preparations or in sections. Should this form of spicule prove to be proper to the species, it would necessitate its removal from the genus *Plakinastrella*).

R.N. 224 (from Station XLI., 12 miles off Galle, 100 fathoms).

Plakinastrella schulzei,* n. sp.—Plate II., fig. 3.

This well-characterised species is represented in the collection by an irregular massive specimen (or fragment) which has been cut off at the base from its attachment. The upper surface is strongly convex and is produced into irregular elevations. The specimen contains many foreign organisms, both internally and encrusting the surface (it is penetrated by the spiral shells of a species of *Tenagodes* (*Siliquaria*), a gastropod which habitually lives in sponges). The colour is purplish grey externally (owing to the presence of numerous granular pigment cells), yellowish within. The vents are irregularly scattered, well-defined circular openings, which may be crateriform; up to about 3 millims. in diameter, but usually a good deal smaller. Inhalant pores (?) are rather conspicuous on some parts of the surface, but irregularly scattered and varying much in size. The specimen measures about 50 millims. in length, 30 millims. in breadth, and 18 millims. in thickness.

The main skeleton is a very irregular interlacement of numerous large oxea and a few short-shafted triænes; the spicules occasionally forming loose wisps. The dermal skeleton is a dense feltwork of small oxea.

Spicules.—(1.) Short-shafted triænes (Plate II., fig. 3, *a–d*), resembling calthrops and subject to much variation in form; commonly with three rays long and bifid and the fourth short and simple, all fairly sharp-pointed; or all the rays may be simple; or one only may be bifid; or one may be trifid, and doubtless other variations could be found. Total diameter measured up to about 0·68 millim. from apex to apex of rays, with primary rays about 0·046 millim. thick.

(2.) Oxea (Plate II., fig. 3, *e–t*). The large oxea of the main skeleton (*e*) are stout, fusiform and gradually sharp-pointed at each end; more or less curved and occasionally slightly angulated at two points, but not centrotylote. They measure, when fully developed, about 1·3 millims. by 0·055 millim. The small dermal oxea (*r*, *s*, *t*) are commonly centrotylote, more or less sharply pointed at each end, and with the two terminal thirds bent upon the middle third at slight angles in the same direction;

* Named in honour of the most eminent of Spongologists, Professor F. E. Schulze.

they are quite smooth and measure about 0·35 millim. by 0·018 millim., but with considerable variation in size. Between the large and small oxea thus described we find so many intermediate in shape and size (*f–q*) that it is impossible to distinguish them as megascleres and microscleres respectively.

(3.) Oxyasters (Plate II., fig. 3, *r–x*) with smooth, slender, sharp-pointed rays and little or no centrum, are very abundant in the deeper parts of the sponge; they measure about 0·02 millim. in total diameter.

The irregular arrangement of the short-shafted triænes (which presumably originated phylogenetically at the surface of the sponge and acquired their characteristic form in direct relation to that position), and the absence or scarcity of typical calthrops, seem to indicate that this species is less primitive than the type of the genus (*P. copiosa*, SCHULZE), and, in fact, somewhat degenerate.

R.N. 149 (from Station XLI., 12 miles off Galle, 100 fathoms).

Stœba, SOLLAS.

Thin, encrusting Pachastrellidæ, with short-shafted triænes, resembling calthrops, for megascleres, and only spined microxea for microscleres.

In 1888 SOLLAS (*loc. cit.*, p. 102) proposed the genus *Stœba* for CARTER'S *Samus simplex* from the Gulf of Manaar, but LENDENFELD (**13**), followed by TOPSENT (**14**), has merged the genus in *Dercitus*. Inasmuch, however, as the type species of *Dercitus* (*D. bucklandi*, Bk. sp.) possesses toxa amongst its microscleres, while *Stœba* does not, it seems to me desirable to retain the distinction between the two, especially as we now know three more or less distinct species without toxa, viz., *Stœba simplex* (= *Samus simplex*, CARTER; *Dercitus simplex*, TOPSENT); *Stœba plicata* (= *Corticium plicatum*, SCHMIDT; *Calcabrina plicata*, SOLLAS; *Dercitus plicatus*, LENDENFELD and TOPSENT), and *Stœba extensa*, n. sp.

SOLLAS'S genus *Calcabrina*, founded for SCHMIDT'S *Corticium plicatum*, must be regarded merely as a synonym of *Stœba*.

Stœba extensa, n. sp.—Plate V., fig. 1.

Sponge thin, encrusting, spreading extensively over the surface of and into the cavities of a mass of calcareous *débris* (Melobesia, Polyzoa, Coral, Worm-tubes, &c., mixed together). Surface for the most part smooth and sub-glabrous, slightly rugose in parts; consistence tough and rather fleshy; colour in spirit, pale grey. Vents and pores not seen. The exposed part of the sponge forms an almost uninterrupted sheet about 45 millims. by 33 millims. in extent, but of irregular outline.

The main skeleton consists of short-shafted triænes scattered abundantly, but quite irregularly through the choanosome, but very sparsely in the ectosome, and there is a thin dermal crust of microxea.

Spicules.—(1.) Triænes (Plate V., fig. 1); with short, stout, sharp-pointed shaft, measuring about 0·136 millim. by 0·02 millim. when fully developed, with cladome about 0·2 millim. across; the cladi are usually extended nearly at right angles to the shaft; they are short and each usually divides into two short, sharp-pointed branches; occasionally, however, the cladi are unbranched and sometimes they are very irregular.

(2.) Spined microxea (Plate V., fig. 1); very slender, straight or very slightly curved, with spination minute but sharp and abundant and fairly uniform throughout the length, excepting that there is frequently a constriction in the middle of the spicule, in which the spination may be more or less wanting; size about 0·02 millim. by 0·00133 millim. (excluding spines). These spicules occur very abundantly in the dermal crust already mentioned and also scattered throughout the sponge.

The ectosome forms a cortex about 0·27 millim. thick, composed of large oval cystenchymatous cells with fibrous tissue between them, the fibres, for the most part at any rate, lying parallel with the surface. The cystenchyme cells measure about 0·06 millim. in longer diameter and are also abundant in the choanosome.

This species is obviously very closely related to the European *Stœba plicata*, on the one hand, and to *S. simplex*, from the Gulf of Manaar, on the other. From the former, which has been fully re-described by Topsent (**14**), it differs in its longer and slenderer and more sharply-pointed microxea, and in the fact that the triænes are nearly all dichotriænes. From the latter it differs in the smaller size of the triænes and the larger size of the microxea, and in the fact that the spines of the microxea are not "most prominent towards the ends," though, as I have pointed out above, they may be more or less absent from the middle of the spicule. It appears to be a good deal more robust in growth than either species. It is quite possible, however, that subsequent researches may make it possible to consider all three as mere varieties of one species, but for the present it seems desirable that they should be kept separate.

Topsent describes the ectosome of *Stœba plicata* as being collenchymatous, but he mentions and figures large "cellules sphéruleuses," which are evidently closely similar to the large cystenchyme cells of *S. extensa*. The partly fibrous cortex of the latter, almost devoid of megascleres, may possibly afford another means of specific distinction.

In external appearance (in spirit at any rate) *Stœba extensa* bears such a close resemblance to the thin encrusting form of *Chondrilla australiensis* that it is difficult, if not impossible, to distinguish the two without microscopical examination.

R.N. 167 (Station LXVI., off Mutwal Island, March 19, 1902, 10 to 35 fathoms).

Family: STELLETTIDÆ.

Astrophora with long-shafted triænes, without calthrops and without sterrasters.

Myriastra, Sollas.

Microsclere a euaster of one form only. Ectosome not a cortex.

Myriastra clavosa (Ridley).

1884, **Stelletta clavosa**, Ridley (16); 1888, **Myriastra clavosa**, Sollas (15).

I have no hesitation in referring to this species four small specimens from deep water off Galle. The specimens are approximately spherical in form and up to about 9 millims. in diameter. There is a single slightly depressed vent, which, in three of the specimens at any rate, has a membranous margin. The colour is grey-yellow. As this is an entirely new locality for the species, which has hitherto been obtained from waters north of Australia, I propose to give the details of spiculation of one specimen in justification of the identification.

Spicules.—(1.) Dichotriænes; shaft, 1·4 millim. by 0·025 millim., gradually and finely pointed; chord, 0·6 millim.; protocladi, 0·08 millim.; deuterocladi, 0·2 millim.

(2.) Anatriænes; shaft, 2·3 millims. by 0·02 millim., very finely and gradually pointed; chord, 0·1 millim.; cladi, 0·06 millim., rather stout; of the shape figured by Ridley.

(3.) Large oxea; fusiform, gradually and sharply pointed, 2·2 millims. by 0·025 millim.

(4.) Cloacal oxea; commonly 0·2 millim. by 0·004 millim., may be rather larger.

(5.) Chiasters; extremely minute, with no distinct centrum, and long, slender, tylote rays varying in number; total diameter, 0·01 millim.

It will be seen from the above that the shaft of the dichotriæne is a good deal shorter than in previously described specimens, but, considering the variation in this respect, we cannot regard this difference as being of specific importance.

R.N. 131, 132, 227, 228 (all from off Galle and onwards up the West Coast of Ceylon, depths up to 100 fathoms).

Myriastra tethyopsis (Carter).

1880, **Stelletta tethyopsis**, Carter (4); 1888, **Myriastra** (?) or **Anthastra** (?) **tethyopsis**, Sollas (15).

There are four specimens of this very remarkable sponge in the collection. Sollas regards the species as insufficiently characterised, but, as a matter of fact, Carter's description is very good, and leaves no doubt as to the identification. The fact that Sollas was unable to assign it definitely to any of his genera tends rather to show the unsatisfactory nature of his system of classification than the insufficiency of the original description.

The specimens (in spirit) are light grey in colour. The smallest is about 10 millims. and the largest about 42 millims. in diameter. The shape is very characteristically turbinate, more or less flattened below, and conical above. The surface is harsh to the touch and finely granular, very minutely and rather sparsely hispid. In the larger specimens a dense mass of long, hair-like spicules projects from more or less of the lower surface. The larger specimens were evidently attached below. The apparent total absence of vents is a remarkable feature. Only in the smallest specimen have I seen what looks like a small natural vent, and that is on the flattened (presumably lower) surface. Doubtless the exhalant apertures are completely concealed by contraction in preserved specimens. Owing to the enormously strong development of the dense radiating skeleton, and the manner in which the cladi of the triænes come close up to the surface (giving it its granular character), I have found it impossible to cut a tangential or surface section in the ordinary way in order to look for pores in the dermal membrane. On attempting to cut such a section the sponge splits up radially along the lines of the gigantic spicules.

The skeleton is remarkably strongly developed, the shafts of the huge oxea and triænes being arranged in dense bundles, which radiate from a central "nucleus" and leave only narrow interspaces between them; while the expanded cladi of the dichotriænes form a thin but dense dermal crust, in which innumerable very minute asters also occur.

Spicules.—(1.) Dichotriænes; shaft about 8·0 millims. long by 0·074 millim. thick a short way below the cladome, tapering very gradually to a narrow, long-drawn-out but rounded point; cladi short, stout, once-forked, expanded almost at right angles to the shaft; chord about 0·46 millim.

(2.) Protriænes; with long and very slender shafts and slender cladi about 0·05 millim. long, commonly projecting from the general surface. Much larger protriænes, with comparatively stout shafts and short stout cladi, occur in the anchoring tufts on the lower surface of the adult sponge.

(3.) Anatriænes; with long slender shafts, and rather stout cladi up to about 0·1 millim. long.

(4.) Oxea; associated in bundles with the shafts of the dichotriænes; fusiform, gradually and fairly sharply pointed at each end; size about 8·0 millims. by 0·073 millim.

(5.) Asters; very numerous at and near the surface of the sponge, with small centrum and numerous slender conical rays of equal length; total diameter about 0·01 millim. Such spicules are very rare in the deeper parts of the sponge, and those which I have seen do not differ in any important respect from the asters of the surface.

The smallest specimen possesses in one part, beneath the surface, in addition to the asters, numerous minute refractive globules, which look as if they might be siliceous.

Stained sections show that there is a very thick gelatinous (collenchymatous) ectosome, excavated by numerous large, irregular cavities, from which occasionally wide canals, provided with numerous transverse diaphragms, lead vertically inwards through the choanosome. Small dermal pores are scattered between the cladi of the dichotriænes. The choanosome is not sharply differentiated from the ectosome, but is finely granular. The flagellate chambers are oval and measure up to about

0·04 millim. in longer diameter; they are densely crowded together, and either eurypylous or with very short, wide exhalant canaliculi.

This species is so peculiar that it might almost form the type of a new genus, but I cannot fix upon characters which would separate it absolutely from Sollas's *Myriastra.* The sponge, however, is not exactly small, nor are the oscules distinct, nor are the pores in sieves, nor yet is the ectosome thin; all of which features are mentioned by Sollas as characters of *Myriastra*, though I should hardly consider them as being of generic value myself.

R.N. 128, 128a, 128b, 130 (Station XLI., 12 miles off Galle, 100 fathoms).

Pilochrota, Sollas.

Microsclere a euaster of one form only. Ectosome differentiated to form a cortex.

Pilochrota haeckeli, Sollas.—Plate II., fig. 4.

1888, **Pilochrota haeckeli,** Sollas (**15**).

There are eight specimens in the collection which agree so closely with Sollas's description as to leave no doubt of their specific identity with the "Challenger" species, represented in the "Challenger" collection by a single specimen from the Philippine Islands. The Ceylon specimens are irregularly spherical or oval in shape, and the largest is about 16 millims. in maximum diameter. The colour in spirit is grey. The vent (when visible) is single, small, and surrounded by a membranous lip, minutely hispid owing to projecting oxea. The inhalant pores are arranged in small sieves, which are irregularly scattered or situated in shallow meandering grooves. The sponge has a strong tendency to attach itself to foreign objects by means of short, root-like processes.

I subjoin the spicular measurements taken from one specimen (R.N. 127), in support of the identification :—

(1.) Orthotriænes (Plate II., fig. 4, *a*); shaft, 2·3 millims. by 0·074 millim., gradually and sharply pointed; cladi, 0·3 millim. long, stout, conical, sharp-pointed, expanded almost at right angles to the shaft, slightly recurved.

(2.) Anatriænes (Plate II., fig. 4, *c*); shaft, 2·8 millims. by 0·037 millim., long and slender, finely pointed; cladi, strongly recurved, fairly stout, sharp-pointed, 0·13 millim. long.

(3.) Somal oxea; fusiform, gradually and sharply pointed at each end, symmetrical, often slightly curved; measuring about 2·3 millims. by 0·04 millim.

(4.) Cloacal oxea; small and slender, about 0·2 millim. by 0·005 millim.

(5.) Chiasters, with very slender, tylote rays; total diameter about 0·012 millim., not very abundant.

(There are also a few curiously abnormal triænes with very short and stout shafts, as shown in fig. 4, *b*, *d*, *e*, but I think that these must be regarded as monstrous forms of the orthotriænes and anatriænes, and not as having any taxonomic value.)

R.N. 127, 127*a*, 127*b*, 127*c*, 127*d* (all from deep water off Galle and onwards up the West Coast); 197 (no special locality); 215 (deep water outside the pearl banks, Gulf of Manaar); 225 (Station XLI., 12 miles off Galle, 100 fathoms).

Pilochrota hornelli, n. sp.—Plate II., fig. 5.

The single specimen is shaped like a somewhat elongated potato, with a fairly smooth but rather uneven and finely granular surface, to which a number of foreign bodies, such as shell-fragments, Foraminifera, &c., are attached. In its present condition it measures about 45 millims. by 33 millims. by 33 millims., but a small piece has been cut off from one end. The texture is somewhat spongy internally, but with a firm, dense outer crust nearly 1 millim. thick in places. The colour is light brown throughout. The inhalant pores are arranged in small groups (pore-sieves) thickly and generally scattered over what was probably the lower half of the sponge; they are also scattered singly on the upper part. There is a single large vent near one end of the upper surface, elongated transversely to the long axis of the sponge and with a narrow, thickened, smooth, fleshy margin. The vent measures about 6 millims. by 2 millims., and is the opening of a short, wide oscular tube formed by the union of a number of large exhalant canals.

The skeleton in the interior of the sponge is loose and irregular, composed principally of large, scattered oxea, not arranged in definite fibres. Towards the surface the spicules tend to collect together into fibres which end in dense brushes composed almost entirely of ortho- and anatriænes. These brushes separate the wide subcortical crypts from one another, but their expanded outer ends form a continuous spicular crust at the surface. The cladi of the orthotriænes are for the most part extended at the surface of the sponge, but do not project beyond it, those of the anatriænes lie somewhat deeper down in the cortex. There are also a large number of orthotriænes whose cladi lie beneath the subcortical crypts while their shafts project inwards into the choanosome.

Spicules.—(1.) Orthotriænes (Plate II., fig. 5, *a–d*); with stout shaft tapering very gradually to a narrow, bluntly rounded or sharp apex, and with short, stout, conical cladi extended almost at right angles to the shaft; two typical examples from a boiled-out preparation gave the following measurements:—(*a.*) Shaft, 1·5 millims. by 0·032 millim.; cladi, 0·123 millim. by 0·03 millim. (*b.*) Shaft, 1·017 millim. by 0·04 millim.; cladi, 0·115 millim. by 0·033 millim. In the dermal crust one or two of the cladi not infrequently become bifurcate, but this takes place very irregularly, and a good many monstrous forms occur.

(2.) Anatriænes (Plate II., fig. 5, *e*); shaft long and fairly stout, not tapering to hair-like dimensions, though, of course, much narrower at the proximal than at the distal extremity; bluntly or sharply pointed; cladi stout, strongly recurved, sharply pointed; front of cladome flattened. A specimen from a boiled-out preparation, somewhat longer than usual, gave the following measurements:—Shaft, 1·96 millim. by 0·019 millim.; cladi, 0·0656 millim. by 0·0164 millim.

(3.) Oxea (Plate II., fig. 5, *f*); fairly stout, fusiform, gradually and usually fairly sharply pointed, gently curved, approximately iso-actinate, measuring about 1·3 millims. by 0·032 millim.

(4.) Chiasters (Plate II., fig. 5, *g*, *h*, *i*); with no centrum and very slender, slightly roughened and distinctly tylote rays; total diameter of spicule up to about 0·02 millim.; abundant, especially in the deeper parts of the sponge.

The histological structure of the strongly developed cortex agrees very closely in some respects with that described and figured by SOLLAS (*loc. cit.*, p. 122) for his *Pilochrota pachydermata.* The cortex itself, about 0·8 millim. in thickness, consists chiefly of very dense fibrous tissue, in which the fibres interlace in various directions. Imbedded in this tissue we find histological elements of two other kinds:—(1.) Large, rounded, deeply staining bodies up to about 0·2 millim. in diameter, each made up of an aggregation of much smaller bodies (cells?), and the whole very finely and uniformly granular. These remarkable bodies have a rather deep yellowish brown colour in unstained preparations, and they form a single layer beneath the surface in the outer part of the cortex. They are evidently homologous with what SOLLAS terms "oval or round clusters of granule-cells" in *P. pachydermata.* Sometimes the finely granular "cells" occur separately as well as aggregated in clusters, especially in the margin of the vent. (2.) Numerous irregularly scattered, small groups of faintly staining, homogeneous, spherical globules, varying in size in each group up to about 0·005 millim. in diameter; abundant in the deeper parts of the cortex and also in the choanosome. These bodies do not seem to have been observed in *P. pachydermata.*

Beneath the fibrous cortex lie extensive sub-cortical crypts, separated from one another by the radiating spicule bundles and a sparse development of ectosomal collenchyma.

The inhalant pore-sieves overlie well-developed chones which penetrate the fibrous cortex to reach the sub-cortical crypts, being provided with sphincters or diaphragms where they join the latter; the sphincters, however, do not lie quite so deeply as the lower limit of the fibrous cortex. From the sub-cortical crypts originate numerous fairly wide incurrent canals which penetrate the choanosome and sub-divide therein.

The choanosome is finely granular, and the flagellate chambers are approximately spherical, about 0·02 millim. in diameter, and apparently eurypylous.

It is not impossible that this species may be identical with SOLLAS's *Pilochrota cingalensis*, also from Galle, but the description of the latter (**15**), apparently based upon a mere fragment, for the author says "*Sponge* (?)," is too imperfect for safe recognition. SOLLAS, moreover, states that the cortex is thin, about 0·35 millim. in thickness, and all the megascleres seem to have their shafts characteristically bluntly pointed or even strongylote, a condition to which there is only a tendency in our specimen. Our species is also very closely related to *Pilochrota pachydermata*, SOLLAS, from Tahiti, but differs in certain respects, such as the form of the chiaster, which is not tylote in *P. pachydermata*.

R.N. 176 (collected in the lagoon inside the reef, Galle, shallow water, by Mr. HORNELL, after whom, on Professor HERDMAN'S suggestion, I have much pleasure in naming the species).

Stelletta, SCHMIDT.

Microscleres euasters of two forms.

It might be advisable to sub-divide this genus according to whether or not a fibrous cortex is present, as SOLLAS has done in similar cases. *Stelletta herdmani* would then come under the first sub-division and *S. vestigium* under the second. I do not, however, think it would be desirable to take such a step until we know more about the value of this character in classification.

Stelletta herdmani, n. sp.—Plate II., fig, 6.

Sponge quite irregular in shape; sometimes vallate; sometimes with occasional digitiform or mammiform projections; often very much mixed up with coarse calcareous débris. Surface uneven, very harsh to the touch and striate owing to the presence of the huge megascleres immediately beneath the thin dermal membrane; not hispid except where apparently worn. Vents few, scattered on prominent parts, up to about 3 millims. in maximum diameter; leading out of deep cloacal tubes, which are of about the same diameter and lined by a sieve-membrane. Inhalant pores scattered in the dermal membrane. Colour (external) ranging from pale yellowish to slate-grey in the same specimen The largest specimen is about 55 millims. in greatest diameter, but is a good deal damaged and much mixed up with foreign matter.

Skeleton very dense and more or less confused; consisting of irregular bundles of huge oxea and triænes, for the most part radiating towards the surface, but lying tangentially beneath the dermal membrane and thus forming an ill-defined but dense spicular cortex about 0·36 millim. thick.

Spicules.—(1.) Plagio- or protriænes (Plate II., fig. 6, *a*, *b*, *c*.); with short, stumpy, conical cladi projecting more or less forwards, and stout shaft, usually somewhat curved, more or less swollen at some distance below the cladi and tapering gradually to a sharp point at the other end. Size somewhat variable, shaft up to about 1·2 millims. by 0·074 millim., with cladi 0·18 millim. long.

(2.) Oxea (Plate II., fig. 6, *d*.); fusiform, straight or slightly curved, tapering gradually to a sharp point at each end; size about 2·8 millims. by 0·09 millim.

(3.) Chiasters (Plate II., fig. 6, *e*–*h*); very abundant in the dermal membrane, scarcer within; with numerous rather short, truncate conical rays, and often with a distinct but small centrum; total diameter about 0·012 millim. or less.

(4.) Oxyasters (Plate II., fig. 6, *i–k*); fairly numerous in the deeper parts, but may be difficult to find; with little or no centrum, and long, slender, conical, sharp-pointed, smooth rays, varying in number; total diameter about 0·029 millim.

Owing to the great size and abundance of the megascleres it is impossible to cut satisfactory sections by the ordinary paraffin method, but such as I have been able to obtain have yielded some interesting results. The ectosome is remarkably developed as a very thick gelatinous layer containing numerous stellate cells (collenchyma), and a thin layer of fibrous tissue (about 0·08 millim. thick), situated about 2·5 millims. beneath the surface and separating the gelatinous layer from the choanosome. The arrangement of the main skeleton appears to be in no way correlated with the differentiation between ectosome and choanosome, the large megascleres passing through the fibrous layer from one to the other without distinction. The mesoglœa of the choanosome ranges from collenchymatous to finely granular, and the flagellate chambers are more or less spherical and about 0·024 millim. in diameter.

There are six specimens of this sponge in the collection. The arrangement of the skeleton reminds one very strongly of Sollas's genus *Stryphnus*, but the absence of amphiasters or sanidasters prevents us from placing the species in that genus (according to Sollas's classification). The species also resembles to a considerable extent Kirkpatrick's *Stelletta* (*Astrella*) *horrens*, from South Africa (17), but is distinguished by its external form, by the arrangement of the pores and vents, and by the details of spiculation.

R.N. 66 (Gulf of Manaar); 89, 137, 137a, 157, 203 (all from off Galle and onwards up the West Coast, depths up to 100 fathoms).

Stelletta vestigium, n. sp.—Plate II., fig. 7.

Specimen irregular in shape, massive, encrusting, and containing many calcareous foreign bodies. (In the same mass as the two specimens of *Tethya lyncurium* var. *a*.) Maximum diameter about 23 millims. Colour in spirit, nearly black. Vents and pores not seen. No cortex.

The skeleton is a confused reticulation of megascleres, mingled with foreign bodies and sometimes collected into loose fibres; with a thin dermal crust of asters, also much mixed with foreign bodies.

Spicules.—(1.) Triænes (Plate II., fig. 7, *a–d*); with cladi reduced to three, two, or one mere spines or protuberances of varying size at the broad end of the spicule; the other end tapering gradually to a more or less sharp or irregular apex. These spicules are of about the same dimensions as the oxea.

(2.) Oxea (Plate II., fig. 7, *e*); rather slender, usually slightly curved; more or less gradually sharp-pointed or irregularly ended; measuring about 0·74 millim. by 0·016 millim.

(3.) Spherasters (Plate II., fig. 7, *f*, *g*); with well-developed centrum and sharp, conical rays; total diameter about 0·024 millim., with rays about 0·008 millim. long; most numerous in the dermal crust, but also abundant below. (A rather noteworthy feature of these spicules, in many cases, in the boiled-out preparations, is the conspicuous nature of the central canal in the rays, which gives the spicule a very peculiar appearance.)

(4.) Oxyasters (Plate II., fig. 7, *h*, *i*); with very small centrum and a rather small number of slender, finely-pointed, smooth rays; total diameter up to about 0·024 millim. Abundant in the choanosome.

This species is particularly interesting on account of the extreme reduction of the cladi of the triænes, affording an absolute transition from the tetractinellid to the monaxonellid condition. This vestigial condition of the cladi, an approach to which is already seen in *Stelletta herdmani*, appears to be associated in this genus with the irregularly scattered arrangement of the triænes (compare the vestigial condition of the cladi of the dermal anatriænes in *Geodia perunicinata*, described later on).

R.N. 200A (Station LXVII., off Talaivillu Paar, 10–14 fathoms).

Ecionema, Bowerbank.

The microscleres include microrhabds in addition to euasters; the former are commonly minutely spined or roughened, and usually form a dermal layer.

Ecionema carteri, n. sp.—Plate I., fig. 5; Plate III., fig. 1.

There are three specimens of this sponge in the collection. The largest and only well-developed example (R.N. 175, Plate I., fig. 5) may be taken as the type of the species. This specimen is massive and quite irregular in shape, with a number of foreign bodies attached to it. The maximum diameter is about 35 millims. The surface appears, in most places, distinctly porous, even to the naked eye, owing to the presence of very numerous, thickly scattered, small pore-sieves (Plate I., fig. 5, *p.s.*) containing the inhalant pores. It is also very minutely and sparsely hispid, at any rate in parts. The vents (Plate I., fig. 5, *o*) are rather numerous, without prominent margins; circular or oval openings varying up to about 2 millims. in diameter; mostly congregated in a depression on what was apparently the upper part of the sponge. They are the apertures of wide, diaphragm-bearing oscular tubes. The texture of the sponge is fairly firm, but compressible. The colour in spirit is pale grey.

Another specimen (R.N. 188) is almost spherical and only about 11 millims. in diameter, without visible vents; it is probably immature. The third (R.N. 259) is an irregular fragment.

The main skeleton in the interior of the sponge is an irregular interlacement of large oxea which, towards the surface, collect into loose radiating wisps, ending in dense brushes of triænes whose cladomes lie at varying depths beneath the dermal membrane, but never very deeply. The dermal membrane is strengthened by a thin crust of spinose microstrongyles, interrupted by the very numerous dermal pores. The minutely hispid character of the surface is due to the presence of very slender, hair-like anatriænes projecting beyond the dermal membrane.

Spicules.—(1.) Plagiotriænes (almost orthotriænes) (Plate III., fig. 1, *a*, *b*); with long shaft tapering very gradually to a sometimes almost filiform extremity, and rather short, stout, sharply pointed or rather blunt cladi; shaft about 1·5 millims. by 0·033 millim., with cladi about 0·148 millim. by 0·027 millim.

(2.) Plagiotriænes (almost protriænes) (Plate III., fig. 1, *c*, *c'*); with long, slender shaft tapering to almost hair-like dimensions. and short conical cladi projecting forwards at an angle of about 45°; shaft about 1·8 millims. by 0·0094 millim.; cladi about 0·028 millim. by 0·008 millim. Not very numerous.

(3.) Anatriænes (Plate III., fig. 1, *d*, *d'*); with long, slender shaft and short, sharp-pointed, strongly recurved cladi; cladome somewhat flattened in front; shaft and cladi of about the same dimensions as in the preceding.

(4.) Very slender, hair-like anatriænes with minute cladomes projecting beyond the surface of the sponge. These spicules seem to be fairly numerous and characteristic, but the cladomes are nearly always broken off in the preparations.

(5.) Oxea (Plate III., fig. 1, *e*); long and comparatively slender, usually slightly curved; fusiform; gradually and usually sharply pointed at each end; measuring, when fully developed, about 1·8 millims. by 0·037 millim.

(6.) Chiasters (Plate III., fig. 1, *g*); with little or no centrum and very slender, cylindrical, very minutely roughened, tylote rays; total diameter up to about 0·016 millim.

(7.) Microstrongyla (Plate III., fig. 1, *f*); straight, rather slender and minutely spined or roughened; measuring up to about 0·02 millim. by 0·002 millim., most abundant in the dermal membrane, but also plentiful in the choanosome.

There is a well-developed cortex about 0·25 millim. thick, composed of a mixture of chondrenchymatous, collenchymatous, and fibrous tissue, the first-named developed chiefly towards the outside and the last towards the inside. The mesoglœa of the choanosome is finely granular, but with an admixture of collenchymatous and chondrenchymatous tissue. The flagellate chambers are approximately spherical, about 0·02 millim. in diameter, and eurypylous. The dermal pore-sieves form the thin roofs of wide chones, which pass vertically through the cortex and are continued directly into the inhalant canals of the choanosome, without any specially differentiated subcortical crypts.

The presence of a fibrous cortex, though not very strongly developed, seems to indicate SOLLAS's genus *Psammastra* for this species, which is nearly related to three sponges described by Mr. CARTER under the names *Stelletta geodides* (18),* *Stelletta*

* *Vide* also SOLLAS, "Challenger" Tetractinellida, p. 200.

bacillifera (20) and *Stelletta bacillifera*, var. *robusta* (21),* the first and third from Australia and the second from the Mergui Archipelago. SOLLAS places the first in his genus *Psammastra*, while he places the last in *Ecionema*, which he distinguishes from *Psammastra* by the absence of cortex, but Mr. CARTER'S specimens of *Stelletta bacillifera*, var. *robusta*, were dry, and it is extremely probable that they possessed a fibrous cortex like that of *Ecionema carteri*; the type of *Stelletta bacillifera* from the Mergui Archipelago may also have been corticate for anything we know to the contrary, and it is almost certain that CARTER'S three sponges and the Ceylon species belong to the same genus. Moreover, we do not even know whether BOWERBANK'S original type of the genus *Ecionema* (*E. acervus*) was corticate or not, a question which it is impossible to decide without properly prepared sections of good material.

R.N. 175 (Lagoon inside reef, Galle, shallow water); 188 (Muttuvaratu Paar, Gulf of Manaar, 8 fathoms); 259 (Ceylon seas).

Ecionema laviniensis, n. sp.—Plate III., fig. 2.

The single specimen is somewhat finger-shaped, but flattened and slightly bifurcate at one (? the upper) end. It measures about 30 millims. in length and 13 millims. in breadth. The greater part of the surface is encrusted with coarse calcareous débris, chiefly Foraminifera and shell-fragments; where these bodies are absent there is a tendency to be minutely and sparsely hispid. In places there is a minutely porous appearance, easily visible under a pocket lens, due to the presence of small thickly scattered pore-sieves. The vents are probably very minute and scattered—I have only observed one. The colour in spirit is pale grey throughout, the texture firm and very compact.

The main skeleton is a confused interlacement of large oxea, towards the surface disposed more or less nearly at right angles to it and occasionally projecting beyond it. At the surface there is a spicular cortex, about 0·13 millim. thick, composed of microstrongyla with a thin layer of minute chiasters externally. Beneath the spicular cortex lie the cladomes of the comparatively few triænes, with their shafts penetrating the deeper parts of the sponge at right angles. (It is, perhaps, worth noting that in the deep groove at one end of the sponge, where it is beginning to bifurcate, the spicular cortex is not developed and there are apparently no triænes, but the large oxea project much further beyond the surface than they do elsewhere.) There are also a few slender anatriænes and protriænes (?) with cladomes projecting far beyond the surface.

Spicules.—(1.) Dichotriænes (Plate III., fig. 2, *a*, *b*); with stout shaft which typically tapers very gradually to a fine point, but may be blunted; protocladi short and stout; deuterocladi about the same length or a little longer or shorter, conical,

* *Vide* also SOLLAS, "Challenger" Tetractinellida, p. 197.

typically sharp-pointed, but may be blunted. A typical example gave the following measurements: shaft, 1·0 millim. by 0·0328 millim.; protocladus, 0·05 millim. by 0·027 millim.; deuterocladus, 0·065 millim. by 0·0164 millim.

(2.) Protriænes?

(3.) Anatriænes (Plate III., fig. 2, *c*, *c'*); with slender, often hair-like shaft and small, variable, often abnormal cladome, perhaps characteristically flattened in front. These spicules are evidently becoming vestigial and are so variable that it would be useless to give measurements; they are, however, still present in abundance.

(4.) Oxea (Plate III., fig. 2, *d*) large and usually stout; nearly always more or less curved, often strongly so, sometimes crooked; gradually and sharply pointed at each end, or more or less blunted; measuring up to about 1·4 millims. by 0·049 millim., but very variable in thickness.

(5.) Chiasters, with short, blunt, sub-cylindrical rays (Plate III., fig. 2, *e*), total diameter about 0·008 millim.; very abundant in the dermal membrane, and often met with in the choanosome, where they are commonly about half as large again and may vary into oxyasters (?) with very slender rays (Plate III., fig. 2, *f*).

(6.) Microstrongyla (Plate III., fig. 2, *g*) almost cylindrical, usually with rounded ends, but occasionally oxeote; minutely spined all over; usually slightly curved; sometimes centrotylote. A typical example measures about 0·1 millim. by 0·008 millim., but they are often much more slender. These spicules are found chiefly in the cortex, but may also be met with occasionally in the deeper parts of the sponge.

(A few slender, smooth microxea (Plate III., fig. 2, *h*) also occur, possibly young forms of other spicules.)

There is no distinct fibrous cortex, at any rate over the general surface, but a dense spicular cortex formed as described above. In the deep depression at the end of the sponge, however, where the spicular cortex is not developed, a certain amount of fibrous tissue is present in its place, and it is quite possible that such is also present concealed between the spicules of the spicular cortex elsewhere. (These facts serve to emphasise the unsatisfactoriness of the fibrous cortex as a generic distinction between *Ecionema* and *Psammastra*, to which attention has already been called under the head of *Ecionema carteri*.) The spicular cortex contains an immense number of rounded pigment cells filled with pigment granules of a rich brown colour.

Scattered abundantly throughout the choanosome are rounded groups of minute highly-refractive granules, staining with borax carmine, but in themselves practically colourless. These at first sight look like flagellate chambers, each group being about 0·02 millim. in diameter, but I do not think that they are really of that nature.

The species is evidently closely related to *Ecionema carteri* and its allies, but is well characterised by the dichotriænes and by the comparatively large size of the microstrongyles.

R.N. 265 (Station XLVI., off Mount Lavinia, 30 fathoms).

Family: GEODIIDÆ.

Astrophora, in which the characteristic microsclere is a sterraster, forming a dense cortical layer.

Geodia, Lamarck.

Geodiidæ, in which the somal microsclere is a polyactinose aster.

Geodia perarmata, Bowerbank.

1873, **Geodia perarmatus**, Bowerbank (22); 1880, **Geodia perarmata**, Carter (4); 1888, **Geodia perarmata**, Sollas (15).

There is an interesting series of specimens belonging to this species in the collection. The smallest is only 13 millims. in diameter, and is approximately spherical in shape; unfortunately, the surface of this specimen is considerably abraded, and I have not been able to make out the arrangement of either inhalant or exhalant apertures. The next in size, about 18 millims. in diameter, is also too much injured to show the arrangement of the apertures satisfactorily. The next is more irregular in shape, about 28 millims. in diameter, and flattened on one side so as to form an approximately circular oscular area about 14 millims. in diameter, but not definitely bounded. This area is covered by a pore-bearing, cribriform membrane, with pores about 0·08 millim. in diameter, and few, if any, larger apertures. The remainder of the surface of the sponge, outside the oscular area, is covered with a cribriform dermal membrane containing thickly scattered inhalant pores of somewhat smaller diameter than the exhalant pores. The specimen next in size is also irregular in shape, closely resembling a potato, and about 45 millims. in diameter. The oscular area now forms an ill-defined, but rather deep concavity on one side, whose floor is covered, as before, by a cribriform membrane, but with a few larger openings where the pores have apparently become confluent and thus formed small "vents"; the maximum diameter of this basin-shaped oscular area, which is not quite circular, is about 17 millims. The largest specimen is a very fine one, irregularly rounded in shape, and about 75 millims. in greatest diameter; it has been attached below at only a few points to calcareous débris. The depressed oscular area occupies the greater part of the flattened upper surface of the sponge, and is about 38 millims. in greatest diameter, and irregularly oval in shape. The floor of the depression is somewhat flattened, but rises up in the middle; the margin is much better defined than in the smaller specimens, but rounded off, except on one side, where it actually overhangs slightly. The pore-bearing membrane presents the same appearance as in the last-described specimen, but the small "vents," due to confluence of the pores, are more numerous; they are hardly 0·5 millim. in diameter. As before, the general surface of the sponge is covered by a richly porous cribriform membrane. There is also in the collection an irregularly-shaped sub-cylindrical specimen, about 36 millims. in length and 18 millims. in diameter, which does not show any distinct oscular area.

It appears, then, that the basin-like character of the oscular area, which was figured by BOWERBANK (22) in the type specimen, and which appears to form a characteristic feature of the adult sponge, is not developed until comparatively late in life, and it appears also that its development is due simply to more rapid growth of the surrounding parts. According to the classification adopted by SOLLAS in his work on the "Challenger" Tetractinellida, this mode of development would necessitate our placing the species in the genus *Cydonium*. SOLLAS himself, however, places the species in the genus *Geodia*, having been insufficiently acquainted with the characters in question. LENDENFELD, in his work on the Tetractinellida of the Adriatic, merges the genus *Cydonium* in *Geodia*, and in this I must agree with him, for the present instance demonstrates very clearly the impracticable character of a classification which involves a study of the development, at any rate until our knowledge is much more complete than at present.

The general surface of the sponge is smooth and, perhaps, even glabrous, where the dermal membrane is intact, but from a few points on the lower surface, in the immediate neighbourhood of the attachment, a few long, hair-like spicules (mostly anatriænes) project. The colour of the general surface (in spirit) is purplish brown, mottled with dull yellow, the pigment being lodged in an immense number of granular brown pigment cells which lie between the layer of sterrasters and the dermal membrane. Internally the sponge is nearly white.

The cortical layer of sterrasters is about 1·2 millim. thick in the largest specimen, and between this layer and the dermal membrane lies a zone about 0·27 millim. thick, in which the cladi of most of the triænes are found. The manner in which the shafts of these triænes pierce the layer of sterrasters, so that their cladi come to lie externally to it, is, as already pointed out by BOWERBANK, very characteristic of the species, and forms a conspicuous feature even in the smallest specimen which I have seen.

The spiculation, as observed in the largest specimen, is as follows:—

(1.) Dichotriænes; shaft stout, about 3·2 millims. by 0·07 millim.; chord, 0·48 millim. to 0·64 millim.

(2.) Protriænes; scarce (seen only in another specimen); cladi about 0·075 millim. long.

(3.) Anatriænes; shaft slender, about 4·2 millims. long; cladi about 0·07 millim. long.

(4.) Somal oxea; about 2·67 millims. by 0·042 millim.

(5.) Cortical oxea; about 0·3 millim. by 0·0083 millim.

(6.) Sterrasters; about 0·13 millim. in diameter.

(7.) Somal chiasters or spherasters; about 0·009 millim. in diameter.

(8.) Choanosomal spherasters with spined rays; about 0·04 millim. in diameter.

The spherasters with spined rays are found just beneath the layer of sterrasters and appear to be characteristic of the species. The fact that the spination of the rays is not figured by Bowerbank in his illustration, nor mentioned in the text, makes me a little doubtful of the identification of the Ceylon species with that originally described by Bowerbank (from an unknown locality). Carter, however, made the identification in the first instance and Sollas has accepted it; and the differences, if they really exist, must be extremely slight.

R.N. 119, 121, 124, 125, 126, 135. (All from deep water, up to 100 fathoms, off Galle and onwards up the West Coast of Ceylon.)

Geodia peruncinata, n. sp.—Plate III., figs. 3, 3a, 3b.

The single specimen in the collection is, unfortunately, only a fragment, amounting to probably somewhat more than half of a small spherical sponge, attached to a small calcareous nodule. The diameter of the specimen is about 11 millims. The colour in spirit is nearly white, both on the surface and in the interior. The cortex is rather thin and very brittle, and the interior of the sponge is soft and friable. It is impossible to make out the arrangement of the exhalant canal-system, but the thin dermal membrane contains numerous small pores, presumably inhalant.

The layer of sterrasters (Plate III., fig. 3, *e*, *e*) is about 0·33 millim. thick, and is separated from the dermal membrane by an interval of about 0·165 millim. occupied by extensive sub-dermal cavities. The dermal membrane is supported on the cladomes of dichotriænes (Plate III., fig. 3, *a′*), whose shafts pierce the layer of sterrasters and the zone of sub-dermal cavities; it is also strengthened and rendered hispid by the presence of immense numbers of short anatriænes which project from the surface at various angles (Plate III., fig. 3, *c*, *c*). Some of the dichotriænes (Plate III., fig. 3, *a*) have their cladi extended beneath the layer of sterrasters, and the remainder of the skeleton is arranged in the usual way, with radiate primary lines.

Spicules.—(1.) Dichotriænes (Plate III., fig. 3, *a*, *a′*); with stout shaft tapering gradually to a narrow, but blunt apex, and short cladi; the deuterocladi usually two or three times as long as the protocladi, but variable and often unequal, gradually and sharply pointed, slightly curved towards one another, or straight. Shaft measuring up to about 2·4 millims. by 0·044 millim., with cladome 0·62 millim. in total diameter and protocladi 0·038 millim. thick.

(2.) Protriænes; a few stout protriænes, more or less broken and sometimes with four cladi, occur amongst the mass of spicules projecting from the base of the sponge.

(3.) Anatriænes (Plate III., fig. 3, *b*); with well-developed cladome and very long, slender shaft. Shaft measured up to about 4·9 millims. in length (and then broken off), with a thickness of 0·016 millim. near the cladome, and cladi stout, conical, and about 0·057 millim. long. (Projecting from the base of the sponge one finds anatriænes with long, hair-like shafts and slender, very sharply recurved cladi.)

(4.) Anatriænes (Plate III., fig. 3, *c*; fig. 3a); with short, slender, fusiform shaft and very small, often vestigial cladome, which may be reduced to a mere knob. The attachment of the cladome to the shaft is so slender that the former is generally broken off and the spicules then may easily be mistaken for the well-known dermal oxea of other species of *Geodia*. The proximal end of the shaft may be oxeote or rounded off, or even tylote. In a typical example the shaft measures about 0·21 millim. by 0·006 millim. The cladome varies so much in its degree of reduction that it is useless to attempt exact measurements, but is generally not more than 0·008 millim. in total diameter. These spicules are found for the most part hispidating the surface of the sponge, but a few occur beneath the layer of sterrasters. I have seen one example which appears to be a reduced protriæne, with a single remaining cladus, but the great majority are anatriænes.

(5.) Oxea (Plate III., fig. 3, *d*); very long and comparatively slender, frequently curved, sometimes very crooked; fairly gradually and sharply pointed; size variable, *e.g.*, 2·5 millims. by 0·029 millim.

(6.) Sterrasters (Plate III., fig. 3, *e*, *e'*; fig. 3B, *c*); markedly oval in shape and measuring about 0·12 millim. by 0·082 millim.

(7.) Small spherasters (or chiasters?) (Plate III., fig. 3B, *a*); with small centrum and numerous almost cylindrical or slightly tylote rays about as long as the diameter of the centrum; total diameter of the spicule about 0·008 millim. Most abundant in the dermal membrane, but plentiful also in the interior.

(8.) Comparatively large spherasters (Plate III., fig. 3, *f*; fig. 3B, *b*); with large centrum and very numerous short, conical rays, whose length is only about one-third the diameter of the centrum or a little more. Total diameter when fully grown about 0·024 millim. Sparsely scattered beneath the layer of sterrasters.

In the structure of the ectosome and the presence of dichotriænes this species is evidently closely related to *Geodia perarmata*. It is, however, distinguished by three characters: (1) the absence of brown pigment cells in the outer part of the cortex; (2) the form of the larger spheraster, which, in *G. perarmata*, has (? always) distinctly spined rays; (3) the presence of the numerous short-shafted, cortical anatriænes,* which are replaced in *G. perarmata* by cortical oxea, though I am inclined to think that a few of these oxea may still show a vestige of a cladome even in *G. perarmata*, while it is quite possible that a few true cortical oxea may occur amongst the reduced anatriænes in *G. peruncinata*.

The presence of the vestigial anatriænes is extremely interesting as indicating the anatriænal origin of the cortical oxea of *Geodia*. Sollas (*loc. cit.*, p. cxlvii) has already observed, in his general remarks on the family Geodiidæ, that "A second finer hispidation is frequently produced by small oxeas, which are confined to the cortex (cortical oxeas). Associated with these, in some few instances, are minute anatriænes, which much remind one of the cladose tylostyles described by Dendy and Ridley in *Proteleia sollasi*." We have here an admirable example of the evolution

* Very similar small cortical anatriænes occur in Lindgren's *Geodia arripiens* from Cochin China (86).

of a monaxonellid spicule from a tetractinellid form by subordination and final suppression of three of the rays.

R.N. 223 (Station XLI., 12 miles off Galle, 100 fathoms).

Geodia areolata, Carter.

1880, **Geodia areolata**, Carter (4); 1888, **Geodia areolata**, Sollas (15).

There are several specimens of this sponge in the collection. They are approximately spherical in shape, and in form and colour closely resemble young specimens of *G. perarmata*, but the largest sent to me is only 21 millims. in diameter. The surface of the sponge is smooth and characteristically marked out into small stellate areas of a pale yellow colour, separated from one another by a reticulation of chestnut-brown pigment. This pattern, however, is not recognisable everywhere. Numerous small apertures appear irregularly scattered over some parts of the surface, but with a tendency towards grouping. These frequently occupy the centres of the pale stellate areas, and they are often guarded by a fringe of convergent dermal oxea. They are frequently covered over by a reticulate dermal membrane. They are the openings of chones, which pierce the layer of sterrasters, but whether they are inhalant or exhalant, or both, I have been unable to decide.

The layer of sterrasters is about 0·46 millim. thick in the largest specimen. The triænes almost invariably extend their cladi beneath this layer, and do not pierce it to reach the dermal membrane. The dermal oxea are abundant and arranged more or less perpendicularly to the surface; they extend from the outer surface of the layer of sterrasters and project for a short distance beyond the dermal membrane. The granular brown pigment cells, to which the sponge owes its characteristic colour, are scattered in the ectosome outside the layer of sterrasters.

The spiculation is as follows:—

(1.) Orthotriænes; with shaft about 2·37 millims. by 0·06 millim.

(2.) Anatriænes; with very long and slender shaft and cladi about 0·054 millim. long.

(3.) Somal oxea; about 2·0 millims. by 0·029 millim.

(4.) Cortical oxea; about 0·2 millim. by 0·008 millim.

(5.) Sterrasters; about 0·08 millim. in diameter, oval or nearly spherical.

(6.) Somal chiasters or spherasters; about 0·0083 millim. in diameter.

(7.) Choanosomal oxyasters or spherasters; mostly with few long and slender, smooth rays; about 0·0165 millim. in total diameter.

No typical protriænes were seen, but only small plagiotriænes, which may be young forms of the large orthotriænes.

In this case, as in that of *G. perarmata*, we can include the species in the genus *Geodia* only by abandoning the restricted definition thereof given by Sollas.

The species, as already indicated, is at first sight easily confounded with *G. perarmata*. The specimens of the two were mixed together in the collection, and only a part of the total number was forwarded to me for investigation, under the impression that they were all specifically identical. I am therefore unable to say how many of each were really collected by Professor HERDMAN and his assistants. Even small specimens are, however, very easily distinguished by microscopical examination, as will be evident from the above descriptions, and the species are not really even closely related.

Mr. CARTER received his material of this species from the Gulf of Manaar.

R.N. 120, 122, 123 (deep water off Galle, up to 100 fathoms).

Geodia ramodigitata, CARTER.

1880, **Geodia ramodigitata**, CARTER (4); 1888, **Geodia** (?) **ramodigitata**, SOLLAS (15).

There is one specimen in the collection which appears to be referable to this species. It is of remarkably irregular shape, with one strongly curved, finger-like projection or branch. Unfortunately the specimen is a good deal injured on one side, so that the exact shape cannot be determined. The maximum diameter of the specimen in its present condition is about 40 millims. The colour (in spirit) is pale grey, and a good many foreign bodies are attached to the surface here and there. The vents are minute, for the most part irregularly grouped over the ends of large exhalant canals, with which they communicate by means of narrow chones penetrating the cortex. The outer ends of these chones are usually covered over by a sieve-like dermal membrane which sub-divides the vent into a group of comparatively small pores. Inhalant pores irregularly scattered, perhaps sometimes in groups, but of the numerous pore-sieves present in the dermal membrane it is extremely difficult to say which are inhalant and which exhalant.

The layer of sterrasters is about 1 millim. thick and lies close up to the dermal membrane, with the cladi of the triænes spreading out beneath it. The dermal membrane is very minutely hispid with projecting oxea.

The spiculation is as follows:—(1.) Orthotriænes; shaft stout, gradually and finely pointed, about 2·5 millims. by 0·08 millim; cladi stout, sharp pointed, up to about 0·35 millim. long, extended nearly at right angles to the shaft. Sometimes one or more of the cladi undergoes reduction or may even become obsolete, leaving the spicule with two, one or no properly developed cladi, as the case may be.

(2.) Protriænes; shaft very long and slender, measured up to about 3·7 millims. by 0·023 millim., with sharp-pointed cladi about 0·18 millim. long.

(3.) Anatriænes; shaft very long and slender, measured up to 4·0 millims. by 0·018 millim.; with stout, recurved, sharp-pointed cladi about 0·09 millim. long; not very numerous.

(4.) Somal oxea; gradually and sharply-pointed at each end, about 2·57 millims. by 0·04 millim., often slightly curved.

(5.) Cortical oxea; about 0·2 millim. by 0·007 millim.

(6.) Sterrasters; about 0·09 millim. by 0·075 millim.

(7.) Chiasters; extremely minute, with short, truncate or slightly tylote rays; total diameter about 0·006 millim.; very abundant in the dermal membrane.

(8.) Oxyasters; of unusually large size, with no distinct centrum, with large, slender, smooth, sharp-pointed rays, rather few in number; total diameter about 0·066 millim.; very abundant in the deeper parts of the sponge.

There are two points in which the spiculation of Professor HERDMAN'S specimen, as given above, differs considerably from that given by CARTER (4) for the type of the species. In the first place, CARTER mentions no cortical oxea, but he remarks that the surface is much worn, so that we need lay but little stress upon this difference. In the second place, the internal oxyasters appear to be twice as large in our specimen as in the type; this also I do not consider a very important difference, as the internal asters of *Geodia* are subject to much variation in size. Their form, on the other hand, agrees very closely in the two cases and appears to be characteristic. The other spicules, also, with the exception of the sterraster, appear to be somewhat larger in the present specimen; but on the whole there can be very little doubt of the correctness of the identification, especially when we remember that Mr. CARTER'S type specimen came from the Gulf of Manaar.

R.N. 136 (Station XLI., 12 miles off Galle, 100 fathoms).

SUB-ORDER: SIGMATOPHORA.

Tetractinellida with triænes; with sigmata for microscleres (when present); without asters.

FAMILY: TETILLIDÆ.

Sigmatophora with well-developed protriænes and with skeleton usually strongly radiate in arrangement.

Tetilla, SCHMIDT.

Cortex absent or feebly developed; no special cortical skeleton.

Tetilla hirsuta, DENDY.

1889, **Tetilla hirsuta**, DENDY (3).

This remarkable species is represented in the collection by three specimens which differ somewhat amongst themselves, but all agree in the possession of the highly characteristic, cup-shaped, poriferous pits. In all the surface is more or less strongly hispid from projecting spicules, and encrusted with a layer of dirt between, to which the colour of the surface is due, this colour varying with the nature of the foreign matter. Two of the specimens are more or less spherical, one (R.N. 129) being attached to a mass of Nullipore; the third (R.N. 241) is constricted and slightly elongated below, where it has been torn off from its attachment. In one specimen (R.N. 129) there are, in addition to the characteristic spicules, a fair number of quite small oxea, varying much in size, and irregularly scattered in the choanosome. Such small oxea do not appear to be present in the type, but, in view of their variability in size and sporadic distribution, one can hardly regard their presence as constituting a specific or even varietal distinction. It should be noted, however, that very similar spicules appear to be characteristic of the next species (*T. poculifera*).

The arrangement of the pores and vents in this sponge is very peculiar and might be thought by some authorities to deserve generic recognition. The former are congregated in more or less deep, cup-shaped pits, guarded by very slender projecting protriænes and prodiænes; these pits occur, mostly, at any rate, on the lower parts of the sponge and may slope upwards. The vents (or better, cloacal cavities) are represented by pits containing the openings of excurrent canals. As SOLLAS has pointed out (**15**, p. cxxv), a somewhat similar arrangement is found in his genus *Cinachyra*, closely related to *Tetilla*, but that genus is also characterised by the presence of a thick cortex containing cortical oxea. In *Tetilla hirsuta* the cortex is only feebly developed, more or less fibrous, but without special cortical spicules.

For further specific details I must refer to the original description, to which I may add that the flagellate chambers are apparently eurypylous.

In the choanosome of R.N. 129 numerous minute and apparently siliceous spherules were observed, up to about 0·004 millim. in diameter. The nature of these bodies will be discussed under the head of *Tetilla anomala*, in which species they also occur.

R.N. 129 (deep water off Galle and onwards up West Coast); 177 (lagoon inside the reef, Galle, shallow water); 241 (Ceylon seas).

Tetilla poculifera, n. sp.—Plate I., fig. 6; Plate III., fig. 4.

The type specimen (R.N. 230, Plate I., fig. 6) is somewhat pear-shaped, with the broad end attached to a mass of calcareous organisms (Polyzoa, &c.). The apex of the sponge is occupied by a deep cup-shaped cloaca (Plate I., fig. 6, *Cl.*), whose margin is fringed with spicules, and whose floor is a sieve-membrane. The surface of the sponge is uneven, irregularly hispid, and thinly encrusted with sand-grains. Colour (in spirit) yellowish grey. Height of specimen 16 millims., transverse diameter 14 millims. Diameter of cloacal aperture 2·5 millims.

The skeleton consists chiefly of bands of large oxea radiating outwards from a central "nucleus"; the ends of these bands commonly project slightly beyond the surface.

Spicules.—(1.) Plagiotriænes (Plate III., fig. 4, *a*, *b*); few in number, but evidently proper to the sponge, though, perhaps, not specifically characteristic. A typical example from a boiled-out preparation has a fairly stout shaft, tapering gradually to a hair-like extremity, and about 1·3 millim. long by 0·0185 millim. thick below the cladome; cladi short and stout, about 0·13 millim. long, with apices fairly sharp and slightly incurved. (I have also seen fragments of two large dichotriænes, but it is doubtful whether these are proper to the sponge.)

(2.) Protriænes (Plate III., fig. 4, *d*, *d'*); with long, slender shaft, and long, slender, sharp-pointed cladi; conspicuous around the cloacal opening; size variable.

(3.) Anatriænes (Plate III., fig. 4, *c*, *c'*); of ordinary form, with short cladi and very long, slender, hair-like shaft. A specimen in a boiled-out preparation has cladi about 0·037 millim. long and shaft about 2·8 millims. long.

(4.) Oxea of the main skeleton (Plate III., fig. 4, *e*); stout, straight, fusiform, and tapering very gradually to the extremities, which may be sharply pointed, or rounded off or irregular; size about 3·1 millims. by 0·046 millim.

(5.) Sigmata (Plate III., fig. 4, *h*); slender, more or less contort, measuring about 0·017 millim. from bend to bend; abundant.

(6.) Small scattered oxea (microxea) (Plate III., fig. 4, *f*, *g*); straight or slightly curved; smooth, slender, fusiform, gradually and finely pointed at each end; size about 0·23 millim. by 0·005 millim. These spicules are scattered irregularly in enormous numbers throughout both choanosome and ectosome; in the latter position they may form quite a dense layer at the surface of the sponge, in which most of them lie tangentially. They may, perhaps, be regarded as microscleres.

Stained sections show that there is no cortex, and that the ectosome, though fairly thick, is not sharply differentiated from the choanosome. The material is not in a fit condition for minute histological investigation, but I have been able to make out that the flagellate chambers are oval and about 0·029 millim. in greater diameter. The inhalant pores are apparently scattered over the surface, and the inhalant canals appear to originate in irregular lacunar subdermal cavities. The larger exhalant canals are provided with numerous diaphragms, and terminate below the sieve-like floor of the cloaca.

The most characteristic features of this species are the structure of the cloaca and the presence of the very numerous smooth microxea. In *Tetilla* (?) *australiensis* (CARTER) minutely spined microxea, 0·21 millim. long, are present, and SOLLAS (**15**, p. 43) observes of this species that the oxeote microscleres are almost unique amongst the Tetillidæ.* The case of *T. hirsuta*, described above, however, seems to show that in the oxea of this genus (as in *Plakinastrella*, &c.) it is impossible to draw a hard and fast line between mega- and microscleres.

In addition to the type described above, there are in the collection two other specimens which may be referred to the same species, viz., R.N. 189 and 205. Both are somewhat imperfect. R.N. 205 has several cup-shaped (cloacal ?) cavities, with sieve-like floors, irregularly distributed; the other is too imperfect to show the character of the vents.

R.N. 189 (Muttuvaratu Paar, Gulf of Manaar); 205 (Gulf of Manaar); 230 (deep water off Galle and onwards up West Coast of Ceylon).

Tetilla anomala, n. sp.—Plate III., fig. 5.

There are two specimens of this sponge in the collection, the larger of which (R.N. 153) may be regarded as the type. It appears to be a fragment, amounting to

* Oxeote microscleres occur also in the genus *Paratetilla* (*vide infrà*).

nearly half, of an irregularly spherical sponge, about 35 millims. in greatest diameter. The surface is rather uneven, minutely hispid, and thinly encrusted with sand. Neither pores nor vents are visible externally. The colour, in spirit, is grey, the texture firm and compact and only slightly compressible.

The skeleton consists chiefly of stout bands of oxeote spicules radiating from a centrally (?) placed "nucleus" to the surface of the sponge. The outer portions of these bands are often abundantly echinated by the cladi of the anatriænes, lying chiefly in the ectosome.

Spicules.—(1.) Protriænes (Plate III., fig. 5, *a*); with rather short, stout cladi and fairly stout shaft, tapering to hair-like fineness. Shaft about 2·76 millims. by 0·015 millim. (at the thickest); cladi about 0·054 millim. by 0·00625 millim. The cladi may be slightly irregular, and I have seen one forked at the extremity. They are sometimes much longer than in the specimen measured. These spicules occur in positions similar to those of the anatriænes, but are very scarce.

(2.) Anatriænes (Plate III., fig. 5, *b*, *b′*); with fairly stout, sharp-pointed cladi and long hair-like shaft; length of shaft about 2·7 millims., of cladi about 0·058 millim. Abundant.

(3.) Oxea (Plate III., fig. 5, *c*); stout, fusiform, gradually and finely pointed at each end; size about 2·8 millims. by 0·046 millim.

(4.) Sigmata (Plate III., fig. 5, *d*); slender, usually contort; very numerous, especially in the walls of the inhalant canals; measuring up to about 0·01 millim. from bend to bend.

(5.) Spherules; smoothly rounded, but irregular in shape; up to about 0·004 millim. in diameter, but usually smaller. These bodies are enormously abundant in the choanosome, but are practically absent from the ectosome. In the type specimen they are thickly, but irregularly scattered; in R.N. 192 they are grouped in oval clusters about 0·11 millim. in longer diameter.

Stained sections show a fairly thick ectosome pretty sharply differentiated from the choanosome and, to some extent, fibrous, but composed chiefly of chondrenchyme with very numerous granular cells. The thickness of this ectosome, which almost amounts to a cortex, in the type specimen, is about 0·74 millim. It is penetrated here and there by narrow inhalant canals, leading almost vertically inwards from the surface. The flagellate chambers are oval or nearly spherical, up to about 0·033 millim. in diameter. Their mode of opening and the arrangement of the excurrent canal system have not been made out. The mesoderm of the choanosome ranges from collenchymatous to chondrenchymatous.

The extraordinary number of the siliceous spherules or globules in this sponge is very remarkable. In R.N. 192 they are, as already stated, grouped together in oval masses. They appear in this case to originate many together in special mother cells, in which they first appear as very minute, highly refringent points. The oval groups are probably still associated with the remains of the mother cells. The exact nature of these bodies and their taxonomic value are extremely doubtful. SOLLAS (15) mentions that such bodies occur in the Tetillidæ associated with sigmaspires, but in *Cinachyra barbata*, where they are said to be as much as 0·0535 millim. in diameter, he regards them as "accessory or accidental" forms, and the only species of *Tetilla* in which they are mentioned appears to be *Tetilla arabica* (CARTER), where they are of about the same size as in *T. anomala*. I myself have seen similar bodies in one specimen of *Tetilla hirsuta* (*vide supra*), but only very locally developed. That the spherules are really siliceous appears to be tolerably certain, for they appear abundantly in preparations of *T. anomala* which have been boiled out with nitric acid. Whether they can be regarded as definite and characteristic spicules is, however, another question, and it appears to me not impossible that they may be simply reserves of siliceous material destined to be re-absorbed later on and used for spicule formation. This view is strongly supported by their very sporadic distribution.

There is possibly a close relationship between *T. hirsuta*, *T. poculifera*, and *T. anomala*.

R.N. 153 (Station V., off Chilaw, 10 fathoms); 192 (Station LVII., outside Dutch Modragam Paar, $11\frac{1}{2}$ to 36 fathoms).

Tetilla limicola, n. sp.—Plate I., fig. 7; Plate III., fig. 6.

Sponge (Plate I., fig. 7) somewhat fig-shaped, constricted below, broadly rounded above; may be slightly lobose; may be laterally compressed; anchored in the mud by a great mass of fine silky spicules attached to the base. Surface glabrous, but at the same time minutely and sparsely hispid above, more strongly hispid on the sides; also very minutely reticulate on the upper parts. Texture soft and spongy, but very compact, *i.e.*, without wide canals or cavities in the interior. Colour in life, pink; in spirit, grey. Vents (Plate I., fig. 7, *o*) of fair size, several, slit-like, in deep or shallow depressions on the upper part of the sponge; each leading into a wide but shallow cloacal cavity with an almost flat floor perforated by numerous minute openings of very narrow exhalant canals. Inhalant pores scattered between the surface tufts of spicules. A spirit specimen (exclusive of the root tuft) measures about 43 millims. in height, 48 millims. in greatest breadth, and 31 millims. in greatest thickness. The root-tuft (Plate I., fig. 7, *r.t.*) is nearly as large as the specimen itself, and in its present condition consists of a mass of soft mud held together by the extremely long and slender silky anchoring spicules, which individually are scarcely visible to the naked eye.

The skeleton consists of the following parts:—

(1.) Loose longitudinal bands of very long, slender oxea run almost parallel to one another throughout the body of the sponge. In a longitudinal section taken across the greatest breadth of the sponge these fibres are seen to converge towards a point situated at a short distance below the depressed apex of the sponge. Owing to the constriction of the sponge below, the lower ends of these fibres approach the surface almost without diverging from one another.

(2.) More or less mingled with the foregoing in the lower parts of the sponge are long, silky bundles of the very long, sinuous, hair-like shafts of anatriænes, whose heads echinate the bundles at varying distances beneath the surface.

(3.) Dense surface brushes, composed partly of oxea which form the ends of the long fibres and partly of protriænes of hair-like thinness, whose cladomes project far beyond the surface.

(4.) Numerous oxea, much shorter than those of the fibres, scattered irregularly throughout the body of the sponge.

(5.) The root-tuft, composed of anatriænes with extremely long and slender shafts, irregularly matted together.

Spicules.—(1.) Protriænes (Plate III., fig. 6, *b.*), (and diænes); shaft and cladi often of hair-like thinness; cladi commonly of unequal length (one sometimes suppressed entirely), projecting forwards at only a very small angle with the shaft. In a perfect example in a boiled-out preparation the shaft is about 3·0 millims. long, about 0·004 millim. thick just below the cladi, and tapering to hair-like fineness at the other end. The longest of the cladi is about 0·05 millim. in length.

(2.) Anatriænes (Plate III., fig. 6, *a*); with extremely long, hair-like shafts, so long and slender that they appear to be invariably broken off even in boiled-out preparations, and I am therefore unable to give the measurements. The cladi are fairly stout, gradually sharp-pointed, recurved at a very acute angle to the shaft, and about 0·04 millim. long by 0·004 millim. thick at the base. In boiled-out preparations the shafts of these spicules stick together in silky wisps.

(3.) Oxea (Plate III., fig. 6, *c.*); long and slender, commonly slightly curved, very gradually and finely pointed, varying greatly in size according to position, measured up to about 2·1 millims. by 0·01 millim.

(4.) Sigmata (Plate III., fig. 6, *d*); slender and commonly contort, measuring about 0·008 millim. from bend to bend. Very numerous.

The material is hardly sufficiently well preserved for minute histological investigation, but the examination of sections prepared by the usual paraffin method shows us the following features. There is no cortex and no distinct dermal membrane, the ectosome not being sharply differentiated from the choanosome. The small inhalant pores, scattered between the dermal brushes of spicules, lead directly into narrow, elongated canals, which run inwards at right angles to the surface and unite below the spicular brushes in larger inhalant canals which penetrate the deeper parts of the sponge. The flagellate chambers are approximately spherical and about 0·025 millim. in diameter; they are probably eurypylous. The exhalant canals are all narrow, and converge towards the flask-shaped cloacal cavities already mentioned. Numerous large ova, many of them having very prominent pseudopodia, are scattered through the choanosome. These ova measure up to about 0·11 millim. in diameter. They have uniformly granular cytoplasm and large, well-defined nuclei, each typically with a single darkly-staining nucleolus.

Of this remarkable sponge eight specimens were found, anchored in the soft mud at the bottom of Tamblegam Lake (a large inlet from Trincomalee Bay); but only one was forwarded to Cape Town for more minute investigation.

The species is evidently nearly related to *Tetilla dactyloidea* (Carter), which that author records (20, 34, 43) from the south-east coast of Arabia, Bombay, and the Mergui Archipelago. The principal difference apparently concerns the excurrent canal-system. In *T. dactyloidea* there appears to be a single vent at the summit of the sponge, and Mr. Carter observes that the terminal aperture divides into a number of branches, which, sub-dividing, permeate the mass generally down to its base. In *T. limicola*, as we have seen, the sponge is very compact throughout, and there are no wide tubes in it, the excurrent canals being very narrow and opening by numerous minute apertures in the floors of somewhat flask-shaped cloacæ with slit-like vents on the surface of the sponge. It is highly probable that this arrangement is a special adaptation to the conditions of life, serving to hinder the entrance of the very fine soft mud, in which it lives, into the interior of the sponge; even as it is, a considerable amount of mud may be seen in the excurrent canals just beneath the floor of the cloaca.

R.N. 70 (one of eight specimens from Tamblegam Lake, Trincomalee).

Craniella, Schmidt.

The ectosome is differentiated into an inner fibrous layer, containing more or less radially arranged cortical oxea, and an outer collenchymatous layer excavated by large subdermal cavities.

Craniella elegans, n. sp.—Plate IV., fig. 1.

Sponge free, irregularly spherical. Surface covered with close-set conuli; hispid with brushes of spicules projecting from the conuli; minutely reticulate between the conuli. Vents not visible in the type specimen. Pores in the thin dermal membrane stretched between the conuli. Colour, in spirit, purplish grey externally, yellow internally. Greatest diameter of type (R.N. 193) about 20 millims. Consistence firm and compact.

The main skeleton consists of stout bundles of spicules radiating from a central "nucleus" and ending in the brushes which project from the surface conuli (Plate IV., fig. 1). These radiating bundles (*r.b.*) are separated from one another by fairly wide intervals, and are composed of large oxea, with anatriænes and protriænes. The cladi of the anatriænes are, for the most part, situated in the outermost part of the choanosome, just beneath the cortex, while those of the protriænes mostly project beyond the surface of the sponge in the hispidating brushes. The special cortical skeleton is, as usual in *Craniella*, confined to the inner, fibrous layer of the cortex, and is composed of stout oxea; these are not arranged strictly radially, but are inclined at various angles to the surface, with their outer extremities commonly abutting at more or less acute angles against the stout bundles of the main skeleton as the latter penetrate the cortex on their way to form the surface brushes.

Spicules.—(1.) Protriænes (Plate IV., fig. 1, *b*); with long shaft, rather stout distally but becoming setaceous proximally, and short, stout cladi of approximately equal length. Shaft in measured specimen 4·78 millims. by 0·0368 millim. (near cladome); cladi, 0·129 millim. long.

(2.) Anatriænes (Plate IV., fig. 1, *a*); with long and very slender, setaceous shafts, and short, stout, sharp-pointed cladi; shaft measured up to 4·87 millims. by 0·0138 millim. (near cladome), with cladi 0·0736 millim. long. Very numerous.

(3.) Oxea of the radiating bands (somal oxea); stout, aniso-actinate; more or less gradually sharp-pointed distally, but drawn out into long setaceous filaments proximally; size up to about 3·27 millims. by 0·046 millim.

(4.) Cortical oxea (Plate IV., fig. 1, *c.o.*); stout, fusiform, aniso-actinate, sharp-pointed at each end, the proximal end narrower than the distal, but not setaceous; commonly slightly curved; size about 1·0 millim. by 0·0368 millim.

(5.) Sigmata; slender, 0·0166 millim. from bend to bend.

The cortex of the type specimen measures, in places, as much as 1·8 millims. thick, and is very sharply differentiated into two layers, of which the outer appears to be usually somewhat thicker than the inner. The outer layer is excavated by very large subdermal (intra-cortical) cavities (Plate IV., fig. 1, *i.c.c.*), which occupy nearly all the space between the radiating spicule bundles of the main skeleton, with the thin dermal membrane stretched over them. The dermal membrane (*d.m.*), and also the deeper parts of the outer layer of the cortex, between the subdermal cavities, contain numerous small brown pigment granules grouped in more or less spherical cells. The inner layer of the cortex (*f.c.*) is densely fibrous and contains no pigment granules; it is strengthened by the special oxea above described, and the fibres lie, for the most part at any rate, parallel to the surface.

The flagellate chambers are about 0·02 millim. in diameter, spherical or oval, eurypylous or with short, wide excurrent canaliculi. The choanosome is crowded with large embryos (Plate IV., fig. 1, *emb.*).

In addition to the type above described, there is in the collection another very small specimen (R.N. 204) of pear-shaped form, with a single apical vent. The maximum diameter of this specimen is only about 8·5 millims. In the structure of the cortex and in the form and arrangement of the spicules, it agrees very well with the type, but the megascleres are all much smaller. This difference, however, is probably due to immaturity, the specimen being of very small size and containing no embryos, while the type, as we have seen, is crowded with them.

R.N. 193 (Station LVII., outside Dutch Modragam Paar, 11½ to 36 fathoms); 204 (Gulf of Manaar).

Paratetilla, n. gen.

Tetillidæ with a special layer of modified triænes, resembling calthrops, lying at the junction between the ectosome and choanosome (or in the ectosome).

The discovery by Professor HERDMAN of another species of Tetillid which shares the remarkable skeletal peculiarities of CARTER'S *Tethya merguiensis* (21), appears to justify the establishment of a new genus for the reception of the two. *Paratetilla merguiensis* is, like our species, an inhabitant of the Indian Ocean (Mergui Archipelago), but its area of distribution extends, according to SOLLAS (15), as far as Torres Straits. The synonymy of this species is, however, somewhat involved, according to LINDGREN (86) and THIELE (87) it should be known as *Tetilla bacca* (SELENKA), with which, according to THIELE, KIESCHNICK'S *Tetilla ternatensis*, *T. amboinensis*, *T. violacea*, and *T. rubra* are again synonymous. If these identifications be correct the range of the species must be yet further extended.

Paratetilla cineriformis,* n. sp.—Plate III., fig. 7.

This species is represented in the collection by four specimens, ranging in diameter from about 12 millims. to about 41 millims. The shape is irregularly hemispherical. All but the smallest have been injured below by tearing off from the attachment, the base of the sponge having evidently been left behind. The smallest, which appears to be fairly perfect, is cushion-shaped, flat beneath and convex above. The surface is more or less uneven, and to some extent hispid, though not very markedly so; it may be very irregular. The consistence is rather soft and spongy. The colour externally (in spirit) is almost black; internally much paler, purplish grey. The arrangement of the vents and pores is very difficult to determine. A few small, pocket-like depressions, irregularly scattered over the surface, probably represent cloacal cavities; their floors are perforated by the numerous minute apertures of slender, exhalant (?) canals; their external openings may be narrow and slit-like. The inhalant pores are probably scattered irregularly over the surface, but I have not been able to make them out distinctly. Some of the specimens are infested by parasitic cirripedes, living beneath the surface in cavities whose external apertures simulate vents.

The main skeleton consists of stout bands of spicules radiating from a large central "nucleus." In addition to these there is the layer of modified triænes lying at the junction of ectosome and choanosome.

Spicules.—(1.) Modified triænes (Plate III., fig. 7, *a–d*), lying at the junction of ectosome and choanosome. These spicules are so irregular in size and shape that it is almost impossible to describe them; the following have been measured: (*a.*) with four simple unbranched rays, one much shorter than the others, resembling a plagiotriæne with shaft shorter than cladi; length of longest ray 0·165 millim., with two

* The specific name is derived from the close resemblance which the sponge bears to a black cinder.

others a little shorter, and the fourth much shorter; (*b.*) with one very short unbranched ray (shaft) and three much longer rays (cladi), of which two are forked; cladi of somewhat unequal length; maximum diameter of cladome from tip to tip of rays 0·276 millim.; maximum diameter of cladi about 0·0166 millim.; (*c.*) similar to (*a.*), but with cladi much curved; the very short shaft, as is commonly the case, rounded off at the extremity; (*d.*) with only three rays, two almost in the same straight line and the third, much shorter (? = shaft) at right angles to them; length of each of longer rays about 0·147 millim.; of short ray about 0·055 millim. The rays of these spicules are often irregularly bent or curved. They are probably, as pointed out by CARTER and SOLLAS in the case of *P. merguiensis*, modified "zone-spicules" (plagiotriænes).

(2.) Protriænes (Plate III., fig. 7, *e*, *e′*); few in number and very variable in dimensions, with shaft and cladi all very slender or fairly stout, and cladome sometimes irregular. The cladome may or may not project beyond the surface.

(3.) Anatriænes (Plate III., fig. 7, *f*, *f′*); with short, stout cladi, and very long slender shaft, often inflated in a bulbous manner at a short distance below the cladome and tapering to hair-like dimensions at the other end. Length of shaft in measured specimen 3·3 millims.; diameter between bulb and cladome 0·007 millim.; length of cladi 0·027 millim. The cladomes of these spicules sometimes project beyond the surface of the sponge.

(4.) Oxea of the main skeleton (Plate III., fig. 7, *g*, *g′*, *g″*); stout, straight or nearly so; fusiform, with the ends gradually and finely pointed, or more or less irregular; size about 2·9 millims. by 0·0365 millim., but usually more slender. Numerous much smaller oxea, apparently young forms, also occur.

(5.) Sigmata (Plate III., fig. 7, *h*); extremely slender, frequently, if not always, contort, about 0·014 millim. from bend to bend; abundant.

In stained sections of the largest specimen the cortex measures up to about 0·28 millim. in thickness. It is composed of a compact tissue which appears to be cystenchymatous rather than collenchymatous, and the cells contain numerous minute brown pigment granules. The choanosome appears to be mostly collenchymatous and contains brown pigment granules similar to those of the cortex, but fewer in number. The flagellate chambers are oval or nearly spherical, up to about 0·0249 millim. in diameter.

This interesting sponge is evidently nearly related to CARTER'S *Tethya merguiensis* (21) (*Tetilla merguiensis* of SOLLAS) from the Mergui Archipelago, off the coast of Burmah, but differs to such an extent that there can hardly be any question of specific identity. The characteristic inhalant pore-sieves and dermal reticulation of CARTER'S species are not recognisable here; the dermal microxea are absent, and the modified "zone-spicules" appear to be much more irregular in shape.

R.N., 184, 187 (Stat. VI., Muttuvaratu Paar, Gulf of Manaar); 214 (deep water outside pearl banks, Gulf of Manaar); 245 (Ceylon seas).

Grade: LITHISTIDA.

Tetraxonida in which the megascleres form desmas, typically united with each other to form a continuous skeleton.

The relationships and classification of the Lithistida still require a great deal of investigation before we can consider our knowledge of the group as by any means satisfactory. They are, of course, usually considered as a sub-division of the Tetractinellida, but inasmuch as many of them have only monaxonid spicules this method of disposing of the group seems somewhat unjustifiable. There appear to be two logical alternatives. We may either regard the Lithistida as being of polyphyletic origin and partition them to the best of our ability amongst other groups, or we may regard them as representing another grade of evolution in a special direction and retain the group provisionally as a matter of convenience, without committing ourselves to an opinion as to whether it is a natural group or not. In the present state of our knowledge the latter appears to me the wisest course to adopt.

As regards the internal classification of the group, I have no doubt that important modifications of the existing arrangement of genera, which we owe to Sollas, must shortly be made. My own experience of the Lithistida is, however, so limited that I prefer not to experiment in this direction, but will content myself with a few critical remarks suggested by the investigation of certain species in Professor Herdman's collection.

Discodermia, Bocage.

Lithistida with tetracrepid desmas and ectosomal discotriænes, and with microscleres in the form of microxea or microstrongyla.

Discodermia emarginata, n. sp.—Plate IV., fig. 4.

The single specimen is of massive form with spreading base attached to a mass of calcareous worm-tubes. The upper surface is strongly convex, rising into two low, mammiform projections, from the broad apices of which (where the small vents are situated) radiate shallow grooves, the outward indications of convergent exhalant canals. Colour throughout (in spirit) pale yellow; texture compact and stony. Diameter of massive central portion about 12 millims., with the basal portion spreading a good deal further as a thin crust.

Skeleton composed of a close reticulation of firmly united tetracrepid desmas with a single layer of discotriænes on the surface. Below the surface are a few slender oxea, which become more numerous and are sometimes collected into loose fibres in the neighbourhood of the vent.

Spicules:—(1.) Stout tetracrepid desmas (Plate IV., fig. 4, *a–e*), more or less tuberculated, especially at the ends of the branches, which proliferate into numerous rounded tubercles, by the interlocking of which the union of adjacent desmas is effected. There are no transitional forms intermediate between these desmas and the discotriænes of the surface, such as Mr. CARTER describes (4), and the desmas are evidently not derived from discotriænes. Each originates from a tetract crepis (calthrops) by branching of the actines and secondary deposition of siliceous material. The initial stages in the development of the desmas are to be found in abundance just beneath the superficial layer of discotriænes, where the skeleton is evidently growing. The young crepis (Plate IV., fig. 4, *a*) is a regular tetract calthrops with minutely roughened surface. In one of the youngest I have seen, the actines measure about 0·04 millim. by 0·004 millim. One actine may be longer than the other three; they are sometimes conical and suddenly constricted at the base. Having attained a length of about 0·08 millim., or it may be less, the actines swell out at their ends and begin to branch irregularly (Plate VII., fig. 4, *c*). Presently the original minute roughening of the surface is covered over by smooth secondary deposits of silica, and the adult, much larger tuberculation appears, though the more central portions of the spicule may often be nearly smooth when fully developed. The diameter of the actines of the fully formed spicule ("epactines" of SOLLAS), between the centre and the point where they commence to branch, is about 0·036 millim. This account of the development of the desmas, while differing widely from that given by CARTER, agrees with the views expressed by SOLLAS in his "Challenger" report.

(2.) Discotriænes (Plate IV., fig. 4, *f*, *g*); disk flat, about 0·23 millim. in diameter; outer surface beset with numerous minute, conical papillæ; margin approximately circular, but minutely crenulated and usually strongly emarginate at one, two or three places, so as to form semi-circular bays or indentations; shaft well developed, stout, conical, fairly sharp-pointed, up to about 0·147 millim. long. These spicules form a single layer on the surface, with overlapping disks. The youngest stage I have recognised in their development is shown in Plate IV., fig. 4, *f*.

(3.) Monaxonid spicules (rhabdi); probably oxeote; long and slender, and commonly tapering very gradually to a fine point. These spicules are so long and slender and so interwoven with the desmas that I have never succeeded in seeing both ends of the same spicule *in situ*, and even in boiled-out preparations they are always broken. They are particularly numerous in the neighbourhood of the vent, but do not, at any rate usually, project beyond the surface. I have measured one up to a length of about 1·2 millims., with a maximum diameter of about 0·006 millim.

(4.) Microrhabds (Plate IV., fig. 4, *h*); usually fusiform and strongylote, with very minutely roughened surface; sometimes slightly curved; size about 0·016 millim. by 0·0027 millim. These spicules are very abundant beneath the layer of discotriænes; and especially in the membrane which immediately surrounds the vent, where they form a continuous layer, the discotriænes being absent.

It is with some reluctance that I have been constrained to add another species of *Discodermia* to the six already described by Mr. CARTER (4, 5) from the Gulf of Manaar (*D. papillata*, *D. aspera*, *D. spinispirulifera*, *D. lævidiscus*, *D. sinuosa*, and

D. sceptrellifera), but I cannot identify Professor HERDMAN'S specimen, from deep water off Galle, with any of these. The richness of the Ceylon seas in species of *Discodermia* is very remarkable. It is strange that I have not been able to find any of Mr. CARTER'S species in Professor HERDMAN'S collection, but they are apparently all small forms, which would not be likely to attract the attention of a collector.

R.N. 234 (Station XLI., 12 miles off Galle, 100 fathoms).

Aciculites, SCHMIDT.

Lithistida with monocrepid desmas and rhabdi, the latter forming a special dermal layer. Without microscleres.

SOLLAS, in his report on the "Challenger" Tetractinellida, places this genus in his family Scleritodermidæ in the "Sub-order" Hoplophora, but it seems to me that it would fall more naturally amongst the Azoricidæ (in the Sub-order Anoplia of SOLLAS). The fact that some of the rhabdi form a dermal layer can hardly be of sufficient importance to justify us in placing the genus not only in a different family, but even in a different "sub-order" from the Azoricidæ, to which it is naturally allied by the form of the desma, the presence of rhabdi, and the absence of microscleres.

Aciculites orientalis, n. sp.—Plate IV., fig. 3.

The single specimen is massive, compact, cushion-shaped, rather irregular, but with rounded outlines, somewhat flattened above and attached below by a broad base to a mass of calcareous débris. Height about 28 millims.; greatest breadth, 38 millims. Texture compact and stony, but with a comparatively soft dermal membrane, which, on the upper surface of the sponge, is easily separable from the underlying part. Vents numerous, minute (say about 0·2 millim. in diameter, but varying), scattered over the upper surface.* Pores scattered. Surface, in parts at any rate, slightly corrugated, with narrow, ramifying and meandering canals showing through the dermal membrane. Colour in spirit grey, both internally and externally.

The main skeleton is a very close and compact reticulation of monocrepid desmas, intermingled more or less abundantly with strongyla. In the dermal membrane the strongyla are very abundant and lie for the most part tangentially, forming a more or less continuous dermal skeleton. Beneath the dermal membrane, where the main skeleton is growing, the desmas are found in various stages of development, not as yet connected with one another.

Spicules.—(1.) Monocrepid desmas (Plate IV., fig. 3, *a–d*). The young spicule (*a*) is an irregular, elongated rod, with minutely roughened surface, which soon begins to branch. The fully grown spicule (*d*) usually consists of a strongly curved main axis with branches coming off chiefly on the convex side. These branches proliferate and

* One much larger opening looks as if it might be artificial.

end in rather sharp, conical papillæ. Similar papillæ may occur on the main axis, but when this is strongly curved they are usually absent from the concave side. The fully developed desma measures about 0·328 millim. in maximum length in a straight line from point to point.

(2.) Strongyla (Plate IV., fig. 3, *e*, *f*); slightly curved and a good deal broader at one end than at the other. The broad end, which may be slightly tylote, is covered with minute spines, while the narrow end is smooth, or nearly so, though often with a very few minute projections. Size, commonly about 0·328 millim. by 0·009 millim. (in the middle).

So far as I am aware, the only other species of *Aciculites* hitherto described is the type of the genus, *Aciculites higginsii*, SCHMIDT (**44**), from Havanna. Our species is evidently very closely related to the West Indian form, which has fortunately been re-examined and described by SOLLAS (**15**, p. 347). In fact, the only specific difference which the description of the latter has enabled me to detect lies in the fact that in the Ceylon species the vents are not protected by tent-like arrangements of radiating rhabdi as described by SOLLAS. Probably, however, other specific differences will be found to exist in the form of the desmas, &c.

We have here an interesting case of apparently discontinuous generic distribution, though the imperfect state of our knowledge of the sponge-fauna of intermediate localities makes it possible that the discontinuity is apparent rather than real.

It may be noted that TOPSENT's *Aciculites incrustans* has now been recognised by that author as belonging to a totally distinct genus, *Desmanthus* (**14**).

R.N. 150 (Ceylon seas).

Taprobane,* n. gen.

Lithistida of plate-like or cup-shaped form, with minute sphinctrate apertures abundantly scattered on each side of the plate; with monocrepid, tuberculate desmas and long, slender oxea; without special ectosomal spicules and with microscleres in the form of sigmata only.

We have here another proof of the artificial character of SOLLAS's classification of the Lithistida. It will be seen from the diagnosis that the sponge upon which the genus *Taprobane* is based might be regarded either as a Scleritodermid without ectosomal spicules or as an Azoricid with sigmata; it is thus very closely related on the one hand to *Scleritoderma*, and on the other to *Azorica*. We have already had occasion to notice, in speaking of the genus *Aciculites*, that SOLLAS places *Scleritoderma* and *Azorica* in different "sub-orders," his Hoplophora and Anoplia respectively, but the discovery of *Taprobane*, combining characters of these two groups, viz., the absence of special ectosomal spicules and the presence of microscleres, alone seems sufficient to necessitate a revision of SOLLAS's scheme.

* So called from the old Greek name for the Island of Ceylon.

Taprobane herdmani, n. sp. Plate I., fig. 8; Plate IV., fig. 2.

Specimen (Plate I., fig. 8) consisting of a stout, erect plate or lamella, strongly curved (almost into the shape of a cup). Surfaces more or less uneven, especially on the outside (which bears numerous galls due to parasitic barnacles). The upper edge is broadly rounded, and the base of attachment is slightly expanded, like the foot of a cup. Both surfaces are slightly and unevenly hispid, the hispidation being almost confined to the more depressed portions. Both surfaces are thickly studded with minute, pustule-like, circular areas, hardly visible to the naked eye. These areas are only about 0·3 millim. in diameter, and each bears the single aperture of an incurrent or excurrent canal surrounded by a well-developed sphincter membrane. The colour (in spirit) is dirty grey; the texture compact and stony. Greatest height about 70 millims.; thickness of lamella about 15 millims.

The main skeleton is a very dense and compact reticulation of desmas, together with loose wisps or brushes of long, slender oxea running at right angles to the surface, beyond which their ends project so as to give rise to the hispidation. The oxea seem to disappear more or less completely from the deeper parts of the sponge, while around the apertures of the canal system, at any rate on the outer surface, they may project as a scanty fringe.

Spicules.—(1.) Desmas (Plate IV., fig. 2); monocrepid and rather sparingly branched, the branches usually coming off almost exclusively from one side of the main axis, which is usually more or less strongly curved. Main axis and branches more or less abundantly ornamented with rounded tubercles; branches (? always) terminating in conical papillæ, which may be bifid at the apex. The union of these desmas is so close and compact that it seems almost impossible to isolate an adult spicule for measurement: but the total length, measured in a straight line from point to point, appears to be about 0·36 millim. The thickness of the main axis, exclusive of tubercles, is about 0·028 millim.

(2.) Oxea; very long and slender, gradually and sharply pointed at each end; commonly more or less curved or crooked; size variable: they are usually broken, but two complete spicules measured about 1·0 millim. by 0·008 millim. and 1·88 millim. by 0·008 millim. respectively.

(3.) Sigmata; slender, contort; total length in a straight line from bend to bend, about 0·01 millim.; abundant throughout the sponge.

One of the most characteristic features of this species is the arrangement of the apertures of the canal system. These appear to be identical in form and arrangement on the two sides of the sponge, but we may conclude from the analogy of other plate-like and cup-shaped sponges that the apertures on the outer side are inhalant pores, and those on the inner side vents. Each aperture, whether pore or vent, lies in the middle of a circular area, sharply defined by the sudden cessation of the reticulation of desmas at its margin. This area is occupied by a very well developed, iris-like diaphragm, with abundant circularly and perhaps also radially arranged myocytes, the contraction of the former of which has, in almost all cases, completely closed the aperture. The diaphragm contains sigmata, but no other spicules. A similar arrangement of the external apertures of the canal-system appears to be characteristic both of *Azorica* and *Scleritoderma;* indeed, our Ceylon species, except for the absence of microstrongyles, resembles very closely indeed SCHMIDT'S *Scleritoderma packardi* from the Gulf of Mexico, as described and figured by SOLLAS in his work on the "Challenger" Tetractinellida.

R.N. 40 (Stat. XV., Periya Paar, Gulf of Manaar, 9 fathoms).

Petromica, TOPSENT.

Lithistida of massive form; with scattered pores and vents; with thin dermal membrane destitute of special skeleton; with monocrepid desmas feebly united or quite separate; with monaxonid rhabdi often collected in fibres which may terminate in surface conuli; without microscleres.

This genus was founded by TOPSENT in 1898 (**45**) for a new Lithistid sponge from the Azores, very closely related to *Azorica.* TOPSENT gives the following diagnosis:—"Azoricidæ massives, en forme de cônes dressés, à surface conuleuse, à pores dispersés, à oscules membraneux, à ectosome dévellopé aspiculeux, à desmas peu ornés et faiblement reliés entre eux."

The discovery of a second species in Ceylon waters, closely related to the type of the genus, forms a further justification for separating *Petromica* from the other Azoricidæ.

Petromica massalis, n. sp.—Plate IV., fig. 5.

Sponge massive, may be attached by a broad base, may be compressed vertically or horizontally. Vents usually numerous, rather small, but variable in size; scattered on the upper part of the sponge, each forming the termination of a vertical oscular tube. Pores scattered. Surface uneven, variable, more or less corrugated; in places covered with a thin, reticulate, pore-bearing dermal membrane overlying large sub-dermal cavities and supported on bundles of large monaxonid spicules which sometimes terminate in conuli. Texture incompressible, but friable; colour (in spirit) yellowish grey throughout. The type specimen (R.N. 257) measures about 37 millims. in height, the same in breadth, and 24 millims. in thickness.

The main skeleton is a reticulation (sometimes close and sometimes so loose that the desmas do not touch one another) of much-branched monocrepid desmas, intermingled with numerous large monaxonid spicules which are partly collected together in coarse fibres (without being united together by any cementing substance). These fibres, as already noticed, sometimes terminate in surface conuli. There is no special dermal skeleton.

Spicules.—(1.) Monocrepid desmas (Plate IV., fig. 5, *a*); much and very irregularly branched; not tuberculate (or very slightly so); branches usually terminating in short, blunt, conical points, or in curved flattened expansions pressed against other desmas. Maximum length from apex to apex of branches about 0·74 millim., with main axis about 0·06 millim. thick.

(2.) Stout and slender monaxonid spicules (Plate IV., fig. 5, *b–e*); more or less curved and variously ended, ranging from oxeote to strongylote and stylote; size about 0·98 millim. by 0·0369 millim., 1·2 millims. by 0·0246 millim., 1·28 millims. by 0·0328 millim., &c.; very variable.

The most interesting feature of this sponge is the strong development of the monaxonid spicules (rhabdi), which, in three out of the four specimens (the fourth being dead and infested by another sponge), play an equal part with the desmas in the composition of the skeleton. This condition of the skeleton suggests that certain Monaxonellid sponges usually associated with the Axinellidæ may be derived from Lithistid ancestors by the suppression of the desmas, or that certain Lithistids with monocrepid desmas may possibly be derived from Monaxonellid ancestors.

Petromica massalis is evidently very closely related to Topsent's *P. grimaldii*, the type of the genus, from the Azores. The principal difference appears to concern the ornamentation of the desmas, which, in *P. grimaldii*, are ornamented at the extremities with little conical tubercles, not pointed. These are absent or very feebly developed in the Ceylon species, but subsequent researches may make it desirable to unite the two.

R.N. 198; 216 (dead, and infested by another sponge; deep water outside pearl banks, Gulf of Manaar); 257 (type); 269 (young; deep water off Galle and onwards up West Coast of Ceylon).

Grade: MONAXONELLIDA.

Tetraxonida in which the primitive tetraxonid and tetractinellid condition of the megascleres has been entirely lost and none but monaxonellid megascleres remain. No desmas are developed.

With the recognition of the true nature of the monaxonellid sponges as reduced Tetraxonida, it becomes once more desirable to modify the name of the group. The old name, "Monactinellidæ," which we owe to Zittel, was objectionable because implying that the spicules are necessarily monactinal (one-rayed), while, as a matter of fact, they may be also diactinal (two-rayed). Sollas therefore altered the name to "Monaxonidæ," which was afterwards altered to "Monaxonida," under which name the group appears in the '"Challenger" Reports' and other recent works.

The name "Monaxonida," however, becomes distinctly objectionable when used for a mere sub-division of the order Tetraxonida, contrasted with the Tetractinellida; and I therefore propose to again modify the name of the group, choosing this time the term "Monaxonellida," which is, I believe, both correct in meaning and in harmony with the scheme of classification adopted.

The Monaxonellida form, however, an unnatural group of polyphyletic origin, which we can only retain as a matter of convenience until we know more about their phylogeny. They are evidently descended from more than one group of tetractinellid ancestors by degeneration of the tetraxon megascleres, and have branched off into an immense number of genera and species, the classification of which, as in the case of all reduced forms, is extremely difficult.

We have seen that the two chief tetractinellid sub-orders are distinguished mainly by the form of the microscleres, the "Astrophora" possessing some form of aster and the "Sigmatophora" sigmata. This same distinction, broadly speaking, runs through the Monaxonellida also, and may be used as the basis of their sub-division into "Astromonaxonellida" and "Sigmatomonaxonellida," names which I now propose as the most appropriate for the two great groups into which the "Monaxonellida" are by general consent divided, and approximately equivalent to the "Clavulina" and "Halichondrina" of VOSMAER and of RIDLEY and DENDY, and to the "Hadromerina" and "Halichondrina" of TOPSENT, &c.

These two groups are sharply distinguished from one another. As far as I am aware, there are only three cases on record of the occurrence of astrose microscleres in association with sigmata or chelæ, and all three are probably to be explained as due to mixture of the spiculation of two distinct sponges—a very frequent occurrence.*

We may regard these two great monaxonellid sub-orders as being descended from the two corresponding tetractinellid sub orders, though this is no doubt but a crude way of looking at the problem, and it may well be that some of the forms which we find most difficult to classify are descended directly from the Homosclerophora, and others from the Lithistida.

The great difficulty in following out this system of classification to its logical conclusions lies in the fact that in many cases the microscleres, as well as the tetract megascleres, have entirely disappeared, apparently by degeneration, and we are then dependent upon the much less trustworthy guidance of other characters. Thus the genera *Halichondria*, *Reniera*, *Axinella*, *Suberites*, &c., with a very simple spiculation composed exclusively of monaxonid megascleres, are in reality more modified forms than *Gellius*, *Sigmaxinella*, *Hymedesmia*, *Spirastrella*, and so on, which have not lost their microscleres.

SUB-ORDER: ASTROMONAXONELLIDA.

Monaxonellida in which the microsclere, when present, is some form of aster.

This sub-order is practically equivalent to the Hadromerina of TOPSENT, which

* The cases in question are SCHMIDT'S *Sceptrella regalis* (23), p. 58 [*vide* also RIDLEY and DENDY (1), p. lxii., footnote]; FRISTEDT'S *Desmacella peachii* var. *stellifera* (24); and TOPSENT'S *Hymeraphia toureti* (25); all very doubtful cases. The so-called amphiasters (or "birotulates") of certain Desmaeidonidæ (*e.g.*, *Axoniderma*, *Iotrochota*, *Amphiastrella*) are not true asters at all, but merely modified isochelæ. [Further discussion on this subject, necessitated by the appearance of TOPSENT'S great work on the Sponges of the Azores (62), will be found in the general remarks on the sub-order Sigmatomonaxonellida.]

that author sub-divides into two sections, according to the prevailing form of megasclere, viz., "Clavulida" and "Aciculida." This sub-division, however, appears to me to be both unnecessary and unnatural, especially when its originator places the genus *Tethya*, with its stylote megascleres, in the division "Aciculida," which is characterized by oxeote megascleres.* I therefore propose to divide the sub-order immediately into families. Of these Topsent (26) makes nine, of which five are represented in the present collection.

In addition to these, I here include the family Chondrosidæ, which have completely lost their megascleres, and, in the genus *Chondrosia* itself, their microscleres also. Some of the old group Axinellidæ (*e.g.*, *Vibulinus*, with astrose microscleres) must likewise be included in this sub-order, and it may prove necessary to institute a new family—Astraxinellidæ—for their reception.

On the other hand, I am inclined to think that some of Topsent's families will prove to be superfluous. Thus I propose to abandon his "Coppatiidæ" and "Streptasteridæ" in favour of the older "Epipolasidæ" of Sollas.

Family: EPIPOLASIDÆ.

Astromonaxonellida with oxeote megascleres, and usually euasters for microscleres.

This family, founded by Sollas (15) for the reception of the genera *Amphius*, *Coppatias*, and *Asteropus*, is, at any rate as regards what we may consider to be its typical representatives, evidently very closely related to the Stellettidæ, a fact which has already been recognised by previous writers. In short, we may safely regard these forms as reduced Stellettids which have lost their tetraxon megascleres, and Sollas himself placed the family next to the Stellettidæ as an appendix to the Euastrosa, though apparently with some doubt.

Topsent divided the genera of Sollas's Epipolasidæ between his own families Coppatiidæ and Streptasteridæ. In the Coppatiidæ he also includes certain genera, such as *Spongosorites*, which have no microscleres at all. *Spongosorites* is well represented in the Sponge-Fauna of Ceylon, but, for reasons which will appear subsequently, I find it desirable to remove it to the Axinellidæ.

Coppatias, Sollas (15).

Epipolasidæ with the skeleton composed of an irregular interlacement of oxea, and microscleres in the form of euasters only.

This genus is almost synonymous with the genus *Stellettinopsis* as employed by Carter.

* It should be pointed out, however, that Sollas and Topsent regard the megascleres of *Tethya* as modified oxea, which they term strongyloxea, but it is impossible to distinguish these from styli.

Coppatias reptans, n. sp.—Plate V., fig. 2.

The single specimen is much elongated, irregularly sub-cylindrical, creeping over and to a slight extent encrusted by calcareous débris. It has apparently lain horizontally. The total length is about 11 centims., and the maximum thickness about 14 millims. One end is much narrower and forms a free digitiform process, strongly curved. The surface is slightly rugose, minutely conulose and minutely and slightly hispid. The colour (in spirit) is dark purplish-grey, paler below and internally. Vents small (mostly minute), numerous, scattered on the upper surface. Inhalant pores abundantly scattered.

The main skeleton is a very confused reticulation of oxeote megascleres, here and there collected into loose bundles. There is no special dermal layer of tangentially disposed oxea, but the surface is rendered more or less hispid by the projecting points of oxea which lie below it. There is, however, a thin dermal layer of densely crowded asters.

Spicules.—(1.) Oxea (Plate V., fig. 2, *a*, *b*, *c*) slightly curved and gradually and sharply pointed; varying a good deal in diameter; about 1·0 millim. by 0·022 millim. when fully grown.

(2.) Chiasters (Plate V., fig. 2, *d*); very minute, with rather numerous, slender, cylindrical rays and little or no distinct centrum; total diameter about 0·006 millim. (sometimes a little more); most abundant at the surface, but also plentiful in the choanosome.

The ectosome is fairly thick, but is excavated by numerous irregular, spacious sub-dermal cavities, into which the inhalant pores open and from which the inhalant canals of the choanosome take their origin. It is clearly differentiated into two layers: an inner, comparatively thin and densely fibrous layer, with the fibres mostly lying parallel to the surface, and an outer, much thicker layer composed of collenchyma with a considerable admixture of fibrous tissue, but with the fibres running irregularly in all directions.

It is a noteworthy fact that the fibrous cells of the ectosome contain a large proportion of the pigment to which the sponge owes its dark colour, arranged in them in the form of minute spherical granules. Similar pigment granules also occur in some of the ordinary stellate cells of the collenchyma, of which the fibre-cells are but a slight modification.

The outer part of the ectosome also contains immense numbers of large, spherical, darkly staining cells, crowded together in large groups or loosely scattered. Similar cells also occur very abundantly, scattered singly or grouped in dense masses, in the choanosome. They remind one strongly of the symbiotic Algæ of *Hexadella* and the corresponding cells of *Asteropus haeckeli*, and are probably of a similar nature. Their immense numbers and their occurrence in such dense masses in both ectosome and choanosome are alone enough to suggest that they are not true constituents of the sponge-tissues.

This species appears to be very closely related to CARTER's *Stellettinopsis* (*Coppatias*) *tuberculata* (18), an Australian species from which the Ceylon sponge differs chiefly in its external form and reptant habit.

R.N. 242 (Stat. XXVII., Cod Bay, Trincomalee, 5 fathoms).

Asteropus, SOLLAS (15).

Epipolasidæ with two sorts of asters, oxyasters and sanidasters.

Asteropus haeckeli, n. sp.—Plate V., fig. 3.

The single specimen is a small, irregular crust which has probably been attached by the base, to which fragments of calcareous débris are still adherent. The upper surface rises up into a broad, low, mammiform projection, with a single, rather large vent (about 2·5 millims. in diameter) at its apex. Surface smooth, but uneven and harsh to the touch, owing to the presence of huge oxea lying tangentially beneath the surface or projecting slightly beyond it. Colour (in spirit) pale grey. Texture internally coarse and cavernous, owing to the large exhalant canals.* Inhalant pores scattered. The specimen may be only a fragment of a much larger crust; its maximum breadth is about 25 millims., and its greatest height (where the vent is situated) about 11 millims.

The skeleton is a very dense and very confused interlacement of huge oxea, sometimes collected into very loose, ill-defined, coarse strands, which run towards the surface.

Spicules.—(1.) Oxea (Plate V., fig. 3, *a*); usually large and stout, fusiform, gradually and fairly sharply pointed at each end; curved; varying much in size, up to about 1·9 millims. by 0·065 millim. Numerous much shorter and more slender forms also occur, which may be immature.

(2.) Sanidasters (Plate V., fig. 3, *c*, *d*); with straight, slender axis dividing into two spines at each end, and with two irregular whorls of spines dividing the total length into three approximately equal parts; or with the axis irregularly spined, and perhaps angulated, so that the whole closely resembles a *Spirastrella* microsclere; total length up to about 0·016 millim. These spicules are very abundant at the surface and also common in the interior.

(3.) Oxyasters (Plate V., fig. 3, *b*); with few, slender, very slightly spined or roughened (? sometimes smooth), sharp-pointed rays and no distinct centrum; total diameter measured up to about 0·04 millim. These spicules are found in the interior of the sponge, but are scarce and easily overlooked.

The ectosome is very thick, and composed of a mixture of cystenchymatous and collenchymatous tissue, slightly fibrous in places, and with numerous darkly staining, oval cells scattered through it, which somewhat resemble the symbiotic Algæ of *Hexadella*, and are probably of a similar nature.

* The oscular tube is occupied by a Polychæte worm.

This species is closely related to CARTER'S "*Stellettinopsis simplex*," from Australia (Fremantle and Port Phillip Heads),* for which SOLLAS (15) established the genus *Asteropus*, and which, with the doubtful exception of SCHMIDT'S *Stellettinopsis annulata*, has, up to the present time, remained the only described species of the genus. (TOPSENT has shown (28) that LENDENFELD'S *Asteropus incrustans* is not referable to the genus *Asteropus* at all.)

The occurrence of another species in Ceylon waters is extremely interesting and affords a good illustration of the close relationship which exists between the Sponge-Fauna of this region and that of Australia. That the two species are not identical I have been able to convince myself by personal examination of a fragment of an Australian specimen kindly forwarded to me some years ago by the authorities of the British Museum (Natural History). The differences concern chiefly the arrangement of the vents, the colour (tawny-brown in the Australian species), and the size of the oxea (which are considerably more robust in the Ceylon species). Still, it is possible that the future discovery of intermediate forms may justify us in uniting the two.

I have taken the liberty of naming this species in honour of the most distinguished author of 'Die Kalkschwämme.'

R.N. 219 (deep water outside pearl banks, Gulf of Manaar).

Cryptotethya, n. gen.

Epipolasidæ in which the ectosome is differentiated into a thin, inner fibrous layer, very dense, and a thick, outer, more or less gelatinous layer. The outer layer is produced into more or less elongated, finger-like projections, between the bases of which the more or less spherical body of the sponge is largely concealed by agglutinated foreign bodies. The main skeleton is radially arranged, consisting of large oxea extending through choanosome and ectosome alike. The microscleres are euasters.

As regards its spiculation, this genus agrees very closely with *Coppatias*, and, like the latter, is evidently very nearly related to *Stelletta*. In the structure of the ectosome it makes a close approach to *Stelletta herdmani*, in which also the triænes have undergone considerable reduction. In fact, *Cryptotethya* may be regarded as derived from some such form as *Stelletta herdmani* by further reduction of the triænes and by the outgrowth of the ectosome into finger-like processes. In the spherical form of the body, and the radial arrangement of the skeleton, it is also related to *Tethya*, but perhaps its nearest ally is SOLLAS'S genus *Magog*, established (15) for the reception of CARTER'S *Chondrilla sacciformis*, from Mauritius, and included by SOLLAS amongst the Tethyidæ. In *Cryptotethya*, however, the oxea are not confined to the choanosome as in *Magog*. Both genera appear to me to come most naturally amongst the Epipolasidæ, though they certainly seem to indicate the manner in

* Mr. CARTER (27) also records the species from Hayti, but the Haytian form is very likely specifically distinct from the Australian.

which the Tethyidæ may have originated, through the Epipolasidæ, from stellettid ancestors.

Cryptotethya agglutinans, n. sp.—Plate V., figs. 4, 5.

The single specimen (Plate V., fig. 4) consists of a more or less spherical body from which radiate irregular finger-like processes of varying shape, long or short, cylindrical or flattened, and sometimes expanded at the free end. Between these projections the surface of the sponge is for the most part concealed by a great quantity of calcareous débris which firmly adheres to the sponge, including melobesian nodules of considerable size, worm-tubes, Foraminifera, &c., the whole forming an irregular mass in the midst of which the body of the sponge is scarcely recognisable. Calcareous débris may also be found in the interior of the sponge, even within the choanosome. I have not succeeded in making out the arrangement of the vents and pores. Some small openings on the ends of some of the projections resemble vents, but on close examination are found to be merely the apertures of cavities inhabited by parasitic barnacles. One at least of the shorter projections (fig. 4, *x*), however, contains longitudinal canals which are evidently either inhalant or exhalant canals proper to the sponge. The surface of the sponge, where exposed, is very uneven and very harsh to the touch, owing to the projection of the large oxea, which readily break off in one's skin and thus make the sponge very unpleasant to handle. The colour of the surface and of the thick outer layer of the ectosome (in spirit) is grey, of the thin fibrous layer of the ectosome white, and of the choanosome nearly white. The maximum diameter of the body of the sponge is about 40 millims., the length of the longest projection about 25 millims.

In the body of the sponge the huge oxea of which the skeleton is composed are for the most part arranged radially and without any distinction between choanosome and ectosome, passing indifferently from one to the other through the dense fibrous layer. Some of the oxea are associated in loose bands which spread out in brushes as they approach the surface. In the projections the oxea naturally lie for the most part longitudinally, but at the expanded end of a broad projection (containing longitudinal canals) I have found a good many placed tangentially at or near the surface. The asters are for the most part arranged (very abundantly) in a thin dermal layer, through which the points of the oxea may project for a short distance.

Spicules.—(1.) Oxea (Plate V., fig. 5, *a*, *b*); stout, fusiform, usually gradually and fairly sharply pointed, but subject to some irregularity at the ends and occasionally stylote. Size very variable, say about 2·5 millims. by 0·073 millim. when fully grown, but often less.

(2.) Chiasters (Plate V., fig. 5, *c*), with little or no centrum and smooth, slender, sub-cylindrical rays, ending bluntly, but not tylote; total diameter commonly about 0·012 millim. These spicules are most abundant at or near the surface of the sponge, but a few precisely similar forms occur in the choanosome.

Owing, on the one hand, to the enormous quantity of foreign matter adhering to the surface, and, on the other, to the great size of the megascleres, which interfere greatly with the cutting of thin sections, the investigation of the canal system of this sponge is attended with exceptional difficulties, and I have come to no satisfactory conclusions on the subject.

One of the most striking features of the sponge is the dense fibrous layer of the ectosome, which, when the sponge is cut in half, is conspicuous even to the naked eye as a white layer about 0·4 millim. thick, dividing the body into inner and outer portions, and forcibly calling to mind the similar layer of fibrous tissue in *Stelletta herdmani*. This dense fibrous layer consists of bundles of fine fibres closely matted together and running in all directions. It does not, perhaps, form quite the innermost portion of the ectosome, for beneath it lies a thin gelatinous layer containing subcortical crypts, from which the inhalant canals of the choanosome probably take their origin.

The outer layer of the ectosome varies much in thickness. It is partly collenchymatous, consisting of a clear gelatinous matrix with an immense number of large granular stellate cells embedded in it, and partly fibrous, the fibrous condition being apparently arrived at by elongation of similar cells in a direction parallel to the surface. Roughly speaking, this fibrous tissue may be said to occur between two layers of the collenchyma, but the two kinds of tissue are not sharply differentiated from one another, and the fibrous layer is not nearly so well defined or so dense as the inner fibrous layer already described. The outer layer of the ectosome alone takes part in the formation of the finger-like projections on the surface of the sponge, the inner fibrous layer not being continued into these.

The choanosome is rather compact and finely granular, but, owing perhaps to want of penetration by the preserving medium, my sections do not enable me to make out details of the histology or the arrangement of the flagellate chambers.

R.N. 62 (Gulf of Manaar).

Family: TETHYIDÆ.

Astromonaxonellida with stylote megascleres and euasters for microscleres; with strongly developed fibrous cortex and radially arranged skeleton.

I have discussed the probable origin of this family in speaking of the genus *Cryptotethya*.

Tethya, Lamarck.

More or less spherical Tethyidæ, without highly specialised pore-bearing grooves and without a sand-layer in the choanosome.

Tethya lyncurium, Lin.

There are in the collection a number of specimens of *Tethya* which have given me a great deal of trouble as regards their correct nomenclature. I have finally decided to regard them as belonging to three varieties of the well-known and extremely variable *Tethya lyncurium* of European waters. For convenience of reference we may distinguish the Ceylon varieties as *a*, *b*, and *c* respectively.

Tethya lyncurium, Lin., var. *a*.

This variety is represented by two approximately spherical specimens growing side by side on a mass of calcareous and other débris. The larger of the two is about 20 millims. in diameter, the other only a little less. The colour in spirit is dull yellowish-grey. The surface is irregularly conulose and gemmiparous, not distinctly tessellated, and to a considerable extent covered by adherent foreign matter. Each has a single prominent and widely open vent, about 2 millims. in diameter, at the summit of a thin-walled tubular projection. The pore-sieves between the conuli are for the most part inconspicuous.

The cortex is very dense and more or less fibrous throughout, but the fibrous tissue is most strongly developed in its deeper portion. The inhalant canals in the cortex are lacunar near the surface and constricted into definite canals deeper down.

The main skeleton consists of stout radiating bundles of megascleres, breaking up into divergent brushes in the cortex. In the choanosome (but not in the cortex) loose spicules of similar form are abundantly scattered (mostly lengthwise) between the bundles.

The megascleres are rather slender, faintly tylote styli, of the ordinary *Tethya* form. The feebly developed head is narrower than the middle of the shaft, and the apex is gradually and more or less sharply pointed. These spicules measure about 1·3 millims. by 0·02 millim. in the main fibres, but are much smaller in the surface brushes, while between the main fibres, in the choanosome, the sizes are mixed.

The microscleres are of two forms only, spherasters and chiasters. The spherasters are mostly found in the cortex, where they are rather sparingly scattered. The centrum is fairly large, and they have sharp-pointed conical rays which may be (rarely) spined or branched. The rays are about 12 in number, and nearly or quite touch one another at their bases. Total diameter about 0·076 millim., with rays 0·02 millim. long. In the cortex the chiasters are most abundant at the surface and in the walls of the inhalant canals; they are also numerous in the choanosome. They have no centrum and about from 6 to 9 distinctly tylote, rather slender rays. The total diameter of the chiaster is about 0·012 millim. Those of the choanosome are commonly six-rayed, and the rays are occasionally more elongated and proportionately more slender than in the ordinary form, but they are almost always distinctly tylote, and the whole spicule is never more than about 0·02 millim. in diameter.

I am convinced that the two specimens described above cannot be distinguished more than varietally from the common European species. The chiasters are, it is true, more distinctly tylote than is usually the case in *T. lyncurium*, but I cannot regard this character as of specific value, for in a specimen from Budleigh Salterton, in Mr. CARTER's collection (now in my possession), the rays of the chiasters are occasionally tylote, though not nearly so strongly as in the Ceylon specimens.*

R.N. 199, 200 (Stat. LXVII., off Talaivillu Paar, 10 to 14 fath., Gulf of Manaar).

Tethya lyncurium, LIN., var. *b.*

There are five specimens in the collection which may be referred to this variety, differing from the foregoing in the following respects :—

(1) There are no prominent vents.

(2) The surface is more or less distinctly tessellated.

(3) The spherasters are considerably larger and more numerous, and have more numerous rays and larger centra. Total diameter up to about 0·1 millim., with rays about 0·024 millim. long; sometimes they are a little smaller; usually they are densely crowded in the cortex ; the number of rays appears to be usually about 25.

(4) The chiasters are more distinctly differentiated into two kinds, the rays of those of the choanosome showing a strong tendency to lose their tylote character and become strongylote or even oxeote, while at the same time elongating somewhat (but not much) and being (? always) slightly roughened.

The largest of the five specimens is only about 21 millims. in diameter. The colour in spirit is dull grey.

R.N. 180, 180A, 180B (all from Lagoon, Galle); 196; 211 (Gulf of Manaar).

Tethya lyncurium, LIN., var. *c.*

This variety is represented by a single specimen, about 24 millims. in maximum diameter, with very strongly tessellated surface and one prominent vent. The cortex is very lacunar between the polygonal, flattened tesseræ.

As regards spiculation, this variety differs from the preceding only in the presence of numerous well-developed oxyasters, chiefly in the choanosome. These spicules have little or no centrum and usually six rays. The rays are rather slender and sharp-pointed, sometimes slightly roughened, but very rarely spined or branched; usually straight or nearly so. Total diameter of the oxyaster about 0·04 millim.

This variety might be justifiably identified either with SELENKA's *Tethya maza* or with PERCIVAL WRIGHT's *T. seychellensis*, but the two preceding varieties unite it so closely with *T. lyncurium* that it seems to me quite unnecessary to make a specific distinction.

R.N. 19 (Gulf of Manaar).

The occurrence of these three varieties of *Tethya lyncurium* within the same limited area is a very interesting fact, and their discovery is likely to be of great assistance in elucidating the relationship of the so-called species of this extremely difficult genus. In this connection it is interesting to note that WILSON (**29**) has lately recorded the occurrence of both *T. lyncurium* and *T. seychellensis* in Porto Rico.

* TOPSENT, however, entertains (**14**) a different view as to the taxonomic value of the tylote character.

Xenospongia, Gray.

Tethyidæ of discoidal form. Choanosome containing much sand in its deeper parts. Inhalant pores localized in well-defined grooves, partly concentric and partly radial in arrangement. Vents on slight prominences. Surface tuberculate. Skeleton composed of bundles of styli ending in brushes, which project from the surface tubercles and also form a slight marginal fringe. Microscleres euasters of various forms and sizes, forming a dense cortical layer, and also abundantly scattered in the choanosome.

The genus *Xenospongia* was established by Gray (**30**) as far back as 1858 for the reception of two remarkable sponges from Torres Straits, of which he gave a very poor description accompanied by excellent figures of the external characters only. He made no attempt to describe the spiculation, and, although this defect was partially remedied by Carter in 1882, our knowledge of the sponge has remained singularly incomplete up to the present day. The genus has only been recorded once since its original discovery, viz., by Holdsworth (**9**) from the Ceylon pearl banks in 1873. No description, however, has ever been published of Holdsworth's specimen, and the identification with Gray's species, though doubtless correct, was quite unsupported by evidence. Holdsworth's record and specimen (which appears to have been forwarded to Gray for further investigation) both seem to have been lost sight of by subsequent writers.

Under the circumstances, it is not remarkable that the systematic position of *Xenospongia* has hitherto remained doubtful. Gray himself, in 1868 (**31**), made it the type of a new family, for which he proposed the name "Xenospongiadæ." Carter, in 1875 (**32**), referred it to his group "Donatina," along with *Tethya lyncurium*, but expressed the opinion that it might ultimately have to come amongst the "Suberitida." In 1882, however, this author (**33**) reverted to Gray's opinion, and proposed "a group named Xenospongina = Xenospongiadæ, Gray." Sollas, in 1888 (**15**), referred the genus doubtfully to the Tethyidæ, pending further information. Topsent, in 1898 (**26**), made a new departure by referring it to the Spirastrellidæ, though, as it seems to me, with very slight justification.

The minute investigation which I have been able to make of Professor Herdman's well-preserved specimen proves beyond doubt that the opinion of Sollas is correct, and that *Xenospongia* is very closely related to *Tethya* itself, alike in spiculation, skeleton arrangement, histology, and canal system, although the external form and the arrangement of the inhalant pores are very peculiar. Even the surface tubercles or conuli, and the somewhat pinkish colour in spirit, remind one strongly of the genus *Tethya*. In *Tethya* also one sometimes sees the beginning of the development of pore-bearing grooves between the conuli, and the branching of the rays of the asters, which takes place so extensively in *Xenospongia*, may also be observed occasionally.

Xenospongia patelliformis, GRAY—Plate VI.

1858, **Xenospongia patelliformis**, GRAY (**30**); 1867, **Xenospongia patelliformis**, GRAY (**31**); 1873, **Xenospongia patelliformis**, HOLDSWORTH (**9**); 1875, **Xenospongia patelliformis**, CARTER (**32**): 1882, **Xenospongia patelliformis**, CARTER (**33**); 1888, **Xenospongia patelliformis**, SOLLAS (**15**); 1898, **Xenospongia patelliformis**, TOPSENT (**26**).

The single specimen in the collection (Plate VI., fig. 1) has the form of an almost circular disk, about 28 millims. in diameter, with convex upper and slightly concave lower surface and rather thin and slightly undulating margin. The lower surface is formed by the agglutinated sand which makes up the greater part of the thickness of the disk. The upper surface is covered with rather small, rounded tubercles or conuli, thickly scattered at fairly regular intervals. These tubercles are about 1 millim. in diameter, and are normally hispid from the projection of the ends of large spicules, now generally broken off short. The margin of the sponge is also very shortly hispid from the same cause (figs. 1, 2, *m.f.*). Just above the margin two narrow grooves (figs. 1, 2, *m.p.g.*) run round the disk, separated from one another by an interval of about 1·5 millim., across which they occasionally communicate with one another by oblique connecting grooves. The width of the grooves varies up to about 0·5 millim., and the floor is crossed at right angles by narrow parallel bands of fibrous tissue of a whitish appearance, arranged very regularly at short intervals. The inhalant pores are very minute and arranged in transverse rows between the fibrous bands in the floor of the grooves (fig. 2). (In the specimens described by GRAY similar grooves radiate more or less abundantly from near the centre of the disk towards the margin; in our specimen these radiating grooves are very feebly developed and recognizable in only a few places. fig. 1, *r.p.g.*) The vents, now more or less closed, are situated at the apices of three low, monticular elevations near the centre of the disk (figs. 1, 2, *o*); these elevations are not very conspicuous and are apparently formed each by the agglomeration of three or four of the surface conuli.* (Dr. GRAY appears to have mistaken the inhalant pores, or groups of pores, for vents; some of the prominent elevations figured by him on his larger specimen probably bear the true vents, though one, at least, of these elevations appears to contain a parasitic barnacle; there appear to be no barnacles in our specimen, but a parasitic worm occupied one of the larger exhalant canals.)

The colour of the sponge on the upper surface (in spirit) is pale yellowish grey, with a faint pinkish tinge in places, reminding one much of *Tethya*. The texture is firm and compact, leathery above, but the greater part of the thickness of the disk is composed almost entirely of coarse sand (fig. 2, *s.g.*), firmly cemented together by the tissues of the sponge. This sand is exposed only on the lower surface. The total thickness of the disk in the middle is about 6 millims.

The main skeleton consists in the lower two-thirds of the thickness of the disk, or

* In addition to the vent-bearing elevations, there is one larger, wart-like protuberance containing some hard foreign body (fig. 1, *a*).

thereabouts, of the above-mentioned sand-grains, between which there are also numerous styli, arranged, partly at any rate, in irregular bundles, and various forms of asters. The upper third of the thickness of the disk is free from sand, and includes a considerable thickness of the choanosome as well as the cortex. Here the main skeleton is formed by stout bundles of styli running vertically to the surface and entering the tubercles, from which they project as dermal brushes (fig. 2, *d*, *b*). These vertical bundles of styli are crossed at right angles by similar bundles which lie near the inner limit of the sand-free layer of the choanosome and terminate in the feebly-developed spicular fringe (*m.f.*) at the margin of the disk.

The cortex (figs. 2, 3, *cort.*) is strengthened by an immense number of asters of various shapes and sizes, forming a very dense skeleton, especially towards the surface. Asters of various kinds are also very abundantly scattered through all parts of the choanosome.

Spicules.—(1.) Styli (Plate VI., fig. 4); long, slender, nearly straight, evenly rounded off at the base and tapering very gradually to the apex. The size of these spicules is so variable that it seems almost useless to give measurements. The largest are so long that it is difficult to get them unbroken; 1·7 millims. by 0·012 millim. is perhaps a fair average size for the full-grown spicule, but considerably stouter (and presumably also longer) examples frequently occur (broken) in boiled-out preparations, while the styli which fringe the edges of the pore-bearing grooves, for example, are, on the other hand, very much smaller than the measurements given above.

(2.) Euasters (Plate VI., figs. 5, 6); enormously abundant and varying so greatly in form and size that it is impossible to separate the different kinds sharply from one another. The following may, however, be regarded as the principal types:—

(*a.*) Spherasters with very small centrum and long, conical, stout, sharply and gradually pointed, often slightly curved actines, about 11 in number; total diameter of spicule about 0·1 millim., with centrum 0·02 millim. in diametei and actines 0·044 millim. long. These asters pass gradually on the one hand into smaller oxyasters, and on the other into larger forms with very irregularly curved and more or less (often much) branched actines; the most copiously branched forms appear to be characteristic of the sandy layer of the choanosome, where they may attain a total diameter of as much as 0·18 millim.

(*b.*) Minute chiasters, with about 8 fairly stout, sub-cylindrical, tylote actines; total diameter about 0·008 millim.

(*c.*) Oxyasters or spherasters, with small centrum and about 11 slender, conical, oxeote, minutely spined actines; total diameter about 0·02 millim. The actines are occasionally branched.

(*d.*) Similar to (*c.*), but with tylote actines; this is perhaps the most uncommon form of the aster.

After carefully removing the sand-grains from below, it is possible to prepare microtome sections of the outer portion of the sponge, including the cortex and that portion of the choanosome which is free from sand. The cortex (Plate VI., figs. 2, 3, *cort.*) is about 0·13 millim. thick between the surface tubercles, but much thicker in the tubercles themselves, which are composed exclusively of cortical tissue and spicules. The greater part of the substance of the cortex is made up of asters of various forms and their accompanying scleroblasts, but it also contains bands of fibrous tissue running in various directions. Stout bands of dense fibrous tissue (figs. 2, 3, *f.b.*) also run vertically inwards from the cortex through the outer part of the choanosome to the sandy layer, where they appear to assist in binding the sand-grains together. The vertical spicule-bundles which run into the surface tubercles are also accompanied by similar bands of fibrous tissue (fig. 2), and the same kind of tissue is also developed in connection with the vents and the pore-bearing grooves.

A noteworthy feature of the cortex is the presence of the very numerous, approximately spherical, vesicular scleroblasts (fig. 3, *scl.*), about 0·016 millim. in diameter; each resembles a cystenchyme cell and encloses one of the smaller asters, the ends of whose actines abut against the thin limiting membrane of the cell, or perhaps sometimes project beyond it. Similar scleroblasts may be observed in the choanosome. The outermost part of the cortex is composed of small-celled chondrenchymatous tissue; the inner part is more or less fibrous, and between the two we find collenchyma with stellate connective-tissue cells.

The flagellate chambers (fig. 3, *fl.c.*) are oval or nearly spherical, closely crowded together in the choanosome and about 0·028 millim. in diameter where least contracted by shrinkage. The state of preservation is not sufficiently good to enable me to make out minute details very satisfactorily, but the chambers are apparently eurypylous.

The inhalant pores are, as I have already observed, minute openings in the floor of the pore-bearing grooves (fig. 2, *m.p.g.*). They are very numerous, and 10 or more may be indicated in a single transverse section of the groove. From each pore a very narrow inhalant canal runs vertically inwards and opens, with its fellows, into a system of irregular crypts which lie beneath the thick floor of the groove and from which wider inhalant canals take their origin and run inwards to the choanosome, in which they sub-divide into smaller branches. Stout bands of dense fibrous tissue run across in the floor of the groove from side to side, between the transverse rows of inhalant pores and pore-canals. Probably, by the contraction of these bands of fibrous tissue, the prominent lips of the groove can be brought together and the groove thus closed.*

The main exhalant canals are only moderately wide and converge towards the vents. Owing to the state of contraction I am unable to say whether there is a single large vent or a group of small ones on each of the vent-bearing prominences. Sections indicate that there may also be small vents between the conuli, and it appears as if one exhalant canal sometimes opens through several small apertures.

* A very similar arrangement is found in a very different sponge, *Esperella murrayi*, as described in the Report on the 'Challenger' Monaxonida.

The geographical distribution of *Xenospongia patelliformis* is, as pointed out by Holdsworth (**9**), very interesting; the only records up to the present time being Torres Straits and Ceylon. That the specimens met with in these two localities are specifically identical, I have little doubt. Gray, in describing the species from Torres Straits, gave no description of the spicules, and did not even mention the occurrence of asters. Carter, to some extent, remedied this defect in 1882 (**33**), but he only figured two forms of aster, and those not very characteristic. His microscopical preparations, however, which are now in my possession and which were presumably made from one of the Torres Straits specimens (for Holdsworth's specimen and record from Ceylon appear to have been entirely lost sight of ever since his note on the subject was published), show both large and small asters of various forms, and the actines of the large ones may occasionally branch. Mr. Carter's preparations are only teased; had they been boiled out from all parts of the sponge, they would probably have shown all the forms of aster described above from Professor Herdman's example.

The external form is, of course, extremely characteristic, and so little does it look like a sponge that the specimen described above was in the first instance placed amongst the Clypeastroids.

R.N. 375. (Stat. I. First haul of trawl, off Negombo, 12 to 20 fathoms, January 31, 1902.)

Family: SPIRASTRELLIDÆ.

Astromonaxonellida usually of massive or encrusting form. Skeleton usually irregular or reticulate, at any rate internally. Megascleres usually stylote or tylostylote. Microscleres asters of various forms.

Hymedesmia, Bowerbank.

Thin encrusting Spirastrellidæ whose spiculation consists of smooth tylostyli and euasters of various forms (occasionally passing into spirasters).

Topsent has given an excellent account of the literary history of this genus in his Monograph of the Sponges of France (**14**). A very large proportion of the known species come from the Gulf of Manaar, and were described by Mr. Carter (**4**) in 1880: viz., *H. stellivarians*, *H. moorei*, *H. spinatostellifera*, *H. capitatostellifera*, and *H. trigonostellata*. Of these five species I have only met with one in Professor Herdman's collection.

The genus is an extremely interesting one from the phylogenetic point of view, for we see here, in the first place, the first appearance of the characteristic suberitid "pin-head" spicule (tylostyle), and, in the second place, the evolution of the typical spirastrellid microsclere from the euaster.

Hymedesmia forms a connecting link between *Coppatias* and *Spirastrella*, *Coppatias*, as we have already seen, is simply a reduced Stellettid in which the cladi of the triænes have become completely aborted, and the megascleres now consist solely of oxea. From the oxeote to the tylostylote form appears at first sight a big jump, but I think it is evident that the pin-headed type in *Hymedesmia* is simply the result of the thinly encrusting habit. The megascleres in this genus are typically arranged at right angles to the base of support, with their apices projecting outwards, often beyond the surface of the sponge, an arrangement which is admirably adapted both to support the soft tissues and to protect the sponge from the attacks of parasitic Crustaceans or other enemies. In this position the proximal end of the megasclere, pressed against the hard base of attachment, is unable to elongate in the normal manner, and siliceous material, which would otherwise have been devoted to its elongation, is accumulated in a swelling or knob—the "pin-head."

Such is, I believe, the origin of the spirastrellid and suberitid tylostyle, and an exactly analogous process appears to have taken place in the echinating spicules of the Ectyoninæ, which are commonly swollen into a "head" at the end which abuts against the skeleton fibre. The at first sight tempting idea that the head of the tylostyle is the vestige of the cladome of a triæne is put completely out of court by the fact that it lies at the wrong end of the spicule, viz., the proximal instead of the distal end.

The evolution of the typical spirastrellid spiraster from the euaster has evidently taken place by elongation and bending of the centrum of the latter, and various stages of the process may be seen in different species of *Hymedesmia*; indeed, the two forms of aster pass so insensibly into one another that it is impossible to base a generic distinction upon their character alone. In the spirastrellid spiraster the rays (actines) are commonly reduced to mere spines or minute blunt projections.

Hymedesmia stellivarians, Carter.

1880, **Hymedesmia stellivarians**, Carter (4).

The single specimen forms a thin yellowish crust, attached to a small melobesian nodule, in company with *Paresperella serratohamata*, &c. In spite of the somewhat meagre character of Mr. Carter's description and figures, I think there can be little doubt of the correctness of the identification, especially as Mr. Carter's specimen also came from Ceylon waters.

All three forms of aster mentioned by Mr. Carter are present, but they are not all of the same size, as might, perhaps, be inferred from his description and figures. Moreover, in our specimen the megascleres are usually a good deal longer in proportion to their thickness than Mr. Carter's figure indicates, but they are also very variable in dimensions.

Under the circumstances it seems desirable to give the following particulars as to the spiculation:—

(1.) Tylostyli; only slightly curved, if at all; with oval head at one end and gradually and more or less sharply pointed at the other; size variable, up to about 0·47 millim. by 0·01 millim.

(2.) Spherasters; (*a*) comparatively large, with large centrum and stout, smooth, conical, sharply pointed rays; closely resembling the large spherasters of *Tethya;* total diameter about 0·02 millim.; (*b*) of medium size, with moderately developed centrum and stout, sub-cylindrical, very distinctly tylote rays (? heads sometimes roughened), about as long as the diameter of the centrum; total diameter of spicule about 0·012 millim.; (*c*) small, with very small centrum and comparatively long, slender, sharp-pointed rays; total diameter about 0·008 millim. (possibly young forms of one or both of the others).

R.N. 220B (deep water off Galle and onwards up West Coast of Ceylon).

Hymedesmia curvistellifera, n. sp.—Plate V., fig. 6.

Sponge thin, encrusting. (The single specimen has evidently been removed from the surface of some Alcyonarian, the large calcareous spicules of which still adhere in great numbers to the base of the sponge.) Surface uneven, corrugated, very slightly hispid. Colour (in spirit) light brown; texture rather friable. Vents and pores not seen. Average thickness of specimen about 0·5 millim.

The main skeleton consists of loose fascicles of tylostyles, springing from the base of attachment and running to the surface, where they spread out in loose brushes and give rise to the more or less hispid character.

Spicules.—(1.) Tylostyli (Plate V., fig. 6, *a*); straight, or nearly so, with large, oval or sub-globular heads and rather slender, sub-fusiform shafts, gradually and usually finely pointed at the apex. Size, when fully developed, about 0·38 millim. by 0·006 millim. Many much more slender forms, with proportionally larger heads, sometimes pear-shaped, also occur; these I take to be immature spicules.

(2.) Asters (Plate V., fig. 6, *b*, *c*, *d*); with strongly-curved centrum and stout, conical, sharp-pointed, smooth spines (rays). The spines show a tendency in some cases to arrange themselves in three groups, one group at each end of the centrum and one in the middle, on the convex side of the curve. The middle of the concave side of the centrum is free from spines, but the curvature is so great that this part of the centrum is often concealed from view, and the spicule then resembles a spheraster. The total diameter of the aster, when fully developed, is about 0·032 millim., but numerous smaller (young) forms also occur. The asters are most abundant in the dermal layer, where they form an almost continuous crust.

This species finds a near relative in TOPSENT's *Hymedesmia tristellata* (14), from Banyuls and the Azores. Closely similar asters occur in that species, but their rays are often covered with minute spines, which I have never seen in the Ceylonese form. I cannot agree with TOPSENT's view that the "triple spherasters" (as he terms them) have resulted from the concrescence of three centra covered with actines; it appears to me, on the other hand, that they have arisen by elongation of the centrum and grouping of the actines, and that we have here the first stage in the evolution of the typical *Spirastrella* microsclere. From this point of view it is of great interest to compare RIDLEY'S *Spirastrella transitoria* (**16**), from the Amirante Group. This is a thinly encrusting species, with "spinispirular, extremely concentrated, composed of only one entire bend," in fact, very closely resembling the aster of *Hymedesmia curvistellifera.* As RIDLEY further observes, "in *S. transitoria* we have the spinispirular almost in the form of the stellate, with which SCHMIDT . . . . . and CARTER . . . . . consider it to be homologous."

S. transitoria is evidently closely related to *S. curvistellifera*, but differs in the proportions of the spicules. Both species, together with *H. tristellata*, and possibly some others, undoubtedly occupy a position intermediate between the typical species of *Hymedesmia* on the one hand and of *Spirastrella* on the other, so that they might, with almost equal propriety, be referred to either genus.

R.N. 320 (Ceylon seas).

Spirastrella, SCHMIDT.

Massive Spirastrellidæ with styli or tylostyli for megascleres and spirasters for microscleres; the spirasters usually forming a dermal crust.

Spirastrella vagabunda, RIDLEY.

1884, **Spirastrella vagabunda**, RIDLEY (**16**).

There are in the collection a number of specimens which, while differing greatly in external form, agree so closely in spiculation that I am obliged to regard them merely as varieties of one and the same species, which appears to be identical with RIDLEY'S *Spirastrella vagabunda.* This species was originally described by RIDLEY from Torres Straits, but at the same time he assigned to it certain specimens in the British Museum Collection which came from Trincomalee and the Galle Coast, Ceylon, a fact which, of course, strongly supports my identification of Professor HERDMAN'S specimens. The Trincomalee specimen referred to was very briefly described by CARTER (**33**) under the name "*Suberites* ? sp." RIDLEY, having examined the same specimen, suggested (*loc. cit.*) that it should be distinguished as "*S. vagabunda* var. *trincomaliensis*," on account of certain slight differences in spiculation. In Mr. CARTER'S cabinet, now in my possession, there is a preparation, labelled in his handwriting "*Suberites trincomaliensis*," which is evidently from the specimen examined and described by him. Subsequently, in 1886, Mr. CARTER (**20**) described a sponge from the Mergui Archipelago under the name *Suberites trincomaliensis*, identifying it with the Ceylonese form.

Spirastrella vagabunda thus appears to be a widely-distributed and variable species. RIDLEY'S *Spirastrella congenera*, from Torres Straits, is probably a mere variety of the same, and perhaps, also, his *S. punctulata*, from Mozambique and Mauritius. The principal characters of the species appear to be the dense, confused arrangement of the main skeleton, the usually stout and distinctly headed tylostyles, and the slender, more or less elongated spirasters.

I propose to regard Professor HERDMAN'S specimens as belonging to four varieties of the species, which may be distinguished as *trincomaliensis*, *tubulodigitata*, *fungoides*, and *gallensis* respectively.

Spirastrella vagabunda, var. **trincomaliensis**, RIDLEY.

1882, "**Suberites**, ? sp., undescribed, Trincomalee," CARTER (**33**); 1884, **Spirastrella vagabunda**, var. **trincomaliensis**, RIDLEY (**16**); 1886, **Suberites trincomaliensis**, CARTER (**20**).

The single specimen in the collection evidently agrees very closely with the specimen examined by CARTER and RIDLEY. It consists of a massive base rising up into a few short, stout, finger-shaped processes. The surface is sub-glabrous, but slightly corrugated vertically; not warty as described by CARTER (this character having probably been due to drying). The colour (in spirit) externally is nearly black, with a greenish tinge, internally dark greenish-brown. Texture compact throughout, but fleshy and fairly compressible, with little or no imbedded foreign matter. The exhalant canals are (in spirit) extremely narrow and surrounded by gelatinous tissue almost free from spicules; they run vertically upwards through the finger-shaped processes in considerable numbers and probably open by minute vents (now nearly all closed) at the apices of these projections. Greatest height of specimen 56 millims.; greatest breadth of massive base 52 millims.; length of finger-shaped projections about 23 millims.

The skeleton is a very dense and confused reticulation of megascleres, interlaced in all directions. On the surface some of them form, in places at any rate, very poorly developed surface brushes.

Spicules.—(1.) Styli and tylostyli; moderately stout, usually more or less curved or crooked; apices, and heads when developed, very variable and apt to be irregular; size of fully grown spicule about 0·62 millim. by 0·009 millim., but variable.

(2.) Spirasters; not very abundant and varying in form from the ordinary zig-zag to one with a simply but strongly curved axis with blunt projections on the convex side; length about 0·012 millim. These spicules agree closely in form and size with those in Mr. CARTER'S preparation, although a good deal shorter than in the type of the species (according to RIDLEY'S measurements).

R.N. 52 (Gulf of Manaar).

Spirastrella vagabunda, var. **tubulodigitata**, nov.

In this variety the sponge consists of hollow, finger-shaped processes or "fistulæ" rising from a sandy base to a total height of about 50 millims. Each process contains several wide, longitudinal exhalant canals, separated from one another by narrow partitions, and usually ends in a single conspicuous vent. The colour varies from light to dark grey.

The skeleton arrangement and spiculation agree closely with those of the last-named variety. The surface brushes of megascleres may or may not be well-developed in different parts of the same specimen.

In one specimen (R.N. 246) a single finger-shaped process swells up at its free end into an irregular nodular mass, and thus makes an approach to the variety *fungoides*.

In R.N. 218 the spirasters are rather longer and the megascleres have better developed heads, and are perhaps usually somewhat stouter than in the type of the variety.

R.N. 154 (type of variety); 218 (deep water outside pearl banks, Gulf of Manaar); 246; 352 (Ceylon seas).

Spirastrella vagabunda, var. **fungoides**, nov.

The type of this variety is an extremely irregular, massive specimen, growing amongst a quantity of nullipore and other calcareous débris. It is characterised especially by the presence of definite porous areas, either forming irregular depressions on the surface, like large pock-marks, or on the flattened tops of fungoid outgrowths. These are probably inhalant pore-areas, for there are at least two fairly large vents forming the outlets of wide oscular tubes; one of these vents is situated on a level with the general surface of the sponge, and the other on a low mammiform projection. The structure internally is somewhat cavernous, and the specimen contains a great deal of imbedded foreign matter. The size of the entire mass is about 88 millims. by 47 millims. by 47 millims., but a large proportion of it consists of nullipore, &c. The colour in spirit is pale yellowish-grey.

The main skeleton is dense and confused; surface brushes are developed in the pore-areas and, as usual, many at any rate of the spicules in these brushes are much smaller than those of the main skeleton.

Spicules.—(1.) Tylostyli; usually slightly curved; with stout fusiform shafts, well-developed, oval heads and finely and evenly pointed apices; size in main skeleton about 0·5 millim. by 0·0167 millim.

(2.) Spirasters; mostly long, slender and zig-zag; occasionally up to as much as 0·048 millim. long, but usually much shorter. Rarely more than 0·002 millim. thick, exclusive of spines; occasionally nearly straight.

In the possession of the occasionally much elongated spirasters this variety resembles Ridley and Dendy's *Spirastrella solida* (1) from the Philippine Islands, which should perhaps be regarded merely as another variety of *S. vagabunda*.

R.N. 54 (type of variety, Gulf of Manaar); 253 (Ceylon seas).

Spirastrella vagabunda, var. **gallensis**, nov.

The larger of the two fragments by which this variety is represented in the collection is an irregularly cylindrical piece, about 52 millims. in length, and varying in diameter from about 10 millims. to about 19 millims. The texture is compact and firm and the specimen contains a good deal of coarse sand imbedded in it. The colour (in spirit) is pale yellowish-grey. The surface is smooth, but rather uneven. No vents visible. Pores scattered in small groups ?

The main skeleton is a very dense and confused reticulation of stout megascleres. The preparation only shows very feebly developed surface brushes.

Spicules.—(1.) Tylostyli; usually curved, with stout, fusiform or sub-fusiform shafts and well-developed ovoid heads; apex gradually and evenly and fairly sharply pointed. Size when full grown about 0·5 millim. by 0·019 millim.

(2.) Spirasters; short and slender, closely resembling those of var. *trincomaliensis;* about 0·012 millim. long; not very abundant.

R.N. 178 (type of variety), 179 (both from Lagoon, Galle, June, 1902).

Spirastrella tentorioides, n. sp.—Plate V., fig. 7.

The single specimen bears a striking resemblance in external form to *Tentorium semisuberites*, consisting of a short columnar body ending above in a strongly convex and sharply-defined pore- and vent-bearing area of darker colour* than the remainder of the surface. The surface of the column is subglabrous and irregularly furrowed longitudinally. On one side a much smaller column is given off as a vertical offshoot, terminating above like the large one. The specimen is attached below to a mass of calcareous débris by a broad base and narrows somewhat towards the apex of the column. Total height about 24 millims. Diameter of the column in the middle about 15 millims. Colour (in spirit) light grey. There are several wide exhalant canals running vertically through the column, and probably several smallish vents at the apex. Only one vent, however, is now visible, forming the outlet of the largest canal, and measuring only about 1·5 millim. in diameter. The inhalant pores are scattered between the surface brushes of spicules on the rounded apex of the column, around the vents.

The main skeleton is a very dense, confused reticulation of megascleres, permeating the whole of the soft tissues, close up to the walls of the canals, on the one hand, and to the dermal surface on the other. In this reticulation the spicules lie in all directions, but around the inhalant canals they are mostly placed lengthwise, with their apices pointing upwards. Surface brushes are confined to the rounded summit of the column, where they are well-developed.

Spicules.—(1.) Tylostyli (Plate V., fig. 7, *a*, *b*); straight or slightly curved, with stout, sub-fusiform shafts gradually and sharply pointed at the apex, and well-developed oval heads; size when full grown about 0·66 millim. by 0·0164 millim., but much smaller in the surface brushes.

(2.) Spirasters (Plate V., fig. 7, *c–g*); varying much in shape and size, usually slender, but sometimes stout; *e.g.*, (*a*) short, slender, simply curved, with projections (hardly spines) on the convex side; length about 0·008 millim.; (*b*) short, slender,

* The darker colour is due to the entanglement of dirt amongst the spicule-brushes.

zig-zag, with projections on all sides; length about 0·016 millim., thickness about 0·002 millim. (excluding projections); (*c*) long, slender, zig-zag or crooked, with small, sharp spines on all sides; size about 0·048 millim. by 0·0027 millim. (excluding spines); (*d*) short, stout, zig-zag, with stout conical spines on all sides; size about 0·022 millim. by 0·004 millim. (excluding spines), with spines about 0·006 millim. long. The spirasters are abundant and form a thin dermal crust.

The canal system of this sponge is somewhat remarkable and, like the external form, reminds one of *Tentorium*. The wide exhalant canals, running vertically upwards to the apex of the sponge, have already been noticed. The inhalant pores, situated also at the summit of the sponge, lead into subdermal cavities from which very narrow inhalant canals run vertically downwards, more or less parallel with the oscular tubes. These canals unite together as they descend and, even in hand-cut and unstained sections, can be easily traced by the brown colour of their walls.

Considering the extraordinary variation which the species of *Spirastrella* exhibit, alike in external form and in the arrangement of pores and vents, I should hardly have considered characters of this nature alone sufficient to justify the establishment of a new one, but should have regarded this form as yet another variety of *Spirastrella vagabunda*. We have here, however, a stout form of the spiraster which is, perhaps, not represented in any of the varieties of that species, and this fact, taken in conjunction with the other characters, seems to me to justify a specific separation.

R.N. 239 (Ceylon seas).

Placospongia, Gray.

Spirastrellidæ with a stony spicular axis and a similar cortex, both composed of closely packed sterrospiræ; with bundles of tylostyles radiating from the axis towards the periphery. Cortex divided into polygonal areas by grooves containing the inhalant and exhalant apertures.

Placospongia carinata (Bowerbank).

[For Literature and Synonymy, see Vosmaer and Vernhout (35).]

In view of the very recent publication of the elaborate monograph on the genus *Placospongia*, by Vosmaer and Vernhout, it is unnecessary to say much about this interesting species. The presence of numerous parenchymatous spirasters ("spinispiræ"), and the fact that the dermal spicule is a microspire, justify the specific identification according to the views of the authors quoted. I also agree with Keller in placing the genus amongst the Spirastrellidæ, it having been shown that the "sterraster" of this sponge is a modified spiraster.

Carter (4) has described a species of *Placospongia* from the Gulf of Manaar which he identified as *P. melobesioides*, and this identification will no doubt hold good, for he expressly mentions the absence of spirasters ("spinispirulæ"). He has also (5) recorded the same species from the vicinity of the Basse Rocks, off the south-east coast of Ceylon. It appears, therefore, that the two species, *melobesioides* and *carinata*, both occur in Ceylon waters.

R.N. 118 (Stat. V., off Chilaw, 10 fathoms).

Negombo, n. gen.

Spirastrellidæ consisting (? always) of tubular processes (? arising from a common base). Megascleres smooth styli; microscleres sanidasters.

This genus may, perhaps, have arisen independently from some sanidastrose form of Tetractinellid, but as regards its existing characters it is so closely related to *Spirastrella* that it may be included in the same family. It is also quite possible that its sanidaster may be merely a modified spiraster.

Negombo tennistellata, n. sp.—Plate V., fig. 8.

Sponge consisting of a group of short, rather thin-walled tubes of very variable diameter, growing up close together, side by side, and more or less fused with one another laterally. Each tube ends above in a single widely-open vent, ranging in diameter from about 3 millims. to about 8 millims. All the tubes are broken off and widely open below, so that it is impossible to say whether or not there was a basal mass from which they sprung, but probably there was. The walls of the tubes contain a great number of large sand-grains embedded rather sparsely in them. The colour (in spirit) is pale yellowish-grey, translucent; the texture rather soft and flexible, but fairly tough. The tubes do not vary greatly in height, the height of the longest being about 31 millims., while its width in the middle is about 6 millims.; the tube next to it is of about the same height, but as much as 12 millims. wide in the middle. The walls of the tubes are scarcely 2 millims. thick in the middle, thinning out somewhat towards the margin of the vent and thickening slightly towards the base. The outer surface of the tube-wall is rough, with more or less embedded sand-grains, and also, between the grains, irregularly reticulate with slightly-projecting ridges; I have not been able to find dermal pores in it. The inner surface of the tube-wall, on the other hand, is covered by a kind of dermal membrane, strengthened by a reticulation of megascleres, and bearing numerous small pores, resembling dermal pores but presumably exhalant, in the interstices of this reticulation.

The main skeleton consists of long styli, not forming definite fibres but sometimes collected into loose wisps. They mostly lie lengthwise in the thickness of the tube-wall and are more abundant in the middle of its thickness than elsewhere. On the inside of the tube-wall there is, as already indicated, a well-developed "dermal" reticulation of styli, crossing one another singly, or in twos or threes, in all directions parallel with the surface. On the outer surface of the tube-wall the dermal membrane contains very numerous microscleres and the megascleres lie at a slightly lower level. On both surfaces the dermal membrane is supported to some extent on the outer ends of very loose, irregular wisps of styli which come off from the dense central portion of the main skeleton.

Spicules.—(1.) Styli (Plate V., fig. 8, *a*, *b*, *c*); rather long and rather slender, subfusiform, with the base rather narrower than the middle and the apex fairly gradually sharp-pointed; usually slightly curved; size about 0·54 millim. by 0·012 millim., but variable. The apices have a tendency to be irregular and occasionally the spicule becomes oxeote.

(2.) Sanidasters (Plate V., fig. 8, *d*); each in the form of a very slender rod, straight or slightly crooked, terminating at each end in a slight swelling or, perhaps, a couple of small spines, and bearing very slender spines along its length, usually most strongly developed in, or perhaps even confined to, a whorl on each side of the middle of the spicule. Total length about 0·012 millim.; maximum diameter, including spines, about 0·004 millim. These spicules appear to be almost, if not quite, confined to the dermal membrane on the outer surface of the sponge.

R.N. 362 (Stat. I., hauls 1–4, January 31, 1902, off Negombo, 12 to 20 fathoms).

Family: CLIONIDÆ.

Astromonaxonellida of boring habit; forming excavations in the shells of Mollusca and other calcareous bodies.

Cliona, Grant.

Clionidæ of which the complete spiculation is composed of tylostyli, oxea, and spirasters. One or two of these forms of spicule may be absent by atrophy.

It will be seen that I have adopted Topsent's views (**36, 37**) as to this genus and its systematic position, in preference to those expressed in the Report on the "Challenger" Monaxonida.

Cliona margaritiferæ, n. sp.—Plate V., fig. 9.

The specimens in the collection consist of pieces of the shell of *Margaritifera vulgaris* (the Ceylon Pearl Oyster), abundantly excavated by the sponge. The chambers which it makes are rounded or oval in form, more or less crowded together, according to age, and connected with one another by narrow tunnels. From the inner sides of the chambers slender, elongated, conical canals radiate at various angles towards the inner surface of the shell. These outgrowths are shaped like spines, and, as in certain other species which I shall refer to later on, give the chambers a very characteristic appearance when viewed by transmitted light. From the outer side of each chamber are given off usually about two cylindrical canals, which perforate the outer layer of the shell at right angles to the surface and terminate in circular vents or pore-areas (fig. 2, on p. 144, shows a shell excavated by this sponge).

The walls of the excavations have a finely granulated or, under the microscope, frothy appearance, due to the presence of innumerable shallow, conchoidal depressions, which are in contact with one another all over the surfaces of the walls.

There is only room in the thickness of the shell for a single layer of chambers. When these have attained their full size, their transverse diameter is about 1·5 millims., but they may be considerably elongated. The diameter of the cylindrical canals which terminate on the outer surface of the shell varies up to about 0·65 millim. The outer end of each is closed, completely or partially, by a thin membrane containing numerous micro- and megascleres. Where the membrane in question stretches completely across the end of the canal, I assume it to be an inhalant pore-sieve, though the pores cannot now be seen; such a membrane may be supported by bundles of tylostyles converging towards the centre. The vents, on the other hand, are more or less widely open and surrounded by a thin, membranous diaphragm, also supported by tylostyles.

The body of the sponge itself (in spirit) forms for the most part a very thin lining (of a pale yellowish-brown colour) to the chambers.

Spicules.—(1.) Tylostyli (Plate V., fig. 9, *a*); straight, or nearly so, slender, very gradually and sharply pointed, and with well-developed globular heads; size about 0·25 millim. by 0·004 millim., with head about 0·006 millim. in diameter. These spicules occur scattered generally, as well as in the neighbourhood of the vents and pores.

(2.) Spirasters (Plate V., fig. 9, *b*, *c*, *d*); usually with about four angulations, fairly stout, and abundantly but rather minutely spinous, size about 0·024 millim. by 0·004 millim., but variable. These spicules pass by transitional forms (Plate V., fig. 9, *e*, *f*, *g*) into

(3.) Spined microxea (Plate V., fig. 9, *h*, *k*); usually bent or angulated in the middle, and measuring about 0·06 millim. by 0·0027 millim., but variable. These forms are extremely numerous in the deeper parts of the sponge. The gradual transition between spirasters and microxea in this species is extremely interesting.

The excavations made by *Cliona margaritiferæ*, even down to the spine-shaped outgrowths of the chambers, are closely similar to those of Hancock's *Cliona spinosa* (38) and *Thoosa cactoides* (38), but the spiculation is very different. *Cliona spinosa* occurs in shells of *Perna* and *Placuna*, and *Thoosa cactoides* in shells of *Meleagrina margaritifera*. Another distinct species, of closely similar form, occurs in shells of *Meleagrina albina?* and has been described by the same author (38) under the name *Cliona cervina*; the spiculation of this species makes a much closer approach to that of *C. margaritiferæ*, but the two appear to be quite distinct.

Topsent (37) has already described, under the name *Cliona indica*, a boring sponge infesting a pearl oyster from Ceylon. This species is evidently nearly related to ours, but the describer gives no information as to the character of the excavations or apertures, and the spiculation differs so much from that of our species that it is impossible to suppose that the two are identical. Both belong, however, to TOPSENT'S third division of the genus *Cliona*.

THIELE'S *Cliona concharum* (**39**), from Japan, perhaps comes nearer to our species than any other, at any rate so far as the spiculation is concerned, the differences in this respect being so slight that subsequent researches may make it desirable to consider the two as being only varietally distinct. In the Japanese form, however, the chambers excavated by the sponge seem to be much smaller, while the spined microxea are a good deal longer (0·09 millim.), than in that from Ceylon.

CARTER'S *Cliona warreni* (**5**), also from the Gulf of Manaar, on the other hand, is a very different species, and, according to TOPSENT (**37**), is identical with the European *Cliona celata*.

R.N. 261 (Gulf of Manaar—very abundant, and destructive, on the pearl banks).

FAMILY: SUBERITIDÆ.

Astromonaxonellida in which the megascleres are styli or tylostyli, and the microscleres have completely disappeared.

Suberites, NARDO.

Suberitidæ of varying form, but without mammiform projections on the surface. Spicules tylostylote (nearly always). Skeleton usually arranged radially, with surface brushes of spicules smaller than those of the main skeleton.

The genus *Suberites*, at any rate so far as its typical species are concerned, for it may possibly be of polyphyletic origin, is, as I have already indicated, probably derived from *Spirastrella* by loss of the spirasters. CARTER even admitted into the genus certain species with spirasters.

It is remarkable that there is only one species of the genus, and of that only a single specimen, in the present collection. In making my preliminary examination in Liverpool (which had to be done very hastily), I identified one of the specimens as *Suberites inconstans*, var. *digitata*, a form previously described by me from near Ceylon, but more careful examination subsequently revealed the presence of spirasters and thus proved that the specimen was really a *Spirastrella*.

Curiously enough, THIELE (**39**) has come to the conclusion that *Suberites inconstans* is in reality a *Spirastrella* in which I have overlooked the spirasters, these being, according to him, small and scarce. This is, of course, possible, but it is by no means proved. THIELE has apparently never seen specimens from Ceylon or India, but identifies certain specimens from Celebes with the species, under the name *Spirastrella inconstans*. Unfortunately I am unable to re-examine the types of the species here in South Africa, as the original specimens and preparations remained in the British Museum.

TOPSENT has sub-divided the old genus *Suberites* into a number of separate genera, and there is a great deal to be said in favour of such a proceeding, though it is doubtful whether all of his distinctions can be maintained. *Suberites cruciatus*, for example, combines certain characters of TOPSENT'S *Laxosuberites* and *Axosuberites* with peculiarities of its own, and I prefer to make use of the old generic name in this instance.

Suberites cruciatus, n. sp.—Plate V., fig. 10.

Specimen consisting of a number of long, slender, flattened branches, springing from a short pedicel of similar structure to themselves and branching in an almost dichotomous manner, but with some of the branches fusing together again higher up. Total height of specimen about 91 millims.; length of pedicel to first fork about 14 millims., breadth 3·5 millims., thickness 2 millims.; breadth of separate branches about 2·5 millims.: thickness about 1·5 millims. Surface rather uneven, very minutely hispid, and beset with very numerous small rounded translucent areas, apparently pore-areas. Vents probably minute and scattered. Colour (in spirit) pale brown; consistence soft and very flexible.

The main skeleton consists of numerous loose bands of tylostyles running lengthwise through the sponge; with numerous similar spicules scattered between in a loose, irregular reticulation. I have not detected any spongin cement. Towards the surface this arrangement gives place to radiating brushes of tylostyles, whose apices project slightly beyond the dermal membrane. Between these brushes lie the fairly extensive sub-dermal cavities.

Spicules.—Tylostyli (Plate V., fig. 10), of rather peculiar form. Usually straight, slender, gradually and finely pointed at the apex: with heads usually elongated transversely at a little distance from the base of the spicule, so as to form a cross. This cruciate character is most pronounced in the youngest and slenderest spicules; in the mature forms the arms of the cross form rounded knobs projecting from the shaft usually at a very slight distance from the base; occasionally there are three of these knobs instead of two. The full-sized spicules measure about 0·31 millim. by 0·005 millim., with head about 0·0093 millim. across.

The shape of the tylostyle in this curious little sponge reminds one of the corresponding spicule in CARTER'S *Hymedesmia spinatostellifera* (4).

R.N. 315 (Stat. LV., outside Periya Paar, 24 fathoms).

FAMILY: CHONDROSIIDÆ.

Corticate Astromonaxonellida with complex canal system and small flagellate chambers. Without megascleres.

These sponges appear to be Astromonaxonellida in which the megascleres (and in the case of *Chondrosia* the microscleres also) have been lost by degeneration. Their strongly developed cortex and complex canal system show that they are not primitively simple forms like the Myxospongida, and, as the megascleres probably passed through a monaxonellid condition before finally disappearing, we may include the family in the monaxonellid rather than in the tetractinellid grade, though, perhaps, logically speaking, it ought to occupy a distinct grade of its own. The form of the microscleres (when present) and the corticate character suggest a close relationship with the Tethyidæ.

The family will always be historically interesting as having formed the subject of one of F. E. SCHULZE's classical memoirs (40).

Chondrilla, SCHMIDT.

Chondrosiidæ with microscleres in the form of euasters of various kinds.

Chondrilla australiensis, CARTER.

1873, **Chondrilla australiensis**, CARTER (41); 1885, **Chondrilla australiensis**, LENDENFELD (42).

The specimens of this sponge form thin crusts of a greyish colour (in spirit) and irregular outline, spreading over masses of calcareous débris. One large specimen is about 80 millims. in greatest breadth. The surface is smooth and sometimes glabrous; it may be minutely reticulate when seen under a lens, and in one specimen (R.N. 185) it is very minutely papillate, with the spherasters so thickly aggregated in the papillæ that they touch one another. The vents are minute and scattered.

Having in my possession several of Mr. CARTER's own microscopical preparations of this species, evidently from the original types, I have been able to make a direct comparison and to assure myself of the correctness of the identification. In both Mr. CARTER's and Professor HERDMAN's specimens the spheraster, with smooth conical rays, measures about 0·028 millim. in diameter, and the oxyaster, with minutely spined rays, sometimes branched at the ends, measures nearly as much. In a Ceylonese specimen I find that neither spicule is strictly confined to either the cortex or the interior of the sponge, but while the spherasters are much more abundant in the cortex, the oxyasters are much more abundant in the interior.

It is noteworthy that Mr. CARTER has recorded (5) the occurrence of *Chondrilla nucula*, the common European species, from the Gulf of Manaar. This species appears to be of very wide distribution.

R.N. 17 (Gulf of Manaar); 185 (Donnan's Paar); 251; 376 (encrusting a shell of *Margaritifera vulgaris*, Cheval Paar).

Chondrilla australiensis, var. **lobata**, nov.

This variety is represented by two specimens (apparently obtained together) which differ conspicuously from the thin, encrusting form above described, being massively lobose, with comparatively large vents placed singly on the top of the lobes. The base of attachment is constricted to a few narrow projections on the lower surface, and the entire body of the sponge exhibits a swollen, tumid appearance. The vents measure up to 2 millims. in diameter, and each is surrounded by a thick, membranous margin, which, in its turn, is usually surrounded by a shallow groove. The surface is sub-glabrous, but uneven and very minutely reticulate. The colour below (in spirit) is very pale grey, but on the upper parts of the lobes the grey is mottled with brown. The texture is compact and fleshy; compressible.

The two specimens are of about equal size; the one selected for measurement is about 42 millims. in length, 17 millims. in breadth, and 18 millims. in height. The cortex is about 0·164 millim. thick.

The spicules agree closely in form with those of the thin, encrusting variety. The spherasters are, however, rather smaller. They have, in both varieties, a strongly marked tendency for their rays to be reduced to low warts or even, perhaps, to disappear, so that in some cases the large centrum is left almost smooth, as in KELLER'S *C. globulifera*, which is, however, specifically distinct.

A lobate variety of *C. australiensis* occurs also in Australia.

R.N. 286, 286A (deep water off Galle and onwards to Colombo. Hauls off Kaltura and off Mount Lavinia, 20 to 30 fathoms, February 19, 1902).

Chondrosia, NARDO.

Chondrosiidæ in which all the spicules have completely disappeared.

Chondrosia reniformis, NARDO.

This well-known Mediterranean species is represented in the collection by two specimens, both attached to the same fragment of a horny sponge. Each is roughly hemispherical in form, with wide base spreading out into a broad, thin "stolon" on one side. The surface is covered with low, irregular tubercles, which may be due in part to contraction. The vents are small and difficult to make out, sometimes, at any rate, on low mammiform projections. The structure of the dense fibrous cortex, with its pigment cells, and that of the choanosome, agree very closely, so far as can be made out in the material at my disposal, with SCHULZE'S classical description (**40**). The pigment cells, however, appear to be mostly in the inner part of the cortex, instead of in the outer part as figured by SCHULZE; but this is not an important difference. Each specimen is about 13 millims. in diameter, and the colour (in spirit) is mottled grey and brown on the surface, and pale greyish-yellow internally.

R.N. 226 (two specimens; deep water off Galle and onwards up West Coast of Ceylon).

SUB-ORDER: SIGMATOMONAXONELLIDA.

Monaxonellida in which the typical microscleres are sigmata, or forms derived therefrom, normal astrose microscleres being absent.

The sponges which comprise this large sub-order may be regarded as descended from the tetractinellid sub-order Sigmatophora (family Tetillidæ) by reduction of the megascleres, in the same way that the Astromonaxonellida may be regarded as being derived from the tetractinellid Astrophora.

In dealing with the Astromonaxonellida I have already had occasion to point out that no reliable instance of the occurrence of true astrose microscleres in conjunction with sigmatose forms has ever been recorded, a fact which argues very strongly in favour of the primary cleavage of the Monaxonellida into two great groups corresponding to the tetractinellid sub-orders Astrophora and Sigmatophora. Since that part of my report was completed, however, and sent to England, TOPSENT's latest work on the 'Sponges of the Azores' (**62**), has been received here. In this work the author describes two apparent Sigmatomonaxonellida in which asters were met with, viz., *Yvesia alecto* and *Leptosastra constellata*, but in neither of these are other microscleres present.

In *Yvesia alecto* the asters are, as TOPSENT himself shows, simply transformed megascleres (spined oxea) with the spines greatly developed, so that they are clearly of secondary origin. It may be pointed out, further, that an analogous transformation takes place in the echinating megascleres of the genus *Cyamon*,* and, probably, also in the genus *Trikentrion*, giving rise to spicules which simulate true asters. It appears, therefore, that in certain Sigmatomonaxonellida astrose spicules have arisen secondarily by transformation of spined megascleres. It is obvious, however, that these cases do not affect the primary division of the Monaxonellida here adopted.

The case of *Leptosastra constellata* offers a more serious difficulty, for here there is no indication that the asters, which form a superficial crust, are other than true astrose microscleres. It is, however, a suggestive fact that the sponge in which they occur is an Ectyonine with spined styli. Two explanations appear to me possible:—(1.) The asters may not belong to the same sponge as the megascleres. Considering the well-known and frequent accidental admixture of the spicules of different species, caused either by the sponges growing over one another or by the taking in of foreign spicules in the same way that grains of sand are taken in, and especially in view of the fact that only a single specimen of the sponge has been obtained; although TOPSENT has assured himself to the contrary, I venture to think that we may be here dealing with a composite spiculation. (2.) It is not impossible that the asters, if proper to the sponge, may be derived secondarily from the spined styli, in much the same way as in the genus *Cyamon*. Their position at the surface of the sponge, however, and their apparently normal form, are opposed to this view. However, until we have further evidence before us, it is quite unnecessary to allow this isolated case of a single specimen to make us alter our views on the classification of the Monaxonellida.

Assuming then that the Sigmatomonaxonellida are derived from the tetractinellid Sigmatophora, the question arises where are we to seek for the point of contact between the two groups? The answer to this question is easily given, for in the genus *Gellius* we have a near approach to the massive species of *Tetilla*, such as *T. limicola*. The replacement of the tetractinellid megascleres by oxea in a massive

* See later under *Cyamon*.

Tetilla, accompanied by the complete loss of the radiate skeleton arrangement, both of which changes are already partially accomplished in such forms as *T. limicola*, would give us a typical *Gellius*, and in *Gellius* I believe we have the starting point of the entire sigmatomonaxonellid series.

From this starting point the Sigmatomonaxonellida have branched off in various directions in the course of their evolution. Total loss of microscleres has given rise to forms with the spiculation composed entirely of oxeote megascleres, constituting the family Homorrhaphidæ of Ridley and Dendy, and the strong development of spongin cement has led to the evolution of the very large sub-family Chalininæ, from which in turn some of the so-called Ceratosa have been derived by total suppression of the spicules and their replacement by horny fibre. The arrangement of the megascleres in a characteristic plumose fashion, accompanied in most cases by the replacement of many of the oxea by styli and the loss of microscleres, has given rise to the family Axinellidæ. The development of a new type of microsclere—the chela—by modification of the sigma, has given rise to the great family group Desmacidonidæ, within which the Ectyoninæ have arisen by development of spined echinating spicules.

In the Report on the "Challenger" Monaxonida, published 17 years ago, Mr. Ridley and I proposed to divide the Sigmatomonaxonellida (= Halichondrina) into four families, viz., Homorrhaphidæ, Heterorrhaphidæ, Desmacidonidæ and Axinellidæ, an arrangement which has been variously modified by subsequent writers, chief amongst whom is Topsent. This author (59) has united our Homorrhaphidæ and Heterorrhaphidæ in one family which he terms "Haploscleridæ," a proceeding which appears to me justifiable in view of the obviously close relationship between the two, and especially in view of the fact that the Renierinæ and Chalininæ have very probably arisen independently from different though closely related genera, the Renierinæ from *Gellius* (and perhaps other genera), and the Chalininæ from *Gelliodes* and *Toxochalina*, as well as, perhaps, in some cases from Renierinæ.

Topsent has also proposed the name "Pœciloscleridæ" in replacement of "Desmacidonidæ"—a proceeding which appears quite unnecessary, although the extent of his family is not quite the same as that of ours.

I therefore propose in this Report to sub-divide the Sigmatomonaxonellida amongst three families, viz., Haploscleridæ (including the Homorrhaphidæ and Heterorrhaphidæ of Ridley and Dendy), Desmacidonidæ and Axinellidæ. The Haploscleridæ, there can be little doubt, should stand first, and indeed occupy the position of a parent group from which the other two families have descended.

Family: HAPLOSCLERIDÆ.

Sigmatomonaxonellida in which microscleres when present are usually in the form of sigmata, or derivatives thereof, but never chelæ. The skeleton is reticulate and the fibre is typically not plumose. The megascleres are usually diactinal.

The most primitive sub-family of this group is undoubtedly the Gelliinæ, from which the Renierinæ and Chalininæ are clearly derived. The other sub-families may be in part Desmacidonidæ which have lost their chelæ; this I am able in the present Report to demonstrate pretty clearly in the case of the Phlœodictyinæ, which I have accordingly removed. TOPSENT has already removed the Tedaniinæ, Desmacellinæ, and Hamacanthinæ as being Desmacidonidæ without chelæ; this may be quite right, but until clear evidence that they are descended from chela-bearing forms is forthcoming, it seems to me equally justifiable to leave them in the parent group. A *Desmacella*, for example, may very well be an *Esperella* which has lost its chelæ, but it seems at least equally probable that it has never reached the stage of having any.

SUB-FAMILY: GELLIINÆ.

Haplosceridæ with diactinal megascleres, and sigmata or toxa or microxea for microscleres.

Gellius, GRAY.

Gelliinæ with little or no spongin, the main skeleton being formed by a reticulation of oxea.

Gellius fibulatus (SCHMIDT).

1862, **Reniera fibulata**, SCHMIDT (47); 1880, **Reniera fibulifera**, CARTER (4); 1892, **Gellius fibulatus**, TOPSENT (48).

There is in the collection a considerable quantity of this sponge growing amongst the branches of a Floridean Alga. I identify it with the European species by direct comparison with a preparation from a specimen from Budleigh Salterton in Mr. CARTER'S cabinet. The differences in spiculation are very slight. In our specimen the slightly curved and gradually sharp-pointed oxea measure about 0·184 millim. by 0·007 millim., and the sigmata about 0·02 millim. from bend to bend.

R.N. 51 (Gulf of Manaar); 299; 348; 350 (all growing in association with apparently the same kind of alga; the last three probably fragments of one and the same specimen).

Gellius angulatus (BOWERBANK), var. **canaliculata**, nov.—Plate IX., fig. 7.

[For synonymy and references *vide* RIDLEY and DENDY (1)].

The single specimen is massive, rounded and slightly elongated, about 18 millims. long by 12 millims. in transverse diameter. It was probably attached by one end, and bears a group of vents at the other. The surface is even and smooth, conspicuously veined by ramifying exhalant canals, which run towards the (upper ?) end of the specimen and open there by means of the moderate-sized vents. Many of these exhalant canals lie just beneath the surface and are covered over only by a thin, translucent membrane, which easily gets rubbed off, leaving the canals as open grooves. Between the exhalant canals there is no separable dermal membrane, and there are no conspicuous sub-dermal cavities. Texture between the canals very compact, but not very hard and rather friable. Colour (in spirit) very pale grey.

The skeleton is a very close and pretty uniform reticulation of single oxea, crossing one another in every direction. The dermal skeleton consists only of scattered oxea placed tangentially.

Spicules.—(1.) Oxea (Plate IX., fig. 7, *a*); rather slender, slightly curved, usually somewhat abruptly or even hastately pointed; about 0·25 millim. by 0·008 millim. to 0·01 millim.

(2.) Sigmata (Plate IX., fig. 7, *b*); slender, C-shaped, with shortly and sharply incurved and sharply pointed ends; often with a slight indication of enlargement or angulation near the middle; measuring about 0·028 millim. from bend to bend when full grown.

(3.) Toxa (Plate IX., fig. 7, *c*); rather short and moderately stout; sharply angulated in the middle and only slightly recurved at the extremities; length up to about 0·044 millim.

This is a pretty little sponge, evidently very nearly related to the European *Gellius angulatus*, from which it differs in the somewhat shorter oxea, the considerably larger sigmata, and the much shorter toxa. It is possible also that the arrangement of the exhalant canals may be characteristic. It is interesting as indicating that sigmata and toxa are simply slightly different modifications of the same form of microsclere.

R.N. 140 (deep water off Galle and onwards up West Coast of Ceylon).

Gelliodes, Ridley.

Gelliinæ with much spongin, more or less completely enveloping or even replacing the megascleres and forming distinct fibres. The microscleres are sigmata.

Gelliodes carnosa, Dendy—Plate VII., fig. 5.

1889, **Gelliodes carnosa,** Dendy (3).

There is one fine specimen of this sponge in the collection, easily recognized by its characteristic external form (Plate VII., fig. 5). The megascleres are much slenderer than in the types and appear to be becoming vestigial, as in so many chalinine sponges, being functionally replaced by the strongly developed horny fibre. The sigmata are still numerous, about 0·02 millim. long, but very slender.

This species forms a conspicuous feature of the Ceylon Sponge-Fauna.

R.N. 69 (Stat. XXVII., Cod Bay, Trincomalee, 5 fathoms; also Gulf of Manaar).

Gelliodes incrustans, n. sp.—Plate IX., fig. 6.

Sponge thin, encrusting; the single specimen growing over both valves of a *Pecten* (which was evidently alive when collected). Maximum thickness about 7 millims.

Surface smooth, but rather uneven. Vents numerous and conspicuous, circular, from about 1 millim. to 2·5 millims. in diameter; mostly flush with the surface, but occasionally on low prominences. Colour (dry) dull greyish-brown, with a purplish tinge in places, which seems to indicate that it was purple in life. Texture (dry) compressible and resilient, but rather stiff.

The main skeleton is a rectangular-meshed network of horny fibre cored by spicules, in which the meshes vary greatly in size. The principal fibres are about 0·033 millim. in diameter, and contain a multispicular core of small oxea which occupy only about one-third (or less) of the total thickness of the fibre. The secondary fibres are more slender and contain fewer spicules. The dermal skeleton (Plate IX., fig. 6) is, for the most part, a unispicular reticulation of oxea with comparatively little spongin; sometimes one sees brushes of projecting oxea, but I am not sure how far these are proper to the dermal skeleton.

Spicules.—(1.) Oxea (Plate IX., fig. 6, *o*); short, slender, slightly curved, subfusiform, gradually and sharply pointed at each end; size about 0·1 millim. by 0·004 millim. A number of very slender, hair-like oxea, probably young or vestigial forms, also occur.

(2.) Sigmata (Plate IX., fig. 6, *s*); very slender and hair-like, C-shaped, up to about 0·02 millim. from bend to bend. Abundant.

This species is nearly related to *Gelliodes licheniformis* (LAMARCK),* but differs, at any rate from the "Challenger" specimen of that species, both in external form and in the much smaller size of the spicules and more regular arrangement of the skeleton.

R.N. 112 (Gulf of Manaar, dry).

Gelliodes petrosioides, n. sp.—Plate IX., fig. 3.

Sponge massive, depressed, cushion-shaped; flattened below, where it has apparently been attached by a broad base; evenly rounded off and strongly convex above. Surface coarsely granular, not hispid. Vents not visible. Pores numerous, scattered in the thin dermal membrane which roofs over the numerous small, rounded subdermal cavities. Colour (in spirit) pale yellowish-grey. Texture compact; hard and almost stony. Greatest diameter of specimen, which is irregularly rounded in outline, about 24 millims.

The main skeleton is a very dense but quite irregular reticulation of very coarse, stout, densely spicular fibre, with a great many loose megascleres scattered between. The stout fibres have a thickness of about 0·164 millim., and probably contain a certain amount of spongin, which, however, is not visible in ordinary sections. The dermal skeleton cannot be sharply distinguished from the main skeleton, and consists of an irregular reticulation of coarse spicular fibre, the interspaces in which are occupied by the thin, pore-bearing dermal membrane.

* *Vide* RIDLEY and DENDY, '"Challenger" Monaxonida,' p. 48.

Spicules.—(1.) Short, stout, fusiform, slightly curved oxea (Plate IX., fig. 3, *a*, *b*, *c*), usually sharply and fairly gradually pointed at each end (often becoming strongylote or stylote); measuring about 0·25 millim. by 0·017 millim., but varying a good deal in thickness.

(2.) Sigmata (Plate IX., fig. 3, *d*); slender, C-shaped or contort, about 0·022 millim. from bend to bend; very numerous.

Were it not for the presence of the sigmata, this species would be a typical *Petrosia*. It appears to be very nearly related to TOPSENT's *Gelliodes fayalensis*,* from the Straits of Pico-Fayal, but is distinguished by the absence of the large oscula, and, perhaps, by other characters.

R.N. 146 (deep water off Galle and onwards up West Coast of Ceylon).

Gelliodes petrosioides, var. **fibrosa**, nov.

I propose this name, at any rate provisionally, for a single small, much-damaged specimen of irregular shape and cavernous structure, with large exhalant canals and vents (?) and very soft, fibrous texture; agreeing very closely with the type of the species in spiculation and in the structure of the main skeleton fibres, but with the fibres better defined and the meshes of the reticulation mostly very wide and not filled up by scattered spicules. The soft texture of the specimen, which is in striking contrast with the hardness and density of the type, is due simply to this greater laxity in the skeleton arrangement.

Except for the presence of the sigmata, this variety closely resembles a *Pachychalina*. It may ultimately, when better specimens are forthcoming, have to be considered as a distinct species.

R.N. 272 (deep water off Galle and onwards up West Coast of Ceylon).

Toxochalina, RIDLEY.

Gelliinæ with much spongin, more or less completely enveloping or even replacing the megascleres, and forming distinct fibres. The microscleres are toxa.

This genus differs from *Gelliodes* only in the replacement of the sigmata by toxa, and in view of the occurrence of both these forms in the same species of *Gellius* (*vide* under *Gellius angulatus*, var. *canaliculata*), it may be questioned whether the two should be kept distinct. They are interesting as forming an obvious starting point in the evolution of the great sub-family Chalininæ.

Toxochalina robusta, RIDLEY.

1884, **Toxochalina robusta**, RIDLEY (16).

There are a number of specimens of this sponge in the collection, agreeing closely, both as regards external form and skeletal characters, with RIDLEY's description of the type from Port Jackson. It is perhaps noteworthy, however, that the megascleres

* TOPSENT (48), p. 78.

are abundant *between* the stout horny fibres, as well as (sometimes) in their axes. The species has also been recorded from off Bahia ("Challenger").

R.N. 8, 9, 38 (all three from Gulf of Manaar); 351 (Ceylon seas).

Toxochalina robusta, var. **ridleyi**, nov.—Plate IX., fig. 2.

The type specimen is very irregular in shape; massive and angular, with a slight tendency towards branching. It has evidently been attached by a broad base to one valve of a Lamellibranch shell (? *Margaritifera vulgaris*), the impress of which is still clearly visible. The surface is smooth and sub-glabrous, but uneven and very distinctly granular when viewed under a lens. The vents are rather numerous (five), about 4 millims. in diameter, with very prominent margins; each is the opening of a wide, deep oscular tube of the same diameter as itself. The texture (in spirit) is compressible and resilient, but stiff and tough. Colour, pale brown. The specimen is about 66 millims. long, 38 millims. broad, and 31 millims. high.

The main skeleton is a reticulation of horny fibre, with very few and slender spicules (Plate IX., fig. 2). The primary fibres are very stout, sometimes as much as 0·164 millim. in diameter, but very variable; typically they run at right angles to the surface and are united by short secondaries to form rectangular meshes, but the network often becomes very irregular and the size of the meshes is very variable. The secondary fibres are usually, but not always, more slender than the primaries. The primaries are cored by a multispicular axis of slender oxea arranged in a plumose manner (as in typical Axinellidæ), but all entirely enveloped in spongin to such an extent that the entire column of spicules only occupies one-third (or less) of the thickness of the fibre. The secondary fibres contain only a few isolated spicules arranged uniserially.

The dermal skeleton consists of a rather close-meshed reticulation of rather slender, unispicular horny fibre. From the nodes of this reticulation brushes of oxeote spicules project vertically. In certain places this dermal skeleton appears to become many layers deep, and the vertical brushes of oxea are continued inwards as more or less plumose columns enveloped in spongin and connected by numerous unispicular cross-fibres, so as to form a close skeleton network beneath the surface, very conspicuous in vertical section, and strongly contrasted with the much coarser, more widely meshed and less abundantly spicular main skeleton below it.

Spicules.—(1.) Oxea (Plate IX., fig. 2, *o*); short and rather slender, slightly curved, fairly gradually sharp-pointed at each end; measuring about 0·08 millim. by 0·004 millim. near the surface, but usually smaller, and especially more slender, in the fibres of the main skeleton. These spicules—at any rate, in the main skeleton—are evidently becoming vestigial.

(2.) Toxa (Plate IX., fig. 2, *t*); slender, more or less strongly curved in the middle, very slightly re-curved at the apices; sometimes slightly roughened in the middle, gradually sharp pointed at the ends; size varying up to about 0·08 millim. (in a straight line from end to end) by 0·002 millim. (in the middle); very abundantly distributed through the soft tissues in association with scattered oxea.

R.N. 109 (Gulf of Manaar. Type); 306 (Stat. XXIV., off Trincomalee).

Strongylophora, n. gen.

Gelliinæ with the skeleton composed of a reticulation of strongyla of various sizes, partly collected in fibres, but with little (if any) spongin. With microscleres in the form of smooth microxea, chiefly found in the dermal membrane.

This is a remarkable genus of somewhat doubtful systematic position. The presence of the fusiform (and often angulated) dermal microxea suggests an affinity with the Homosclerophora and Pachastrellidæ amongst the Tetractinellida, rather than with the Sigmatophora. We cannot, however, lay very much stress upon this character when we remember the generalized character of microxea and the fact that such spicules also occur in the Ectyonine genus *Fusifer* (*vide* DENDY, **10**).

Strongylophora durissima, n. sp.—Plate IX., fig. 1.

Sponge massive, irregular; may be depressed and cake-like or subcylindrical and slightly ramose. Surface very uneven, sometimes with angular grooves and ridges, giving it a curious crumpled appearance; minutely and uniformly granular. Vents few, scattered; circular and often rather large, up to about 4 millims. in diameter; each the opening of a wide cylindrical oscular tube which runs vertically inwards for a considerable distance. Inhalant pores minute, abundantly scattered in the meshes of the dermal reticulation. Colour (in spirit) greyish-brown throughout. Texture hard and stony, but brittle, and rather cavernous internally owing to the presence of the numerous canals of varying diameter. The larger of the two specimens measures about 45 millims. in maximum diameter.

The main skeleton is an irregular but fairly close-meshed and, towards the surface, sub-rectangular reticulation of more or less stout spicular fibre composed of closely packed strongyla, with numerous loose strongyla scattered between the fibres. The dermal skeleton (Plate IX., fig. 1) is a reticulation of mostly large and single strongyla; their ends come in contact with one another, many together, at the principal nodes of the reticulation, from which they radiate, and at each of these nodes there is also a little heap of very short strongyla. The presence of these nodal heaps gives the characteristic granular appearance to the surface of the sponge.

Spicules.—(1.) Strongyla (Plate IX., fig. 1, *s.*); usually stout, more or less curved or angulated in the middle; evenly rounded off at each end; ranging in size from about 0·026 millim. by 0·006 millim. (or perhaps even less) to about 0·26 millim. by 0·02 millim. (A few long and very slender spicules, oxeote and strongylote, occur in the interior of the sponge; they are probably abnormal forms of the strongyla, with which they are connected by intermediates.)

(2.) Microxea (Plate IX., fig. 1, *m.*); fusiform and usually angulated in the middle, from which they taper gradually to a very sharp point at each end; size fairly uniform, about 0·028 millim. by 0·002 millim. Very abundant in the thin transparent dermal membrane in the meshes of the dermal skeleton; also found less frequently in the interior of the sponge.

R.N. 156; 244 (Ceylon seas).

Sub-Family: RENIERINÆ.

Haplosclerida in which the microscleres have entirely disappeared and the skeleton consists of a reticulation of oxeote megascleres with little or no spongin.

This sub-family is apparently derived from the Gelliinæ by loss of microscleres. Inasmuch, however, as the microscleres constitute the most important guides to the classification of monaxonellid sponges, their total loss may in certain cases leave one in considerable doubt as to the true systematic position of the species concerned. The close relationship of *Reniera* to *Gellius* I take to be fully established by the form of the megascleres and by their arrangement. In the genus *Halichondria*, on the other hand, there appears to me to be less certainty, and the long, slender, slightly curved form and confused arrangement of the oxea suggest a possible origin from some astromonaxonellid genus, such as *Coppatias*, by loss of the astrose microscleres. It is impossible in the present state of our knowledge to decide this question definitely, but it is quite likely that, as regards the genera *Reniera* and *Halichondria*, we are dealing with a case of convergent evolution rather than of close genetic relationship.

Reniera, Nardo.

Renierinæ in which the skeleton is composed of a close reticulation of usually single megascleres, each forming one side of a rectangular, triangular or polygonal mesh. Spicules short, oxeote or strongylote, usually united together at the ends only by spongin cement.

Reniera implexa, Schmidt.

1868, **Reniera implexa**, Schmidt (**50**); 1887, **Reniera implexa**, Ridley and Dendy (**1**).

I identify with this species a single small specimen consisting of a few irregularly branched tubes, mostly about 5 millims. in diameter and widely open at the end. The surface has a minutely reticulate or porous appearance. The colour (in spirit) is brownish-yellow, and the consistence very soft, compressible and tender.

The skeleton is a rather irregular, triangular-meshed reticulation, for the most part of single spicules, with occasional loose plurispicular bands feebly developed.

The spicules are slender, slightly curved oxea, gradually sharp-pointed at each end and measuring up to about 0·136 millim. by 0·004 millim., usually perhaps a little less.

This species has been recorded from the Adriatic by Schmidt, and from the Azores by Ridley and Dendy (**1**) and Topsent (**62**).

R.N. 201 (Stat. LXIV., south of Modragam Paar, 5 fathoms, March 17, 1902).

Reniera pigmentifera, n. sp.—Plate IX., fig. 10.

This species is represented in the collection by a large number of small fragments which may perhaps represent only a single specimen. The external form appears to have been more or less flabellate, with rounded margin. The vents are about 2 millims. in diameter and appear to have been scattered singly along the margin (and elsewhere ?). The surface has a porous appearance to the naked eye, and is very minutely hispid. The colour (in spirit) is dark brown throughout, sometimes with a purplish tint, and the texture is very soft and crumbling.

The skeleton is an irregular "Isodictyal" network of short spicules, sometimes connected together at their ends by spongin cement; primary fibres, from one to about three spicules in thickness, are recognisable in places. There is no distinct dermal skeleton.

Spicules.—(1.) Oxea (Plate IX., fig. 10, *a*); slightly curved and gradually sharp pointed at each end; measuring about 0·144 millim. by 0·007 millim., but often much more slender.

(2.) Strongyla (Plate IX., fig. 10, *b*); stout, very slightly curved, broadly rounded off at each end; variable in length, up to about 0·12 millim. by 0·009 millim.; may be shorter and at the same time somewhat stouter.

(3.) Styli (Plate IX., fig. 10, *c*, *d*); short and stout, very similar in size and shape to the strongyla, but pointed at one end. Of course, intermediate forms of spicules also occur.

A remarkable feature of this sponge is the immense number of granular, brown or purple-coloured pigment cells which it contains. These cells are rounded in outline and about 0·002 millim. in diameter, and are thickly scattered all through the sponge.

R.N. 290 (numerous fragments. Jokkenpiddi Paar, 10 fathoms).

Reniera zoologica, n. sp.—Plate IX., fig. 8.

The single specimen appears to be half of a pear-shaped sponge which has been torn in two longitudinally. It has probably been fixed by the narrower end, and bears a single rather large vent (?) opening out of a wide oscular tube near the broad upper end. The surface is encrusted with large Foraminifera and sand-grains. The colour (in spirit) is pale grey, and the texture (internally) crumb-of-bread-like. Total height of specimen 34 millims., greatest breadth about 20 millims.

The main skeleton is an irregular network of spicules, partly arranged singly in an "Isodictyal" manner and partly collected in irregular multispicular bands. No spongin cement is recognisable in my preparation.

The dermal skeleton is a dense but thin layer of oxea, lying very close together and crossing one another in all directions parallel with the surface.

Spicules.—Oxea (Plate IX., fig. 8); moderately stout, slightly curved, gradually sharp pointed at each end; size when fully developed about 0·18 millim. by 0·007 millim. Numerous very slender forms, probably young, also occur.

R.N. 262 (Gulf of Manaar).

Reniera, sp. ?

A small massive specimen with a couple of short, mammiform, vent-bearing projections. Surface smooth. Colour (in spirit) pale yellow; texture compact and firm, but brittle.

Main skeleton a compact, irregular, "Isodictyal" reticulation of spicules without any fibres. Dermal skeleton a dense but thin layer of tangentially placed oxea crossing one another in all directions parallel with the surface.

Spicules.—Oxea; slightly curved, usually gradually sharp-pointed at each end; occasionally strongylote; size about 0·164 millim. by 0·008 millim.

This species may possibly be identical with one of the numerous imperfectly known European species of *Reniera* (*Isodictya*).

R.N. 232 (deep water off Galle and onwards up West Coast of Ceylon).

Petrosia, Vosmaer.

Renierinæ usually of hard or even stony texture, owing to the density of the skeleton, which is composed of an irregular reticulation of oxeote or strongylote megascleres (usually short and thick), packed close together, sometimes in stout fibres.

Those species of this genus which have a more or less fibrous skeleton make a close approach to the genus *Pachychalina*.

Petrosia testudinaria (Lamarck).

[For literature and synonymy *vide* Dendy (**3**).]

This handsome sponge (see text-figure 1) has been recorded from Queensland (Ridley)

Fig. 1. *Petrosia testudinaria* (Lamk.), Gulf of Manaar; reduced one-half.

Fig. 2. Pearl-oyster shell honeycombed by *Cliona margaritiferæ* Dendy (see p. 128).

and from the Mergui Archipelago (CARTER, DENDY), as well as from the Gulf of Manaar (DENDY).

R.N. 42 (Stat. LXI., Gulf of Manaar); 238 ? (deep water off Galle; fragments).

Petrosia similis, RIDLEY and DENDY.

1887, **Petrosia similis**, RIDLEY and DENDY (1).

There are in the collection a number of irregular, massive or more or less lobate specimens, with numerous rather large, scattered vents, which I refer to this species. The spicules measure about 0·22 millim. by 0·014 millim. The character of their ends varies greatly, from strongylote to apiculate and sharp-pointed.

The species was originally obtained by the "Challenger" from south of the Cape of Good Hope and between Kerguelen and Heard Islands.

R.N. 12, 61 (both from Gulf of Manaar); 289; 327 (Ceylon seas).

Petrosia similis, var. **delicatula**, nov.

This variety is distinguished from the typical form of the species by its more delicate texture and smaller vents, which are usually more or less blocked up by a strong development of gelatinous tissue. The spiculation differs little, if at all, from that of the types.

R.N. 84, 133, 276 (all from deep water off Galle and onwards up West Coast).

Petrosia similis, var. **halichondrioides**, nov.

In external appearance this variety closely resembles *P. similis*, var. *delicatula*. The single specimen is strongly compressed, with the rather small but conspicuous and widely open vents placed on prominent ridges. The texture (in spirit) is firm and compact, but brittle. The skeleton is very confused and dense, without distinct fibres, and the spicules are much more slender and *Halichondria*-like than in the typical form, being gently curved oxea, for the most part gradually sharp-pointed at each end, and measuring, say, about 0·2 millim. by 0·006 millim.

R.N. 79 (Gulf of Manaar).

Petrosia densissima, n. sp.—Plate IX., fig. 9.

Sponge massive, sub-conical, attached by the broad base; with rather irregular surface bearing feebly developed, meandering grooves. Surface minutely granular, without distinct dermal membrane, slightly sandy. Vents very small and scattered Colour (in spirit) rather dark greyish-brown on the surface; pale yellowish-grey internally. Texture extremely compact and hard; stony; incompressible. The larger of the two specimens (R.N. 138A) measures about 40 millims. in height by 42 millims. in greatest breadth.

The skeleton is extraordinarily dense and compact, consisting of a sub-rectangular-meshed reticulation of very stout spicular fibres, in which both primary and secondary fibres are about as thick as the width of the meshes between them, say about

0·13 millim. The fibres are compact, but the arrangement of the spicules in them is very confused and there is no visible spongin. Many spicules occur scattered irregularly between the fibres, so that the whole skeleton forms an almost solid mass of spicules. There is no special dermal skeleton.

Spicules.—Stout, fusiform oxea (Plate IX., fig. 9); slightly curved and usually sharply and fairly gradually pointed; size when fully developed about 0·24 millim. by 0·02 millim., but with numerous smaller forms which are presumably young.

This species is evidently very closely related to THIELE'S *Petrosia imperforata* from Celebes (**39**).

R.N. 138, 138A (both from deep water off Galle and onwards up West Coast of Ceylon).

Halichondria, FLEMING.

Renierinæ in which the skeleton consists of a confused reticulation of long and slender oxea (or strongyla) with little or no spongin; the spicules sometimes associated in ill-defined bands or fibres.

I have already indicated the doubt which exists as to the true relationship of this genus. Possibly it is, as at present understood, of polyphyletic origin, including species derived from several ancestral forms by loss of microscleres.

Halichondria panicea, JOHNSTON.

[For literature and synonymy *vide* RIDLEY and DENDY (**1**) and DENDY (**2**).]

This widely distributed species is represented in the collection by two well differentiated form-varieties, so that it seems desirable to distinguish them by varietal names. In both varieties many of the more superficial oxea are arranged more or less at right angles to the surface, with their apices projecting to a greater or less extent, thus making an approach to the genus *Trachyopsis*. In both the full-grown spicules measure up to about 1·0 millim. in length and are of the usual *Halichondria* type. Their arrangement in the interior of the sponge is quite irregular and confused.

Halichondria panicea, JOHNSTON, var. **megalorhaphis**, CARTER.

1881, **Amorphina megalorhaphis**, CARTER (**5**).

This variety is irregularly encrusting, growing out into lobose or digitiform processes, and with small scattered vents.

R.N. 87, 231, 248 (all from deep water off Galle and onwards up West Coast).

Halichondria panicea, JOHNSTON, var. **hemispherica**, nov.

This variety is massive and compact, more or less hemispherical or cushion-shaped, with vents usually arranged in conspicuous groups on the convex upper surface. It attains a considerable size, the largest specimen measuring about 100 millims. in greatest diameter and about 40 millims. in thickness in the middle.

R.N. 67 (Gulf of Manaar); 96 (Gulf of Manaar, dry); 141?, 142 (both from deep water off Galle and onwards up West Coast); 249 (Stat. XV., Periya Paar).

Trachyopsis, n. gen.

Renierinæ in which the main skeleton is composed of a dense, irregular network of oxea, while the surface is protected by similar (or perhaps more slender) spicules arranged in dense vertical brushes, which support the pore-bearing dermal membrane.

This genus is of somewhat doubtful systematic position; in certain features it recalls the genera *Trachya* and *Spongosorites*, and it differs from typical Renierinæ in the replacement of the reticulate dermal skeleton characteristic of that group by radially arranged brushes of oxea.

Trachyopsis halichondrioides, n. sp.—Plate X., fig. 10.

Sponge massive (or thickly encrusting?); upper surface slightly convex, rising up at irregular intervals into a few short, thick-walled, cylindrical, tubular processes, each terminated by a single circular vent. General surface smooth and almost glabrous, but uneven; very minutely reticulate as seen under a lens. Inhalant pores minute and scattered. Colour in spirit, pale yellowish-grey. Texture of body hard and compact, penetrated by numerous narrow vertical canals. Greatest diameter of specimen, which is irregular in outline, 44 millims.; thickness about the middle 15 millims. (but the specimen has evidently been cut off from its base). Height of largest projection about 8 millims.; diameter in the middle about 5·5 millims.; diameter of the vent at its apex 2·5 millims.

The main skeleton is an extremely dense and very irregular reticulation of stout oxea, with a tendency to arrange themselves in ill-defined tracts running towards the surface. Immediately beneath the surface the oxea, here perhaps somewhat more slender than usual, are arranged in dense brushes perpendicularly to the dermal membrane, beyond which their apices may project very slightly.

Spicules.—Oxea (Plate X., fig. 10); short, usually stout, sub-fusiform, gently curved or (often) biangulate, fairly gradually and sharply pointed at each end; size, when fully developed, about 0·64 millim. by 0·0328 millim.; frequently more slender.

R.N. 147 (deep water off Galle and onwards up West Coast of Ceylon).

Sub-family: CHALININÆ.

Haplosclerida without microscleres and with diactinal megascleres. Skeleton a network of more or less strongly developed horny fibre cored by megascleres.

It is highly probable that this sub-family is of polyphyletic origin, being derived from several genera of Gelliinæ and Renierinæ by loss of microscleres and strong development of spongin. Some species have probably been derived from *Toxochalina* and *Gelliodes* simply by loss of microscleres, the horny fibre being already strongly developed in those genera, while others have probably arisen from *Reniera* and *Petrosia* simply by strong development of the horny fibre, the microscleres having been already lost.

The excessive development of spongin appears to have taken place independently in many genera, and this fact, coupled with the loss of the characteristic microscleres and the uniform character of the megascleres, renders it extremely difficult to arrive at a natural classification of the Chalininæ.* The subject is, however, much too complex to be discussed here at length, especially as there are not a very large number of species in the collection. For our present purposes it will suffice to make use of the established genera, *Pachychalina*, *Chalina*, *Ceraochalina*, and *Siphonochalina*, without committing ourselves to an expression of opinion as to their genetic relationships. Owing to their degenerate character, it is impossible to define even these in such a way as to distinguish them quite sharply from one another.

Pachychalina, SCHMIDT.

Chalininæ of various external form, lobose or digitate, not tubular; with stout skeleton fibres, containing very numerous well developed spicules arranged multiserially.

Pachychalina subcylindrica, n. sp.—Plate X., figs. 1, 2.

Sponge elongated, rather slender, irregularly cylindrical or angular, probably branched and repent. Surface fairly smooth but uneven, with a very few coarse aculeations; minutely reticulate to the naked eye. Vents fairly large (about 2·25 millims. in diameter), irregularly scattered, with slightly prominent margins. Colour (in spirit) light brown. Texture compressible, resilient, rather coarsely fibrous, but somewhat fragile. The largest piece measures about 95 millims. in length, with a very variable thickness up to about 9 millims.

The main skeleton is a sub-rectangularly meshed network of very stout multispicular fibre, about 0·066 millim. in diameter; with meshes varying greatly in size, and with numerous spicules scattered irregularly between the fibres. The fibres themselves contain a very large number of spicules, but no visible spongin. The dermal skeleton (Plate X., fig. 1) is an irregular, polygonal-meshed network of similar coarse multispicular fibre.

Spicules.—Oxea (Plate X., fig. 2); more or less curved or angulated; when fully developed stout and very sharply pointed at each end; measuring about 0·14 millim. by 0·008 millim. Numerous slender forms also occur, probably immature.

In the feeble development of the spongin this species occupies an intermediate position between the genus *Petrosia* and the more typical Chalininæ.

R.N. 292; 360 (Stat. II., north of Negombo, 9 fathoms).

* Compare LENDENFELD (**51**) and DENDY (**63**). In the paper referred to I have explained the reasons why I cannot accept LENDENFELD's classification of the Chalininæ.

Pachychalina delicatula, Dendy.

1889, **Pachychalina delicatula,** Dendy (3).

With this species I identify three specimens, all characterized by their great softness and delicacy of texture, but all containing a good deal of sand.

R.N. 55, 264 (both from Gulf of Manaar); 364 (Stat. I., hauls 1–4, January 31, 1902, Colombo to Negombo, 12 to 20 fathoms).

Pachychalina brevispiculifera, n. sp.—Plate X., fig. 7.

The single specimen is compressed, digitate to flabellate (presumably erect), branching and anastomosing. The branches or fronds are sometimes narrow and sometimes broad, but always greatly flattened, and only about 6 millims. in thickness. The surface is beset with small conical aculeations, which form the principal nodes in a very strongly developed dermal skeletal reticulation. Vents rather large (about 4 millims. in diameter) but very shallow; numerous, but confined almost or quite entirely to one of the flattened sides of the frond or branch. Colour (in the dry state) light brown; texture coarsely fibrous, compressible, resilient, fragile. The single specimen measures about 120 millims. in height by 110 millims. in greatest width.

The main skeleton is a very coarse, sub-rectangularly or irregularly meshed network of very stout horny fibre almost filled with well developed and very abundant spicules arranged multiserially in all the fibres. The primary fibres, running lengthwise through the branches, measure up to about 0·164 millim. in thickness, and the secondaries are sometimes nearly as stout, though usually a good deal slenderer. Sometimes two or more primary fibres run close together side by side, connected with one another at frequent intervals by numerous very short secondaries. The dermal skeleton is a coarse, irregular reticulation of similar fibre, varying greatly in thickness and with meshes of varying diameter. The fibres, especially those of the dermal skeleton, are occasionally echinated by projecting oxea.

Spicules.—Oxea (Plate X., fig. 7); slightly curved; sub-fusiform; short, stout and sharp-pointed at each end; measuring about 0·1 millim. by 0·0055 millim.

R.N. 110 (Gulf of Manaar, dry).

Pachychalina spinilamella, Dendy.—Plate VII., fig. 4.

1889, **Pachychalina spinilamella,** Dendy (3).

I identify with this species a number of specimens of somewhat variable external form, but all characterised by their strongly conulose surface and with closely similar skeleton arrangement. A fairly typical example is represented in Plate VII., fig. 4. R.N. 14, 296 and 326 are characterised by their more slender, irregularly branching form and smaller vents.

R.N. 14, 25, 94 (Periya Paar, &c., Gulf of Manaar); 172, 296, 326 (Ceylon seas).

Chalina, Grant.

Chalininæ of various external form; not tubular. Skeleton reticulation typically rectangular; fibres usually slender, with much spongin and few but usually well developed spicules.

Chalina subarmigera (Ridley)—Plate X., fig. 5.

1884, **Cladochalina subarmigera**, Ridley (**16**); 1887, **Chalinopora subarmigera**, Lendenfeld (**51**); 1898, **Chalina subarmigera**, Lindgren (**86**).

This species is represented in the collection by two specimens, which agree very well with Ridley's original description, except that the margins of the vents are slightly prominent and there are fewer spicules in the fibres of the main skeleton. The characteristic external form is shown in Plate X., fig. 5.

The species was obtained by the "Alert" in Torres Straits and at Albany Island (north coast of Australia), and has also been recorded by Lendenfeld from Port Jackson, and by Lindgren from the Coast of Cochin China.

R.N. 116 (Gulf of Manaar, dry): 288 (Ceylon seas).

Chalina obtusispiculifera, n. sp.—Plate X., fig. 9.

Sponge elongated, slender, cylindrical; may be irregularly branched (? erect or repent). Surface even, very minutely hispid in its present condition. Texture (in spirit) soft and resilient, but fairly tough. Colour pale yellowish-brown. Vents and pores not seen. The largest specimen (R.N. 370) is about 130 millims. long by 3·5 millims. in diameter.

The skeleton is a well-developed reticulation of pale-coloured horny fibre cored by strongyla. The principal fibres run lengthwise through the sponge, branching as they go, and the branches curve outwards towards the surface; they are connected by short secondary fibres to form an irregular network. The principal fibres are about 0·04 millim. in diameter and contain many spicules arranged multiserially as well as much spongin extending well beyond the spicular core. The secondary fibres are only about half as thick and contain fewer spicules. There is no specially differentiated dermal skeleton, unless we consider the outermost secondary fibres of the main skeleton as such (Plate X., fig. 9).

Spicules.—Cylindrical strongyla (Plate X., fig. 9); broadly rounded off at each end, never pointed; nearly straight; measuring up to about 0·12 millim. by 0·007 millim., but frequently much more slender.

This species is easily recognised by its external form and blunt cylindrical spicules. Both specimens are more or less washed out and contain numerous foreign spicules and other débris. In R.N. 285 none of the spicules appear to attain as great a thickness as that given above for the type.

R.N. 285 (deep water off Galle and onwards up West Coast); 370 (deep water outside pearl banks, Gulf of Manaar).

Chalina clathrata, n. sp.—Plate X., fig. 3.

Sponge massively encrusting, the single specimen being attached to the valve of a *Pinna;* clathrous; with very uneven surface proliferating into numerous small, blunt outgrowths. Vents numerous and large (up to about 8 millims. in diameter), scattered singly, each at the end of a short tubular projection and forming the termination of a wide cylindrical oscular tube. Surface minutely reticulate. Texture very delicate, soft, compressible, resilient; colour (after drying) light yellowish-brown, with a tinge of purple. The single specimen measures about 220 millims. in maximum diameter.

The main skeleton is a sub-rectangularly or irregularly meshed network of very pale-coloured horny fibre. The fibre varies greatly in diameter (averaging, say, about 0·025 millim.) and contains very few spicules, arranged for the most part uniserially and absent altogether in places. The dermal skeleton is a close, polygonally or rectangularly meshed network of horny fibre cored by uniserially arranged spicules; the fibres being about 0·0165 millim. in diameter and the meshes about 0·1 millim. in diameter.

Spicules.—Very slender, usually slightly curved oxea or strongyla, measuring about 0·112 millim. by 0·002 millim., occurring in and between the fibres and often reduced to vestiges (Plate X., fig. 3).

With its large prominent vents and deep oscular tubes this species makes an approach to the genus *Siphonochalina*, while its massive (though clathrous) form recalls RIDLEY'S *Acervochalina*.

R.N. 102 (Gulf of Manaar, dry).

Chalina cymæformis (ESPER ?).

? 1798–1806, **Spongia cymæformis**, ESPER (**6**); ? 1870, **Spongia cymæformis**, EHLERS (**58**).

Sponge shortly stipitate, bushily lamellar or frondose or sub-digitate. Lamellæ about 9 millims. thick, with broadly rounded margins. Surface rather uneven, minutely conulose, especially where the dermal membrane has been rubbed off. Vents small (about 2 millims. in diameter), more or less abundantly scattered, chiefly on the inner surfaces of the lamellæ. Inhalant pores scattered in the dermal membrane. Texture (in spirit) soft and compressible, but very tough and resilient; rather woolly. Colour brown. The most typical specimen (R.N. 16) is about 67 millims. high by 90 millims. in greatest breadth, with a stalk about 22 millims. high and 18 millims. thick. It bears a very close resemblance to the figure of *Chalina palmata*, given by RIDLEY and DENDY (**1**), as well as to ESPER'S figure of his *Spongia cymæformis* (Plate 69).

The main skeleton consists of what, at first sight, look like rather slender, ill-defined, plurispicular fibres running towards the surface at irregular intervals and branching as they go, connected by still less well-defined secondary fibres from one to about four spicules broad. No spongin is at first sight visible, but closer examination shows that a very large quantity is really present in the fibres, more or less completely imbedding the spicules; owing to its very pale colour and great transparency, however, it readily escapes observation. Numerous spicules occur scattered irregularly between the fibres. There is no special dermal skeleton, the dermal membrane being practically destitute of spicules.

Spicules.—Slender, slightly or rather strongly curved oxea; more or less gradually sharp-pointed at the ends; size variable, say about 0·12 millim. by 0·003 millim.

It is probable that this species is identical with Esper's *Spongia cymæformis* (from Ceylon). It also appears to be nearly related to *Chalina palmata* from European, Indian and Australian waters; differing, however, in the absence of the dermal skeleton reticulation. In habit the species reminds one very much of some species of *Axinella*, a resemblance which appears from Ehlers' description to have been increased in the case of Esper's specimen by the presence of styli mingled with the oxea.

R.N. 16 (Gulf of Manaar); 349 (Stat. LV., west of Periya Paar, 20 fathoms).

Ceraochalina, Lendenfeld.

Chalininæ of various external form; not tubular. Texture hard, owing to the great thickness of the skeleton fibres, in which the spongin is very strongly developed and the spicules much reduced in size and sometimes also in number.

Ceraochalina retiarmata, n. sp.—Plate X., fig. 4.

The single specimen forms an erect, thin lamella, attached below by a constricted base; sub-dividing into flattened branches and giving off irregular digitiform processes almost exclusively in one plane; the branches to a slight extent anastomosing with one another. Surface glabrous, minutely granular under a lens; rather uneven. Vents minute, about 0·5 millim. in diameter, mostly arranged uniserially on the narrow margins. Inhalant pores scattered in the meshes of the dermal reticulation. Colour (in spirit) rather dark brown; texture compressible, resilient, tough and fibrous. Total height of specimen about 33 millims.; greatest breadth about 66 millims.; thickness of lamella about 3·5 millims.

The main skeleton is a network of stout horny fibre, sparingly cored by very slender vestigial oxea. The primary fibres are about 0·1 millim. in diameter and curve upwards and outwards towards the surface, branching as they go. They are connected together by short secondaries about 0·05 millim. in diameter and containing fewer spicules. There is also a system of tertiary fibres, much more slender (from about 0·008 millim. to about 0·024 millim. in diameter) and containing from one to about four rows of well-developed oxea imbedded in spongin. These tertiary fibres form an irregular network which seems to bear no relation to the rest of the main skeleton, except that its fibres are attached frequently to those of the latter.

The dermal skeleton is very strongly developed, forming a close polygonal-meshed reticulation of horny fibres cored by usually two or three rows of well developed oxea and echinated abundantly by similar oxea projecting from the fibre singly or in small groups. The diameter of the dermal fibre is about 0·024 millim.; of the meshes between the fibres about 0·16 millim., but variable.

Spicules.—Rather short, slightly curved, gradually sharp-pointed oxea (Plate X., fig. 4), measuring about 0·084 millim. by 0·004 millim. in the dermal skeleton and in the tertiary fibres of the main skeleton, but becoming more or less vestigial in the other fibres.

R.N. 342 (Stat. V., off Chilaw, 10 fathoms).

Ceraochalina reticutis, n. sp.—Plate X., fig. 8.

The type specimen (R.N. 58) forms an agglomeration of short, irregular, sub-cylindrical or angular branches, slightly anastomosing with one another and branching with great irregularity. The branches vary greatly in diameter, from about 4 millims. to about 11 millims., and have a slightly nodose appearance. The entire mass measures about 80 millims. in greatest breadth. Vents small (about 1 millim. in diameter), but conspicuous and with slightly projecting margins; scattered abundantly and sometimes in ill-defined longitudinal series. The dermal membrane is parchment-like, and under a pocket lens appears very finely and regularly reticulate in triangular meshes, which are the coarser meshes of the dermal skeleton composed of dark brown spongin fibre. Texture (in spirit) compressible, very resilient, tough; colour dark brown.

The main skeleton is a fairly regular, sub-rectangularly meshed network of strong horny fibre. The principal fibres run longitudinally through the branches, sub-dividing as they go and curving outwards to the surface. They measure up to about 0·08 millim. in diameter, and contain a considerable number of slender vestigial spicules, irregularly and multiserially arranged. The secondary fibres are about as thick as the primaries, but contain fewer spicules (which are also vestigial). The meshes of the main skeleton reticulation vary a good deal in size; averaging, say, about 0·33 millim. in diameter.

The dermal skeleton (Plate X., fig. 8) is a very well developed, close, polygonal-meshed reticulation of horny fibre containing only a very few slender spicules scattered here and there. The fibres of which this reticulation is made up are of two principal sizes: (*a*) stout, about 0·03 millim. to 0·05 millim. in diameter, radiating from the ends of the primary fibres of the main skeleton and forming the coarser triangular-meshed reticulation visible under a pocket lens; (*b*) more slender, but very variable in diameter, forming a very close-meshed but irregular reticulation in the meshes of the coarser reticulation. A large number of well developed spicules may be irregularly scattered in the dermal membrane outside the horny fibres of the dermal skeleton.

Spicules.—Oxea; varying greatly in degree of development; in the horny fibres very slender and vestigial (Plate X., fig. 8, *v.s.*), but often well developed in the soft tissues between the fibres, especially in the dermal membrane (Plate X., fig. 8, *o*). When fully developed they are slightly curved and somewhat hastately sharp-pointed, measuring about 0·072 millim. by 0·00265 millim.

R.N. 58 (Gulf of Manaar); 321; ? 346 (distinguished from the type chiefly by the numerous well developed oxea arranged uniserially in the slenderer fibres of the dermal skeleton and multiserially in the stouter fibres; while the spicules themselves are occasionally strongylote).

Ceraochalina multiformis, Lendenfeld, var. **manaarensis**, Dendy—Plate VII., fig. 2.

1889, **Pachychalina multiformis**, var. **manaarensis**, Dendy (**3**).

I identify with this variety a single specimen attached to a pearl oyster, which is represented in Plate VII., fig. 2. A feature which I omitted to mention in my original description of the variety is the echination of the fibres of the dermal skeleton by projecting oxea, singly or in groups.

The species was recorded by Lendenfeld (**51**) from Australia and New Zealand.

R.N. 98 (Gulf of Manaar, dry).

Ceraochalina ceylonica, n. sp.—Plate VII., fig. 3: Plate X., fig. 6.

Sponge (Plate VII., fig. 3) massive, irregular, sometimes clathrous, with a slight tendency to become lobose or digitate. Surface strongly and copiously aculeated by sharp-pointed conuli about 4 millims. in height; minutely fibro-reticulate between the conuli. Vents numerous, scattered, about 4 millims. or 5 millims. in diameter; the openings of deep, cylindrical oscular tubes. Colour (in spirit) pale brown; texture firm and tough, but compressible and resilient. The largest specimen (R.N. 5, figured) measures 200 millims. by 160 millims. in horizontal dimensions, by 90 millims. in height.

The main skeleton is a very strongly developed, irregular or rectangularly meshed network of stout, horny fibre, containing usually a large number of small oxea scattered irregularly throughout the spongin substance, but almost always more or less parallel with the long axis of the fibre. Occasionally (R.N. 5) the spicules are much less strongly developed and may be completely absent from some of the fibres. Numerous spicules also occur scattered between the fibres. The thickness of the fibres is variable, say about 0·08 millim. for the primaries and not much less for the secondaries

The dermal skeleton is a polygonally meshed network of fibre containing a very large proportion of spongin and a good many spicules. The latter are, for the most part, imbedded in the spongin substance more or less longitudinally; at frequent intervals, however, little groups of oxea, or single spicules, project more or less at right angles from the fibre in an echinating manner, and thus give a rather characteristic appearance to the dermal skeleton. The meshes of the dermal reticulation are about 0·2 millim. in diameter, and the fibres from about 0·008 millim. upwards.

Spicules.—Slender oxea (Plate X., fig. 6), slightly curved and more or less gradually and sharply pointed; size about 0·088 millim. by 0·003 millim., but subject to a good deal of variation, and frequently, if not usually, more slender.

R.N. 4, 5, 50, 108, 113 (all from Gulf of Manaar).

Siphonochalina, SCHMIDT.

Chalininæ of tubular form. Tubes smooth, both inside and out, usually narrow; each with a large circular vent at the summit.

Siphonochalina communis (CARTER), var. **tenuispiculata**, nov.—Plate VII., fig. 1.

This variety (Plate VII., fig. 1) agrees very closely in external form with the specimens of *Siphonochalina communis* described by CARTER (5) and myself (3) from the Gulf of Manaar. Mr. CARTER gave no measurements of the spicules in the case of the type of the species, but the specimens in Professor HERDMAN's collection differ rather strikingly from that collected by Mr. THURSTON and described by myself, in that the spicules are very much more slender and very much more numerous in both primary and secondary fibres and in the fibres of the dermal skeleton. In fact, the spicules, though very abundant in all the fibres and occurring throughout the entire, or almost the entire, thickness of each fibre, are so slender as to be almost vestigial, measuring about 0·072 millim. by 0·001 millim.

In skeletal characters, although the spicules are more slender, this variety agrees much more closely with my *Siphonochalina crassifibra* from the same locality (3) than with CARTER's *S. communis;* differing from *S. crassifibra* chiefly in the smaller size of the tubes. Thus it has the external form of *S. communis* combined with the skeletal characters of *S. crassifibra*, and I therefore propose to regard all three forms as mere varieties of one and the same species.

Professor HERDMAN informs me that the sponge in life had a violet-pink colour.

RIDLEY (16) records the species (under CARTER's name *Tabulodigitus communis*) from Port Jackson, Australia, and also from Kurrachee.

R.N. 6, 7, 117 (dry, figured; all from Gulf of Manaar, Stat. II., 8 fathoms).

SUB-FAMILY: DESMACELLINÆ.

Haploscleridæ with monactinal megascleres. Microscleres various.

Desmacella, SCHMIDT.

Desmacellinæ with reticulate skeleton composed of styli or tylostyli. Microscleres sigmata, toxa and trichodragmata variously combined.

Desmacella tubulata, n. sp.—Plate IX., fig. 4.

Sponge consisting of cylindrical, tubular processes, more or less widely open above

(? always) and (sometimes, at any rate) united together below. (Possibly they may have been attached to a common body, but only fragmentary tubes are present in the collection.) Diameter of individual tubes about 6 millims.; thickness of tube-wall about 1·25 millims. Outer surface slightly granular and very minutely hispid. Inner surface with numerous very minute openings of exhalant canals. Colour (in spirit) pale greyish-yellow. Texture very soft, compressible, fragile.

The main skeleton is a very irregular but close reticulation of slender styli, either isolated or in loose bundles; with no visible spongin cement. There is no special dermal skeleton.

Spicules.—(1.) Long slender styli (Plate IX., fig. 4, *a*, *b*); slightly curved or bent, broadly and evenly rounded off at the base, sharply and more or less gradually pointed at the apex; size about 0·28 millim. by 0·005 millim.

(2.) Trichodragmata (Plate IX., fig. 4, *d*); extraordinarily abundant, especially beneath the outer surface, and very variable in size, sometimes forming wisp-like fibres, sometimes breaking up into separate microxea (Plate IX., fig. 4, *e*); varying in length from about 0·02 millim. upwards, and always very slender.

(3.) Sigmata (Plate IX., fig. 4, *c*); also extraordinarily abundant; slender, commonly much contort, also C-shaped; occasionally in small bundles (sigmodragmata); length from bend to bend variable, say about 0·02 millim.

This appears to be a very well characterized species, and I know of no other which comes very near it. The immense number of microscleres is very remarkable.

R.N. 209 (Gulf of Manaar); 324.

SUB-FAMILY: HETEROXYINÆ.

Haploscleridæ with a dense cortex composed of radially arranged megascleres. Megascleres smooth and spined oxea. Microscleres present or absent.

I propose this sub-family for the reception of the genera *Heteroxya*, TOPSENT, and *Acanthoxifer*, n. gen., the former of which is, apparently with very slight justification, placed by its founder amongst the Tethyidæ.

Acanthoxifer, n. gen.

Heteroxyinæ with a dense spicular cortex broken up into polygonal plates by pore-bearing grooves. Main skeleton a confused reticulation of oxea. Cortical skeleton composed chiefly of dense brushes of oxea arranged at right angles to the surface. Megascleres smooth and spined oxea. Microscleres trichodragmata.

This remarkable genus is evidently nearly related to TOPSENT'S *Heteroxya* (45), but differs in several respects, notably in the presence of trichodragmata, which indicates that the true position both of *Acanthoxifer* and *Heteroxya* is amongst the Haploscleridæ and not amongst the Tethyidæ, where TOPSENT has placed *Heteroxya*. The presence of the spined oxeote megascleres suggests a possible relationship to the Spongillinæ.

The breaking up of the cortex into polygonal plates or nodules by pore-bearing (and ? vent-bearing) grooves remind one forcibly of the genus *Placospongia* amongst Spirastrellidæ, but the resemblance is entirely superficial.

Acanthoxifer ceylonensis, n. sp.—Plate IX., fig. 5.

Sponge massively encrusting, irregular, with flattened or convex upper surface and broad base of attachment. Surface very minutely hispid or granular, uneven, nodular or tubercular, the nodules or tubercles being very low and roundedly polygonal in shape, separated by grooves of varying distinctness. Generally the grooves are broad and shallow: sometimes they are narrow, with prominent margins. Diameter of nodules, say, about 4 millims., but variable and irregular. Colour (in spirit) light brown. Texture compact, fleshy, but with much calcareous débris embedded. Pores and vents not recognisable externally. The largest specimen is cake-shaped, about 42 millims. in horizontal diameter, and up to 17 millims. in thickness.

The main skeleton is a quite confused, lax reticulation of very abundant, long, oxeote megascleres, occasionally collected together into loose, ill-defined bands, but without any distinct fibre, and with a little spongin becoming visible in stained sections. The cortical skeleton is very strongly developed and consists of dense brushes of oxea placed side by side and lying at right angles to the surface, beyond which their apices project (but are now nearly all broken off). These brushes are backed up internally by a very dense, irregular reticulation of oxea. The cortical skeleton is absent beneath the grooves which separate the surface nodules. Thus there is a separate section of the cortical skeleton for each nodule or tubercle, thinning out as it approaches the grooves in such a manner as to become strongly convex on the inner aspect.

Spicules.—(1.) Smooth oxea (Plate IX., fig. 5, *a*); long and rather slender, slightly curved or bent, variously and often irregularly ended, sometimes stylote (Plate IX., fig. 5, *b*). Size variable, say about 0·74 millim. by 0·012 millim. Abundant in the main skeleton and occasionally met with in the surface brushes.

(2.) Spined oxea (Plate IX., fig. 5, *c*); usually slightly and symmetrically curved (or angulated) in the middle; tapering fairly gradually to a sharp point at each end; provided with numerous very minute, sharp spines, most abundantly developed towards the two ends; size about 0·38 millim. by 0·008 millim. Characteristic of the cortical skeleton, but also common in the interior of the sponge.

(3.) Trichodragmata (Plate IX., fig. 5, *d*); oblong bundles of extremely slender rhaphides, which do not usually become dissociated even on boiling with nitric acid. Size usually about 0·016 millim. by 0·004 millim.; occasionally much longer.

Stained sections show that the ectosome (between the spicules) is chiefly collenchymatous, sometimes with a tendency to become fibrous near the surface. In both ectosome and choanosome are an immense number of minute granules of a pale yellowish colour, aggregated in rounded masses of very varying size. These may be symbiotic algæ.

R.N. 213, 217 (both from deep water outside pearl banks, Gulf of Manaar); 247.

Family: DESMACIDONIDÆ.

Sigmatomonaxonellida in which some of the microscleres are chelæ (except when these have been lost by degeneration).

The presence of microscleres in the form of chelæ constitutes a natural character by which the Desmacidonidæ are, as a rule, easily distinguished from all other sponges. Unfortunately, however, the chelæ are very apt to disappear by degeneration, especially in the sub-families Ectyoninæ and Phlœodictyinæ, and we have then to depend upon other characters—such as the presence of spined echinating styli—for guidance in classification. That the chela, one of the most remarkable forms of microsclere known to us, has originated by modification of the sigma, there can, I think, be little doubt. In the Report on the "Challenger" Monaxonida* we showed that in ontogeny the chela arises from a sigmoid form (*Esperella mammiformis*) and that sigmata and chelæ must therefore be grouped in the same category. Nor are intermediate forms of adult spicules unknown to us, such as the curious "bipocilli" of the genus *Iophon*, especially those of *Iophon chelifer*, Ridley and Dendy (**1**), and, most notable of all, the bidentate sigmata of Topsent's *Gellius bidens* (**64**).

We are, therefore, justified in regarding the Desmacidonidæ as derived from the Haplosceridæ by modification of the sigmoid microscleres into chelæ, though why this modification should have taken place is very hard to understand. It is extremely difficult to see how the very peculiar and highly specialized chelate form of microsclere can be of any special advantage to its possessor, and we have here one of those numerous cases in which, so far as we can see at present, the theory of natural selection signally fails to account for the facts.

I have already pointed out that the sub-family Phlœodictyinæ must be transferred to the Desmacidonidæ on account of the presence of chelate microscleres in the genus *Histoderma*, certain species of which are obviously very closely related to *Phlœodictyon* and *Oceanapia*. For the purposes of this Report the three sub-families Esperellinæ, Phlœodictyinæ and Ectyoninæ will be sufficient. Topsent's sub-family Dendoricinæ appears to me to be an unnatural group which cannot be maintained, the differentiation of the ectosomal megascleres being far too general and widespread a character to be utilised as distinguishing the sub-family, whose members fall very naturally in one or other of the remaining sub-families. The sub-family Bubarinæ, proposed by the same author, has, I am glad to see, been again abandoned by him in his latest work (**62**).

* Page xx.

Sub-family: ESPERELLINÆ.

Desmacidonidæ without echinating spicules, and without fistular outgrowths of the sponge body.

Esperella, Vosmaer.

Esperellinæ of various external form, usually massive, lobose or ramose. Skeleton usually fibrous, often with much spongin. Megascleres monactinal, stylote or tylostylote. Characteristic microscleres palmate anisochelæ, to which may be added smooth sigmata, toxa, trichodragmata and small isochelæ* in various combinations.

Esperella parishii (Bowerbank ?), Ridley.

[For synonymy and literature *vide* Ridley and Dendy (**1**), p. 65.]

There is one small, thinly encrusting specimen of this sponge in the collection, growing on a calcareous nodule in association with *Paresperella serratohamata* and *Hymedesmia stellivarians*. The specimen agrees very closely in spiculation with the description given by Ridley (**16**), except that the megascleres are a little larger and the trichodragmata contain many more spicules.

The species has been hitherto recorded from the Straits of Malacca (Bowerbank); Port Darwin, Australia (Ridley), and the Philippine Islands ("Challenger"). Re-examination of the "Challenger" specimen, however, has convinced me that it does not belong to the same species as those described by Ridley from Australia and found by Professor Herdman in Ceylon waters, as it possesses toxa. It must be remembered that Bowerbank (**49**) originally described toxa as forming part of the spiculation, but Ridley regarded these as foreign elements. It is probable that we have here a confusion between two species.

It appears not improbable that the "thin fragment" recorded by Carter (**4**) from the Gulf of Manaar, under the name *Esperia tunicata*, Sdt., may be specifically identical with our specimen.

R.N. 220A (deep water off Galle and onwards up West Coast of Ceylon).

Esperella plumosa (Carter).

1882, **Esperia plumosa**, Carter (**33**); 1886, **Esperia plumosa**, Carter (**20**).

Sponge irregularly frondose or digitate; clathrous. Surface irregularly cactiform or conulose, covered by a very well-developed, stellately reticulate dermal membrane. Vents not seen; pores scattered in the meshes of the dermal reticulation. Texture (in spirit) coarsely fibrous, compressible, resilient, fragile. Colour grey. The largest fragment measures about 62 millims. in height by 41 millims. in greatest breadth.

The main skeleton is an irregular reticulation of coarse, stout, multispicular fibre without visible spongin; the main fibres running lengthwise and branching and

* Possibly young forms of the anisochelæ.

anastomosing with one another. The fibres are not very sharply defined and numerous megascleres occur scattered between them. The dermal skeleton is a very well-developed, triangular-meshed, stellate reticulation of stout, multispicular fibre (about 0·05 millim. in diameter).

Spicules.—(1.) Styli; fairly stout, often slightly crooked, with fairly well-developed oval heads and slightly constricted necks; sharply and rather abruptly pointed at the apex; size about 0·3 millim. by 0·009 millim.

(2.) Broad palmate anisochelæ, very similar to those of *Esperella simonis*;* about 0·048 millim. long; frequently in rosettes.

(3.) Minute palmate isochelæ; numerous, about 0·012 millim. long.

(4.) Large, stout sigmata, C-shaped and contort, with abruptly recurved and very sharply pointed ends; size about 0·08 millim. from bend to bend by 0·006 millim. thick in the middle.

(5.) Slender toxa with gently rounded curves; up to about 0·08 millim. long by 0·002 millim. thick in the middle; often in sheaves (toxodragmata) when young.

I have been able to satisfy myself by personal examination of Mr. CARTER's type preparation of his *Esperia plumosa* (now in my possession) of the specific identity of the Ceylon form with the sponge recorded by CARTER from Mauritius, and subsequently from the Mergui Archipelago also. As Mr. CARTER's descriptions are very scanty, I have thought it desirable to give the above details concerning what is evidently a widely distributed and characteristic species in the Indian Ocean, distinguished by an exceptionally varied and beautiful spiculation.

R.N. 298, 328, 361 (three fragments amongst a large number; all from Ceylon seas).

Esperella crassissima, n. sp.—Plate XI., fig. 6.

The single specimen is rounded, cushion-shaped, attached by the base to a mass of calcareous débris. The upper surface is strongly convex and bears a single large prominent vent about 3 millims. in diameter. Surface with a more or less strongly marked reticulate appearance, due to the coarse sub-dermal network of very stout spicular fibre, the oval meshes of which are normally covered over by a thin pore-bearing membrane, now mostly rubbed off. Pores scattered in the meshes of the dermal skeleton. Texture (in spirit) rather hard but slightly compressible and resilient; coarsely fibrous. Colour pale grey. Maximum diameter of specimen about 24 millims.

The main skeleton is a very well-developed reticulation of very stout, compact spicular fibre up to about 0·33 millim. in diameter, composed of very numerous closely packed spicules and without visible spongin. The meshes of this reticulation vary greatly in size and shape; perhaps 1·3 millims. would be a fair average diameter. Immediately beneath the surface the main skeleton passes into the more compact

* *Vide* (1), Plate XV., fig. 16.

sub-dermal reticulation, with rounded meshes averaging about 0·5 millim. in diameter, separated by fibres of about the same diameter (more or less). Over this lies a true dermal reticulation composed mostly of loosely scattered spicules (sometimes aggregated in slender fibres) lying tangentially in the pore-bearing dermal membrane.

Spicules.—(1.) Tylostyli (Plate XI., fig. 6, *a*); slightly curved, rather stout; with well developed oval heads narrower than the middle of the shaft, from which they are separated by a well marked constriction; gradually or rather abruptly sharp pointed at the apex. Size about 0·49 millim. by 0·016 millim.

(2.) Large palmate anisochelæ of the ordinary form (Plate XI., fig. 6, *b*, *c*), measuring about 0·06 millim. by 0·024 millim. Very numerous, mostly in groups which look like disorganised rosettes; found chiefly just beneath the surface. In the dermal membrane numerous small palmate isochelæ occur scattered singly; these are about 0·012 millim. long and are probably young forms.

(3.) Sigmata (Plate XI., fig. 6, *d*); slender, C-shaped and contort, up to about 0·036 millim. long; numerous.

(4.) Trichodragmata (Plate XI., fig. 6, *e*); short, compact; about 0·02 millim. by 0·006 millim. Very abundant.

This species is very closely related to *Esperella fusca*, Ridley and Dendy (1), obtained by the "Challenger" off Bahia; it differs, however, in the more strongly developed main skeleton and consequently greater hardness of texture, and in the sharply pointed character of the tylostyles; possibly also in colour.

R.N. 240 (Ceylon seas).

Esperella tenuispiculata, n. sp.

Sponge irregularly massive, with a tendency to grow out into rounded lobes or short, thick branches. Surface very uneven, covered over by a soft dermal membrane. Vents few, small, scattered. Pores scattered (perhaps in irregular groups) in the dermal membrane. Texture (in spirit) soft and spongy, but intensely gritty from the presence of an immense quantity of coarse sand, chiefly in the interior of the sponge. Colour varying from grey to brown. The largest specimen is about 63 millims. long by 36 millims. in greatest breadth.

The skeleton is to a large extent replaced by the abundant sand-grains, which may be held together in very irregular bands by spongin cement. Between and in association with these we have loose, wispy bands of styli running towards the surface, or simply scattered styli. There is no dermal skeleton.

Spicules.—(1.) Tylostyli, very much reduced; straight, slender; with distinct oval heads, constricted necks and fairly gradually sharp-pointed apices; size about 0·21 millim. by 0·004 millim., but often more slender.

(2.) Small palmate anisochelæ, about 0·02 millim. long; rather scarce but constant.

(3.) Slender sigmata, C-shaped and contort, about 0·036 millim. from bend to bend; sometimes very abundant.

In its intensely arenaceous habit and the consequent reduction of the proper skeleton, this species resembles *Esperella arenicola*, Ridley and Dendy (1), and *E. crassa*, Dendy (10), both from Bass Straits. It differs from the former, however, in the absence of trichodragmata, and from the latter in the presence of sigmata.

R.N. 293; 305; 334; 344 (Ceylon seas).

Paresperella, n. gen.

Encrusting or massive Esperellinæ, with megascleres in the form of tylostyli or styli; with microscleres in the form of palmate anisochelæ and serrated sigmata, to which others (such as toxa) may be added.

The existence of several esperelline species with serrated sigmata justifies the erection of a new genus, of which the type will be Carter's *Esperia serratohamata*, I am not aware that this very extraordinary form of spicule has hitherto been met with in any other genus.

There are probably at least three species of the genus *Paresperella* in the neighbourhood of Ceylon, for in an indeterminable sponge encrusting a calcareous nodule from "Deep water off Galle and onwards" I have found (as a foreign body) a huge serrated sigma (Plate XI., fig. 3) like those of *Paresperella serratohamata*, but far too large to be referred to that species. It measures 0·3936 millim. from bend to bend and 0·0146 millim. thick in the middle of the shaft, while, according to Mr. Carter's measurements, the corresponding spicule in *P. serratohamata*, though large, measures only 0·1 millim. by 0·0052 millim. Curiously enough, *P. serratohamata* was also first known from a single spicule.

Lindgren (86) has described, under the name *Esperella macrosigma*, a species of *Paresperella* in which the serrated sigmata attain still more enormous dimensions, measuring 0·48 millim. in length by 0·024 millim. in diameter. This species comes from the straits of Korea, and it is quite likely that it occurs also in Ceylon waters and may be represented by the single spicule above described.

The genus is, of course, very closely related to *Esperella*, from which it has evidently been derived.

Paresperella serratohamata (Carter)—Plate XI., fig. 2.

1880, **Esperia serratohamata**, Carter (4).

A minute specimen of this remarkable sponge occurs on a calcareous nodule in association with *Hymedesmia stellivarians* and *Esperella parishii*. The spiculation agrees very well with Mr. Carter's description, but the apices of the tylostyles are uniformly mucronate (Plate XI., fig. 2, *a*). This character is not mentioned in Mr. Carter's description, and the figure which he gives of the tylostyle is on too small a scale to afford satisfactory evidence.

Lambe (85) records this species from Vancouver, but I am doubtful, from the measurements which he gives of the spicules, whether his identification is correct; we have probably here yet another species of the genus.

R.N. 220c (deep water off Galle and onwards up the West Coast of Ceylon).

Paresperella bidentata, n. sp.—Plate XI., fig. 1.

Sponge intensely arenaceous, the single specimen consisting of a friable mass of coarse yellow sand, held together and permeated by the soft sponge-tissues. Somewhat cavernous internally. Surface uneven, with a soft dermal membrane visible in places. The single specimen is an irregular massive fragment about 25 millims. in maximum diameter.

The main skeleton of the sponge, between the closely aggregated sand-grains, consists of slender megascleres, mostly loosely scattered, but occasionally collected in fairly stout multispicular fibres. In the dermal membrane there is a distinct but very loose and wide-meshed reticulation of slender spicular fibre, three or four spicules wide, supported here and there on very loose sub-dermal brushes belonging to the main skeleton.

Spicules.—(1.) Tylostyli (Plate XI., fig. 1, *a*); long, slender, straight or nearly so, with oval heads, about equal in diameter to the middle of the shaft, and slightly constricted necks; typically with the apex slightly enlarged, truncated, and provided with two (sometimes three ?) minute conical teeth placed side by side on the truncated end (with their long axes parallel with the long axis of the spicule). The enlargement from which these teeth project contains a diverticulum of the central canal of the spicule. These spicules are best developed in the dermal membrane (and in the lining membrane of the large canals ?). In the dermal membrane they form the reticulation of spicular fibre mentioned above, and measure about 0·27 millim. by 0·0053 millim. In the deeper parts of the sponge, between the sand-grains, they are more slender and their apices sometimes appear to end in simple, long-drawn-out points.

(2.) Palmate anisochelæ (Plate XI., fig. 1, *c*, *d*), about 0·028 millim. long; mostly in rosettes near the surface, very abundant and similar to those of *P. serratohamata*.

(3.) Sigmata (Plate XI., fig. 1, *b*, *b*); long and slender, usually contort, with sharply incurved apices and (? always) with more or less distinct teeth on the outer side of each bend, similar to those on the sigmata of *P. serratohamata*, but much less strongly developed. Size about 0·052 millim. from bend to bend by 0·002 millim. thick in the middle.

This species differs from *P. serratohamata* in the presence of two teeth, instead of one, at the apex of the tylostyle; in the much more slender and less distinctly toothed or serrate character of the sigmata, and in the absence of toxa; as well as in the arenaceous habit, which has doubtless caused considerable reduction in the proper skeleton. I know of no other case where one can trace such a close and evident relationship between an arenaceous sponge with reduced skeleton and a non-arenaceous congener. The bidentate character of the apex of the tylostyle is very remarkable, especially in comparison with the mucronate character of the corresponding spicule in *P. serratohamata*.

R.N. 263A (Gulf of Manaar).

Iotrochota, Ridley.

Esperellinæ of massive, ramose, or flabellate form, and usually of dark purple or brown colour. Skeleton reticulate. Megascleres styli, to which diactinal forms may be added, especially in the more superficial parts of the sponge. Typical microscleres birotulate (apparently modified isochelæ).

In previous papers I have used the term "Amphiaster" for the birotulate spicules of this and certain other genera of Esperellinæ. There can, however, be little doubt that these microscleres are modified isochelæ, and do not belong to the astrose series at all. They are connected with the more typical isochelæ by the peculiar isochelæ of the genera *Chondrocladia* and *Axoniderma*, and may conveniently be termed "birotulate isochelæ."

Iotrochota purpurea (Bowerbank), Ridley.

1875, **Halichondria purpurea**, Bowerbank **(49)**; 1884, **Iotrochota purpurea**, Ridley **(16)**.

The Ceylon variety of this species is characterized by its dark brown instead of purple colour in spirit.* It is also easily distinguished from *Iotrochota baculifera* by this character as well as by the replacement of the tylote megascleres by slender styli, commonly arranged in radiating tufts at the surface.

The specimens are for the most part irregularly cylindrical in shape, may be much branched; and the surface is covered irregularly with small, sharp conuli. The styli of the main skeleton are usually sharp-pointed and very variable in size. The birotulate isochelæ are numerous and about 0·02 millim. long. Not infrequently, the straight, slender styli in the radiating tufts at the surface of the sponge exhibit an inflation not far from the middle of the shaft, causing them to resemble a pipette. The fibres of the main skeleton reticulation are stout and contain much spongin as well as very many spicules.

The original type of the species was described by Bowerbank from the Straits of Malacca. Ridley recorded it from Torres Straits, Albany Island, Port Molle, and the Amirante Group. The West Indian *Iotrochota birotulata* (Higgin) **(53)** and the Southern Australian *Iotrochota coccinea* (Carter)† are very possibly identical with this species, or only varietally distinct.

R.N. 258; 297; 309; 343; 354; 366 (Stat. V., off Chilaw, 10 fathoms, and elsewhere in Ceylon seas. Some are mere fragments).

* It should, however, be noted, that a portion of the collection was preserved in formalin and transferred to spirit afterwards. I do not know which specimens were treated in this way, nor do I know what effect such treatment may have had upon the colour.

† *Vide* Dendy **(10)**.

Iotrochota baculifera, Ridley.

1884, **Iotrochota baculifera**, Ridley (**16**); 1887, **Iotrochota baculifera**, Ridley, var. **flabellata**, Dendy (**2**).

There are in the collection a number of dark purple-coloured specimens, mostly small or mere fragments, which I identify with this species. The flabellate habit, characterizing my variety *flabellata*, is not recognisable in most of them, and it seems hardly worth while to retain a special varietal name for the Ceylon form. In a boiled-out preparation of R.N. 164 I find the styli frequently much stouter than the measurements which I gave from Mr. Thurston's specimens, often measuring about 0·2 millim. by 0·012 millim., but very variable in diameter, while the tylota measure about 0·246 millim. by 0·007 millim., and the birotulate isochelæ about 0·02 millim. long. It will be seen that these measurements agree very closely with those given by Ridley for the type specimen from Port Darwin.

Thiele (**39**) has recorded the species also from Celebes.

R.N. 47 (Gulf of Manaar); 164; 317; 322; 331 (all from Ceylon seas).

Sub-family: PHLŒODICTYINÆ.

Desmacidonidæ in which the sponge body is provided with fistular outgrowths, and, usually at any rate, with a spicular rind or cortex.

In this sub-family I include the genera *Phlœodictyon*, *Oceanapia*, *Histoderma*, *Sideroderma* and *Amphiastrella*, which appear to me to form a very natural group.

The microscleres are usually more or less completely suppressed.

Phlœodictyon, Carter.

Phlœodictyinæ with oxeote or strongylote megascleres and no microscleres at all.

Lundbeck (**88**) has shown pretty conclusively that Carter's name "*Phlœodictyon*" must be revived for this genus, the type species of "*Rhizochalina*," described by Schmidt, being true Chalininæ.

Phlœodictyon fistulosum (Bowerbank).

1873, **Desmacidon fistulosa**, Bowerbank (**22**); 1880, **Desmacidon Jeffreysii**, Carter (**4**); 1884, **Rhizochalina fistulosa**, Ridley (**16**); 1888, **Rhizochalina fistulosa**, Ridley and Dendy (**1**); 1897, **Oceanapia fistulosa**, Topsent (**83**); 1904, **Phlœodictyon fistulosum**, Topsent (**62**).

Mr. Carter recorded this species from the Gulf of Manaar under the name *Desmacidon Jeffreysii*. It differs, however, from the British *Oceanapia jeffreysi*, as Mr. Carter himself pointed out, in the absence of sigmata. In this respect it agrees with the Australian *Phlœodictyon fistulosum*, with which I have no hesitation in identifying it.

In a footnote to the account of this species in the Report on the "Challenger"

Monaxonida, Mr. RIDLEY and I suggested that *Rhizochalina* and *Oceanapia* should be united in one genus, and in a subsequent paper (**10**) I have carried out this suggestion. Our reason for this proposal was that at one of the "Challenger" stations (188, off New Guinea) specimens with and without sigmata appear to occur together, and are so closely similar in external appearance that they cannot be distinguished otherwise than microscopically. It seems equally reasonable, however, to suppose that the two genera actually occur together in this locality, or that there has been some confusion in the sorting out of the specimens. We can hardly suppose that the same species sometimes occurs with, and sometimes without, sigmata. I therefore propose to return to the arrangement originally adopted in the "Challenger" Report, substituting, for the reason above given, the name "*Phlœodictyon*" for "*Rhizochalina*."

Neither Mr. CARTER nor I have been able to find sigmata in the Ceylon specimens, though I have myself examined about half-a-dozen microscopically.

One of Professor HERDMAN's specimens has the body, which varies much in shape and is often very irregular, up to 48 millims. in maximum diameter. As pointed out by Mr. CARTER, the fistular processes are long and may be ramified. They sometimes appear to be naturally closed at the extremity (except, perhaps, for small pores), and sometimes open. In nearly all cases they have been broken off short.

R.N. 81, 90, 237 (all from deep water off Galle and onwards up West Coast of Ceylon); 260; 363 (fistulæ only, Stat. I., hauls 1–4, January 31, 1902, Colombo to Negombo, 12 to 20 fathoms). Also other unnumbered specimens and loose fistulæ.

Histoderma, CARTER.

Phlœodictyinæ with usually diactinal megascleres and microscleres in the form of isochelæ, to which others may be added.

An examination of Mr. CARTER's own preparations of his *Phlœodictyon singaporense* (**54**) has revealed the presence of small palmate isochelæ. I therefore propose to place this species, together with a closely related Ceylonese form, in the genus *Histoderma*.

The presence of isochelæ in this genus is of great interest and necessitates the inclusion of the Phlœodictyinæ amongst the Desmacidonidæ, the two species referred to forming an important connecting link between *Phlœodictyon* and *Oceanapia* on the one hand and *Desmacidon* on the other.

Histoderma vesiculatum, n. sp.—Plate XI., figs. 8, 9.

This remarkable sponge is represented in the collection by two fragments of about equal size and closely similar appearance. Each consists of an elongated cylindrical body inflated at irregular intervals to form oval vesicles. In one specimen there are two distinct vesicles connected by a short cylindrical piece, and from the larger of the two, which is broken across at the end, another short cylindrical piece is given off as a branch. The slender cylindrical portions, and the vesicles too, are now more or less hollow, but they contain the remains of the coarse skeleton network and a certain amount of decomposed soft tissue. Thus, in the present condition of the specimens, the outer wall of the sponge forms a thin but firm shell enclosing a wide cavity in which lie the remains of the choanosome. How far the sponge was hollow in life cannot now be ascertained. The colour (in spirit) is dark brown throughout, with a slight purplish tinge on the surface. The surface is smooth, but has a very characteristic tessellated appearance, caused by the very stout sub-dermal reticulation of spicular fibre showing through the thin dermal layer. Each specimen has a total length of about 27 millims. The largest vesicle measures about 11 millims. by 9 millims., and the slender cylindrical portions are about 4 millims. in diameter (sometimes rather less).

The main skeleton forms a very wide-meshed reticulation of very stout spicular fibre, occupying the interior of the sponge; the meshes being very irregular in shape and size. The diameter of the fibre, which appears to be composed entirely of very closely packed megascleres, is about 0·165 millim. There is a sub-dermal reticulation of similar fibre with roundedly polygonal meshes, the meshes being about 1 millim. in diameter. This supports the dermal skeleton (Plate XI., fig. 8), which is very well developed and extremely beautiful, consisting of a single layer of strongyla of various lengths lying tangentially side by side as closely packed together as possible, with a few much larger oxea, or sometimes styli, intermingled with them.

Spicules.—(1.) Oxea (Plate XI., fig. 8, *o*, *o*, *o*); rather long and only moderately stout; slightly curved, usually sharply but sometimes rather abruptly pointed at each end; size about 0·3 millim. by 0·009 millim., but variable. Abundant in the fibres of the skeleton and scattered in the soft tissues between, where numerous very slender, hair-like forms, possibly young, also occur.

(2.) Strongyla (Plate XI., fig. 8, *s*, *s*); cylindrical, more or less curved, and evenly rounded off at each end; size extremely variable, from 0·04 millim. by 0·005 millim. to 0·1 millim. by 0·007 millim., or perhaps more. Characteristic of the dermal skeleton, but also found in the spicular fibres and soft tissues of the choanosome.

(3.) Palmate isochelæ (Plate XI., fig. 9), about 0·016 millim. long; very similar to those of *Desmacidon conulosa*, as figured in the Report on the "Challenger" Monaxonida; numerous.

(4.) I have also seen one "birotulate" of about the same length as the ordinary isochelæ; with very slender and apparently straight shaft and short umbrella-like ends with minutely dentate margins. Whether or not this forms a constant element in the spiculation I am not prepared to say, but its presence is very interesting in view of the normal occurrence of such spicules in the genus *Amphiastrella*.

This species differs from *Histoderma singaporense* (Carter) chiefly in external form, but also in the more slender character of the oxea.

Lindgren, however, has described (86), under the name *Rhizochalina singaporensis*

(CARTER), a sponge from the China Sea, in which he also discovered isochelæ. This specimen seems to resemble the Ceylon form very closely, and it is possible that future investigations may show them all to be specifically identical.

R.N. 212 (deep water outside pearl banks, Gulf of Manaar).

SUB-FAMILY: ECTYONINÆ.

Desmacidonidæ in which some of the megascleres take the form of spined styli, originally developed as echinating spicules of the skeleton fibre or projecting at right angles from the substratum.

The members of this sub-family are usually easily recognised by their spined styli, but, as in the case of perhaps every type of spicule, the spined styli may be lost again by degeneration. Such degeneration has obviously taken place in the genus *Raspailia*, which, until recently, has been confounded with the Axinellidæ. As a rule, microscleres are present in the form of isochelæ (to which toxa are frequently added), but these also may be lost.

Myxilla, SCHMIDT.

Ectyoninæ, usually of massive, irregular form, in which the megascleres are spined styli, which may or may not be echinating, and variously ended diactinal forms which typically belong to the dermal skeleton. The typical microscleres are tridentate isochelæ, to which other forms may be added.

This genus in a certain sense occupies, as pointed out by Mr. RIDLEY and myself in the Report on the "Challenger" Monaxonida, a position intermediate between the sub-families Esperellinæ and Ectyoninæ, including both species with definite echinating spicules and species in which such spicules cannot be distinguished from those of the ordinary skeleton reticulation. It appears probable, from their form, that the spined styli originated in the first instance as echinating spicules, *i.e.*, spicules in which the growth of one end (the base) became arrested by pressure against a firm substratum, while the apex projected freely into the surrounding soft tissues and thus formed an internal defence against the attacks of parasites. In some species these echinating spicules appear to have passed into the main skeleton and form a reticulation with one another.* It appears desirable, therefore, to regard the presence of spined styli (or tylostyli) as constituting the leading feature of the Ectyoninæ, without insisting too strongly upon their actual arrangement.

In the genus *Myxilla* itself it is sometimes impossible, owing to the irregular character of the skeleton reticulation, to distinguish sharply between echinating and non-echinating styli, and, as I have pointed out before (**10**), I cannot, therefore, agree with TOPSENT (**62**, &c.) and HANITSCH (**46**) in retaining GRAY'S genus *Dendoryx* for species in which no special echinating spicules are recognisable.

* Compare *Rhabderemia indica* and its relationship to the thin encrusting forms of the same genus. See also below, under *Myxilla tenuissima*.

This important genus is represented in the present collection by only two species, but both of these are of exceptional interest owing to their unusual habit, the one being a typical sand-sponge and the other a very thinly encrusting form.

Myxilla arenaria, n. sp.

Sponge massive, irregular; intensely and coarsely sandy, with a distinct translucent dermal membrane visible in places. Pores and vents (?). Greatest diameter of type (R.N. 263) 30 millims. Colour (in spirit) light brown (the colour of the sand) or grey; texture very friable.

Main skeleton composed almost entirely of sand, with slender strongyla scattered between the sand-grains and also collected in loose, wispy fibres; and with small spined tylostyli or styli very sparsely echinating the sand-grains. Dermal skeleton composed of slender strongyla scattered irregularly in the dermal membrane.

Spicules.—(1.) Strongyla, perhaps sometimes faintly tylote; straight, slender, smooth; measuring about 0·146 millim. by 0·002 millim.

(2.) Spined tylostyli or styli; straight; gradually and very sharply pointed at the apex; rather sparsely and irregularly spined, chiefly at and near the base, which is generally distinctly tylote. Size variable, say about 0·056 millim. by 0·004 millim. (near the head, including spines).

(3.) Tridentate isochelæ, with small teeth and fairly stout, strongly curved shaft; length about 0·014 millim.; not very abundant.

(4.) Slender sigmata; C-shaped and contort; measuring about 0·032 millim. from bend to bend, but rather variable in size.

As usual in sand-sponges, the proper skeleton is reduced in accordance with the arenaceous habit. In external appearance the sponge closely resembles *Paresperella bidentata*, and might easily be mistaken for that species.

R.N. 263 (Gulf of Manaar); 266 (pearl banks off Aripu).

Myxilla tenuissima, n. sp.—Plate XI., fig. 5.

Sponge extremely thin, encrusting. The single specimen forms a small crust of a pale yellowish colour growing on a mass of calcareous worm-tubes in association with *Discodermia emarginata.* Vents and pores not seen.

The skeleton consists partly of slender tylota, scattered irregularly and in loose wisps, and partly of spined tylostyles projecting vertically from the substratum, upon which their bases rest while their apices point outwards.

Spicules:—(1.) Tylota (Plate XI., fig. 5, *a*); smooth, slender, straight or nearly so, with rather feebly developed oval heads and commonly with the shaft slightly inflated (tylote) in many places at irregular intervals. Size about 0·148 millim. by 0·002 millim.

(2.) Spined tylostyli (Plate XI., fig. 5, *b*); quite straight and abundantly spined all over; with spherical head not much wider than the shaft, which tapers gradually from the head to a fine, sharp apex. Spines rather small, conical and sharp pointed; on the head rather longer than elsewhere and arranged in a radiating manner, so that the head, when viewed end on, resembles a spheraster. Size variable, up to about 0·08 millim. in length by 0·008 millim. in thickness where the shaft joins the head (exclusive of spines). These spicules are very numerous and, though quite separate from one another, are placed pretty close together.

(3.) Stout tridentate isochelæ (Plate XI., fig. 5, *c*, *d*) of the usual *Myxilla* type, with rather strongly curved shaft; length about 0·032 millim.; very numerous.

This is a *Myxilla* with the encrusting habit of a *Hymedesmia*, and with correspondingly arranged skeleton. In spiculation it closely resembles TOPSENT'S *Dendoryx certa* (**48**), but differs in skeleton arrangement, the spined styli forming a network in the latter species. In fact, *Myxilla tenuissima* bears much the same relationship to *Myxilla* (*Dendoryx*) *certa* that *Rhabderemia pusilla* does to *Rhabderemia indica.*

R.N. 234A (on same mass as R.N. 234, "deep water off Galle and onwards").

Clathria, SCHMIDT.

Ectyoninæ of various habit, frequently clathrous; skeleton a reticulation of fibre, usually with much spongin, containing smooth styli and echinated by spined styli. Typical microscleres small palmate isochelæ, to which toxa are frequently added.

I have already (**10**) indicated the necessity for abandoning the genus *Rhaphidophlus* of EHLERS, which differs from *Clathria* only in the possession of a dermal crust of radially disposed styli. The degree of development of this crust varies to such an extent, however, that it is quite impossible to base a generic distinction on this character alone.

Clathria frondifera (BOWERBANK).

1875, **Halichondria frondifera,** BOWERBANK (**49**); 1884, **Clathria frondifera,** RIDLEY (**16**); 1889, **Clathria corallitincta,** DENDY (**3**).

I do not think it is possible to keep the Ceylonese form, described by me under the name *Clathria corallitincta*, separate from the common Australian and Indian Ocean species, originally described by BOWERBANK from the Straits of Malacca and Gaspar Straits under the name *Halichondria frondifera* and subsequently re-investigated by RIDLEY.

The external form of the sponge is very characteristic, and one of Professor HERDMAN'S specimens (R.N. 44) bears a remarkably close resemblance to a specimen from the Mascarene group figured by RIDLEY (*loc. cit.*, Plate liii., fig. j). The spiculation, however, seems to be somewhat variable, and I must add to the description which I gave of Mr. THURSTON'S specimens the following particulars concerning those in the present collection.

The palmate isochelæ may be abundant. Smooth, slender toxa of very various length are also met with. These are best developed in R.N. 85 and 281, where they attain a length of about 0·184 millim., being almost straight from end to end except for a small bow in the middle. The stout styli of the main skeleton vary greatly in thickness. The slender styli or tylostyli may form a fairly distinct dermal skeleton, in which they are either irregularly scattered or arranged in more or less definite radiating brushes. The bases of these spicules are sometimes minutely spined (R.N. 169).

One of the specimens (R.N. 97) is attached to a pearl oyster (*Margaritifera vulgaris*).

R.N. 44, 97, 268 (all Gulf of Manaar); 85, 169, 281 (all deep water off Galle and onwards up West Coast of Ceylon).

Clathria indica, DENDY.

This common species (DENDY, **3**) is represented in the collection by four specimens.

R.N. 27, 106 (both from Gulf of Manaar, Stat. IX., &c.); 166; 291 (Ceylon seas).

Clathria spiculosa (DENDY).

1889, **Rhaphidophlus spiculosus**, DENDY (**3**).

There is one small specimen of this sponge which makes a close approach to the original types both in external form and spiculation.

R.N. 335 (Ceylon seas).

Clathria spiculosa, var. **ramosa**, nov.

This variety agrees closely with the types of the species in skeleton arrangement and spiculation, but differs conspicuously in its elongated, slender, sub-cylindrical, irregularly branching external form. It thus makes a very close approach to RIDLEY'S *Echinonema gracilis* from the Mascarene Islands (**16**), but the megascleres in the Mascarene species are much stouter.

R.N. 168; 308; 310; 333; 368 (deep water outside pearl banks, Gulf of Manaar).

Clathria spiculosa, var. **tessellata**, nov.—Plate VIII., fig. 2.

This variety again differs from the types of the species only in external features, which are, however, very characteristic. The sponge consists of more or less erect, thick, irregular lamellæ, with the margin rising up here and there into short, digitiform processes. The vents are minute and few, marginal or on the ends of the processes. The most striking character of the variety, however, is the tessellated appearance of the surface, due to the presence of a close, polygonal-meshed reticulation of (presumably) pore-bearing grooves; the meshes of the reticulation are about 1 millim. to 1·5 millims. in diameter. The general appearance of the sponge is well shown in the figure. One specimen (R.N. 92A) measures about 70 millims. in greatest breadth and the same in height. The colour (in spirit) is dark grey, and the texture characteristically firm and fleshy, and very tough.

R.N. 92; 92A (Gulf of Manaar).

Raspailia, Nardo.

Ectyoninæ of elongated, slender, branching habit. Skeleton composed of a dense central axis of spicular fibre containing much spongin, from which bundles or tufts of spicules radiate to the surface. Smooth monactinal (sometimes diactinal) megascleres are present, and also (normally) spined echinating styli. No microscleres.

As already indicated, the members of this genus bear a strong superficial resemblance to Axinellidæ, but it is evident from the presence of the spined echinating styli (though these may be vestigial) that they are really highly modified Ectyoninæ.

Raspailia thurstoni, Dendy.

There is one specimen of this sponge (Dendy, **2**, 1887) in the collection.

R.N. 39 (Stat. LX., outside Muttuvaratu Paar, 30 fathoms)

Raspailia fruticosa, Dendy, var. **tenuiramosa,** nov.—Plate VIII., fig. 5.

1887, **Raspailia fruticosa,** Dendy (**2**).

There are in the collection two specimens, one dry and one in spirit, which differ from the type of the species only in the much more slender and much shorter branches, and in the greater density of the skeleton, which is less distinctly reticulate. The branches are usually only from 2 millims. to 3 millims. in diameter, and very numerous, so that the whole sponge is even more fruticose than the type. The largest specimen (dry) is about 55 millims. in total height and 78 millims. in greatest breadth; it is represented in Plate VIII., fig. 5.

R.N. 100 (dry, Gulf of Manaar); 173.

Raspailia hornelli, n. sp.—Plate XI., fig. 7.

The single specimen is erect, arborescent, branching in one plane. The branching at first sight appears to be dichotomous, but in reality the two branches present are both given off from the same side of a main axis which in no way differs from them in appearance, except that the part below the first branch, which we may consider as representing the stalk, is more rounded in transverse section and slightly expanded below at the attachment, while the branches themselves are slightly flattened. Each branch is very much narrowed at the end to form a slender, elongated apex. The surface is rather coarsely granular, with numerous minute apertures between the granules; slightly hispid in places. Colour (in spirit) dark brown. Texture tough, compressible, resilient. Total height about 99 millims. Length of stem below the first branch 33 millims., diameter about 5 millims. Length of longest (lowest) branch about 64 millims.; greater transverse diameter of branches when fully developed about 6 millims.

The skeleton consists of a network of stout horny fibre, irregularly cored by smooth megascleres and fairly abundantly echinated by spined styli. There is a well marked axial condensation of the reticulation, in which most of the larger spicules are to be found densely packed together lengthwise in the stout horny fibre. From this axial portion more slender fibres run obliquely outwards to the surface, where each one ends (typically) in a projecting brush composed of a very few long, stout styli, surrounded at the base by numerous much shorter and very slender styli (these often appear to be absent). The outwardly-directed horny fibres are irregularly cored by usually slender megascleres and abundantly echinated towards their outer ends by spined styli. They are connected together to form a network by short secondary fibres of similar structure, but more slender. There are also many of the smooth megascleres scattered through the soft tissues apparently without any relation to the fibres at all

Spicules.—(1.) Smooth styli (Plate XI., fig. 7, *a*); long and comparatively stout, evenly rounded off at the base, gradually and sharply pointed at the apex; usually slightly curved towards the base; size about 0·65 millim. by 0·018 millim.; found chiefly in the axial condensation (but also scattered in the soft tissues outside it) and in the surface brushes.

(2.) Smooth styli (Plate XI., fig. 7, *b*, *c*); very slender, straight or nearly so, evenly rounded off at the base and very finely and gradually pointed at the apex; size, say about 0·24 millim. by 0·0027 millim., but sometimes longer; characteristic of the surface brushes, but also occurring frequently between the axis and the surface; perhaps sometimes oxeote.

(3.) Smooth oxea (Plate XI., fig. 7, *d*, *e*, *f*, *g*); rather short and fairly stout, fusiform, more or less curved or angulated in the middle, gradually sharp pointed at each end; size very variable, commonly about 0·2 millim. by 0·012 millim., but may be as much as 0·46 millim. by 0·014 millim.; abundant, scattered irregularly outside the horny fibres, and within them.

(4.) Strongyla (Plate XI., fig. 7, *h*, *h*); very short and comparatively stout, straight, equal-ended and broadly rounded off at each end; size very variable, say about 0·2 millim. by 0·024 millim.; sometimes pretty numerous in the axial condensation and occasionally met with outside it, but very erratic in occurrence.

(5.) Spined styli or sub-tylostyli (Plate XI., fig. 7, *k*, *l*, *m*); rather short, straight, tapering gradually from base to apex, which, though narrow, is bluntly pointed; covered all over with very minute, sharp spines, which are most abundant at the base and apex; size about 0·08 millim. by 0·008 millim. (at the base, including spines).

Numerous small, spherical, granular, brown pigment cells, about 0·01 millim. in diameter, are scattered through the outer part of the soft tissues.

This species, though evidently closely related to the European *Raspailia* (*Dictyo-*

cylindrus) *hispida*, is readily distinguished by the details of its spiculation. I have much pleasure in naming it after Mr. HORNELL, to whose energy this collection owes, I am told, so much of its value.

R.N. 59 (Stat. IV., off Karkopani, Gulf of Manaar).

Agelas, DUCHASSAING and MICHELOTTI.

Ectyoninæ in which the skeleton is composed of horny fibre echinated by verticillately spined styli; with no other spicules.

For synonymy and references I must refer to the Report on the "Challenger" Monaxonida (p. 163).

Agelas mauritiana (CARTER).

1883, **Ectyon mauritianus**, CARTER (**54**); 1887, **Agelas mauritianus**, RIDLEY and DENDY (**1**); 1903, **Agelas cavernosa**, THIELE (**87**).

This species is represented by a tubular fragment 31 millims. long and up to about 16 millims. in diameter; widely open at both ends and with the wall of the tube only about 3·5 millims. thick. It is of rather dark brown colour and firm, resilient consistence.

The skeleton is a close, irregular network of stout, amber-coloured horny fibre echinated very abundantly by the characteristic verticillately spined styli, which measure about 0·176 millim. by 0·016 millim. (including spines).

This beautiful species has hitherto been recorded from Mauritius (CARTER), off Tristan da Cunha (?) ("Challenger"), and from Ternate (THIELE).

R.N. 358 (Ceylon seas).

Agelas ceylonica, n. sp.—Plate XII., fig. 9.

The type specimen* consists of a few slender, anastomosing, sub-cylindrical branches, arising from an irregular, proliferous basal crust attached to a calcareous nodule. The branches are only about 2 millims. in diameter, and their surface is irregular and sometimes minutely hispid. Texture (in spirit) compressible, resilient, fibrous and fairly tough. Colour brown. Vents minute and scattered on the branches.

The skeleton is an irregular network of pale-coloured horny fibre about 0·03 millim. in diameter, abundantly echinated by the spined styli, which are occasionally also found embedded lengthwise in the fibre, two or three side by side.

Spicules.—Verticillately spined styli (Plate XII., fig. 9), straight or slightly curved; the spines mostly small and conical, especially about the middle of the spicule; those at the base irregularly arranged, larger, and often hook-shaped, with the sharp points curved towards the apex of the spicule; apex sharp-pointed and free from spines for a short distance. Size variable, but characteristically long, say about 0·24 millim. by

* A second specimen closely resembles the type.

0·02 millim. at the base (including spines). Although they are verticillately spined, the annulation of these spicules is not nearly so distinct as in *Agelas mauritiana.*

R.N. 304; 312 (type). (Both from Ceylon seas.)

Echinodictyum, Ridley.

Ectyoninæ with reticulate main skeleton composed of spicular fibre containing smooth oxea and echinated by spined styli. Smooth styli may also be present. Microscleres usually absent.

Echinodictyum clathratum, n. sp.—Plate XI., fig. 4.

The single specimen forms a sub-spherical, clathrous mass of rather thin, short, flattened trabeculæ, echinated on the outer surface by slender conuli. Vents and pores not seen. Colour (in spirit) pale greyish-yellow; texture soft and resilient, fairly tough. Total diameter about 20 millims.

The main skeleton is a very irregular network of fairly stout spicular fibre; the size and shape of the meshes and the thickness of the fibres varying greatly. The fibres contain a very large number of oxeote megascleres closely packed together side by side, while the spongin cement which unites them is inconspicuous on account of its very pale colour. The fibres are echinated more or less abundantly by spined styli which project from them almost or quite at right angles. Numerous loose megascleres (oxea and styli) are scattered between the fibres. There is a dermal skeleton of well developed brushes of very slender styli; the brushes are well separated from one another, and each exhibits a beautiful radiate arrangement of its component spicules. These brushes appear to be confined to the outer surface of the sponge as a whole, and are absent from the surfaces of the inner trabeculæ.

Spicules.—(1.) Oxea (Plate XI., fig. 4, *c*, *d*); smooth, slender, usually more or less sharply bent at or near the middle, gradually and sharply pointed at each end; size very variable, commonly about 0·25 millim. by 0·006 millim. In the fibres and scattered between them, forming the greater part of the skeleton.

(2.) Smooth styli (Plate XI., fig. 4, *a*, *a*); very long and fairly stout, tapering gradually from the evenly rounded base (which may be very faintly tylote) to the sharply pointed apex; nearly straight but generally slightly curved towards the base; size variable, say about 1·26 millims. by 0·012 millim. These spicules lie parallel to the surface in the thickness of the sponge-lamella, without any definite arrangement.

(3.) Smooth styli (Plate XI., fig. 4, *b*); very slender, almost hair-like; straight or gently curved; evenly rounded at the base, very gradually and finely pointed at the apex; size about 0·34 millim. by 0·002 millim. In the dermal brushes.

(4.) Spined tylostyli (Plate XI., fig. 4, *e*, *f*); rather long and slender, straight, tapering gradually from the slightly developed head to the narrow, fairly sharp-pointed apex. Spines small but abundant all over, especially on the head. Size about 0·1 millim. by 0·006 millim. where the shaft joins the head.

I have also seen three small isochelæ about 0·018 millim. long, and two or three sigmata, one of which measured about 0·05 millim. from bend to bend; but these spicules are so scarce that I am doubtful whether they are proper to the sponge.

This is an interesting species, having (if we leave out of account the doubtful microscleres) the spiculation of an *Echinodictyum* combined with the habit of an *Echinoclathria*. It is evidently nearly related to THIELE'S *Echinodictyum cavernosum* from Celebes (**39**), but differs in its pale colour and in the presence of the large styli.

R.N. 325 (Ceylon seas).

Aulospongus, NORMAN.

Massive Ectyoninæ with plumose columnar skeleton, comprising both smooth and spined styli in the spiculation. Without microscleres.

In my 'Report on a Second Collection of Sponges from the Gulf of Manaar' (**3**) I expressed the opinion that NORMAN'S genus *Aulospongus* (**55**) was unnecessary, and that the species for which it was established might be included in the genus *Axinella*. Further consideration has, however, induced me to alter my views on this question, and to consider the presence of the spined styli as constituting a sufficient generic distinction from *Axinella*, and, indeed, necessitating the removal of the genus to the Ectyoninæ.

This genus is evidently closely related to *Raspailia*, and constitutes one of the apparent connecting links between the Ectyoninæ and Axinellidæ. THIELE (**39**) has referred to the genus *Raspailia* two or three Japanese species, one, at least, of which (*Raspailia* (?) *villosa*) should perhaps be included in *Aulospongus*. The Australian *Raspailia cacticutis* (*vide* DENDY, **10**) may also possibly belong here, and likewise Mr. CARTER'S *Dictyocylindrus sessilis* from the Gulf of Manaar (**4**).

Aulospongus tubulatus (BOWERBANK).

1873, **Haliphysema tubulatum**, BOWERBANK (**8**); 1878, **Aulospongus tubulatus**, NORMAN (**55**); 1889, **Axinella tubulata**, DENDY (**3**).

Fig. 3. *Aulospongus tubulatus* (BOWERB.); from Gulf of Manaar; nat. size.

There are a number of specimens of this sponge in Professor HERDMAN'S collection. The species (fig. 3) forms one of the most characteristic elements in the Sponge-Fauna of Ceylon, and is of especial biological interest as affording an example of symbiosis, or perhaps commensalism, between a Sponge and an Annelid. I have nothing to add to the account which I gave in my 'Report on a Second Collection of Sponges from the Gulf of Manaar' (**3**).

R.N. 1, 2, 3 (and others not numbered; all from Gulf of Manaar (Stats. V., IX., XV., LV., LXI., LXVIII.).

Acarnus, Gray.

Ectyoninæ in which the megascleres may be stylote, oxeote, tylote and cladotylote, the latter forming the characteristic "grapnel-spicules" which typically echinate the skeleton fibre. Microscleres may be present in the form of palmate isochelæ and toxa.

Acarnus ternatus, Ridley.—Plate VIII., fig. 4.

There is in the collection a remarkably fine dry specimen of this species (R.N. 105, Plate VIII., fig. 4), of proliferous and thickly flabellate habit, with rather large vents (about 8 millims. in diameter) on the summits of the lobes. The specimen measures 270 millims. in greatest breadth by 150 millims. in height, and its colour is brown. There are also a couple of small specimens in spirit, the best of which is sub-cylindrical in form and irregularly branched.

The spongin of the skeleton fibres is very strongly developed but very pale-coloured.

Spicules.—(1.) Styli, measuring about 0·3 millim. by 0·0164 millim.

(2.) Cladotylota (grapnels), with usually three large, strongly recurved, sharp teeth; shaft about 0·21 millim. by 0·012 millim.

(3.) Slender tylota with slightly spined heads; about 0·22 millim. by 0·0035 millim. in the middle.

(4.) Oxea; long and very slender, gradually sharp-pointed at each end, may be angulated at or near the middle; say about 0·74 millim. by 0·004 millim.

(5.) Toxa; say about 0·152 millim. by 0·008 millim., but often more slender.

(6.) Palmate isochelæ, about 0·02 millim. long.

The slender oxea occur irregularly distributed outside the horny fibres. Ridley (**16**) makes no mention of them in his description, but they might be overlooked or regarded as accidental. Keller, on the other hand, describes and figures similar spicules in his *Acarnus wolffgangi* from the Red Sea (**61**). The latter species may possibly prove to be a mere synonym of *A. ternatus*.

The species has hitherto been recorded from Torres Straits (Ridley), Bombay (?) (Ridley), Amirante Islands (Ridley), and Tahiti ("Challenger").

R.N. 105 (dry, Gulf of Manaar); 313; 329 (Ceylon seas).

Cyamon, Gray (*emend.*).

Ectyoninæ in which the principal megascleres are smooth styli and tylostyli; the echinating spicules have a radiate form, and there are no microscleres.

In 1867, Gray (**31**) proposed this genus for Bowerbank's *Dictyocylindrus vickersii*, of which a single spicule was figured and described in the 'Monograph of British Spongiadæ.'* It was not until 1879 that this species was first really described by

* Vol. i., p. 267, fig. 234.

CARTER (**56**), who, however, did not adopt GRAY's genus, but adhered to BOWERBANK's original name.

In 1880, CARTER (**4**) also described two species from the Gulf of Manaar, which he named *Microciona quadriradiata* and *M. quinqueradiata* respectively, and called attention to the resemblance of the echinating spicules in these species to those of "*Dictyocylindrus vickersii*." It appears to me that all these three species must be included in one genus, distinguished as in the diagnosis given above, for which we may retain GRAY's name *Cyamon*.

This genus appears to be nearly related to *Trikentrion*, but is distinguished from it by the absence of oxeote megascleres (compare CARTER, **56**).

The peculiar radiate echinating spicule is probably derived from a spined echinating stylus by great enlargement of three or four of the basal spines. In this way it may come to resemble a tetractinellid spicule or an aster. It is extremely interesting to compare with these forms the equally peculiar echinating "grapnel" spicule of *Acarnus*, in which a tetractinellid form may also be arrived at secondarily, but by enlargement of spines at the apex instead of at the base of the spicule.

Cyamon quinqueradiatum (CARTER).

1880, Microciona quinqueradiata, CARTER (**4**).

The single specimen in the collection forms a sub-circular crust, about 11 millims. in diameter and 3 millims. thick in the middle, attached to a mass of nullipore.* The surface is uneven and irregularly conulose, and there is in parts a distinct, thin dermal membrane. In parts also the surface is sparsely hispid from the projection of some of the large spicules. The texture is soft and compressible, internally somewhat cavernous, and the colour (in spirit) is pale yellowish-brown.

The skeleton consists chiefly of tylostyles and styles of various sizes, the latter (at any rate usually) longer than the former. These spicules sometimes have their bases resting on the substratum and sometimes they are arranged in short plumose columns; some have their apices projecting for a considerable distance beyond the surface. The echinating spicules are rather scarce and local in their distribution, mostly to be found amongst the bases of the other spicules; though plentiful here and there, they might easily be overlooked except in fortunate preparations.

The spiculation agrees fairly closely with CARTER's description, but I think he has laid too much stress upon the distinction of the various forms of styli and tylostyli. In our specimen these pass gradually into one another; the slender "acuate" is not recognisable as a distinct type (it may be simply a young form), while the tylostyli have larger heads than appears from CARTER's description and figure. There may be either three or four smooth rays in the echinating spicule (in addition to the spined ray), but it agrees very closely with CARTER's description and figure.

R.N. 270 (deep water off Galle and onwards up West Coast).

* In association with a small specimen of *Petromica massalis*, R.N. 269.

Plocamia, Schmidt.*

Ectyoninæ of varying form; may be encrusting or erect and branched. The characteristic spicules are dumb-bell-shaped or sausage-shaped megascleres, in addition to which styli or tylostyli of various forms (some of which are typically echinating) may be present. The microscleres are isochelæ and (at any rate usually) toxa.

Plocamia manaarensis (Carter)—Plate VIII., fig. 1.

1880, **Dictyocylindrus manaarensis**, Carter (**4**); 1881, **Dirrhopalum manaarense**, Ridley (**60**).

There are several specimens of this curious sponge in the collection. Mr. Carter figured and described both external form and spiculation, and Mr. Ridley added valuable information on the latter point and on the question of systematic position. It is therefore unnecessary for me to do much more than refer to Plate VIII., fig. 1, which represents a much finer specimen than any hitherto obtained. The colour of the sponge (in spirit) varies from pale yellowish-grey to almost black,† and the branching is extremely irregular. One specimen (R.N. 367) shows very clearly how the main stem may be attached to the substratum by an expanded base.

Lambe (**85**) has recorded this species from California, but I think that his identification is probably erroneous.

R.N. 41 (Gulf of Manaar); 76 (Stat. XXXIII., 18 fathoms); 107 (off Galle, February 13, 1902); 278 (deep water off Galle and onwards up West Coast of Ceylon); 367 (deep water outside pearl banks); 374 (Stat. LX., 20–30 fathoms, Gulf of Manaar).

Bubaris, Gray.

Ectyoninæ of usually encrusting habit. Skeleton consisting of an inner mass of diactinal (vermicular) spicules, from which large styli or tylostyli project vertically outwards. Without microscleres.

This genus was founded by Gray (**31**) for Bowerbank's *Hymeraphia vermiculata*, the type of the genus *Hymeraphia* (*H. stellifera*) being a totally different sponge. Topsent (**59**, **62**) has already adopted the genus.

It is probable that there are a large number of encrusting sponges, with skeleton arrangement very similar to that of *Bubaris*, which are in reality not closely related to one another, but derived from several groups by adaptation to an encrusting habit (compare *Hymedesmia* amongst Astromonaxonellida). In such cases we must judge of their systematic position rather by the form of the spicules than by the mere arrangement of the skeleton.

The possible relationship of the genus *Bubaris* to the Axinellidæ is indicated in the Report of the "Challenger" Monaxonida (p. 182).

* For literature, &c., *vide* Ridley and Dendy (**1**).

† See footnote under *Iotrochota purpurea*.

Bubaris eruca (Carter).

1880, **Hymerhaphia eruca,** Carter (4); 1894, **Rhabderemia eruca,** Topsent (59).

There are three specimens of this very curious encrusting sponge in the collection; it has been well described and figured by Carter (*loc. cit.*), who himself pointed out its close resemblance to Bowerbank's *Hymeraphia vermiculata*, which is the type species of the genus *Bubaris*.

Topsent (62) has recently proposed to include this species in his genus *Monocrepidium*, distinguished from *Bubaris* by the tuberculation of the diactinal megascleres. In *Bubaris eruca* the spicules in question are annulated rather than tuberculated.

R.N. 183 (Stat. XLIII., off Kaltura, February 19, 1902, depth 22 fathoms); 239a, 240a (both from deep water off Galle and onwards up West Coast).

Rhabderemia, Topsent.

Encrusting or massive Ectyoninæ in which the principal megascleres are styli with strongly curved base, shaped like a hockey stick, and the principal microscleres are contorted sigmata. There are no chelæ and the echinating spicules appear to be greatly reduced or absent.

Topsent (48) established this genus in 1892, originally for the reception of Carter's *Microciona pusilla* and *M. intexta* (57), and a new species described by himself under the name *Rhabderemia guernei*. *R. pusilla*, being mentioned first, may be taken as the type of the genus. *R. guernei* and the new species which I am about to describe under the name *Rhabderemia indica*, agree so closely with *R. pusilla* that there can be no reasonable doubt of their generic identity. *R. intexta* differs more from the typical species, but may still, I think, be included in the genus. It is distinguished from the others by the possession of spined megascleres and the absence of small slender styli. There is in Mr. Carter's cabinet, however, a preparation labelled by him "*Microciona minutula*," which is intermediate in spiculation, having large bent styli minutely spined at the apex and also very slender styli slightly roughened at the base. It is further characterized by having toxa amongst the microscleres, and is evidently quite distinct from *Rhabderemia* (*Microciona*) *pusilla*, with which Mr. Carter has apparently confounded it.*

It is probable that some other species hitherto referred to the genus *Microciona* will also have to be included under *Rhabderemia*; on the other hand, as I have shown in dealing with *Bubaris eruca*, this species has been erroneously included in the genus *Rhabderemia* by Topsent.

Rhabderemia indica, n. sp.—Plate XII., fig. 10.

The specimen encrusts and almost completely envelopes some large fragments of shell, and attains on one side of the shell a thickness of 7 or 8 millims. The shape of the entire specimen with its enclosed shell-fragments is massive and irregular.

* The name *pusilla* was intended by Carter to be *minutula*, *vide* Carter (57 and 4).

The surface is uneven but fairly smooth; granular; with a distinct, translucent dermal membrane in places. Vents probably small and scattered. Texture rather soft, spongy and friable. Colour (in spirit) dull grey. Greatest diameter of the entire mass about 48 millims.

The skeleton is a close-meshed, very irregular reticulation of megascleres, many of which are collected together into loose multi-spicular bands running perpendicularly to the surface. These primary fibres, if we may so call them, are connected together by still looser and more irregular secondary bands, and the whole is confused by immense numbers of irregularly scattered megascleres. There is no special dermal skeleton and I have detected no spongin.

Spicules.—(1.) Styli, "rhabdostyles" of Topsent (Plate XII., fig. 10, *a*, *b*, *c*); base evenly rounded off, not tylote; basal part of shaft sharply bent at an angle to the remainder, like the end of a hockey stick, occasionally somewhat spirally curved; remainder of shaft straight or nearly so; gradually or somewhat hastately pointed at the apex; size fairly uniform, about 0·24 millim. by 0·006 millim., the bent basal portion being about 0·018 millim. long. These make up the main skeleton.

(2.) Very small, slender styli (Plate XII., fig. 10, *d*); straight or nearly so; tapering gradually from rounded base to finely pointed apex; with very slightly roughened surface; size about 0·044 millim. by 0·002 millim. at the base. Scattered very abundantly through the soft tissues as microscleres, and very uniform in size. I am inclined to think that these spicules are vestigial echinating styli.

(3.) Sigmata (Plate XII., fig. 10, *e*); very much contort, slender, often twisted into a kind of half-knot in the middle, sharply pointed at each end (when one end appears bluntly rounded, or even knobbed, it is probably due either to its having been broken short or to fore-shortening in perspective). The greatest length, measured in a straight line from bend to bend, is only about 0·012 millim., but if the spicule were straightened out it would measure at least twice as much. Very abundant.

This species is distinguished from *Rhabderemia pusilla* by the greater length of the bent styli and the much smaller size and roughened surface of the minute styli; from *R. guernei* by the absence of the peculiar microscleres which Topsent terms "thraustoxes," and by the smaller size of the megascleres and the roughening of the minute styli; from *R. intexta* by the presence of the minute styli, the smoothness of the large megascleres and the form of the sigmata. It differs from all in its much more robust growth, which constitutes perhaps its most noteworthy feature.

R.N. 341 (Ceylon seas).

Family: AXINELLIDÆ.

Sigmatomonaxonellida in which the microscleres have usually been entirely lost by degeneration; the megascleres are usually, in part or entirely, stylote; the skeleton arrangement is usually, but not always, plumose; and there are no spined echinating styli.

Owing to their loss of microscleres and want of other well-marked characters, this family is one of the most unsatisfactory with which we have to deal. The plumose arrangement of the megascleres in the main skeleton cannot be regarded as exclusively diagnostic, for it is met with also in Ectyoninæ and even in Chalininæ, and too great reliance upon this character has led to the inclusion of forms amongst the Axinellidæ which certainly should not be included in that family. I have already indicated that those so-called Axinellids in which true asters have been observed (*e.g.*, *Vibulinus*) should be placed amongst the Astromonaxonellida. The genus *Raspailia*, similarly, has been removed from the Axinellidæ to the Ectyoninæ, but we are still left with a somewhat heterogeneous collection of sponges which it is extremely difficult to define, and which will probably be subjected to considerable re-arrangement in the future. A curiously constant feature in this group is the irregularity exhibited by the ends of the megascleres and the manner in which the stylote and oxeote forms tend to pass into one another.

It is highly probable that the group, even as here restricted, is of polyphyletic origin.

Spongosorites, Topsent (*emend.*).

Axinellidæ with the main skeleton composed of an irregular but dense reticulation of large oxea or styli, and dermal skeleton composed of a thin layer of very much smaller oxea lying tangentially, and in close contact with the main skeleton; oxea typically biangulate.

Topsent (**14**, &c.) places the genus *Spongosorites* in his family Coppatiidæ, assuming that it has lost the characteristic microscleres, and calling attention to the apparent tetractinellid affinity indicated by the biangulate oxea. It appears to me, on the other hand, to come more naturally amongst the Axinellids, being not distantly removed from *Leucophlœus* and *Ciocalypta*, as indicated by the new species described below, in one of which we perhaps find a clue to the evolution of the curious finger-shaped "processes" of the latter genus. In *Ciocalypta tyleri*, var. *aberrans*, we also sometimes find biangulate oxea.

The genus *Spongosorites* may also be nearly related to Thiele's *Dactylella* (**39**).

Spongosorites topsenti, n. sp.—Plate XII., fig. 1.

There are six specimens of this curious sponge in the collection, differing so much amongst themselves in external form that it seems desirable to give a short account of each.

R.N. 152 is a depressed cake-shaped sponge of nearly circular outline, with convex upper and almost flat lower surface, the latter having been evidently attached to the substratum all over. Greatest diameter 36 millims., thickness in the middle 13 millims. The upper surface is somewhat corrugated, with shallow grooves (indicating underlying canals) radiating in a stellate manner from low, mound-like projections, one at least of which bears at its summit a small group of vents through which the radiating canals open, while another bears no visible apertures at all. The upper surface also bears one very small digitiform process, about 5 millims. long and 2 millims. in diameter, with no visible opening, and there may have been more of these processes, now broken off. The texture is hard and compact, almost stony, and the colour (in spirit) is dull brownish-grey.

R.N. 68 is similar in general features, but the upper surface is much more strongly convex; the broad, mound-like projections are rather better developed, but still few in number (about three, grouped in the middle of the upper surface), and one bears a conspicuous vent. The slender digitiform processes without visible openings are more numerous than in R.N. 152. Greatest diameter of specimen 34 millims.

R.N. 182 is a small hemispherical specimen only about 15 millims. in diameter, with the convex upper surface produced in the middle into a single stout digitiform process, about 11 millims. long by 6 millims. thick, but of irregular shape. This process contains wide canals which enter it from the body of the sponge. There are apparently none of the slender digitiform processes. I have seen no vents, but the specimen is somewhat damaged.

R.N. 202 is closely similar to the last, but rather larger, with a single stout digitiform process in the middle, containing longitudinal canals, but now broken short.

R.N. 134 is a small specimen about 26 millims. in diameter, with slightly conulose surface and two very short but stout finger-like processes.

R.N. 77 is much larger than any of the preceding, and the base, instead of being flat below, has grown partially round several loose calcareous nodules. It is strongly convex and more or less conulose and corrugated above, and the upper surface also bears two or three well-developed, stout, erect digitiform processes, very irregularly distributed. These processes contain more or less well-developed longitudinal canals, but there are no visible vents. On the general surface of the sponge the usually low conuli are in places elongated to form slender projections about 4 millims. long, and with strongly hispid surface. The base of this specimen is about 78 millims. long by 35 millims. in greatest breadth. One of the larger processes is about 26 millims. high by 15 millims. broad at the base, tapering upwards almost to a point.

From the above descriptions it would appear that the sponge is normally cushion- or cake-shaped, with the upper surface conulose or rugose, and sometimes bearing processes of two kinds, viz., (1) large processes which appear to contain the exhalant canals and to be produced by elongation of low, mammiform, vent-bearing projections, with the conspicuous vents probably replaced by a cribriform dermal membrane; and (2) small slender processes produced by elongation of the surface conuli, and apparently bearing no special relation to the canal system.

The main skeleton in the body of the sponge consists of a very dense and confused reticulation of scattered spicules lying in all directions and varying greatly in form and size, stout and slender mixed up together. At the surface, lying immediately on the main skeleton, there is a thin dermal layer of short and rather slender oxea, through which the apices of the large underlying spicules frequently project. In the processes of both kinds, large and small, the spicules of the main skeleton for the most part run lengthwise, and there is the same irregular dermal reticulation of small oxea. There are none of those characteristic radiating pillars of spicules, supporting the dermal membrane over large sub-dermal cavities, which we find in a typical *Ciocalypta*.

Spicules.—(1.) Large and very stout (Plate XII., fig. 1, *a–k*), typically fusiform oxea, but variously ended, sometimes stylote or strongylote, always more or less curved, sometimes biangulate, sometimes very crooked and irregular; size about 1·1 millims. by 0·065 millim., but variable.

(2.) Short, slender oxea (Plate XII., fig. 1, *l*); usually biangulate, gradually and sharply pointed at each end, symmetrical; measuring about 0·18 millim. by 0·008 millim., but variable. These forms occur chiefly, but not entirely, in the dermal skeleton; while between these and the largest spicules numerous intermediate forms (Plate XII., fig. 1, *m*) may be observed.

The above account of the spiculation is taken from R.N. 152, but the spiculation of the other specimens does not differ in any important respect.

The species may be distinguished from its European congener, *S. placenta* (the type of the genus), by the development of the finger-like outgrowths (which, however, may be not always present) and by details of spiculation, such as the absence of the central inflation of the oxea.

R.N. 68 (Gulf of Manaar); 77 (Stat. XLV., off Pantura, 25 fathoms); 134, 202 (deep water off Galle and onwards up West Coast); 152; 182 (Stat. XLIII., off Kaltura, February 19, 1902).

Spongosorites (?) lamellata, n. sp.—Plate XII., fig. 2.

Sponge irregular, compressed, lamello-digitate; only 3 millims. or 4 millims. in average thickness, with a maximum length of about 45 millims. ? Erect. Surface granular in appearance and minutely hispid, fairly smooth but uneven; margins rounded. Colour (in spirit) pale greyish-yellow.

The main skeleton consists of a dense and very irregular reticulation of styli, mostly scattered singly, but occasionally collected in loose strands. The dermal skeleton is formed of a thin layer of small slender oxea, lying tangentially to the surface and very irregularly scattered.

Spicules.—(1.) Styli (Plate XII., fig. 2, *a*, *b*, *c*); usually fairly stout and slightly curved or crooked (especially towards the base), narrowing slightly to the base, which is evenly rounded, and tapering gradually to the apex, which is sharply pointed; size, when fully grown, about 0·95 millim. by 0·02 millim., but numerous smaller and more slender forms occur which are apparently young.

(2.) Oxea (Plate XII., fig. 2, *d*, *e*); slender, sub-fusiform, slightly curved or angulated once or twice, sharply pointed at each end; size very variable, averaging, say, about 0·2 millim. by 0·0055 millim. These spicules occur chiefly at the surface of the sponge, but are also found in the interior.

This species differs widely from *Spongosorites topsenti*, not only in external form but also in the (? invariably) stylote character of the larger spicules.

R.N. 236 (deep water off Galle and onwards up West Coast of Ceylon).

Spongosorites (?) **lapidiformis**, n. sp.—Plate XII., fig. 3.

The three specimens by which this species is represented in the collection are quite irregular in shape; massive, and everywhere evenly rounded off, like water-worn pebbles, with no recognisable points of attachment or differentiation of surfaces. The surface is granular and very shortly hispid; harsh to the touch; occasionally veined by underlying ramifying canals. Vents few, small, sometimes hardly recognisable. Texture hard and compact, without separable dermal membrane. Colour (in spirit) pale wax-yellow. The largest specimen measures about 29 millims. in maximum diameter.

The skeleton is a very dense, irregular reticulation of megascleres, partly collected together in ill-defined bands. This reticulation extends right up to the surface of the sponge, and there is no special dermal skeleton, and apparently no spongin.

Spicules.—(1.) Very stout, fusiform oxea (Plate XII., fig. 3, *a*, *b*); slightly curved and gradually and sharply pointed at each end; measuring, say, about 0·87 millim. by 0·0495 millim.; pretty frequently becoming stylote (Plate XII., fig. 3, *c*) by rounding off of one end, and rarely even strongylote. These oxea are connected by intermediate forms (Plate XII., fig. 3, *d*) with

(2.) Slender oxea (Plate XII., fig. 3, *e*); slightly curved, gradually sharp-pointed at each end; measuring, say, about 0·54 millim. by 0·012 millim.; irregularly intermingled with the large oxea, and perhaps only young forms thereof.

This species is of very doubtful systematic position. Had it not been for the presence of so many stylote spicules, I should probably have referred it to *Halichondria*. It differs from typical species of *Spongosorites* in the absence of a special dermal layer of small oxea.

R.N. 143, 144, 145 (all from deep water off Galle and onwards up West Coast).

Hymeniacidon, Bowerbank (*emend.*).

Axinellidæ of massive habit. Skeleton reticulate, composed of spicular fibre usually containing a good deal of spongin; with no special dermal skeleton. Megascleres styli or sub-tylostyli; no microscleres.

I have pointed out on a previous occasion (10) that Lendenfeld's genus *Stylotella* (with which Topsent's *Stylinos* is admittedly synonymous) is not distinguishable from *Hymeniacidon.* The position of the genus amongst the Axinellidæ is, of course, open to question, but it seems to come at least as naturally here as anywhere else.

Hymeniacidon petrosioides, n. sp.—Plate XII., fig. 4.

The type specimen (R.N. 151) is massive, cushion-shaped, strongly convex above and irregularly concave below, having evidently been attached to the substratum at a few points only. Upper surface fairly even but coarsely granular. Vents (probably) few, small and scattered. Texture very hard and compact; surface harsh to the touch. Colour (in spirit) dull grey, with a purplish tinge here and there. Greatest breadth about 47 millims.; maximum thickness about 19 millims. There is another much smaller specimen of irregularly massive form.

The skeleton is a dense, close-meshed reticulation of short, stout styli, in which one can readily distinguish stout, multispiculous main fibres running at right angles to the surface at distances of about one spicule's length from one another, and connected crosswise by isolated spicules and bundles of spicules, with other similar spicules irregularly scattered in the soft tissues.

Spicules.—Short, stout, more or less curved or bent styli (Plate XII., fig. 4), broadly rounded off at the base (occasionally slightly tylote) and gradually sharp pointed at the apex; fairly uniform in size, measuring about 0·39 millim. by 0·022 millim. (There are apparently no oxea.)

This species appears to be nearly related to TOPSENT'S *Stylinos jullieni* from the Atlantic (**48**), but the spicules are much larger. In external appearance it bears a very close resemblance to *Thrinacophora durissima*, with which it may easily be confounded until microscopically examined, and, indeed, I am inclined to think that these species of *Hymeniacidon* are really closely related to the massive species of *Thrinacophora.* We may also have here, so to speak, a point of contact between the Axinellidæ and Desmacidonidæ, indicated both by the form and arrangement of the megascleres and the presence of trichodragmata in the last-named genus. The spicular fibre in *Hymeniacidon* is not plumose, or, at most, very feebly so, but it is impossible to draw a hard and fast line between the plumose type of fibre characteristic of the Axinellidæ and the non-plumose type characteristic of the Desmacidonidæ, &c.

R.N. 151; 316 (Ceylon seas).

Thrinacophora, RIDLEY and DENDY.

Axinellidæ with typically plumose skeleton and with microscleres in the form of trichodragmata.

Thrinacophora agariciformis, n. sp.—Plate XII., fig. 6.

Sponge consisting (usually, at any rate) of a short, thick stalk (which has evidently been attached below), supporting a thick, rounded, cushion-shaped body which is irregularly depressed above so as to form a more or less shallow, very thick-walled cup; or the top of the sponge-body may be flattened, with several irregular, shallow depressions. Surface minutely and uniformly conulose; the conuli barely 0·5 millim. in diameter and separated from one another by deep but narrow, meandering grooves. In the depression at the top the conuli may be covered over by a thin translucent membrane containing small circular vents. Consistence compressible, resilient. Colour (in spirit) pale yellowish-grey. A typical specimen (R.N. 163, not quite the largest) gave the following measurements: total height 25 millims.; length of stalk 8 millims.; diameter of stalk 13 millims.; longer diameter of body 31 millims.; shorter diameter 21 millims.

The skeleton is arranged in a typical axinellid manner, consisting chiefly of plumose columns of spicules running at right angles to the surface and ending in the conuli. These columns lie pretty close together and are connected with one another crosswise by occasional groups of spicules, or by single spicules, running across at right angles from one to the other; there are also numerous irregularly scattered spicules in the interspaces. The spicules are cemented together in the columns, and sometimes also in the cross connections, by a large amount of very pale-coloured spongin. There is no special dermal skeleton, but the surface may be rendered slightly hispid by the projection of the terminal spicules of the columns.

Spicules.—(1.) Short styli (Plate XII., fig. 6, *b*, *c*); fairly stout and more or less curved, especially towards the base, which is broadly rounded off; with gradually and finely pointed apex; size about 0·268 millim. by 0·01 millim., but variable.

(2.) Oxea (Plate XII., fig. 6, *d*, *e*); usually gently and evenly curved and sharply pointed, but often irregularly ended; of about the same size as the short styli, and very numerous.

(3.) Very long and slender, setaceous styli (Plate XII., fig. 6, *a*) (sometimes oxea), measuring, say, about 0·75 millim. by 0·008 millim., but variable. These spicules are found lying lengthwise in the interspaces between the plumose columns.

(4.) Trichodragmata (Plate XII., fig. 6, *f*); bundles of short and very slender, hair-like microscleres, slightly curved, the whole bundle measuring, say, about 0·032 millim. by 0·005 millim., but variable. These occur scattered quite irregularly between the spicular columns.

This beautiful and well-characterised little sponge is represented in the collection by seven specimens. It differs widely from any of its known congeners in external form, and spirit specimens are easily mistaken, at first sight, for young examples of *Phakellia donnani*, though readily distinguished on closer inspection by their paler colour, more finely conulose surface, &c. It is apparently common and may be looked upon as one of the most characteristic species of the Ceylon Sponge-Fauna.

R.N. 160A; 160B; 163; 163A; 314; 332; 356 (all from Ceylon seas).

Thrinacophora durissima, n. sp.—Plate XII., fig. 5.

Sponge sessile, cushion-shaped, very strongly convex above and somewhat contracted below, but attached by a broad base. Surface even, but granular or minutely conulose, the conuli being in part covered over by a translucent dermal membrane; very minutely hispid. Vents small, few, scattered; surrounded by feebly developed grooves arranged in a somewhat stellate fashion. Colour (in spirit) pale yellowish-grey. Texture compact, very hard; surface harsh to the touch; internal structure radially columnar. Greatest diameter about 23 millims.

The skeleton is composed chiefly of close-set, rather irregular, plumose columns of megascleres, running at right angles to the surface and ending in the small conuli or granules. These columns are connected by numerous spicules, isolated or in loose bands, which run across at right angles from one to another, while numerous megascleres are also scattered irregularly in the soft tissues.

Spicules.—(1.) Oxea (Plate XII., fig. 5, *b*); short, fairly stout, fusiform, gently and symmetrically curved, gradually sharp-pointed at each end; size up to about 0·39 millim. by 0·024 millim., but usually somewhat less, especially in diameter.

(2.) Styli (Plate XII., fig. 5, *a*); with broadly rounded base and gradually sharp-pointed apex; usually more or less curved towards the base; dimensions about the same as those of the oxea. Perhaps not quite so abundant as the oxea.

(3.) Trichodragmata (Plate XII., fig. 5, *c*, *d*); short, stout bundles of very slender, hair-like spicules, the whole bundle having, as usual, a faint brownish colour; dimensions of the entire bundle about 0·02 millim. by 0·008 millim.; abundant towards the surface of the sponge.

This curious little sponge is evidently closely related to TOPSENT'S *Thrinacophora spissa* (**48**) from the North Atlantic, and forms an interesting connecting link between that species (which has only oxeote megascleres, apparently arranged in a halichondrioid rather than an axinellid fashion) and the more typical species of the genus.

R.N. 355 (Ceylon seas).

Axinella, SCHMIDT.

Axinellidæ of varying habit, but not flabellate. With plumose skeleton composed of smooth styli or oxea and no microscleres.

Axinella labyrinthica, DENDY.

There are three specimens of this sponge in the collection. The species is easily recognisable by its external appearance, and I have nothing to add to my former description, DENDY (**3**), 1889.

R.N. 33, 103 (both from Gulf of Manaar); 357 (Ceylon seas).

Axinella manus, n. sp.—Plate XII., fig. 8.

Sponge erect, stipitate, branched in a somewhat palmate manner, but with the branches coming off at different levels and curving slightly towards one another (so as to suggest a hand holding a ball). Stem cylindrical, slightly expanded below, about 25 millims. long and 9 millims. in diameter. Branches about as thick as the stem, slightly flattened, short (usually about 30 millims. long), rather few in number, terminating in abrupt, conical apices. The vents are small openings in the floors of stellately arranged or longitudinal grooves, which give a characteristic appearance to the sponge, and are chiefly placed on the inner surface of the branches, but also occasionally on the outer surface and on the stem. Surface between the vent-bearing grooves granular or minutely conulose. Texture compressible, resilient but tough, with the stem a good deal harder than the branches. Colour (in spirit) rather light grey. Total height of specimen 84 millims.

The skeleton is rather loose and irregular, consisting (in the branches) of plumose columns radiating outwards to the surface and with many spicules irregularly scattered between; the whole becoming quite confused towards the middle of the branch, but without any special axial condensation.

Spicules.—(1.) Rather short and fairly stout styli (Plate XII., fig. 8); more or less curved towards the base, which is broadly rounded off; gradually and sharply pointed at the apex; size about 0·295 millim. by 0·016 millim., but often more slender.

(2.) Oxea; almost symmetrically curved and gradually sharp pointed at each end; of about the same dimensions as the styli; abundant.

This species, in the arrangement of the vents and in the skeletal characters, makes a close approach to *Phakellia donnani* and *P. symmetrica*, and demonstrates very clearly the impossibility of distinguishing sharply between the genera *Phakellia* and *Axinella*.

R.N. 53 (Gulf of Manaar).

Axinella tenuidigitata, n. sp.—Plate XIII., fig. 4.

The single specimen is a small massive sponge of short, thick, irregularly cylindrical form, attached by a broad base below and strongly convex on the upper surface, from which a number of slender, elongated, finger-like processes are given off. Surface uneven and irregularly hispid, especially on the digitiform processes; in part minutely and irregularly conulose and in part covered by a distinct, sub-glabrous, translucent dermal membrane. The digitiform processes are solid and they may unite with one another. Vents apparently small and scattered between the processes. Colour (in spirit) pale wax-yellow; texture hard and compact. Height of body about 20 millims., diameter about 15 millims.; length of processes, of which there are about half a dozen, about 11 millims., with a diameter of not much more than 1 millim.

The skeleton in the body of the sponge consists of an irregular reticulation of long styli, which, as they approach the surface, arrange themselves in loose, irregular, plumose columns. The digitiform processes are composed each almost entirely of a dense axis of similar spicules closely crowded together and placed longitudinally, with a few spicules projecting outwards beyond the surface, so as to give rise to its hispid character.

Spicules.—Apparently all stylote and all long (Plate XIII., fig. 4), but varying much in thickness; usually only very slightly curved (towards the base), but sometimes crooked; broadly rounded off at the base, which may be somewhat narrower than the middle part of the spicule, and gradually and sharply pointed at the apex. The stouter forms measure about 1·18 millim. by 0·0328 millim. In the digitiform processes they are a good deal more slender, and slender forms also occur intermingled with the stout ones in the body of the sponge.

R.N. 202A (deep water off Galle and onwards up West Coast of Ceylon).

Axinella halichondrioides, n. sp.—Plate XII., fig. 7.

Sponge encrusting, extended horizontally. Upper surface somewhat convex and rather uneven, with small monticular elevations, each bearing a single vent, scattered at fairly regular intervals; granular (minutely conulose) between the elevations, the conuli being normally covered over by a thin, transparent dermal membrane. Colour (in spirit) light brown; texture firm and compact, columnar in vertical section. Greatest breadth of specimen about 64 millims.; thickness in the middle about 16 millims. Height of vent-bearing projections up to about 2 millims. Diameter of vents about 1 millim. Distance between vents about 9 millims.

The skeleton consists chiefly of very stout but rather loose and irregular and only slightly plumose columns of spicules running vertically to the surface and ending in loose brushes in the small surface conuli. These columns contain a very large number of spicules and are connected together by short, loose bands of spicules running across the interspaces at right angles. There are also a large number of spicules irregularly and loosely scattered through the soft tissues.

Spicules.—Mostly oxeote (Plate XII., fig. 7, *a*); gently and uniformly curved, gradually and sharply pointed at each end; size about 0·31 millim. by 0·01 millim. A few styli of about the same size also occur (Plate XII., fig. 7, *b*, *c*).

This species resembles pretty closely THIELE'S *Axinella incrustans* (**39**) from Japan, but its spiculation shows it to be distinct.

R.N. 75 (outside pearl banks, Gulf of Manaar).

Phakellia, BOWERBANK.

Axinellidæ of compressed, flabellate (or cup-like) form, usually with vents on one of the flat surfaces and inhalant pores on the other. Without microscleres.

Phakellia donnani (BOWERBANK).

1873, **Isodictya donnani**, BOWERBANK (**8**); 1887, **Axinella donnani**, DENDY (**2**).

There are a dozen specimens of this characteristic species in the collection, in various stages of growth. The spiculation, as usual in the Axinellidæ, is somewhat variable, and oxeote as well as stylote spicules occur. In view of the cup-shaped (or sometimes flabellate) form (see fig. 4) it seems desirable to remove the species from the genus

Axinella and put it in *Phakellia*, if indeed the distinction between these two genera is to be maintained.

Fig. 4. *Phakellia donnani* (Bowerb.), from Gulf of Manaar, nat. size. A, flabellate; B, cup-shaped form.

R.N. 10, 15, 20, 21, 22, 23 (all from Gulf of Manaar); 160; 160a; 160b; 160c; 181, 181a (the last two from Stat. XLIII., off Kaltura, depth 22 fathoms, February 19, 1902).

Phakellia symmetrica, n. sp.—Plate XIII., fig. 3.

The single specimen is a short-stalked, flabellate sponge, the somewhat compressed stalk widening out not very suddenly into a single vertical expansion with evenly rounded margin and without any proliferation. The two surfaces are exactly alike; minutely conulose with small circular openings (? inhalant pores) everywhere between the conuli, and with numerous stellate vents scattered at moderately wide intervals. Towards the margin the surface becomes longitudinally grooved rather than conulose, and there are also a few marginal vents. Colour (in spirit) dull yellowish-grey; texture compressible, resilient, tough. Total height of specimen about 55 millims.; length of stalk about 16 millims.; greatest breadth of frond about 41 millims.; thickness of frond in the middle about 8 millims.

The skeleton is composed of moderately stout, slightly plumose fibres curving upwards and outwards to the surface (where they terminate in the small conuli) and connected together by short, irregular cross fibres, so as to form an ill-defined reticulation with many spicules scattered irregularly in the interspaces. The skeleton fibres contain much spongin, not very conspicuous, however, on account of its pale colour.

Spicules.—Styli (occasionally oxeote) of two principal varieties: (*a.*) Comparatively short and stout (Plate XIII., fig. 3, *a*, *b*); more or less curved towards the base, which is evenly rounded off, and gradually and sharply pointed at the apex; size about 0·23 millim. by 0·009 millim. (*b.*) Comparatively long and slender (Plate XIII., fig. 3, *d*), slightly curved towards the base, which is evenly rounded off, and gradually and finely pointed at the apex; size about 0·5 millim. by 0·008 millim.

This pretty little sponge may prove to be merely a variety of *Phakellia donnani*, connected with the typical form by the flabellate variety figured in my paper on the Sponge-Fauna of Madras (**2**). For the present, however, it is perhaps better to keep the two distinct.

R.N. 159 (Muttuvaratu Paar, 8 fathoms).

Phakellia ceylonensis, n. sp.—Plate VIII., fig. 3; Plate XIII., fig. 5.

The single specimen (Plate VIII., fig. 3) is shortly stipitate, erect, thinly flabellate and very proliferous. The branching and anastomosing vertical lamellæ of which it is composed all terminate at about the same level in thin, sinuous margins. The lamellæ are scarcely 3 millims. in thickness and have a tendency to become perforated by larger and smaller apertures. The two surfaces of the lamella are not distinguishable; each is finely conulose (granular) and minutely and slightly hispid. Vents not recognisable. Texture tough and resilient; colour (in spirit) greyish-brown. Total height only about 41 millims., but with a maximum breadth of about 90 millims.

The skeleton is dense, composed of plumose columns radiating upwards and outwards into the small surface conuli, and merging internally into an irregular but fairly dense reticulation of spicules. There is a large development of very pale-coloured spongin.

Spicules.—(1.) Styli; slightly curved or bent, evenly rounded off at the base, usually very gradually and finely pointed at the apex; of two principal sizes, but very variable: (*a.*) Comparatively short and stout (Plate XIII., fig. 5, *a*), say about 0·2 millim. by 0·008 millim. (*b.*) Long and slender (Plate XIII., fig. 5, *b*), say about 0·44 millim. by 0·005 millim.

(2.) Oxea (Plate XIII., fig. 5, *c*, *d*, *e*); subject to much the same variations in size as the styli, and variously ended.

This species is nearly related to CARTER'S *Phakellia flabellata* from Australia (*vide* DENDY, **10**), but for the present at any rate it may be regarded as specifically distinct.

R.N. 34 (Gulf of Manaar).

Phakellia crassistylifera, n. sp.—Plate XIII., fig. 6.

The single specimen is a small, irregular, proliferously lamellar and slightly clathrous sponge, without recognisable point of attachment. The surface is granular and minutely hispid, and there are no visible vents. Texture hard, tough, resilient. Colour (in spirit) pale wax-yellow. Height (?) 31 millims.; greatest breadth about 19 millims.; thickness of lamellæ variable, say about 2 millims.

The skeleton is a very dense, close and irregular reticulation of very stout fibre, composed of a large quantity of almost colourless spongin, in which numerous usually stout styli are more or less completely embedded. The primary fibres are stouter than the secondaries, and may have a somewhat plumose character; but the whole reticulation is so confused, and the spongin, though very abundant, so pale in colour, that at first sight the entire skeleton looks like a dense, irregular network of thickly scattered styli.

Spicules.—Styli (Plate XIII., fig. 6); usually stout and comparatively short and more or less curved; broadly rounded off at the base, which is not narrowed, and usually sharply and gradually pointed at the apex; but the apex is occasionally bluntly rounded off, so that the spicule becomes strongylote with unequal ends. Size commonly about 0·46 millim. by 0·0285 millim., but very variable in diameter; often much more slender than the measurement given, and occasionally a good deal stouter; sometimes rather longer.

R.N. 256 (Ceylon seas).

Acanthella, Schmidt.

Axinellidæ of usually flabellate form and more or less cartilaginous consistence. With more or less strongly aculeate or conulose surface. With no microscleres.

Acanthella carteri, Dendy.—Plate VIII., fig. 6.

There are several specimens of this sponge in the collection, and as the external form has not yet been figured, Professor Herdman has kindly had one of them photographed for this report (Plate VIII., fig. 6). There is a strong development of very pale-coloured spongin fibre associated with the spicules, which I omitted to mention in my original description, Dendy, **3** (1889).

Keller's *Acanthella aurantiaca* (**61**), from the Red Sea, comes very near to this species, if it be not identical with it.

R.N. 11, 36, 49 (all from Gulf of Manaar, Stats. II., IV., V.); ? 301 (perhaps young); ? 336 (perhaps young).

Acanthella flabelliformis, Keller.

The single specimen is thinly flabellate; ? stipitate (the stalk may have been broken off, the specimen being somewhat damaged and worn); both surfaces beset with rather sharp longitudinal ridges, showing a tendency to break up into conuli; with deep, semi-cylindrical, longitudinal grooves between the ridges. The floor of the grooves is formed by a rather thick, translucent dermal membrane, containing no spicules and easily stripping off; in this membrane are scattered numerous small vents. Colour (in spirit) dark greyish-brown. Texture tough, compressible, resilient. Height of the single lamella of which the specimen consists 37 millims.; breadth 51 millims.; thickness (including ridges) about 5 millims.

The skeleton is a reticulation of stout spicular fibre, containing much spongin and comparatively few, though still very numerous, spicules. The main fibres curve upwards and outwards to the surface, and are united by irregular cross-fibres. The arrangement of the spicules, both in the fibres and between them, is very irregular and confused. The main fibres are often somewhat plumose.

Spicules.—Oxea; straight or curved, slender, gradually and sharply pointed at each end; size fairly uniform, up to about 0·3 millim. by 0·0065 millim.; occasionally stylote.

The soft tissues are densely charged with small, round, granular brown cells, probably pigment cells.

This species is chiefly characterised by its oxeote spicules and by the distinctly reticulate skeleton with its strong development of spongin. It appears to form a connecting link between the genera *Acanthella* and *Phakellia.*

I have little doubt of the specific identity of the Ceylon form with that from the Red Sea, where it is, according to KELLER, one of the most abundant and characteristic forms on the reefs. Such slight differences as I have observed will be sufficiently evident by comparison of the description given above with that given by KELLER (**61**), in 1889. KELLER tells us that the colour in life is blue.

R.N. 31 (Gulf of Manaar).

Auletta, SCHMIDT.

Axinellidæ of tubular form; without microscleres.

Auletta lyrata (ESPER).

1798–1806, **Spongia lyrata**, ESPER (**6**); 1870, **Raspaigella lyrata**, EHLERS (**58**); 1889, **Auletta aurantiaca**, DENDY (**3**).

There are a number of specimens of this species in the collection, which show it to be an extremely variable one, both as regards external form and spiculation. The re-discovery of the typical flabellate form, agreeing closely with ESPER'S figs. 1 and 2 (Plate 67), enables me to identify my *Auletta aurantiaca* with ESPER'S *Spongia lyrata*, which was also obtained from Ceylon.

Typical examples may be described as follows:—

Sponge erect, flabellate, shortly stalked. Lamella thick, slightly proliferous, with broadly rounded margin bearing a row of small, sometimes sphinctrate vents, which are the outlets of vertical oscular tubes. Surfaces of lamella rather minutely conulose or rugose, and slightly hispid. Texture (in spirit) compressible and resilient, but tough; colour yellowish-grey. One specimen (R.N. 345) has a total height of about 31 millims., the lamella is about 42 millims. in breadth, and 7 millims. in thickness. The vents are rather less than 1 millim. in diameter.

The main skeleton consists of wispy bands of long, slender spicules united together by abundant very pale-coloured spongin, running upwards and outwards to the surface conuli (from which their terminal spicules project more or less) and connected with one another by occasional short cross-fibres of one spicule's length, forming an ill-defined, rectangular-meshed network of spicular fibre. In these fibres the spicules lie approximately parallel to one another, there being none of the typical axinellid arrangement except in the surface brushes. Between the fibres, which have a very loose, irregular appearance, numerous isolated spicules are scattered.

Spicules.—(1.) Styli; long and very slender, nearly straight; evenly rounded off at the base and fairly sharply pointed at the apex; size about 0·41 millim. by 0·005 millim., but variable.

(2.) Slender oxea; variously ended; mostly a good deal shorter than the styli.

A second specimen (R.N. 174) differs in having the margin of the sponge thinner, the vents fewer and somewhat larger (with a tendency to occupy separate prominences of the margin), and the spicules somewhat stouter.

In the arrangement of the vents, this typical form of the species resembles *Phakellia tumida*, from Australia (**10**), but the genus *Phakellia*, if retained, should probably be restricted to species with the vents arranged on one or both of the flat surfaces of the lamella. It differs from my "*Auletta aurantiaca*" in the more slender form of the spicules, as well as in the distinctly flabellate character of the sponge, which may be regarded as formed from a number of *Auletta* tubes fused together side by side.

R.N. 174; 345 (Stat. LXVIII., Gulf of Manaar, 10 fathoms).

Auletta lyrata, var. **glomerata**, nov.

In this variety the sponge consists of an irregular agglomeration of short, finger-like processes, more or less united together laterally, and each containing a longitudinal oscular tube terminating at the apex of the process in a sphinctrate vent. In other respects, including spiculation, this variety resembles the preceding, and the whole mass is attached to the substratum by a short stalk.

This variety makes a near approach to THIELE'S *Auletta halichondrioides*, from Japan (**39**), while in external form it closely resembles fig. 3 of ESPER'S Plate 67.

R.N. 170 (pearl banks off Aripu); 194 (south of Dutch Modragam Paar); 303.

Auletta lyrata, var. **crassispiculata**, nov.

I propose this name for three irregularly branched, loosely bushy specimens, characterised mainly by the large size of the spicules, which, however, vary so much that it is almost impossible to express the difference by measurements. The tubular branches of which the sponge is composed are short and rather slender.

R.N. 43, 60 (both from Gulf of Manaar); 161 (deep water off Galle and onwards up West Coast).

Auletta lyrata, var. **brevispiculata**, nov.

This variety is represented in the collection by one very fine specimen of much larger size than usual and consisting of a great mass of branching and anastomosing tubes, each ending in a sphinctrate vent now more or less completely closed by the membranous sphincter. The whole mass is attached to a very short, stout stem, and the shape and size of the individual branches do not differ from those of the specimens of "*Auletta aurantiaca*" originally described by me. The total height of the specimen, however, is 122 millims., and the greatest breadth about 73 millims. The branching is very irregular.

The spicules commonly measure about 0·35 millim. by 0·0164 millim.

R.N. 45 (Gulf of Manaar).

Auletta elongata, n. sp.—Plate XIII., fig. 7.

The type specimen (R.N. 73) consists of a bunch of seven elongated, sub-cylindrical tubes, branching out from each other and from the short, thick stem by which they are attached to the substratum. All the tubes grow vertically upwards, close together and parallel with one another, and they do not vary greatly in length. Each terminates in a wide vent, which may be more or less closed by a membranous sphincter. Colour in spirit, dull yellowish-grey. Texture of tubes compressible, resilient, stiff; stem hard and tough. Total height of specimen 90 millims.; length of stem about 18 millims.; diameter of stem about 10 millims.; length of longest unbranched tube about 52 millims.; diameter of tube about 8 millims. The thickness of the wall of the tube is about 2 millims., and the inner surface of the wall bears the numerous small apertures of the exhalant canals, while the outer surface is granular and porous in appearance and minutely hispid.

The skeleton consists chiefly of very stout bands of spicular fibre, which run longitudinally through the inner half of the tube-wall, branching and anastomosing with one another in a quite irregular manner. From these stout fibres very short, irregular, loose, somewhat plumose columns of long, slender spicules run almost vertically outwards to the surface of the sponge, beyond which the apices of some of them project; the distance between the longitudinal fibres and the outer surface being only about one spicule's length. No spongin is recognisable in ordinary unstained sections.

Spicules.—Very variable in form and thickness, the stoutest being found for the most part in the coarse longitudinal fibres, while more slender ones radiate thence to the surface. The following may be regarded as the chief varieties :—

(1.) Styli (Plate XIII., fig. 7, *a*, *b*); fairly stout or slender, slightly curved, evenly rounded off at the base, bluntly or sharply pointed at the apex; size about 0·83 millim. by 0·022 millim.; passing into

(2.) Oxea (Plate XIII., fig. 7, *c*), of about the same dimensions, but more or less sharply pointed at each end.

(3.) Strongyla (Plate XIII., fig. 7, *d*, *e*); more or less crooked, often very much so; size, say, about 1·2 millims. by 0·022 millim.

More slender forms of all occur, and the slenderer styli may be nearly as long as the strongyla or much shorter than the stout styli whose measurement is above given.

This species is evidently nearly related to *Auletta lyrata*, differing chiefly in the arrangement of the skeleton and the length of the tubes.

R.N. 73 (outside pearl banks, Gulf of Manaar); 148, 283 (fragment, both from deep water off Galle and onwards up West Coast of Ceylon).

Leucophlœus, Carter.*

Axinellidæ of massive habit, often clathrous. Skeleton reticulate, composed of stout multispicular fibres with little if any spongin; with a well-developed dermal skeleton composed of a reticulation of spicule-bundles or a crust of tangentially placed spicules. Megascleres typically stylote, sometimes oxeote. No microscleres.

* *Vide* Carter (**54**), p. 323.

This genus, which was never diagnosed by its author, is an extremely difficult one to deal with. In our Report on the "Challenger" Monaxonida, Mr. RIDLEY and I decided to suppress it as a synonym of *Hymeniacidon*, but it has lately been revived by THIELE (39) as a distinct genus, and I am prepared to follow him in this respect. I cannot quite see, however, why THIELE should, in the same work, have established another genus (*Amorphilla*) for the reception of closely similar forms (especially as he gives no definite generic diagnoses), unless it be on account of the comparatively small size of the spicules.

If we decide to separate *Leucophlœus* from *Hymeniacidon*, as I think we must, it must be mainly on the ground of the presence in the former of a strongly developed dermal skeleton (composed, mostly at any rate, of tangentially placed spicules) which often forms a white crust in dry specimens.

Our knowledge of these sponges, however, is still very deficient, and their systematic position very doubtful. I retain the genus amongst the Axinellidæ on account of the presence of stylote megascleres and the apparent relationship to *Ciocalypta* as pointed out by Mr. CARTER. *Leucophlœus fœtidus*, with its long oxeote megascleres, perhaps comes nearer to *Halichondria* than any other species, and may indicate a close relationship with the Renierinæ.

Leucophlœus fœtidus (DENDY).

1889, **Hymeniacidon** (?) **fœtida**, DENDY (3); 1897, **Amorphinopsis fœtida**, TOPSENT (83); 1898, **Ciocalypta fœtida**, LINDGREN (86).

There is one good specimen of this sponge in the collection, differing from the type as originally described in its partially trabecular and clathrous external form, and in the pale yellowish (not blackish) grey colour of the surface (in spirit).

I have already pointed out the resemblance which this species bears to RIDLEY and DENDY'S *Hymeniacidon* (?) *subacerata*, and it is not impossible that the presence of the small projecting styli in the dermal membrane of both these species may ultimately prove to be of generic import.

R.N. 63 (Gulf of Manaar).

Ciocalypta, BOWERBANK.

Axinellidæ provided with elongated, digitiform processes springing from a massive body. In the processes the skeleton is arranged in a plumose manner with a dense central axis. There is a thin dermal membrane supported on spicular columns and usually strengthened by a reticulation of tangentially placed spicules, overlying extensive sub-dermal cavities. There are no microscleres.

Ciocalypta tyleri, BOWERBANK.

There is in the collection one specimen which I must refer to the typical form of this species (22). This specimen (R.N. 29), which I examined hastily in Liverpool, has unfortunately not been sent out to me, as it appeared to be identical with another which was sent instead (R.N. 29A), and the only preparation which I have of it (made in Liverpool) shows none of the very large spicules characteristic of the variety *manaarensis* previously described by me (**3**), though it is not impossible that such may occur in other parts of the sponge.

R.N. 29 (Gulf of Manaar).

Ciocalypta tyleri, var. **aberrans,** nov.

The single specimen consists of a flattened, cushion-shaped body of oval outline, with a number (now four, but apparently one at least has been broken off) of slender, upright, digitiform processes springing from the upper surface. These processes are long and conical, tapering gradually almost to a point, and with no visible vents; their walls, however, are pierced by numerous small dermal pores. The surface of the sponge between the roots of the processes is rather uneven and somewhat rugose, with branching canals radiating from the roots of the processes beneath the surface, through which they are plainly visible; these canals are continuous with the large canals which run lengthwise through the digitiform processes, about four in each. The general surface of the sponge is very minutely hispid; the walls of the processes have a minutely reticulate appearance and may also be very slightly hispid. The texture of the basal part of the sponge (which has been cut off below) is fairly compact, except for the numerous cylindrical canals, some of which run almost vertically downwards from the bases of the digitiform processes. The colour of the sponge (in spirit) is dull brownish-grey. The longer diameter of the base measures about 45 millims., the shorter diameter about 24 millims.; the thickness in the middle of the base (now) is about 13 millims. The digitiform processes are about 29 millims. long and 6 millims. in diameter at the base, from which they taper gradually to the narrow, blunt apex.

The skeleton in the body of the sponge is a dense, irregular reticulation of loosely scattered spicules, chiefly oxeote, of various sizes. There is no special dermal skeleton and no extensive sub-dermal cavities, and the spicules at the surface do not differ in size, form, or arrangement, from those below. In the digitiform processes there is a central axis surrounded by about four longitudinal canals, separated from one another by rather thin longitudinal septa radiating from the central axis. Both axis and septa are crowded with spicules similar to those in the body of the sponge, but mostly arranged lengthwise. From the more peripheral portions of the septa radiate loose brushes of, for the most part, more slender and shorter oxea, which spread out beneath the dermal membrane and support it on their apices, which may project slightly beyond the surface. Although the more peripherally placed spicules of each brush are inclined very obliquely to the surface, there is no true dermal reticulation, but the dermal membrane may contain irregularly scattered spicules of various sizes.

Spicules.—Oxea of various dimensions; usually gently curved, symmetrical, gradually and fairly sharply pointed at each end; sometimes biangulate instead of simply curved; occasionally stylote with broadly rounded base. Size varying up to about 0·69 millim. by 0·025 millim.; sizes indiscriminately mixed in the body of the sponge, partially sorted out as described above in the digitiform processes, measuring in the surface brushes usually only about 0·377 millim. by 0·0082 millim.

This variety differs from the typical form of the species in the absence of the special dermal skeleton of slender oxea placed tangentially.

R.N. 29A (Stat. XLIII., off Kaltura, 22 fathoms).

Collocalypta, n. gen.

Axinellidæ consisting of a basal crust, from which isolated digitiform processes spring vertically upwards. With a thick, collenchymatous ectosome which, in the digitiform processes, is penetrated by wide longitudinal canals communicating with the exterior by groups of small canals ending in dermal pores. Skeleton consisting in the basal portion of erect plumose columns of megascleres; in the digitiform processes of an axial core of spicular fibre from which loose bands of spicules radiate outwards between the longitudinal canals to surface conuli. Spicules more or less cemented together by spongin. Without microscleres.

This remarkable genus bears a very striking superficial resemblance to *Ciocalypta*, from which, however, it differs widely in the presence of the thick, collenchymatous ectosome and the typically axinellid (plumose) character of the main skeleton, as well as in the total absence of dermal skeleton (compare, however, *Ciocalypta tyleri*, var. *aberrans*), and the presence of abundant spongin cement.

Collocalypta digitata, n. sp.—Plate VII., fig. 6; Plate XIII., figs. 1, 2.

Sponge (Plate VII., fig. 6) consisting of a flat, wide-spreading, encrusting base, about 8 millims. thick, from which arise erect digitiform processes widely separated from one another by irregular intervals. These processes vary much in size, the largest in my possession is about 53 millims. high by 8 millims. in diameter in the middle. They usually taper to a sharp apex and are, as a rule at any rate, unbranched. The surface of the basal crust, between the processes, is smooth or nearly so, but it may be slightly hispid, and it is covered by a good deal of foreign matter in places. The digitiform processes have a distinctly conulose and, at the same time, longitudinally corrugated surface. They bear no visible vents, but numerous minute pores (now all closed). The colour of the sponge (in spirit) is pale grey; the consistence tough and fleshy.

The skeleton in the basal crust consists of stout, erect, plumose columns of spicular fibre, closely crowded together. The spicules are arranged in the typical axinellid manner, with their outer ends projecting obliquely upwards and outwards, while their inner portions are cemented together by a considerable amount of spongin. Each column is continued through the ectosome as a loose tuft of more slender and longer spicules than those which compose its deeper portion, and the apices of these spicules commonly project beyond the surface. There is no dermal skeleton. In the digitiform processes we find a very dense, stout axial core of spicules more or less cemented together by spongin, from which numerous loose bundles of spicules radiate obliquely outwards and upwards into the surface conuli, beyond which their apices may project. Here, again, there is no dermal skeleton.

Spicules.—Oxea (Plate XIII., fig. 1), of various shapes and sizes according to situation; (*a.*) in the columns of the basal skeleton, stout, sub-fusiform, slightly curved, irregularly ended, variable in size, say about 0·56 millim. by 0·03 millim.; (*b.*) in the ectosome of the base, comparatively long and slender, slightly curved, irregularly ended, measuring, say, about 0·88 millim. by 0·02 millim.; (*c.*) in the digitiform processes the spicules are mostly of the long and slender type just described, but occasionally stout and comparatively short forms occur.

One of the most characteristic features of this sponge is the thick gelatinous ectosome (Plate XIII., fig. 2, *ect.*), composed of collenchyma, with a hyaline, or sometimes finely granular, matrix containing an immense number of large, stellate, connective-tissue cells. In the basal crust this ectosome is about 0·65 millim. thick. In the digitiform processes it forms an even thicker layer around the dense central axis of spicular fibre (Plate XIII., fig. 2), but it is penetrated by large longitudinal canals (*l.c.*), about half a dozen in number, and varying in diameter up to about 2·25 millims. These canals are separated from one another by radially arranged longitudinal septa (*sept.*), in which the bundles of spicules run out from the central axis to the surface conuli. The ectosome on the outer sides of the longitudinal canals is reduced to a membrane of varying thickness, containing no spicules and penetrated by short, narrow canals which place the great longitudinal canals in communication with the exterior. These short canals are arranged in groups at wide intervals, and those of each group unite together into a single larger canal before opening into the longitudinal canal. The dermal pores are doubtless arranged in corresponding groups, probably with one pore at the end of each of the smaller canals, but they are now all closed (their position is shown in Plate XIII., fig. 2, *d.p.*). The fact that the smaller canals unite together as they pass inwards to the great longitudinal canals seems to indicate that this is an inhalant system. The arrangement of the exhalant system I have not succeeded in making out, and the choanosome is not sufficiently well preserved to enable me to give any details with regard to the flagellate chambers.

The digitiform processes may contain a good deal of sand outside the spicular axis.

R.N. 74, 74A (outside pearl banks, Gulf of Manaar).

Order 4: EUCERATOSA.

Non-calcareous sponges without siliceous spicules, but with a skeleton consisting of horny fibres developed independently, *i.e.*, not in relation to any pre-existing spicular skeleton. (The skeleton is sometimes replaced or supplemented to a greater or less extent by foreign bodies.)

The study of the very interesting series of twenty-two species, by which the horny sponges are represented in the present collection, has caused me greatly to modify my views as to the phylogeny of this group. Hitherto I have, in common with certain other writers on the subject, been in the habit of regarding it as a group of polyphyletic origin, derived probably from several distinct groups of monaxonellid sponges by substitution of spongin for spicules. This view I now believe to be true only for a very limited number of horny sponges, which might be distinguished from the true Ceratosa (or "Euceratosa," as I propose to term them) under the name "Pseudoceratosa," until such time as our increased knowledge shall enable us to assign them to their proper systematic positions. This is already possible in some cases, as, for example, in certain species of the Chalinine genus *Siphonochalina* (*Spinosella*), concerning which I observed as far back as 1887, in my memoir on the West Indian Chalinine Sponges (**75**):—

"Here we can trace in different species of the same genus the gradual degeneration and disappearance of the spicules until we come down to forms like *Spinosella maxima*, mihi (Plate LXI.), and *Spinosella plicifera*, D. and M. (Plate LVIII., fig. 5; Plate LX., fig. 1), which sometimes still contain traces of the spicules imbedded in the horny fibre, and apparently on the verge of disappearance, while at other times they contain no spicules whatever; and yet the specimens with spicules and those without are specifically indistinguishable."

As regards the great majority of the horny sponges, however, I feel convinced that they form a natural and compact group, in which it is almost impossible to separate even the genera from one another by hard and fast lines. Thus I am in close agreement with Poléjaeff, who summarizes (**74**) his own observations on the classification of the group as follows:—"*With the exception of the genera Darwinella, Ianthella, and Psammopemma, all genera are devoid of any properties separating them absolutely from one another.*"

Lendenfeld (**66**) has endeavoured to show that the Ceratosa are divisible into two great groups of very different phylogenetic origin, viz., "Monoceratina" and "Hexaceratina." It would not be difficult to expend a very large amount of criticism upon his system, but, without going into detail, I must remark that this main sub-division appears to me to be wholly erroneous, and that the connection between these two groups is so close that it is quite impossible to separate them from one another; while, instead of the "Hexaceratina" being derived from the Hexactinellida and the "Monoceratina" from the Monaxonellida, as Lendenfeld would have us believe, it appears to me tolerably certain that the majority of the "Monoceratina"* are descended from ancestral "Hexaceratina," and the latter in turn from Myxospongida.

Some justification of my views concerning the phylogeny of the Euceratosa will,

* It must be remembered that Lendenfeld's "Monoceratina" include both Pseudoceratosa and Euceratosa; the latter alone are here referred to.

I hope, appear in the course of the subsequent pages; in the meantime I may give the following summary of the conclusions at which I have arrived:—

In the first place it is pretty obvious that the Aplysillidæ (constituting a large part of the so-called "Hexaceratina") form the starting point of the evolutionary series within the order. The primitive character of such genera as *Aplysilla* and *Darwinella* is clearly indicated by the simple canal-system, the large sac-shaped flagellate chambers, and the very simple skeleton of branched spongin-fibres, supplemented in *Darwinella* by detached spicules of spongin. The presence of these so-called spicules at first sight seems to lend colour to LENDENFELD'S views as to the relationship between the Aplysillidæ and Hexactinellida. It is very difficult to see, however, how the horny spicules in question can have anything to do with the siliceous spicules of the Hexactinellida; their shape is extremely variable and they are probably best regarded simply as isolated portions of the general spongin skeleton, secreted by groups of spongoblasts which, for some unknown reason, have become isolated from their fellows.

Altogether the Aplysillidæ agree very closely in structure with the Myxospongida, especially with the genera *Halisarca* and *Hexadella*, and it is not impossible that the curious fibres of *Halisarca* may represent a rudiment of a horny skeleton. That the spongin skeleton in the Aplysillidæ has been developed quite independently of that of the Monaxonellida, and with no relation to a pre-existing siliceous skeleton, admits, I think, of little doubt. The character of the skeleton, consisting in the simplest cases of a thin basal lamina of spongin, from which slightly branched fibres spring vertically upwards and end in surface conuli, without anastomosing with one another to form a network, is quite different from what we find in typical horny Monaxonellida, in which the spongin is originally deposited as a cement which binds together the spicules of a reticulate skeleton, and in which, consequently, when the spicules disappear, the spongin is left in the form of a network of horny fibres. A very similar network of horny fibres appears, however, to have been independently evolved in the higher Euceratosa.

This difference in the arrangement of the horny skeleton—in the one case in the form of a network and in the other case in the form of separate tree-like fibres—has given occasion to MINCHIN (12) to divide his "Grade" Keratosa into two orders, viz., "Dictyoceratina (= Monoceratina, LDF.)" and "Dendroceratina (= Hexaceratina, LDF., *pars*)," the latter group including only the family Aplysillidæ. MINCHIN'S distinction cannot, however, be maintained as a basis of classification, for, as LENDENFELD himself recognised, there are undoubted Aplysillids (*e.g.*, *Dendrilla elegans*, LENDENFELD) which possess a reticulate skeleton, and in the present report I propose the new genus *Megalopastas* for such forms, of which two species occur in Ceylon waters.

The importance of the genus *Megalopastas* lies in the fact that it forms a connecting link between the Aplysillidæ and Spongeliidæ, and thus completely breaks down the distinction between "Monoceratina" and "Hexaceratina," or "Dictyoceratina" and "Dendroceratina." The Spongeliidæ, like the Aplysillidæ, have large sac-shaped flagellate chambers, simple canal-system, and clear transparent ground-substance. In fact, they differ from the Aplysillidæ only in their reticulate skeleton and in their habit of taking foreign bodies into the fibre. The so-called "pith" in the fibre is also less obvious, but this is an extremely variable character, and one upon which we cannot place very much reliance for purposes of classification. In *Megalopastas pulvillus*, for example, one and the same section may show great differences in this respect, some fibres showing a strongly marked pith, differentiated by its darker colour, and others apparently having no pith at all (Plate XV., fig. 3), the difference apparently depending upon differences in local conditions at the time when the fibre is growing, which give rise to a more or less distinct lamination analogous to the annual rings in a tree trunk.

Moreover, when we remember that SCHULZE has described (**71**), under the name *Spongelia spinifera*, a species in which the arenaceous fibres do not form a network at all, but are arranged in a tree-like manner, as in the genus *Aplysilla*, we see at once that the distinction between the Spongeliidæ and Aplysillidæ is purely arbitrary, though, as a matter of convenience, it may, perhaps, still be maintained. From the Spongeliidæ the transition to the Spongiidæ, by complication of the canal-system, reduction in the size of the flagellate chambers and granulation of the ground substance between them, is very simple.

I therefore conclude that the Euceratosa are a natural group descended from the Myxospongidæ, that their evolution starts with the Aplysillidæ and ends with the Spongiidæ, between which the Spongeliidæ occupy an intermediate position, and that the reticulate skeleton of the higher types has been independently evolved from a more primitive dendritic skeleton.

FAMILY: APLYSILLIDÆ.

Euceratosa with a dendritic or reticulate skeleton composed of spongin-fibres containing a more or less distinct pith, but usually without foreign inclusions; sometimes also with isolated spicules of spongin; with a lacunar canal-system and large sac-shaped flagellate chambers opening by wide mouths direct into wide exhalant lacunæ.

Darwinella, MÜLLER.

Aplysillidæ with a dendritic skeleton and with isolated spicules of spongin.

Four species of this remarkable genus have been described, viz., *D. aurea*, MÜLLER (**67**); *D. australiensis*, CARTER (**18**); *D. joyeuxi*, TOPSENT (**89**); and *D. simplex*, TOPSENT (**84**); but it appears to me somewhat doubtful whether they should all be regarded as specifically distinct from one another.

Darwinella simplex, Topsent, 1892 (**84**, *vide* also **62**)--Plate XV., figs. 1, 2.

The single specimen forms a thin crust extending over a considerable area on the surface of a branching tube which has apparently belonged to some annelid worm. The surface of the sponge is glabrous and covered with sharp-pointed conuli, about 1 to 1·5 millims. in height and some 2 to 3 millims. distant from one another. The maximum thickness of the crust is only about 2 millims. The dermal membrane is minutely reticulate and lifted up in a tent-like manner on the ends of the vertical skeleton fibres to form the surface conuli. The colour (in spirit) is dark purple,* and the texture very soft and tender. The vents are inconspicuous, only one small one having been detected. The inhalant pores are abundantly grouped in pore-sieves, which occupy the oval or rounded meshes of the dermal reticulation.

The skeleton consists, in the first place, of sparingly and irregularly branched, pithed horny fibres (Plate XV., figs. 1, 2) of the usual *Darwinella* type, which rise more or less vertically from the base of the sponge and terminate in rounded apices in the surface conuli. These fibres have a diameter of about 0·165 millim. near the base, diminishing to about half as much in the conuli. The base of the fibre is expanded into a thin plate of spongin, doubtless attached to the substratum; the fibres themselves do not appear to form any anastomoses. The wall of the fibre is only about 0·01 millim. thick, and the interior is generally occupied by a much-branched filamentous fungus (?), composed of rows of short cells, which more or less completely replaces the pith in the older parts of the fibre (Plate XV., fig 2). In the younger parts of the fibre (Plate XV., fig. 1) the pith exhibits the characteristic thimble-shaped layers described and figured by Lendenfeld in *D. aurea*.

In the second place we have horny spicules of the usual *Darwinella* type, but rather sparingly developed and, so far as I have been able to ascertain, all of the triradiate form. They are irregularly scattered through the soft tissues, and I have seen no union between them. The rays are long, slender and tapering; say about 0·5 millim. long by about 0·025 millim. thick near the base.

The canal-system and general anatomy agree very closely with the description and figures given by Lendenfeld (**66**) for *D. aurea*.

The Ceylon specimen agrees very well with Topsent's descriptions of the species, but the horny spicules (in the single specimen available) do not appear to attain so large a size. The species has hitherto been recorded only from the Mediterranean and the Azores.

R.N. 302 (Ceylon seas).

Megalopastas, n. gen.

Aplysillidæ with an entirely reticulate skeleton and without spongin spicules.

As I have already pointed out, Lendenfeld (**66**) includes in his genus *Dendrilla* both species (*e.g.*, *D. rosea*) without and species (*e.g.*, *D. elegans*) with a reticulate

* *Vide* footnote under *Iotrochota purpurea*.

skeleton. It is very doubtful, however, whether the genus, as constituted by LENDENFELD, is separable from the older *Aplysilla*. The type species of *Dendrilla* appears to be a form with a dendritic skeleton, viz., *D. rosea*, and if we are to separate the species with reticulate skeleton, we can, for etymological reasons, hardly employ the name *Dendrilla* for them.

In my report on Mr. THURSTON'S Second Collection of Sponges from the Gulf of Manaar (3) I attempted to avoid the necessity for erecting a new genus by employing BOWERBANK'S old name *Spongionella* for what must now be regarded as the type of the genus *Megalopastas*, viz., *Megalopastas nigra*. I must admit, however, that BOWERBANK'S type of the genus *Spongionella*, viz., *S. pulchella*, is probably not an Aplysillid at all (according to LENDENFELD it is a "*Leiosella*"), while, on the other hand, BOWERBANK (8) also applied the name *Spongionella* to another totally different sponge, viz., *Phyllospongia* (*Spongionella*) *holdsworthi*, and *Spongionella* is retained by LENDENFELD (66) as a sub-genus of *Phyllospongia*. I therefore now revert to what was my original intention in 1889, and propose the new genus *Megalopastas*, the name being chosen in allusion to the large size of the flagellate chambers.

The anatomical characters of the genus are shown in Plate XV., fig. 4, which represents, somewhat diagrammatically, a vertical section of an Australian species, *M. elegans* (LENDENFELD'S *Dendrilla elegans*), of which I happen to have much better preserved material than of the Ceylon species. Excepting that in *M. elegans* the ectosome is thicker and the outermost secondary fibres of the skeleton do not lie so near the surface, so that there is no "dermal skeleton," the figure would serve almost equally well for either of the Ceylon species. My preparations of *M. elegans* contain numerous embryos, enclosed in spherical endothelial capsules, and mostly in the stage represented in the figure, consisting of a solid inner mass of cells surrounded by an outer layer modified near one end to form a pigment ring. This embryo agrees pretty closely with those described by SCHULZE in *Spongelia* (71) and *Euspongia* (72), and its occurrence perhaps tends to show the correctness of my views as to the close relationship of the so-called "Hexaceratina" to the other Euceratosa.

Megalopastas nigra (DENDY).—Plate XIV., fig. 7; Plate XV., figs. 5–8.

1889, **Spongionella nigra**, DENDY (3).

This very remarkable species was originally discovered by Mr. THURSTON and is represented in Professor HERDMAN'S collection by two specimens. The sponge (Plate XIV., fig. 7) is sessile, and consists of a number of vertical lamellæ, branching and anastomosing with one another, often in a very complex manner. The largest specimen I have seen was about 250 millims. high and the same in breadth, with lamellæ about 5 millims. thick. The colour of the living sponge is black (THURSTON), when dry, dull black, and in spirit rather lighter, blackish-grey. Texture (in spirit) very compressible and resilient; moderately tough. Surface granulated, the granules being really minute, close-set conuli. Vents abundantly scattered, but almost or quite confined to one surface of each lamella. The vents are compound, each consisting of an aggregation of several smaller ones, the entire group only from 1 millim. to 2 millims. in diameter.

The main skeleton (Plate XV., fig. 5) is a rectangularly meshed network of very distinct primary and secondary fibres, the primaries running vertically to the surface and the secondaries crossing them more or less at right angles. The primary fibres average about 0·049 millim. in diameter, and the secondaries about half as much. The outermost secondary fibres form a well-developed dermal or sub-dermal skeleton (Plate XV., fig. 5, *d.s.*; fig. 6), in the form of an irregular network with fairly wide polygonal meshes, the fibres averaging about 0·02 millim. in diameter.

There are many more minute conuli on the surface than there are of the stout primary fibres, and those which do not contain the apices of such fibres are supported by short fibres which spring vertically from the tangential fibres of the dermal skeleton (Plate XV., figs. 5, 8).

All the fibres of the skeleton are composed of pale-coloured spongin without any foreign enclosures. They are not distinctly "pithed" except at the growing apices (Plate XV., fig. 7), where the usual thimble-shaped layers of spongin are added one on top of the other, as in other Aplysillidæ, but even here the "pith" is not distinctly differentiated.

The ectosome forms a thin dermal membrane containing the inhalant pores, and the choanosome is very delicate and gelatinous. The canal-system agrees closely with that of *Aplysilla*, as described and figured by SCHULZE (70). It is lacunar, and the flagellate chambers are sac-shaped and large, averaging when full-grown about 0·07 millim. in diameter. They are not placed very close together and they open directly into the excurrent lacunæ, without special exhalant canaliculi.

R.N. 71, 161A (Pearl banks, Gulf of Manaar—not uncommon).

Megalopastas pulvillus, n. sp.—Plate XV., fig. 3.

The single specimen has the form of a small flattened cushion, slightly convex above and (has been) attached by a broad flat base below. The outline of the specimen is irregularly rounded. The upper surface bears several small, compound vents, each about 2 millims. in total diameter; it also appears granular from the presence of numerous minute, slender, sharp-pointed conuli containing the ends of the primary fibres. The inhalant pores are conspicuous under the microscope in small groups in the thin, translucent dermal membrane. Texture (in spirit) firm, but compressible and resilient; colour, pale yellowish-grey. Diameter of specimen about 18 millims.; thickness in the middle about 5 millims.

The skeleton (Plate XV., fig. 3) is a partly rectangular- and partly polygonal-meshed network of pale amber-coloured horny fibre, in which the primary fibres are very clearly differentiated, radiating towards the surface and terminating in long, slender apices in the surface conuli. The primary fibres not infrequently branch, while at the base of the sponge they are seen to originate in a thin horizontal spongin-lamella, which evidently forms the means of attachment to the substratum. The primary fibres are about 0·096 millim. in diameter, the secondaries are usually a good deal more slender, say about 0·04 millim. in diameter, but variable. Both primary and secondary fibres frequently exhibit a very distinct pith of variable thickness, which evidently simply represents the older part of the fibre surrounded by fresh accretions of spongin. Even in old parts of the primary fibres the old slender apices may frequently be observed thus imbedded in the new growth (Plate XV., fig. 3, *ap.*). The principal secondary fibres run across at right angles between the primaries, but numerous others run in various directions. The outermost secondary fibres form a pretty definite dermal skeleton with polygonal meshes of very variable size. Here and there short, vertical, gradually tapering branches arise from this network and enter some of the surface conuli. These branches evidently form the commencements of new primary fibres, as in *M. nigra.*

The ectosome is feebly developed, forming a thin dermal membrane containing the inhalant pores and overlying the sub-dermal cavities. The canal-system is lacunar. The flagellate chambers are large and sac-shaped, about 0·088 millim. in longer diameter; they open by wide mouths direct into wide exhalant lacunæ. The ground substance between them is very feebly developed, gelatinous-looking and broken up into trabeculæ by the smaller inhalant lacunæ in the characteristic aplysillid fashion. The larger exhalant canals converge towards the compound vents, where they open to the exterior.

It will be seen from the above description that this species agrees closely in skeletal characters and canal-system with *M. nigra*, but it differs widely in external form and colour (in spirit). The fact that the specimen contains large ova and embryos in endothelial capsules likewise seems to indicate that it is not merely a young form of *M. nigra.* Owing to the much greater distinctness of the pith in the horny fibres the species is a more typical aplysillid than its congener.

R.N. 191 (Muttuvaratu Paar, Gulf of Manaar).

Family: SPONGELIIDÆ.

Euceratosa with a (usually) reticulate skeleton of horny fibres without distinct pith, but containing foreign bodies; or with a skeleton composed of foreign bodies united together by little if any spongin. With lacunar canal-system and large, sac-shaped flagellate chambers opening directly by wide mouths into wide exhalant lacunæ.

This family may be retained as a matter of convenience, but it is, as I have already indicated, logically impossible to separate it sharply from the Aplysillidæ, for the genus *Megalopastas*, on the one hand, and Schulze's *Spongelia spinifera*, on the other, are strictly intermediate between the two groups.

Spongelia, NARDO.

Spongeliidæ with a skeleton composed of distinct, but more or less areniferous, horny fibres.

Spongelia fragilis, MONTAGU, var. **ramosa**, SCHULZE.

1879, **Spongelia pallescens**, sub-species **fragilis**, var. **ramosa**, SCHULZE (**71**); 1889, **Spongelia fragilis**, var. **irregularis**, LENDENFELD (**66**), *pars*.

There is a single, partly macerated specimen of this variety in the collection. The external form appears to have been loboso-digitate. The skeleton network is very coarse, with rectangular meshes, and densely charged throughout with sand. The soft tissues are very densely charged with chains of algæ, probably *Oscillaria spongeliæ*. The large sac-shaped flagellate chambers measure up to about 0·1 millim. in longer diameter.

Under the name *Spongelia fragilis*, var. *irregularis*, LENDENFELD has already (**66**) recorded a sponge from Ceylon which probably belongs to this variety, as he himself admits that his var. *irregularis* partly corresponds with SCHULZE'S var. *ramosa*. The species, at any rate, appears to be cosmopolitan, if not the variety also.

R.N. 307 (Ceylon seas).

Spongelia elastica, var. **lobosa**, SCHULZE.

1879, **Spongelia pallescens**, sub-species **elastica**, var. **lobosa**, SCHULZE (**71**); 1889, **Spongelia elastica**, var. **lobosa**, LENDENFELD (**66**).

There is one specimen of this variety in the collection, consisting of a massive, columnar and slightly clathrous basal portion, giving off numerous short, irregular, digitiform processes above. The surface is covered with acute conuli, larger and further apart on the lower than on the upper portions of the sponge, varying from about 0·5 millim. to 2·5 millims. in height. Between the conuli is stretched the usual reticulate dermal membrane, and the lines of the dermal reticulation are areniferous. The texture (in spirit) is soft and elastic and the colour pale greyish-yellow. The specimen measures about 58 millims. in height by 40 millims. in maximum diameter. The apices of the branches are commonly occupied by parasitic barnacles, each enclosed in a cavity which opens to the exterior by a small terminal aperture resembling a vent.

The primary fibres of the skeleton, ending in the conuli, are abundantly charged with foreign matter, chiefly sponge-spicules, while the connecting fibres are almost free from foreign matter, and form a moderately close network. The canal-system and histology agree closely with SCHULZE'S classical description. The large, sac-shaped flagellate chambers, about 0·08 millim. in maximum diameter, are imbedded in a sparsely developed gelatinous ground substance. They have numerous prosopyles and open directly by wide mouths into the exhalant canals.

This variety is well known in the Mediterranean and, according to Lendenfeld, occurs also in the North Atlantic and in Australian seas.

R.N. 165 (deep water off Galle and onwards up West Coast of Ceylon).

Spongelia elastica, var. **crassa,** nov.—Plate XIV., fig. 4.

This variety differs from var. *lobosa* in the much coarser main fibres, filled with much larger foreign particles (sand grains), and in the more areniferous character of the connecting fibres, which, however, are still occasionally quite free from sand. In external appearance (Plate XIV., fig. 4) the single specimen closely resembles the specimen of var. *lobosa* described above, but it may readily be distinguished by its much more rigid and coarsely arenaceous character. The very stout main fibres contain sand grains of extremely various size. The network of connecting fibres is very irregularly developed and sometimes is absent over wide areas. The sponge is infested by numerous small chætopod worms imbedded in the soft tissues.

R.N. 35 (Gulf of Manaar).

Spongelia incrustata, n. sp.

Sponge compressed, irregularly lobose, proliferous. Surface with small acute conuli irregularly scattered over it at varying intervals, and only about 1 millim. in height; minutely reticulate over large areas, while over areas quite as large the dermal reticulation is completely obliterated by the sand cortex. Vents rather small and mostly on the margins of the lobes. Texture (in spirit) rather soft, compressible, flaccid, cavernous internally. Colour yellowish-grey throughout. The largest specimen is about 100 millims. in maximum diameter, and the lobes are generally not more than 5 millims. or 6 millims. thick, though variable.

The skeleton consists in the first place of the dense arenaceous cortex, which is well developed everywhere, except in the thin dermal membrane of the pore-areas which lie between the meshes of the dermal reticulation (where present). This cortex is about 0·5 millim. thick. Internally the skeleton also consists chiefly of sand-grains, arranged in irregular tracts rather than in well-defined fibres, but often held together by spongin cement. Between these tracts are wide areas free from sand.

The canal system is that of a typical *Spongelia*. The sub-dermal cavities, underlying the pore-sieves, are large, and the whole canal-system is lacunar in a high degree. The flagellate chambers are sac-shaped and up to about 0·08 millim. in longer diameter, opening by wide mouths into the exhalant canals and provided with numerous prosopyles. The mesoglœa between them is very scantily developed, clear and gelatinous, but with numerous stellate connective-tissue cells. The walls of the larger exhalant canals contain numerous elongated muscle-cells.

This species appears to be nearly related to Lendenfeld's *Spongelia laxa* from the South Coast of Australia (**66**), but the surface conuli are more or less acute instead of rounded, the skeleton fibres are apparently much less well-defined, and the sand cortex is apparently much thicker.

R.N. 72 (outside pearl banks, Gulf of Manaar); 279 (deep water off Galle and onwards up West Coast of Ceylon).

Psammopemma, Marshall.

Spongeliidæ in which the skeleton is composed of densely aggregated sand-grains which are more or less connected together by spongin.

Psammopemma crassum (Carter), var. **clathrata**, nov.

1885, **Holopsamma crassa**, Carter (18): 1889, **Psammopemma crassum**, Lendenfeld (66).

The specimens differ from the types as described by Mr. Carter in their clathrous form and in the absence of large conspicuous vents. They are extremely irregular and friable, and densely charged with coarse sand, over which a distinct pellucid dermal membrane, free from sand, is frequently stretched. The surface is very uneven, sometimes ribbed and sometimes conulose; the texture incompressible but fragile, and the colour (in spirit) pale brown.

The sand grains are not arranged in distinct fibres, but in ill-defined bands forming an irregular reticulation. They are connected at the points of contact by a very small quantity of spongin cement.

The flagellate chambers are large (about 0·08 millim. in longer diameter) and sac-shaped, and open direct into the exhalant canals by wide mouths. The ground substance between them is clear and transparent and very sparsely developed, except in the neighbourhood of the larger canals, which are surrounded by an abundant gelatinous collenchyma, with numerous stellate or fibrous connective-tissue cells.

The types of the species came from Australia, and Lendenfeld also records it from New Zealand.

R.N. 64 (type of variety, Gulf of Manaar); 330 (Ceylon seas).

Family: SPONGIIDÆ.

Euceratosa with a reticulate horny skeleton and with small, more or less spherical flagellate chambers, commonly provided with special narrow exhalant canaliculi. The ground-substance between the chambers is compact and densely charged with fine granules.

Cacospongia, Schmidt.

Spongiidæ with a very wide-meshed skeleton network, and with distinctly lamellated horny fibres which are usually of a brown colour and of very variable diameter.

Cacospongia scalaris, Schmidt.

1862, **Cacospongia scalaris**, Schmidt (47); 1879, **Cacospongia scalaris**, Schulze (72); 1889, **Stelospongia scalaris**, Lendenfeld (66).

There are several rather small specimens in the collection which agree closely with the Mediterranean form as described and figured by SCHULZE. The connecting fibres are often very irregular in arrangement and very variable in diameter. The histological features are not very well preserved, but the flagellate chambers probably have elongated exhalant canaliculi, as described by SCHULZE.

The main fibres may contain many foreign bodies. What can LENDENFELD mean by saying that the fibres are all of uniform diameter and never contain foreign bodies, in direct opposition to the observations of SCHMIDT and SCHULZE?

R.N. 18 (Gulf of Manaar); 162 (three specimens); 347 (all Ceylon seas).

Euspongia, BRONN.

Spongiidæ of compact structure and with a very fine-meshed skeletal network of slender and fairly uniform horny fibre. Primary fibres, usually containing foreign bodies, radiate towards the surface and are connected together by a close but very irregular-meshed network of more slender connecting fibres free from foreign bodies.

LENDENFELD (66) has already recorded several species of *Euspongia* from Ceylon, viz.:—

E. trincomaliensis, which he identifies with one of HYATT'S American varieties of "*Spongia officinalis*";

E. irregularis, var. *pertusa*, which is also recorded from North America, Australia, and the tropical Pacific; and

E. irregularis, var. *dura*, also recorded from Madagascar and Australia.

There are two forms in Professor HERDMAN'S collection which appear to be quite distinct from all these.

Euspongia officinalis, AUCTORUM, var. **ceylonensis**, nov.—Plate XIV., fig. 3; Plate XVI., fig. 5.

There are in the collection several nice specimens of a bath sponge which obviously belong to a variety of *Euspongia officinalis*, closely resembling *E. officinalis*, var. *rotunda*, of HYATT (69) and LENDENFELD (66). The latter is one of the American varieties, and there is probably sufficient difference in the Ceylon sponge to merit recognition under a new varietal name.

The sponge is massive and compact, without vestibules Of the two specimens which I now have before me, the one (in spirit) is slightly elongated vertically and at the same time slightly compressed laterally and slightly flattened on the top, while the base is somewhat constricted and charged with pebbles and other foreign matter. The vents are rather large and conspicuous, scattered on the top and sides of the sponge, from 2·5 millims. to 5 millims. in diameter, sometimes more or less prominent. Each vent forms the termination of a long vertical oscular tube, of the same diameter as itself. The surface is thickly and uniformly covered with minute, low conuli (about 0·8 millim. apart, from apex to apex), from the summits of which fine ridges radiate into the intervening valleys, where they branch and anastomose with one another, so as to give rise to a delicate reticulation which is scarcely visible to the naked eye, and in the meshes of which the dermal pores are situate in small groups.

The colour of the surface in spirit is black, paling to grey below and internally, and the texture compact, but compressible and very elastic. The specimen thus described measures about 90 millims. in height by 73 millims. in greatest breadth. Another somewhat similar spirit specimen has been photographed for me by Professor HERDMAN, and is represented, about two-thirds natural size, in Plate XIV., fig. 3.

Professor HERDMAN has also sent me part of the macerated skeleton of a much larger specimen. The piece sent is a segment of what appears to have been a massive, hemispherical sponge, with very strongly convex upper surface and broad flattened base. Numerous large vents, up to 8 millims. in diameter, are scattered singly over the upper surface, each at the end of a long, vertical oscular tube. Between these vents the surface is rather uneven (but not channelled or grooved) and honeycombed by close-set narrow vertical canals (inhalant) about 0·5 millim. in diameter, which reduce the skeleton reticulation to a mesh-work of thin trabeculæ which terminate at the surface in small, slightly projecting villi. The texture, after soaking in water, is very soft and elastic and not very tough, and the colour is pale greyish-yellow. The specimen from which this piece was taken must have been about 200 millims. in diameter by 100 millims. in height.

The primary fibres of the skeleton (Plate XVI., fig. 5) run parallel with one another (at distances of about 0·8 millim.) towards the surface, where they end singly in the conuli. They rarely branch, and apparently never anastomose. They are about 0·04 millim. in diameter and composed chiefly of broken sponge spicules, with comparatively little spongin cementing them together. They are connected with one another by a polygonal-meshed network of secondary fibres, in which the meshes vary greatly in size and shape, while the fibres are of fairly uniform diameter and only rarely contain foreign matter. Average diameter of meshes, say, about 0·17 millim. ; diameter of the secondary fibres themselves, when fully developed, about 0·02 millim., but often less.

Owing to the quantity of broken spicules which they contain, the primary fibres are distinctly visible to the naked eye in the macerated sponge, appearing as very fine threads of a paler colour than the rest of the skeleton, and thus constituting what is perhaps the most obvious distinctive feature of the variety.

The dermal membrane contains numerous broken sponge-spicules scattered through it.

In internal anatomy this variety agrees minutely with SCHULZE's classical account of the bath sponge (72), so that it is unnecessary to describe the canal-system and histology in this place. One point perhaps deserves mention, and that is the very strong development of long bands or cords of granular fibrous cells, running through the sponge in various directions (but mostly more or less at right angles to the surface), and not by any means confined to the neighbourhood of the larger canals. These bands are, as already suggested by SCHULZE for closely similar structures in the Adriatic bath sponge, probably muscular, and their function appears to me to be to effect the contraction of the sponge as a whole and thus squeeze the water out very thoroughly when necessary.

This Ceylon bath sponge appears to differ from most of the varieties of *Euspongia officinalis* in the greater slenderness of the very pale-coloured secondary or connecting fibres of the skeleton. SCHULZE gives the average thickness of these fibres in *Euspongia officinalis* as 0·03 millim. to 0·035 millim., while in our variety they attain only a thickness of about 0·02 millim., and are often less.

Owing to this character the sponge acquires a remarkable softness, but at the same time loses somewhat in durability. This want of durability may impair its value as an article of commerce, but in view of its softness and elasticity and its great absorbent power, combined with its good shape and size, I am inclined to think that it would be worth while to experiment in the way of placing it upon the market if it can be obtained in sufficient quantity.

R.N. 37 (several specimens in spirit); 101 (dry). All from Trincomalee.

Euspongia tenuiramosa, n. sp.

Sponge consisting of irregular, slender branches, usually only about 5 millims. or 6 millims. in diameter and apparently repent. The branches are more or less angular or nodose, and usually very crooked. The surface is more or less concealed by coarse, calcareous débris, such as the shells of large Foraminifera, &c. Where free from foreign matter, it is covered with small, sharp conuli, scattered at very various intervals. Vents small and few; pores not observed. Colour (in spirit) purplish-brown or nearly black. Texture, where free from foreign matter, which occurs internally as well as at the surface of the sponge, compressible and resilient. The longest branch is about 60 millims. in length by 5 millims. in diameter, but the diameter varies much.

The skeleton is an irregular but fairly close, polygonal- or sometimes quadrangular-meshed network of rather dark-coloured fibre varying much in diameter. Here and there primary fibres can be recognised running into the surface conuli, and these may contain a rather slender core of broken sponge-spicules. The primary fibres have a diameter of about 0·05 millim. The connecting fibres vary from about the same diameter downwards to about 0·008 millim. The diameter of the meshes varies so much that it is useless to give measurements.

The material is not very well preserved for histological investigation, but, so far as I have been able to make out, the internal anatomy offers no features of special interest and agrees closely with that of other species of the genus. The flagellate chambers are small, about 0·024 millim. in diameter, and nearly spherical, and the ground-substance between them is finely granular. I have not been able to make out the nature of their openings. The usual cylindrical cords of elongated fibre-cells are present, and there is a collenchymatous ectosome. There appears also to be a thin cuticle similar to that of various species of *Hippospongia.*

As regards skeletal characters this species agrees closely with LENDENFELD's very comprehensive *Euspongia irregularis*, but the external appearance is so characteristic that it seems to deserve a distinct specific name.

R.N. 311; 339 (Yard Cove, Trincomalee, shallow water).

Hippospongia, SCHULZE.

Spongiidæ of clathrous structure, but otherwise resembling *Euspongia*, except that the skeleton fibre may be much coarser and the whole sponge harder.

Except in its harder and more incompressible character, I cannot see that LENDENFELD's genus *Hyatella* differs from SCHULZE's *Hippospongia*, yet LENDENFELD himself describes a *Hippospongia dura* which is, perhaps, as hard as any *Hyatella.*

Hippospongia intestinalis (LAMARCK).

1813, **Spongia intestinalis**, LAMARCK **(73)**; 1877, **Spongelia velata**, HYATT **(69)**; 1884, **Hippospongia intestinalis**, RIDLEY **(16)**; 1889, **Hyatella intestinalis**, LENDENFELD **(66)**.

This species is represented in the collection by several specimens of elongated tubular form, very intestinal in appearance and of a light brown colour, with their walls perforated here and there at irregular intervals, and the surface slightly conulose. The tubes may branch and anastomose, but are for the most part well separated from one another and usually about 10 millims. in diameter, but variable. The characteristic surface reticulation of slender horny fibre is very well developed, and the surface appears to be covered by a remarkable continuous but separable cuticle, which possibly has some connection with the dermal skeleton, but I have not been able to elucidate its true nature. The main skeleton is very irregular and composed of mostly stout amber-coloured horny fibre. Primary fibres cored with foreign bodies are visible here and there.

The flagellate chambers are small (about 0·03 millim. in diameter) and approximately spherical, and the ground-substance between them is finely granular. The special exhalant canaliculi, if present, are short. Stout bands of elongated fibres, presumably muscular and mostly longitudinal in direction, are developed as in other Spongidæ, and there may be a good deal of collenchyma around some of the larger canals.

The species has been recorded from the Mediterranean, Zanzibar, the Mascarene Islands, and the Amirante Group **(66)**, and from Porto Rico **(29)**.

R.N. 65 (Gulf of Manaar); 83 (deep water off Galle and onwards up West Coast); 337 (Ceylon seas).

Hippospongia clathrata (Carter)—Plate XIV., fig. 2.

1881, **Hircinia clathrata**, Carter (5); 1887, **Hircinia clathrata**, Dendy (2); 1889, **Hircinia clathrata**, Dendy (3); 1889, **Hyatella clathrata**, Lendenfeld (66).

There is a single specimen of this well-characterised sponge in the collection. Lendenfeld (66) has added particulars as to the canal-system to our previous knowledge. The sponge contains no filaments, but the bands or cords of fibrous tissue in the choanosome, so characteristic of many other Spongidæ, are very well developed. The species was recorded by Carter from the Gulf of Manaar and the Red Sea, and it also occurs in Australia (Dendy, Lendenfeld) and on the American coast of the North Atlantic (Lendenfeld).

The figure represents the characteristic appearance of a spirit specimen, no good illustration of the external form having yet been published.

R.N. 24 (Gulf of Manaar).

Hippospongia anomala, Poléjaeff.

1884, **Hippospongia anomala**, Poléjaeff (74); 1889, **Hippospongia anomala**, Lendenfeld (66).

There is one specimen in the collection which, although of smaller size, agrees very well in nearly all respects with Poléjaeff's description and figure of the type specimen from Torres Straits. Our specimen consists of an erect, sub-cylindrical cavernous body, expanding gradually below and giving off two short digitiform processes on one side. The interior, especially in the lower portion, is sub-divided by trabeculæ, and the surface is covered over by a thin, parchment-like dermal membrane pierced by numerous larger and smaller circular apertures, especially abundant towards the extremity. These apertures lead into the large vestibular spaces in the interior of the sponge. The end of the main body and those of the two processes taper suddenly to rather sharp apices, and are covered with fairly numerous small conuli, elsewhere the surface is nearly smooth and glabrous and provided with a delicate cuticle, like that of *Hippospongia intestinalis*. Poléjaeff's expression "shagreen-like" may refer to the same character. The colour (in spirit) is pale grey, the texture compressible and very resilient. The height of the specimen is about 120 millims. and the maximum diameter at the base about 50 millims.

The skeleton is a pretty close but irregular polygonal-meshed network of fibres of very uniform diameter, about 0·02 millim. to 0·03 millim. thick, and free from foreign bodies. Occasionally only one observes much stouter primary fibres, composed principally of broken sponge spicules, running towards the surface and sometimes branching. Occasionally also one sees very slender connecting fibres amongst the ordinary ones; these are probably young. There is no specially differentiated dermal skeleton, but the main skeleton reticulation comes close to the surface. A good many broken spicules are scattered in the dermal membrane.

The canal system is remarkable for the unusual length of the exhalant canaliculi of the flagellate chambers, reminding one of the similar condition described by

SCHULZE (72) in *Cacospongia scalaris.* POLÉJAEFF (74) has already called attention to variability in the development of the cameral canaliculi in this species, so that we can hardly consider the presence of long exhalant canaliculi as a character of specific value.

R.N. 56 (Gulf of Manaar).

Hippospongia dura, LENDENFELD (66).

The single specimen consists of an irregular massive body tapering gradually upwards (?) or on one side (?) into a sub-cylindrical fistular process, the conical extremity of which is perforated by numerous small, round apertures leading into the internal vestibular space. Similar apertures are scattered more sparsely on other parts of the sponge. Internally the sponge is cavernous, with wide, sub-cylindrical, vestibular spaces, more or less sub-divided by trabeculæ of smaller diameter than the vestibules. The vestibular spaces are covered in at the surface partly by a somewhat parchment-like dermal membrane and partly by superficial extensions of the trabeculæ themselves. The surface is rather uneven, but not distinctly conulose ; a considerable amount of calcareous and other foreign matter is attached to it. The texture, in spirit, is hard and only slightly compressible, and the colour rather dark brown throughout. The specimen measures about 110 millims. in greatest length (height ?) and 60 millims. in greatest breadth at right angles to the length.

The skeleton is an unusually close and fairly uniform network of rather stout, amber-coloured horny fibre. There is no distinction between primary and secondary fibres, except at wide intervals, where the network becomes somewhat closer and forms stout columns radiating towards the surface. In these columns many primary fibres run side by side and nearly parallel with one another, connected at frequent intervals by short, transverse secondaries to form a very stout, but ill-defined, compound, trellis-like fibre. Elsewhere the stouter fibres frequently run parallel with the surface of the sponge and are connected together by more slender fibres which run transverse to the stouter ones. In other places again the network is quite irregular. The stouter fibres, forming the bulk of the skeleton, are about 0·04 millim. or 0·05 millim. in diameter; the more slender ones are very variable. Usually the fibres are quite free from foreign bodies, but broken spicules may be found occasionally in fibres of the trellis-like groups. There is no special dermal skeleton, but the ordinary reticulation of fibres comes close to the surface, which is covered by a thin cuticle like that of *Hippospongia intestinalis* and *H. anomala.* A remarkable feature of the skeleton fibre is the brilliant yellow colour which it assumes in sections stained with picro-carmine. The superficial cuticle stains in the same way, and sometimes appears to be continuous with the more superficial skeleton fibres, but this is a point which requires further investigation.

The flagellate chambers are nearly spherical, only about 0·024 millim. in diameter, and the ground-substance between them is finely granular. There is a rather thin, collenchymatous ectosome, containing a good many brown pigment cells. Cylindrical bands or cords of elongated fibrous cells are developed as usual.

Lendenfeld describes the species, apparently from a dry specimen, from the American coast of the North Atlantic. Under these circumstances the identification may seem somewhat hazardous, but the species is so well characterised by its general form, its colour and texture, and its peculiar skeleton arrangement, that I do not think there can be much doubt about it. Of course, it is possible that there has been a mistake about the locality of the type specimen, which is in the British Museum Collection.

R.N. 57 (Gulf of Manaar).

Phyllospongia, Ehlers.

Spongiidæ of thin, lamellar form, often cup-shaped. With a close-meshed skeleton network of slender horny fibre.

Phyllospongia papyracea (Esper), var.—Plate XIV., fig. 6.

1798-1806, **Spongia papyracea**, Esper (6); 1870, **Phyllospongia papyracea**, Ehlers (58); 1877, **Phyllospongia papyracea**, Hyatt (69); 1884, **Phyllospongia papyracea**, Ridley (16); 1889, **Phyllospongia papyracea**, *pars*, Lendenfeld (66).

This variety is represented in the collection by a fine dry specimen, of which a photograph is reproduced in Plate XIV., fig. 6. The specimen is frondose, proliferous and decumbent, and has apparently been attached to the substratum at many points. The thickness of the fronds is about 1·25 millims. The consistence (when perfectly dry) is stiff and rather fragile, the colour light brownish-yellow. The upper surfaces of the fronds are marked with feebly developed concentric and radiating ridges, and also by numerous narrow grooves, frequently arranged in a branching or stellate manner and probably containing minute exhalant apertures. The lower surface is entirely free from such grooves. Both surfaces appear minutely reticulate under a lens, and neither possesses a continuous sand-cortex, though there is a good deal of sand scattered on the upper surface.

The skeleton is a close network of very pale-coloured horny fibres usually about 0·02 millim. in diameter. The fibres are mostly free from foreign matter, but the primary lines, radiating to the surface, contain many comparatively large sand-grains.

Except for the presence of the stellate or branching grooves on the upper surface and the sand-grains in the primary fibres, this species agrees very closely with the figures and description of the type given by Esper and Ehlers. As the type came from Southern India (Tranquebar), it is not likely that the Ceylon form is more than varietally distinct.

The species has been previously recorded from Tranquebar (Esper); Cape of Good Hope (Hyatt); and Mozambique (Ridley). Lendenfeld also records it from

Australia and New Zealand, but his identifications are not always trustworthy, and he appears to me to have got a wrong conception of the species. Thus he states that "in every case the sponge is attached by a short peduncle." He also includes (perhaps rightly) the cup-shaped *Phyllospongia holdsworthi* in the species.

R.N. 104A (Gulf of Manaar).

Phyllospongia holdsworthi (BOWERBANK).

1873, **Spongionella holdsworthii**, BOWERBANK (8); 1889, **Phyllospongia papyracea**, *pars*, LENDENFELD (66).

There are several exquisitely cup-shaped specimens of this sponge in the collection. BOWERBANK's figures and descriptions do not appear to me to be very typical, and it seems not impossible that he had also before him, when writing, specimens of *Phyllospongia papyracea*. The specimens which I have examined are regularly cup-

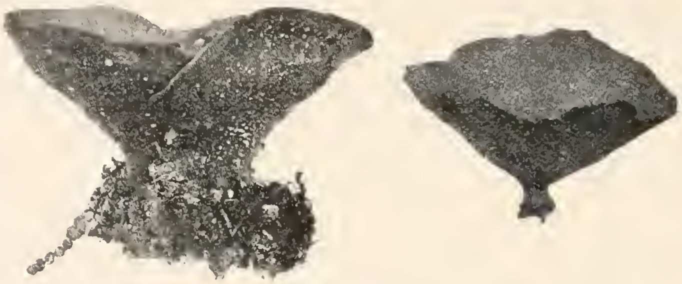

Fig. 5. *Phyllospongia holdsworthi*, half nat. size.

shaped (see text-fig. 5), with an entire margin and a very well developed peduncle branching out into root-like processes below. The wall of the cup is only about 1·5 millims. thick, stiff and tough and slightly flexible in the perfectly dry state. Both surfaces are smooth or nearly so, but show feebly developed concentric and sometimes radiating ridges. The vents are minute, usually circular in outline, and abundantly scattered over the inner surface only of the cup, which is covered by a thin sand-cortex not sufficiently developed to conceal the minutely reticulate character of the dermal skeleton. There is no sand-cortex on the outer surface, which is also minutely reticulate. Professor HERDMAN informs me that the colour of the sponge in life is purplish-brown, and my dry specimens still retain a distinctly purple tinge in places.

The skeleton is a close-meshed but very irregular network of horny fibre, mostly about 0·02 millim. in diameter and free from sand, but with stouter primary lines radiating to the surface and containing numerous comparatively large sand-grains, especially towards the inner surface of the sponge.

Bowerbank's figures certainly represent a form which is intermediate in external appearance between what I regard as the typical cup-shaped *P. holdsworthi* and the foliaceous *P. papyracea*, and it is quite possible that the two are not more than varietally distinct.

Bowerbank quotes from a letter of Mr. Holdsworth the following interesting particulars:—"Spongionella is only found on the 9-fathom line of the large pearl-bank. It is attached to pieces of dead coral or stones. When alive it is of a dark brown; and when taken out of the water it looks exactly like dirty wet leather. If you soak a bit of one of the dark specimens* you will see it with as nearly as possible the original appearance. This sponge is so strictly confined to the locality above mentioned, that its discovery by the divers is considered the strongest evidence that the outer part of the bank has been reached."

Professor Herdman adds, as the result of his much more extended examination of the Gulf of Manaar, that "although very characteristic of the Periya Paar and other deeper grounds west of the Cheval Paar, still it is not absolutely confined to these, but may be found elsewhere, as on the Muttuvaratu Paar."

R.N. 30; and other specimens (dry). (Periya Paar, Muttuvaratu Paar, &c., Gulf of Manaar.)

Hircinia, Nardo.

Spongiidæ with a coarse-meshed skeleton network usually containing much foreign matter. Denser aggregations of the network along the primary lines frequently form trellis-like compound fibres. Filaments are usually present in the ground-substance.

Hircinia fusca, Carter—Plate XIV., fig. 1.

1880, **Hircinia fusca**, Carter **(4)**, not **Hircinia fusca**, Ridley **(16)** and Lendenfeld **(66)**.

This is a very remarkable and well-characterised species. It was originally described by Carter in less than four lines, and the species was styled "provisional." It is, therefore, little wonder that Ridley and Lendenfeld have erred in identifying certain slender branching sponges from other localities with the Ceylon species. Carter's description of the external form should, however, have been sufficient to prevent any such misconception, for a slender, branched, cylindrical sponge, narrower at the base, and with conuli only 1 millim. high, can hardly be identical with one which is described as "massive, digitate, branched lobate, cactiform on the surface." In addition to these characters, the dark brown colour and the resemblance to *Aplysina fusca*, noted by Mr. Carter, leave no doubt in my mind that Professor Herdman's specimens really belong to the species in question, an opinion which is rendered almost

* Professor Herdman's dry specimens are very pale in colour.

certainly correct by the fact of their coming from the same locality. Under the circumstances it seems desirable to give some details with regard to the species.

There are two good specimens in the collection, one in spirit (R.N. 48) and one dry (R.N. 99). The former (figured) is massive, irregular, attached by a broad spreading base, from which compressed digitate or flabellate processes rise vertically upwards, bearing small vents at their apices (vents about 1·5 millims. in diameter). The surface is cactiform, with usually sharp-pointed but broad conuli, up to about 3 millims. in height, but usually less. The distance between the conuli varies greatly, but they are usually widely separated from one another by intervals of about 8 millims. The surface between the conuli is smooth or wrinkled, finely granular, under a lens very minutely reticulate and porous. The colour on the surface (in spirit) is warm brown, internally it is much paler, yellowish. The texture is compressible and resilient, but extraordinarily tough and leathery, so that it is very difficult to cut sections. This leathery character is obviously due to the enormous quantity of "filaments" which the sponge contains. Internally it is somewhat cavernous, owing to the presence of numerous cylindrical canals running vertically upwards towards the vents. This specimen measures about 190 millims. in greatest breadth of base and 56 millims. in greatest height.

The dry specimen is strongly compressed, flabellate, and only very slightly proliferous, with a narrow margin bearing a row of vents. It contains much more sand than the spirit specimen, but in other respects agrees closely. It measures about 135 millims. in height by 120 millims. in greatest breadth.

The skeleton is composed principally of large sand-grains, with a comparatively small quantity of spongin; arranged as follows:—(1) Very stout columns or tracts of sand-grains run vertically through the sponge and end in the surface conuli. These columns are compound structures, in which the sand-grains are held together by numerous short, slender spongin threads running from one to the other, in much the same way as LENDENFELD (**66**) has figured for *Psammopemma marshalli*. They apparently represent an exaggerated condition of the trellis-like main fibres of certain other Hirciniæ. (2) A very irregular network of more slender secondary fibres, composed of sand-grains held together by spongin threads as in the main columns, but the large sand-grains often only in single series. (3) In the dermal membrane there is a thin layer of broken sponge-spicules and large sand-grains, the former lying somewhat more superficially than the latter. Numerous broken spicules also occur along with the sand in the deeper parts of the sponge.

The canal-system appears to be that of a typical *Hircinia*, but, owing to the large quantity of sand and "filaments," it is impossible to get satisfactory sections. The flagellate chambers are not well preserved, but they appear to be about 0·04 millim. in diameter and approximately spherical, and the ground-substance between them is finely granular. The soft tissues are very densely charged with filaments. These have a maximum thickness of about 0·004 millim. between the heads. The heads, which stain deeply with picro-carmine, are about 0·008 millim. in diameter and somewhat variable in shape, sometimes nearly spherical and sometimes more or less pointed at the end.

Ridley's *Dysidea fusca*, which that author (**16**) supposed might be identical with Carter's *Hircinia fusca*, appears to be quite a different sponge.

R.N. 48, 99 (pearl banks, Gulf of Manaar); 271 (small specimen with fewer filaments. "Deep water off Galle and onwards up West Coast of Ceylon").

Hircinia tuberosa, n. sp.—Plate XVI., fig. 2.

The sponge consists of a very irregular, somewhat tuber-like body, from which irregular, finger-like processes are given off in various directions, the whole much mixed up and partially coated with calcareous débris. In the largest specimen the central portion of the sponge measures about 60 millims. in diameter, and the two larger processes each about 44 millims. in length by 18 millims. in diameter. The surface is very uneven, but sub-glabrous (not reticulate) between the foreign adhesions, and only slightly conulose, the conuli being low, irregular, and widely separated from one another. Internally the sponge is cavernous, being permeated by wide, cylindrical, meandering vestibules, which are covered in at the surface of the sponge by a thin, parchment-like dermal membrane, pierced here and there by rounded apertures. These apertures are evidently vents. They vary from about 0·5 millim. to 4 millims. in diameter, and are frequently arranged in groups. They are found sometimes on the central portion of the sponge, but more frequently on the more or less fistular, finger-like processes. Texture extremely coarse and gritty throughout, but tough. Colour (in spirit) pale yellowish-grey throughout. There is a distinct but thin sand-cortex in the parchment-like dermal membrane.

The skeleton (Plate XVI., fig. 2) is an extremely irregular network of more or less trellis-like horny fibre, partly enclosing and partly connecting together the very numerous sand-grains and other foreign bodies with which the sponge is filled. Main fibres are recognisable, but not very well defined, and the whole is so irregular that it is useless to give measurements.

The flagellate chambers are about 0·03 millim. in diameter and approximately spherical, and the ground-substance between them is finely granular.

Filaments are present in enormous numbers and usually collected together in more or less dense bundles. They measure about 0·006 millim. in maximum diameter between the heads, and their heads are approximately spherical and about 0·008 millim. in diameter.

R.N. 86, 88, 88a (all from deep water off Galle and onwards up West Coast).

Hircinia schulzei, n. sp.—Plate XVI., fig. 3.

Sponge slender, cylindrical, irregularly branched, and attached at many points to fragments of calcareous débris, amongst which it appears to creep. A few rather short and somewhat club-shaped branches, about 25 millims. in length and 3 millims. in maximum diameter, probably rose vertically upwards from repent stems of about the same diameter. The surface is pretty uniformly covered with low conuli, between which narrow longitudinal canals may be seen running beneath a thin membrane, which is occasionally broken through by a single small vent or by a sieve-like group of very small vents. The colour (in spirit) is very pale yellow and the texture pretty stiff, but compressible and resilient.

The skeleton (Plate XVI., fig. 3) consists of widely distant, longitudinal main fibres curving outwards towards the surface and connected at irregular intervals by a round-meshed lattice work of secondaries. The main fibres are pretty regularly cylindrical and about 0·12 millim. in diameter, not fascicled, and containing a good many fragments of sponge-spicules. The connecting fibres are entirely free from foreign matter; they vary much in diameter, but are usually pretty stout.

The canal-system is of the type usually met with amongst the Spongiidæ. The small flagellate chambers are approximately spherical and up to about 0·04 millim. in diameter, with short, wide, exhalant canaliculi. The ground-substance between them is finely granular. A very conspicuous histological feature is the presence of numerous long, cylindrical cords of fibrous tissue running longitudinally through the sponge. These cords are composed each of a compact mass of elongated, finely granular cells, each with a very distinct, darkly staining nucleus. They closely resemble the similar fibrous bands found in *Euspongia*, &c., and are probably contractile. The characteristic *Hircinia* filaments are abundantly scattered through the soft tissues. They are, however, very slender, and I have not succeeded in making out the nature of their terminations.

This appears to be a very distinct and well-characterised species, differing from *Hircinia dendroides*, Schmidt, which is, perhaps, its nearest ally, in its much more slender branches and much more regular main fibres. I have much pleasure in dedicating it to the zoologist to whom we chiefly owe our accurate knowledge of the Spongiidæ.

R.N. 277 (deep water off Galle and onwards up West Coast of Ceylon).

Hircinia anomala, n. sp.—Plate XIV., fig. 5; Plate XVI., fig. 1.

Sponge massive, irregular, with a tendency to become lobose or digitate. Surface uniformly covered with small, sharp conuli, about 1 millim. in height and 2 millims. apart; with a minute reticulation of fine ridges chiefly radiating from the apices of the conuli. Sometimes the surface reticulation is suppressed, and it may be present or absent in different parts of the same specimen. The surface is not sandy, except sometimes at the apices of the conuli. Vents inconspicuous, the sponge being, perhaps, sometimes lipostomous. Pores scattered abundantly in the meshes of the dermal reticulation. Colour (in spirit) varying from pale brown to black on the surface; pale brown internally. Consistence firm, but compressible and elastic. The largest specimen is about 75 millims. in length by 42 millims. in greatest breadth; another is about 140 millims. long, with a maximum diameter of 25 millims.

The skeleton (Plate XVI., fig. 1) is an extremely irregular network of highly arenaceous fibres. There is no distinct differentiation into main and secondary fibres, but the reticulation is much closer along tracts which run vertically to the surface and end in the surface conuli. These denser parts of the reticulation are evidently homologous with the trellis-like main fibres of other Hirciniæ. Between them large tracts may remain entirely devoid of skeleton. The fibres themselves vary a good deal in thickness and in the amount of foreign matter which they contain. Usually there is a very large proportion of sand or sponge spicules, and comparatively little spongin; occasionally, however, I have seen fibres without foreign inclusions. The spongin of the fibres is very distinctly lamellated.

The flagellate chambers are approximately spherical, up to about 0·04 millim. in diameter (but often smaller), and either eurypylous or with short exhalant canals. The ground-substance between them is finely granular, though perhaps somewhat less markedly so than in typical Spongiidæ. The larger canals are surrounded by a very large quantity of gelatinous, vesicular-looking collenchyma, and commonly more or less sub-divided by septa. Bands of fibrous tissue penetrate the soft tissues as in other Spongiidæ, but I have not found any of the "filaments" so common in the genus *Hircinia*. R.N. 13 contains an immense number of unicellular bodies of a pale yellow colour (staining brown with picro-carmine); these are oval or nearly spherical, and about 0·02 millim. in diameter; each with a small nucleus. Occasionally they appear to be broken up into fragments. Probably they are unicellular Algæ, comparable to those which I have described in *Hexadella*. R.N. 82 and 171 contain numerous groups of smaller cells which are, perhaps, the same Alga in process of division.

This species exhibits characters intermediate between those of the Spongeliidæ and those of the Spongiidæ. The skeleton, in its highly arenaceous character, agrees with that of *Spongelia*, but the small size of the flagellate chambers and the granular character of the ground-substance prevent us from including it in that genus. The absence of filaments, on the other hand, militates against our regarding the species as a typical *Hircinia*, but the nature of these filaments and their taxonomic value are still so obscure that I am not inclined to exclude the sponge from the genus solely on account of their absence.

In external appearance the species somewhat resembles *Cacospongia scalaris*.

R.N. 13 and 91 (Gulf of Manaar); 82 and 171 (deep water off Galle and onwards).

Aplysina, Nardo.

Spongiidæ with distinctly pithed horny fibres forming a coarse-meshed skeleton network. Of very compact texture, with narrow canals and very small flagellate chambers.

Aplysina purpurea, CARTER.

1880, **Aplysina purpurea**, CARTER (**4**); 1881, **Aplysina purpurea**, CARTER (**65**); 1889, **Aplysina purpurea**, DENDY (**3**); 1889, **Psammopemma fuliginosum**, LENDENFELD, *pars* (**66**).

There is only a single dry specimen of this sponge in the collection, so that I am not in a position to add anything to the descriptions of the species given by CARTER and myself, except by referring back to some preparations of spirit material collected by Mr. THURSTON, which show the sponge to be a true *Aplysina* and not, as LENDENFELD has supposed, a *Psammopemma*.

The skeleton is composed of dense local aggregations of very irregular, branching and anastomosing horny fibres, accumulated along certain tracts to form the so-called "compound fibres," while large intervening areas remain free from fibre altogether. The fibres themselves have a very curious structure, consisting of a very thin outer layer (if any) and a very thick "pith," the latter exhibiting a granular or often minutely reticulate appearance. They are free from foreign bodies. The inhalant pores are abundantly scattered over certain parts of the surface. The structure of the soft tissues is very compact and the flagellate chambers are small and probably aphodal or diplodal. In short, the canal-system probably agrees closely with that described and figured by SCHULZE in *Aplysina aërophoba*, although the condition of my material is not good enough to render a detailed comparison possible.

LENDENFELD has, as already indicated, made the curious mistake of confounding this species with "*Psammopemma fuliginosum*," a totally different sponge. CARTER'S specimens of *Aplysina purpurea* were from the Gulf of Manaar and Trincomalee, but he subsequently (**65**) identified an Australian sponge with the same species. Still later, however, when describing his *Pseudoceratina durissima* (**18**), he showed that the *Australian* specimen previously identified by him as *Aplysina purpurea* should really be considered as a specimen of *Pseudoceratina durissima*. LENDENFELD, accordingly (**66**), in a manner very characteristic of that writer, observes that "CARTER himself has shown that his *Aplysina purpurea* and his *Pseudoceratina durissima* are identical," which, of course, is by no means the case. At the same time he omits the locality from which the types of *Aplysina purpurea* were obtained from the geographical distribution of *Psammopemma fuliginosum*, under which name (while admitting that it is not the oldest) he also includes (rightly or wrongly) CARTER'S *Pseudoceratina durissima*.

Mr. CARTER has given a characteristic sketch of the external form of the sponge, together with figures of the skeletal structure (**65**, Plate IX., fig. 1), which are sufficient for the identification of the species.

There can be no doubt that KELLER'S *Psammaplysilla arabica* from the Red Sea (**61**) is very closely related to, if not identical with, this species. The compound skeleton fibres, consisting entirely (according to KELLER) of reticulate "Marksubstanz," the cactiform surface, and black-violet colour in alcohol, all point to generic if not specific identity. In the Ceylon specimens, however, there appears to be (usually at any rate) no sand in the skeleton fibres. KELLER makes his species the type not only of a new genus, but even of a new family. He considers it to be closely related to *Aplysilla*, but, unfortunately, his material did not enable him to investigate the form and arrangement of the flagellate chambers, or he would probably have seen that the affinity was rather with *Aplysina*, as the firm, almost leathery texture of the living sponge and its stony hardness when dry might alone have indicated. I follow Mr. CARTER in retaining the Ceylon species, at any rate (with which KELLER does not appear to have been acquainted), in the latter genus, from which it differs in no important respect. In any case the name *Psammaplysilla* appears to have been very unfortunately chosen, as the sandy character of the fibre is hardly of generic value, and the relationship with *Aplysilla* is not nearly so close as that with *Aplysina*, a very distinct genus.

R.N. 95 (Stat. IV., off Karkopani, 6–9 fathoms, Gulf of Manaar).

Aplysina herdmani, n. sp.—Plate XVI., fig. 4.

The single specimen consists of a rather thin, irregular, flattened crust, from which short, slender, cylindrical, digitiform processes rise vertically upwards at wide and irregular intervals. The ends of these processes are truncated, and each has a single small vent in the middle.* The surface, both of the basal crust and of the digitiform processes, is glabrous, but beset with numerous minute conuli, from the apices of which the ends of the primary fibres sometimes project. The colour, in spirit, is dull purple throughout ; the texture compact and rather fleshy, but compressible and resilient. The maximum diameter of the basal crust is about 55 millims. and its thickness about 4 millims. The digitiform processes are about 11 millims. high by only 2 millims. or 3 millims. in diameter.

The skeleton, in the basal crust, consists of a reticulation of thin-walled, pithed fibres of a rather dark brown colour, amongst which distinct primary fibres, running vertically into the surface conuli, are clearly differentiated (Plate XVI., fig. 4). These primary fibres are about 0·08 millim. in diameter, and the very thick, granular "pith" contains abundant broken sponge spicules as foreign inclusions. The primary fibres sometimes branch, and they are connected together by a network of secondaries which vary greatly in diameter, being sometimes as stout as the primaries and sometimes very slender, only about 0·016 millim. in diameter. The secondary fibres are free from foreign matter and the stouter ones commonly run across between the primaries and thus form rectangular meshes, but the meshes are usually irregularly polygonal and very variable in diameter.

In the digitiform processes the main fibres—containing broken spicules—run longi-

* One of the processes forks into two close to its extremity, and each of the very short branches thus produced bears a small vent on its truncated end.

tudinally and give off short branches—also containing broken spicules—into the surface conuli. The secondaries are arranged as in the basal crust.

The flagellate chambers are very small, only about 0·024 millim. in diameter, and approximately spherical, but the arrangement of the collared cells, on the inhalant side of the chamber only, gives them a curious crescentic appearance; moreover, they frequently appear in sections to be arranged in single curved rows; surrounding the narrow exhalant canals at about equal distances, and doubtless communicating with them by very long and narrow canaliculi, but the condition of the specimen is not good enough to enable me to make out minute histological details. The ectosome is chondrenchymatous rather than collenchymatous, but a large quantity of gelatinous tissue is developed around the larger canals in the choanosome. In the neighbourhood of the flagellate chambers the choanosome is abundantly granular, and both ectosome and choanosome contain numerous pigment cells.

It affords me much pleasure to name this well-characterised species after Professor W. A. Herdman.

R.N. 340 (Ceylon seas).

Class: CALCAREA.

Porifera with a skeleton composed of calcareous spicules.

The number of calcareous sponges in the collection is remarkably small, only four species being represented, two of which, however, are new. I have discussed the classification of the group in considerable detail in my earlier writings (**76, 78, 80**) and adhere to the opinions therein expressed.

Order 1: HOMOCŒLA.

Calcareous sponges in which the endoderm consists throughout of collared cells.

Leucosolenia, Bowerbank.

With the characters of the order.

Leucosolenia (Clathrina) coriacea (Montagu), var. **ceylonensis**, nov.—Plate XIII., fig. 8.

[For literature and synonyms *vide* Haeckel (**7**)].

This well-known European species is represented in the collection by a slight variety belonging to the reticulate section of the genus *Leucosolenia* as defined by the present writer (**76**). The sponge forms massive, closely reticulate colonies of slender ascon-tubes, each colony with a constricted base of attachment; with fairly numerous, small but prominent true oscula formed each by the coalescence of several tubes in a projection from the general surface. The ascon-tubes are only about 0·16 millim. in diameter and there is no pseudoderm. The entire colony attains a diameter of some 10 millims. or 20 millims. The colour in alcohol is pale grey.

The spicules are nearly all regular triradiates (Plate XIII., fig. 8, *a.*, *b.*, *c.*); with slender, not very sharply pointed rays of pretty uniform diameter and measuring about 0·088 millim. in length by 0·008 millim. in diameter at the base. The apex is rather abruptly and rather irregularly pointed. There are apparently no quadriradiates at all, but two (R.N. 377, 378) of the three specimens in the collection show a few very slender oxea (Plate XIII., fig. 8, *d*) projecting from the surface of some of the tubes. I have not been able to obtain these spicules in an unbroken condition, but they apparently closely resemble those found in the next species; whether or not they should be regarded as constant features of this variety, I am unable to say with certainty.

R.N. 377, 378, 379 (all from Cheval Paar).

Leucosolenia (Clathrina) tenuipilosa, n. sp.—Plate XIII., fig. 9.

Sponge forming massive, reticulate colonies of ascon-tubes, closely resembling the preceding variety but somewhat coarser. Here and there on the surface of the colony the tubes converge to unite in small, prominent, true vents. The tubes themselves are about 0·5 millim. in diameter, and they form a close reticulation without any pseudoderm. The colour in alcohol is pale grey. The largest specimen (R.N. 158, which may be regarded as the type of the species) is cake-shaped and flattened, measuring about 47 millims. in length, 37 millims. in breadth, and 16 millims. in thickness.

The skeleton is arranged as usual in the genus, and the spicules are of three kinds :—

(1.) Regular triradiates (Plate XIII., fig. 9, *a*), with rather stout, slightly fusiform rays, bluntly and rather abruptly pointed at the apex, which is often somewhat irregular. Rays measuring about 0·1 millim. in length by 0·012 millim. in diameter at the thickest part.

(2.) Quadriradiates (Plate XIII., fig. 9, *b*, *c*) abundant; resembling the triradiates, but with an apical ray projecting at right angles into the gastral cavity. This ray is somewhat variable in form and size; typically it is long and slender, gradually and sharply pointed, and slightly undulated towards the extremity; in the type specimen it attains a length of about 0·14 millim.

(3.) Very slender, hair-like oxea (Plate XIII., fig. 9, *d*), sparsely hispidating the surface of the tubes. These may attain a length of more than 0·4 millim., with an average diameter of only about 0·002 millim. They taper very gradually from the proximal extremity, which is somewhat hastately sharp-pointed and may be as much as 0·004 millim. thick, to the distal, which is hair-like and apparently nearly always broken off.

This species is evidently closely related to *Leucosolenia coriacea*, var. *ceylonensis*, but differs in the presence of the quadriradiates, and also in the greater stoutness and the frequently fusiform shape of the rays of the triradiates.

R.N. 158 (Stat. LXIV., 5 fathoms, south-east of Modragam, March 17, 1902); 158A (south of Cheval); 380 and 381 (both from Cheval Paar, March 4, 1902).

ORDER 2: HETEROCŒLA.

Calcareous sponges in which the collared cells are confined to more or less well-defined flagellate chambers.

FAMILY: GRANTIIDÆ.

Heterocœla with a distinct and continuous dermal cortex, completely covering over the chamber-layer and pierced by inhalant pores. There are no sub-dermal sagittal triradiates, nor conspicuous sub-dermal quadriradiates. The flagellate chambers vary from elongated and radially arranged to spherical and irregularly scattered; while the skeleton of the chamber layer varies from regularly articulate to irregularly scattered

Leucandra (HAECKEL).

Grantiidæ in which the flagellate chambers are spherical or sac-shaped, never arranged radially around the central gastral cavity, with which (or with the main exhalant canals derived therefrom) they communicate by a more or less complicated exhalant canal-system. The skeleton of the chamber layer is composed of irregularly scattered radiate spicules, but it may still present traces of its derivation from a radially symmetrical type in the presence of a few sub-gastral sagittal triradiates.

Leucandra donnani, n. sp.—Plate XIII., fig. 10.

The only specimen in the collection consists of a single Leucon person of sac-like form; elongated, sub-cylindrical, but slightly compressed; rather strongly curved; tapering gradually from broadly rounded base to narrower apex, where the terminal osculum is situated. The outer surface is nearly smooth, but slightly granulated in appearance. The osculum has no spicular fringe, but a slightly developed membranous margin. The total length of the specimen is 23 millims.; the maximum diameter at the base is about 9·5 millims., and the diameter of the vent is 2 millims. The thickness of the sponge-wall in the middle is about 2 millims. The colour (in spirit) is light brown and the texture firm but brittle.

The dermal cortex, of sagittal triradiates, is only about 0·05 millim. thick; beneath it lie large, irregular sub-dermal cavities, without, however, any special supporting skeleton of their own. The gastral cortex, of sagittal quadriradiates, is about as thick as the dermal cortex and pierced by the numerous apertures of the exhalant canals. The skeleton of the chamber layer consists for the most part of very large sagittal triradiates, generally arranged with the basal ray pointing outwards.

The canal-system is typically leuconoid; the flagellate chambers, abundantly scattered in the ground-substance between the gastral and dermal cortex, being spherical or sac-shaped, and having a maximum diameter of about 0·08 millim. The epithelial cells lining the larger canals contain numerous brown pigment granules.

Spicules.—(1.) Dermal triradiates (Plate XIII., fig. 10, *c*, *d*); sagittal, with slender rays of not very unequal length, measuring, say, about 0·276 millim. in length by 0·016 millim. in thickness at the base, and tapering pretty gradually from base to apex, which is sharp-pointed. The rays are all straight, and the angle between the two paired rays is only slightly greater than the other two angles.

(2.) Triradiates of the chamber-layer (Plate XIII., fig. 10, *a*, *b*); stout, sagittal, with the basal ray somewhat shorter than the paired rays. Rays usually straight; somewhat fusiform and gradually and very sharply pointed. Angle between paired rays only slightly greater than the other two angles. The paired rays in a typical example measured about 0·7 millim. in length by 0·066 millim. in maximum diameter, with a basal ray about 0·57 millim. long and of about the same thickness as the others.

(3.) Gastral quadriradiates (Plate XIII., fig. 10, *e*, *f*); strongly sagittal, with the paired rays extended nearly, or quite, at right angles to the conspicuously shorter basal ray, and with the still shorter apical ray directed forwards almost in a line with the basal. The rays are all straight, or nearly so, and only moderately stout, and taper gradually from the base to the sharp-pointed apex. Length of paired rays about 0·188 millim., with a diameter at the base of 0·012 millim.; with basal ray about 0·072 millim. long and apical ray about 0·048 millim. long; the basal ray of about the same diameter as the paired rays; the apical ray rather more slender.

(4.) Fusiform oxea (Plate XIII., fig. 10, *g*); very slightly curved; gradually and finely pointed at the inner end, but with the outer end nearly always broken off; moderately stout, measuring, say, about 0·74 millim. in length by 0·02 millim. in maximum diameter. Arranged in sparse bundles at right angles to the surface, with the outer ends projecting but slightly.

This species is perhaps most nearly related to Lendenfeld's *Leucandra typica* (79) [= *Leuconia typica*, var. *tuba*, of Poléjaeff (77)], from the East Coast of Australia (and Bermudas ?), but differs considerably in details of spiculation. I have much pleasure in naming it after Captain Donnan, the veteran Inspector and explorer of the Ceylon pearl banks.

R.N. 186 (Donnan's Muttuvaratu Paar, Gulf of Manaar).

Family: AMPHORISCIDÆ.

Heterocœla with a distinct and continuous dermal cortex. With conspicuous subdermal quadriradiate spicules with inwardly directed apical rays. Flagellate chambers varying from elongated and radially arranged to spherical and irregularly scattered.

Heteropegma, Poléjaeff.

Amphoriscidæ with elongated flagellate chambers arranged radially around the central gastral cavity. With a vestigial tubar skeleton of minute radiates. With a very thick dermal cortex, composed principally of triradiate spicules.

Heteropegma nodus-gordii, Poléjaeff (77).

This remarkable and well-characterised species is represented in the collection by a single good-sized specimen, which agrees very closely with the types described by Poléjaeff in 1883 from Australia (Cape York) and the Bermudas. The only other species known is the very closely related *H. latitubulata* from near Port Phillip Heads (80), so that the genus is apparently a characteristic Australian one, and the discovery of *H. nodus-gordii* (the Northern Australian form) at Ceylon affords another good example of the close relationship between the Ceylonese and Australian Sponge-Fauna. The anatomy of this species has been figured both by Poléjaeff (77) and by myself (78).

R.N. 155 (Ceylon seas).

LIST OF THE CEYLON SPONGE-FAUNA

so far as at present known; showing the classification adopted and the geographical distribution of those species which have been recorded from localities beyond the Ceylon area. The species marked H occur in Professor Herdman's collection; those marked D are doubtful* :—

Class: NON-CALCAREA.

Order: Myxospongida.

H 1. *Hexadella indica*, n. sp.
D 2. *Halisarca* (?) *rubitingens*, Carter (5).

Order: Tetraxonida.

Grade: Tetractinellida.

Sub-order: Homosclerophora.

Family: Plakinidæ.

H 3. *Dercitopsis ceylonica*, n. gen. et sp.

Sub-order: Astrophora.

Family: Pachastrellidæ.

H 4. *Plakinastrella intermedia*, n. sp.
H 5. ,, *schulzei*, n. sp.
6. *Stœba* (*Samus*) *simplex* (Carter, 4)†, Ternate (87).
H 7. *Stœba extensa*, n. sp.
8. *Triptolemus* (*Samus*) *parasiticus* (Carter, 4).†
9. *Nethea* (*Tisiphonia*) *nana* (Carter, 4).†
10. *Sphinctrella* ? (*Tisiphonia*) *annulata* (Carter, 4).†

Family: Stellettidæ.

11. *Myriastra* (*Stelletta*) *crassicula* (Carter, 5).†
H 12. ,, *clavosa* (Ridley). Off north coast of Australia; Philippine Islands; Amboyna (83); Ternate (87); Coast of Cochin China (86).
H 13. *Myriastra tethyopsis* (Carter).
14. *Pilochrota ceylonica*, Sollas (15).
H 15. ,, *haeckeli*, Sollas. Philippine Islands.

* In compiling this list no notice has been taken of varietal distinctions. It may be noted that the sponges described by me in my paper on "The Sponge-Fauna of Madras" (2) all came from the Gulf of Manaar (*vide* Thurston, 99).

† *Vide* Sollas (15).

H 16. *Pilochrota hornelli*, n. sp.
H 17. *Stelletta herdmani*, n. sp.
H 18. „ *vestigium*, n. sp.
19. *Aurora* (*Stelletta*) *globostellata* (CARTER, **21**).†
H 20. *Erionema carteri*, n. sp.
H 21. „ *lariniensis*, n. sp.

FAMILY: Geodiidæ.

H 22. *Geodia perarmata*, BOWERBANK.
H 23. „ *peruncinata*, n. sp.
H 24. „ *areolata*, CARTER.
H 25. „ *ramodigitata*, CARTER.
26. „ *globostellifera*, CARTER. Port Darwin, Australia (RIDLEY, **16**).*
27. *Erylus carteri*, SOLLAS (**15**) = *Stelletta euastrum* CARTER (**4**).

SUB-ORDER: SIGMATOPHORA.

FAMILY: Tetillidæ.

H 28. *Tetilla hirsuta*, DENDY.
H 29. „ *poculifera*, n. sp.
H 30. „ *anomala*, n. sp.
H 31. „ *limicola*, n. sp.
H 32. *Craniella elegans*, n. sp.
H 33. *Paratetilla cineriformis*, n. gen. et sp.

FAMILY: Samidæ.

34. *Samus anonymus*, GRAY; *fide* CARTER (**4**). Bahia, West Indies, Australia, South Seas, Seychelles (**15**).

GRADE: LITHISTIDA.

35. *Discodermia papillata*, CARTER (**4**).
36. „ *aspera*, CARTER (**4**).
37. „ *lævidiscus*, CARTER (**4**).
38. „ *sinuosa*, CARTER (**5**).
H 39. „ *emarginata*, n. sp.
40. *Racodiscula* (*Discodermia*) *spinispirulifera* (CARTER, **4**).†
41. *Racodiscula* (*Discodermia*) *sceptrellifera* (CARTER, **5**).†
42. *Corallistes aculeata*, CARTER (**4**).
43. „ *verrucosa*, CARTER (**4**).
D 44. *Corallistes elegantissima*, CARTER (**4**).
H 45. *Aciculites orientalis*, n. sp.
H 46. *Taprobane herdmani*, n. gen. et sp.
H 47. *Petromica massalis*, n. sp.

GRADE: MONAXONELLIDA.

SUB-ORDER: ASTROMONAXONELLIDA.

FAMILY: Epipolasidæ.

48. *Coppatias* (*Tisiphonia*) *penetrans* (CARTER, **4**).
H 49. „ *reptans*, n. sp.
H 50. *Asteropus haeckeli*, n. sp.
H 51. *Cryptotethya agglutinans*, n. gen. et sp.

FAMILY: Tethyidæ.

H 52. *Tethya lyncurium*, LIN. Semi-cosmopolitan (especially in the North Atlantic).
H 53. *Xenospongia patelliformis*, GRAY. Torres Straits.

FAMILY: Spirastrellidæ.

H 54. *Hymedesmia stellivarians*, CARTER. Azores (**48**).
55. „ *moorei*, CARTER (**4**).
56. „ *spinatostellifera*, CARTER (**4**).
57. „ *capitatostellifera*, CARTER (**4**).
58. „ *trigonostellata*, CARTER (**4**).
H 59. „ *curvistellifera*, n. sp.
H 60. *Spirastrella vagabunda*, RIDLEY. Torres Straits; Ternate (**87**); Aden (**92**).
H 61. *Spirastrella tentorioides*, n. sp.
H 62. *Placospongia carinata* (BOWERBANK). Widely distributed in tropical seas (**35**).
63. *Placospongia melobesioides*, GRAY, *fide* CARTER (**4**). Widely distributed in tropical seas (**35**).
H 64. *Negombo tenuistellata*, n. gen. et sp.

FAMILY: Clionidæ.

65. *Cliona warreni*, CARTER (**5**).
66. „ *indica*, TOPSENT (**37**).
H 67. „ *margaritiferæ*, n. sp.
68. *Thoosa socialis*, CARTER (**4**).
69. *Dotona pulchella*, CARTER (**4**). Azores (**62**).
70. *Alectona higgini*, CARTER (**4**).

FAMILY: Suberitidæ.

71. *Suberites vestigium*, CARTER (**4**).
D 72. „ *inconstans*, DENDY (**2**).
H 73. „ *cruciatus*, n. sp.

* RIDLEY's identification seems a little doubtful (*vide* SOLLAS, **15**).
† *Vide* SOLLAS (**15**).

FAMILY: Chondrosiidæ.

74. *Chondrilla nucula*, SCHMIDT; *fide* CARTER (5). Adriatic, Florida, Antilles, Azores (48); Red Sea (61).

H 75. *Chondrilla australiensis*, CARTER. Australia; Coast of Cochin China (86).

H 76. *Chondrosia reniformis*, NARDO. Adriatic; Aden (92); Amboyna (83).

SUB-ORDER: SIGMATOMONAXONELLIDA.

FAMILY: Haplosceridæ.

SUB-FAMILY: Gelliinæ.

H 77. *Gellius fibulatus* (SCHMIDT). Adriatic; European coast of North Atlantic; Azores (62); Australia (16); Ternate (87).

H 78. *Gellius angulatus* (BOWERBANK). British seas (52); Azores (1, 48, 62); Iceland (88).

H 79. *Gelliodes carnosa*, DENDY.

H 80. ,, *incrustans*, n. sp.

H 81. ,, *petrosioides*, n. sp.

H 82. *Toxochalina robusta*, RIDLEY. Port Jackson (Australia).

H 83. *Strongylophora durissima*, n. gen. et sp.

SUB-FAMILY: Renierinæ.

84. *Reniera madrepora*, DENDY (2). Java (86).

D 85. *Reniera albescens* (= *Halichondria albescens*, JOHNSTON), *fide* CARTER (4). British seas (81).

H 86. *Reniera implexa*, SCHMIDT. Adriatic (50); Azores (1, 62).

H 87. *Reniera pigmentifera*, n. sp.

H 88. ,, *zoologica*, n. sp.

H 89. *Petrosia testudinaria* (LAMARCK). Queensland (16); Mergui Archipelago (3)

H 90. *Petrosia similis*, RIDLEY and DENDY. South of Cape of Good Hope and between Kerguelen and Heard Islands (1).

H 91. *Petrosia densissima*, n. sp.

H 92. *Halichondria panicea*, JOHNSTON. Cosmopolitan (1).

H 93. *Trachyopsis halichondrioides*, n. gen. et sp.

SUB-FAMILY: Chalininæ.

H 94. *Pachychalina subcylindrica*, n. sp.

H 95. ,, *delicatula*, DENDY.

H 96. ,, *brevispiculifera*, n. sp.

H 97. *Pachychalina spinilamella*, DENDY.

H 98. *Chalina subarmigera*, RIDLEY. Torres Straits (16); Port Jackson (51); Coast of Cochin China (86).

H 99. *Chalina obtusispiculifera*, n. sp.

H 100. ,, *clathrata*, n. sp.

H 101. ,, *cymæformis* (ESPER ?).

H 102. *Ceraochalina retiarmata*, n. sp.

H 103. ,, *reticutis*, n. sp.

H 104. ,, *multiformis*, LENDENFELD. Australia and New Zealand (51).

H 105. *Ceraochalina ceylonica*, n. sp.

H 106. *Siphonochalina communis* (CARTER). Port Jackson (16); Kurrachee (16).

SUB-FAMILY: Desmacellinæ.

H 107. *Desmacella tubulata*, n. sp.

SUB-FAMILY: Tedaniinæ.

108. *Tedania digitata*, SCHMIDT, *fide* DENDY (2). Cosmopolitan (1).

SUB-FAMILY: Heteroxyinæ.

H 109. *Acanthoxifer ceylonensis*, n. gen. et sp.

FAMILY: Desmacidonidæ.

SUB-FAMILY: Esperellinæ.

H 110. *Esperella parishii*, RIDLEY. Port Darwin, Australia (16).

H 111. *Esperella plumosa* (CARTER). Mauritius (33); Mergui Archipelago (20).

H 112. *Esperella crassissima*, n. sp.

H 113. ,, *tenuispiculata*, n. sp.

D 114. *Esperella tunicata* (SCHMIDT), *fide* CARTER (4). Adriatic (47); Azores (62).

H 115. *Paresperella serratohamata* (CARTER). Vancouver, *fide* LAMBE (85).*

H 116. *Paresperella bidentata*, n. sp.

H 117. *Iotrochota purpurea* (BOWERBANK). Straits of Malacca (49); North Australia (16); Amboyna (83); Amirante group (16); ? South Coast of Australia (10); ? West Indies (53).

H 118. *Iotrochota baculifera*, RIDLEY. Western Indian Ocean (16); North Australia (16); Amboyna (83); Celebes (39); Ternate (87); Coast of Cochin China (86).

* LAMBE's identification is probably erroneous.

119. *Vresia* (?) (*Halichondria*) *acceratospiculum* (CARTER, 4).

120. *Paramyxilla** (*Halichondria*) *infrequens* (CARTER, 5).

SUB-FAMILY: Phlœodictyinæ.

H 121. *Phlœodictyon fistulosum* (BOWERBANK). Northern and Western Australia (1, &c.); Amboyna (83); Azores (1; 62); ? off Bahia (1); Ternate (?) (87).

122. *Histoderma* (*Suberites*) *fistulatum* (CARTER, 4). West Australia, *fide* CARTER (4).

H 123. *Histoderma vesiculatum*, n. sp.

SUB-FAMILY: Ectyoninæ.

H 124. *Myxilla arenaria*, n. sp.

H 125. „ *tenuissima*, n. sp.

H 126. *Clathria frondifera* (BOWERBANK). Straits of Malacca and Gaspar Strait (49); Queensland and Torres Strait (16); Western Indian Ocean (Providence, Amirante, Seychelles) (16); Red Sea (91); Java Sea (86).

H 127. *Clathria indica*, DENDY.

H 128. „ *spiculosa* (DENDY).

H 129. *Raspailia thurstoni*, DENDY.

H 130. „ *fruticosa*, DENDY.

H 131. „ *hornelli*, n. sp.

132. *Plumohalichondria* (*Halichondria*) *plumosa* (MONTAGU); *fide* CARTER (5). British seas (52, &c.); off Bahia (1); Kerguelen (82).

133. *Microciona armata*, BOWERBANK, *fide* CARTER (4). British seas (52).

134. *Microciona atrasanguinea*, BOWERBANK, *fide* CARTER (4). British seas (52).

135. *Microciona affinis*, CARTER (4).

136. *Hymeraphia clavata*, BOWERBANK, *fide* CARTER (4). British Isles (52); Azores (62); Amboyna (83); &c. (*vide* 62).

137. *Hymeraphia* (*Microciona*) *bulboretorta* (CARTER, 4).

138. *Hymeraphia* (?) (*Microciona*) *fascispiculifera* (CARTER, 4).

139. *Hymeraphia* (?) *unispiculum* (CARTER, 4).

H 140. *Agelas mauritiana* (CARTER). Mauritius (54); off Tristan da Cunha (?) (1); Ternate (87).

H 141. *Agelas ceylonica*, n. sp.

H 142. *Echinodictyum clathratum*, n. sp.

H 143. *Aulospongus tubulatus* (BOWERBANK).

144. „ (?) (*Dictyocylindrus*) *sessilis*, CARTER (4).

H 145. *Acarnus ternatus*, RIDLEY. Bombay (?) (16); Amirante (16); Torres Straits (16); Tahiti (1); Ternate (87).

H 146. *Cyamon quinqueradiatum* (CARTER).

147. „ (*Microciona*) *quadriradiatum* (CARTER) (4). West Indies (4).

H 148. *Plocamia manaarensis* (CARTER). California, *fide* LAMBE (85).†

H 149. *Bubaris eruca* (CARTER).

150. *Rhabdoploca* (*Microciona*) *curvispiculifera* (CARTER, 4). Azores (62).

H 151. *Rhabderemia indica*, n. sp.

FAMILY: Axinellidæ.

H 152. *Spongosorites topsenti*, n. sp.

H 153. „ (?) *lamellata*, n. sp.

H 154. „ (?) *lapidiformis*, n. sp.

H 155. *Hymeniacidon petrosioides*, n. sp.

H 156. *Thrinacophora agariciformis*, n. sp.

H 157. „ *durissima*, n. sp.

H 158. *Axinella labyrinthica*, DENDY.

H 159. „ *manus*, n. sp.

H 160. „ *tenuidigitata*, n. sp.

H 161. „ *halichondrioides*, n. sp.

162. „ (?) (*Hymeraphia*) *erecta*, CARTER (4). North and South Atlantic and Southern Ocean (1); Azores (62).

H 163. *Phakellia donnani* (BOWERBANK).

164. „ *ridleyi*, DENDY (2).

H 165. „ *symmetrica*, n. sp.

H 166. „ *ceylonensis*, n. sp.

H 167. „ *crassistylifera*, n. sp.

H 168. *Acanthella carteri*, DENDY.

H 169. „ *flabelliformis*, KELLER. Red Sea (61).

H 170. *Auletta lyrata* (ESPER).

* This genus I now propose for the reception of CARTER'S *Halichondria infrequens*. It is evidently nearly related to *Myxilla*, and may be diagnosed as follows:—"Esperellinæ whose principal megascleres are spined oxea, with which are associated smooth tylota. Microscleres tridentate isochelæ and sigmata."

† LAMBE'S identification is doubtful.

H 171. *Auletta elongata*, n. sp.

H 172. *Leucophlœus fœtidus* (DENDY). Amboyna (83); Ternate (87); (?) China Sea (86).

H 173. *Ciocalypta tyleri*, BOWERBANK. Port Elizabeth (22); Southern and Eastern Coasts of Australia (3, 10).

H 174. *Collocalypta digitata*, n. gen. et sp.

ORDER: EUCERATOSA.

FAMILY: Aplysillidæ.

H 175. *Darwinella simplex*, TOPSENT. Mediterranean, Azores.

H 176. *Megalopastas nigra* (DENDY).

H 177. „ *pulvillus*, n. sp.

FAMILY: Spongeliidæ.

H 178. *Spongelia fragilis*, MONTAGU. Cosmopolitan.

H 179. „ *elastica*, SCHULZE. Cosmopolitan.

H 180. „ *incrustata*, n. sp.

D 181. „ (?) *conica* (BOWERBANK, 8). Western Indian Ocean (Glorioso Island) (16).

H 182. *Psammopemma crassum* (CARTER). Australia and New Zealand (66).

FAMILY: Spongiidæ.

183. *Cacospongia cavernosa*, SCHMIDT (*fide* LENDENFELD, 66). Almost cosmopolitan (66).

H 184. *Cacospongia scalaris*, SCHMIDT. Mediterranean.

H 185. *Euspongia officinalis*, AUCTORUM. Almost cosmopolitan (66).

186. *Euspongia irregularis*, LENDENFELD (*fide* LENDENFELD, 66). Madagascar; East Coast of Australia; Torres Straits; Oceania; Bahamas (66).

H 187. *Euspongia tenuiramosa*, n. sp.

188. „ *trincomalensis*, LENDENFELD (*fide* LENDENFELD, 66). Nassau; Havannah; Pernambuco (66).

H 189. *Hippospongia intestinalis* (LAMARCK). Mediterranean; Zanzibar; Mascarene and Amirante Islands; Porto Rico.

H 190. *Hippospongia clathrata* (CARTER). Red Sea; Australia; American Coast of North Atlantic.

H 191. *Hippospongia anomala*, POLÉJAEFF. Torres Straits.

H 192. *Hippospongia dura*, LENDENFELD. American Coast of North Atlantic.

193. *Stelospongia onduatjeana*, LENDENFELD (66).

H 194. *Phyllospongia papyracea* (ESPER). Tranquebar; Cape of Good Hope; Mozambique; (?) West Coast of Australia; (?) New Zealand; (?) Chatham Islands (66).

H 195. *Phyllospongia holdsworthi* (BOWERBANK).

H 196. *Hircinia fusca*, CARTER.

197. „ *vallata*, DENDY (2). Port Phillip Heads, Australia (66).

H 198. *Hircinia tuberosa*, n. sp.

H 199. „ *schulzei*, n. sp.

H 200. „ *anomala*, n. sp.

D 201. „ *arundinacea*, CARTER (4).

H 202. *Aplysina purpurea*, CARTER.

203. „ *fusca*,* CARTER (4). Seychelles (16); South-west Coast of Australia (65).

204. *Aplysina spengelii*, LENDENFELD. Jamaica (66).

H 205. *Aplysina herdmani*, n. sp.

CLASS: CALCAREA.

ORDER: HOMOCŒLA.

H 206. *Leucosolenia coriacea* (MONTAGU). North-east Atlantic (7).

H 207. *Leucosolenia tenuipilosa*, n. sp.

208. *Leucosolenia* (*Ascaltis*) *darwinii* (HAECKEL, 7). Red Sea, Java (7).

ORDER: HETEROCŒLA.

FAMILY: Sycettidæ.

209. *Sycetta sagittifera*, HAECKEL (7).

210. *Sycon raphanus*, SCHMIDT, *fide* HAECKEL (7). Mediterranean, Red Sea (7); South Coast of Australia (7, 80).

FAMILY: Grantiidæ.

211. *Leucandra* (*Leucetta*) *primigenia* (HAECKEL, 7). Cosmopolitan.

212. *Leucandra* (*Leucortis*) *pulvinar* (HAECKEL, 7).† West Coast of Australia, Red Sea (7).

H 213. *Leucandra donnani*, n. sp.

FAMILY: Amphoriscidæ.

H 214. *Heteropegma nodus-gordii*, POLÉJAEFF. North Australia, Bermudas (77).

215. *Leucilla* (*Leucandra*) *cucumis* (HAECKEL, 7). South Coast of Australia (7).

* According to LENDENFELD (66), this species is identical with HYATT'S *Dendrospongia crassa*. If so, the geographical range must be extended to Nassau.

† CARTER (5) adopts HAECKEL'S varietal name *indica* for the Ceylon form.

It appears from the above list that no less than 215 species of sponges (including about seven doubtful ones) have now been recorded from Ceylon waters, which evidently form an extremely rich centre of sponge distribution. Of these 215 species, 146 occur in Professor HERDMAN'S collection, of which 77 (or 52·7 *per cent.*) are here described as new. I consider it very satisfactory to have been able to identify as many as 69 previously known species in the collection, especially as I always prefer giving a new specific name to making a doubtful identification; mistakes of the latter kind being often far more difficult to correct than those of the former. Seventy-five out of the total number of species have been recorded from localities beyond the Ceylon area.

As regards the general character of the Ceylon Sponge-Fauna, the most striking feature, next to its richness, is its close relationship with the Sponge-Fauna of Australia and the adjacent islands. In the Report on the "Challenger" Monaxonida we defined an area of distribution (No. IV. on the chart) including Australia and the islands north of Australia as far as the Philippines (inclusive). This we called the Indo-Australian area. No less than 47 out of the 75 species whose range is known to extend beyond the Ceylon region are common to the latter and our Indo-Australian region—the majority of them occurring actually along the Australian Coast.

Of these 47 species, the following are not known to occur except in the Indo-Australian area (in the "Challenger" sense) and westwards as far as Southern India:—*Stœba simplex*, *Myriastra clavosa*, *Pilochrota haeckeli*, *Geodia globostellifera*, *Xenospongia patelliformis*, *Chondrilla australiensis*, *Toxochalina robusta*, *Reniera madrepora*, *Petrosia testudinaria*, *Chalina sub-armigera*, *Siphonochalina communis*, *Esperella parishii*, (?) *Iotrochota purpurea*, *Histoderma fistulatum*, *Leucophlœus fœtidus*, *Hippospongia anomala*, *Hircinia vallata*, *Leucilla cucumis*. The following extend (so far as known) westwards not further than the East Coast of Africa or eastwards not further than New Zealand:—*Spirastrella vagabunda* (Aden), *Ceraochalina multiformis* (New Zealand), *Iotrochota baculifera* (Western Indian Ocean), *Clathria frondifera* (Western Indian Ocean, Red Sea), *Acarnus ternatus* (Western Indian Ocean, Tahiti), *Ciocalypta tyleri* (Port Elizabeth), *Psammopemma crassum* (New Zealand), *Phyllospongia papyracea* (Mozambique, Australia ?, New Zealand ?), *Aplysina fusca* (Seychelles), *Leucosolenia darwini* (Red Sea), *Leucandra pulvinar* (Red Sea). Another characteristic Indo-Australian species is *Agelas mauritiana*, hitherto recorded only from Mauritius, Ceylon, Ternate (under the synonym *A. cavernosa*, THIELE), and doubtfully from Tristan da Cunha.

If, on the other hand, we compare the Ceylon Sponge-Fauna with that of the Red Sea, as elaborated chiefly by KELLER (**61**), we notice a considerable difference. KELLER records a total of 88 species from the Red Sea, to which TOPSENT (**91**, **92**) has added 13. Of these, only 14 are known to occur in Ceylon, viz.:—*Spongelia fragilis*, *Euspongia officinalis*, *Cacospongia cavernosa*, *Hippospongia clathrata*, *Clathria frondifera*, *Acanthella flabelliformis*, *Spirastrella vagabunda*, *Placospongia* *melobesioides*, *Chondrilla nucula*, *Chondrosia reniformis*, *Leucosolenia darwini*, *Sycon raphanus*, *Leucandra primigenia*, *Leucandra pulvinar*, of which all but five (*Clathria frondifera*, *Acanthella flabelliformis*, *Spirastrella vagabunda*, *Leucosolenia darwini*, and *Leucandra pulvinar*) are so widely distributed that their occurrence is of little significance. A few other Red Sea species, however, are very closely related to Ceylon forms, and it is not improbable that two or three which have been described by KELLER under new names may be identical with Ceylon species, as will appear from the descriptive part of this report. Amongst the Australian Sponge-Fauna also a number of species occur which are very nearly related to Ceylon species, and which have not been taken account of in the above comparison.

A considerable number of sponges have also been described from South and East African waters outside the Red Sea. The "Challenger" made collections in the neighbourhood of the Cape of Good Hope, and KIRKPATRICK (**17**) has lately described 45 species collected by Dr. GILCHRIST. KELLER (**61**) also gives a considerable list of species from the East African area, in which, however, while excluding South Africa, he includes the islands of the Western Indian Ocean visited by the "Alert." In spite of these researches only four Ceylon species appear to have been met with along the African Coast itself (outside of the Red Sea), viz. :—*Phyllospongia papyracea* (Mozambique), *Ciocalypta tyleri* (Port Elizabeth), *Tedania digitata* (Mozambique), and *Spongelia fragilis* (Zanzibar), the last two being cosmopolitan. On the other hand, a number of Ceylon species extend, as we have seen, to the islands of the Western Indian Ocean, viz. :—*Hippospongia intestinalis*, *Euspongia irregularis*, *Cacospongia cavernosa*, *Spongelia* (?) *conica*, *Aplysina fusca*, *Tedania digitata*, *Iotrochota baculifera*, *Iotrochota purpurea*, *Clathria frondifera*, *Acarnus ternatus*, *Agelas mauritiana*, *Chondrilla nucula*, *Samus anonymus*, *Leucandra primigenia*. These species have very possibly spread south-westwards from Ceylon along the chain of small islands formed by the Maldives, Seychelles, Chagos, Amirantes, &c.

Even if we make allowance for errors and omissions in identification and doubtful species, and also for the important fact that many more species are known from Australasian waters than from the Red Sea and East African Coast, it appears probable from the above data that the Sponge-Fauna of Ceylon is more closely related to that of the eastern side of the Indian Ocean than it is to that of the western side, and the Ceylon region may be safely included zoo-geographically in our Indo-Australian area. The similarity of the Sponge-Fauna of Ceylon to that of Australia is doubtless to be accounted for by the facilities of distribution and suitable habitats afforded by the broken coast line which extends between the two, for it is probable that, owing to the brief duration of their free-swimming larval condition, shallow-water sponges are rarely able to traverse wide areas of deep ocean.

A few other points concerning the geographical relationship of the Ceylon Sponge-Fauna are, perhaps, worth noticing in this place. The Sponge-Fauna of the Azores has lately been worked out in great detail by TOPSENT (48, 62), who records eight species from that area which are also met with in Ceylon, while two of these, *Dotona pulchella* and *Rhabdoploca unispiculifera*, have not yet been met with elsewhere. The genus *Petromica*, also, is only known as yet from the Azores and from Ceylon, the two species being almost identical. Hence, in spite of the great difference in point of distance, the Sponge-Fauna of the Azores appears to resemble that of Ceylon nearly as much as does that of the Red Sea!

There also appears to be a certain amount of affinity between the Sponge-Fauna of Ceylon and that of the American coast of the North Atlantic, especially amongst the horny sponges (*e.g.*, *Hippospongia dura*), though, perhaps, some of the identifications in this group are a little doubtful. The Lithistid genus *Aciculites*, however, has, so far as I am aware, only been recorded from Ceylon and Havannah, and the two species in these two remote localities are closely similar.

Very nearly two-thirds of the total number of species are, however, so far as is known at present, peculiar to the Ceylon area, and, although the number of such species (at present 140) will certainly be largely decreased by future identifications and discoveries in other localities, it will, on the other hand, also be augmented by fresh additions to the list of the Ceylon Sponge-Fauna. My investigations of the Sponge-Fauna of other parts of the world also lead me to believe that while a considerable number of species enjoy a very wide geographical range, the majority have comparatively small areas of distribution. I strongly suspect, however, that a large number of our so-called "species" will ultimately be found to be so closely connected by intermediate forms that it will no longer be possible to separate them sharply from one another. In the meantime they must be distinguished by separate names, and, if the different forms are fully and properly described, it should be easy for future workers to trace out their true relationships.

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DESCRIPTION OF PLATES.

PLATE I.

Fig. 1. *Hexadella indica*; vertical section of R.N. 46, combined drawing.

Ch., inhalant chones; *Ch.L.*, choanosomal lamella; *Cr.*, sub-cortical crypts; *Ect.*, ectosome; *F.C.*, flagellate chambers; *L.E.C.*, larger exhalant canal; *Mem.*, roofing membrane of inhalant chones; *P.E.C.*, primary exhalant canals; *P.I.C.*, primary inhalant canals; *Sy.A.*, symbiotic algæ.

,, 2. *Hexadella indica*; small portion of vertical section through choanosomal lamella, more highly magnified (Zeiss F., Oc. 2).

C.T.C., connective-tissue cells; *Ep.*, epithelium lining primary inhalant and exhalant canals; *I.Ca.*, inhalant canaliculi. (Other lettering as before.)

,, 3. *Hexadella indica*; tangential section of the ectosome, seen from below, showing the inhalant chones, &c. × 52. (Lettering as before.)

,, 4. *Plakinastrella intermedia*; R.N. 224. × 2.—*o.*, vent.

,, 5. *Ecionema carteri*; R.N. 175. × 2.—*o.*, vents; *p.s.*, pore-sieves.

,, 6. *Tetilla poculifera*; R.N. 230. × 3. Upper part in section.

Cl., cloaca; *L.E.C.*, larger exhalant canals.

,, 7. *Tetilla limicola*; R.N. 70. Nat. size.

o., vents; *r.t.*, root tuft of spicules matted together with mud.

,, 8. *Taprobane herdmani*; R.N. 40. Slightly reduced; from a photograph.

PLATE II.

Fig. 1. *Dercitopsis ceylonica*; R.N. 139. Spicules. All × 230.

a.–h., calthrops and triods; *i.–o.*, oxea.

,, 2. *Plakinastrella intermedia*; R.N. 224. Spicules.

a.–d., dichotriænes, × 52; *e.–n.*, oxea, × 52; *o.–p.*, microxea, × 230; *q.–v.*, oxyasters, × 230.

,, 3. *Plakinastrella schulzei*; R.N. 149. Spicules.

a.–d., triænes, × 52; *e.–q.*, oxea, × 52; *r.–t.*, microxea, × 230; *u.–x.*, oxyasters, × 230.

,, 4. *Pilochrota haeckeli*?; R.N. 127. Spicules. All × 52.

a., orthotriæne; *b.*, monstrous form of orthotriæne; *c.*, anatriæne; *d.*, *e.*, monstrous forms of anatriæne.

,, 5. *Pilochrota hornelli*; R.N. 176. Spicules.

a., *b.*, orthotriænes, × 52; *c.*, *d.*, cladomes of orthotriænes seen from above, × 52; *e.*, anatriæne, × 52; *f.*, oxeote, × 52; *g.–i.*, chiasters, × 230.

,, 6. *Stelletta herdmani*; R.N. 137. Spicules.

a.–c., triænes, × 52; *d.*, oxeote, × 52; *e.–h.*, chiasters, × 230; *i.–k.*, oxyasters, × 230.

,, 7. *Stelletta vestigium*; R.N. 200A. Spicules. All × 230.

a.–d., reduced triænes; *e.*, oxeote; *f.*, *g.*, spherasters; *h.*, *i.*, oxyasters.

PLATE III.

Fig. 1. *Erionema carteri*; R.N. 175. Spicules.

a., *b.*, plagiotriænes, ×52; *c.*, plagiotriæne (protriæne ?), ×52; *c'.*, cladome of *c.*, ×230; *d.*, anatriæne, ×52; *d'.*, cladome of *d.*, ×230; *e.*, oxeote, ×52; *f.*, microstrongyla, ×230; *g.*, chiasters, ×230.

„ 2. *Ecionema laviniensis*; R.N. 265. Spicules.

a., dichotriæne, ×52; *b.*, cladome of dichotriæne, seen from above., ×52; *c.*, anatriæne, ×52; *c'.*, cladome of *c.*, ×230; *d.*, oxeote, ×52; *e.*, chiasters, ×230; *f.*, oxyasters (?), ×230; *g.*, microstrongyla, ×230; *h.*, microxeote (?), ×230.

„ 3. *Geodia perunicinata*; R.N. 223. Arrangement of the skeleton as seen in vertical section, ×52.

a., *a'.*, dichotriænes; *b.*, somal anatriæne; *c.*, reduced cortical anatriænes; *d.*, oxea; *e.*, sterrasters in cortical layer; *e'.*, young sterrasters in choanosome; *f.*, large spherasters.

„ 3A. *Geodia perunicinata*: R.N. 223. Reduced anatriæne, ×230.

„ 3B. *Geodia perunicinata*; R.N. 223. Microscleres. All ×230.

a., small spheraster (chiaster ?); *b.*, large spheraster; *c.*, outline of sterraster, to show relative size.

„ 4. *Tetilla poculifera*; R.N. 230. Spicules.

a., *b.*, plagiotriænes, ×52; *c.*, anatriæne, ×52; *c'.*, cladome of *c.*, ×230; *d.*, protriæne, ×52; *d'.*, cladome of *d.*, ×230; *e.*, oxeote, ×52; *f.*, *g.*, microxea, ×230; *h.*, sigmata, ×230.

„ 5. *Tetilla anomala*; R.N. 153. Spicules.

a., part of protriæne, ×230; *b.*, anatriæne, ×52; *b'.*, cladome of *b.*, ×230; *c.*, oxeote, ×52; *d.*, sigmata, ×230.

„ 6. *Tetilla limicola*; R.N. 70. Spicules from body. All ×230.

a., anatriæne, cladome and part of shaft; *b.*, protriæne, cladome and part of shaft; *c.*, oxeote; *d.*, sigmata.

„ 7. *Paratetilla cineriformis*; R.N. 214. Spicules.

a.–d., modified triænes, ×230. (The central canal of these spicules is indicated by the dark shading.) *e.*, protriæne, ×52; *e'.*, cladome of *e.*, ×230; *f.*, anatriæne, ×52; *f'.*, cladome of *f.*, ×230; *g.*, oxeote, ×52; *g'*, *g''*, ends of *g.*, ×230, showing their irregularity in shape and the central canal; *h.*, sigmata, ×230.

PLATE IV.

Fig. 1. *Craniella elegans*; R.N. 193. Vertical section, ×28.

a., anatriænes; *b.*, protriænes; *c.o.*, cortical oxea; *d.m.*, dermal membrane; *emb.*, embryo; *f.c.*, fibrous layer of cortex; *i.c.c.*, intracortical (sub-dermal) cavities; *r.b.*, radiating spicule-bundles of main skeleton.

„ 2. *Taprobane herdmani*; R.N. 40. Desmas. All ×230.

a., *b.*, young monocrepid desmas; *c.*, adult desma.

„ 3. *Aciculites orientalis*; R.N, 150. Spicules. All ×230.

a., *b.*, *c.*, young monocrepid desmas; *d.*, adult desma; *e.*, *f.*, strongyla.

„ 4. *Discodermia emarginata*; R.N. 234. Spicules. All ×230.

a.–d., stages in the development of the tetracrepid desma; *e.*, end of branch of an adult desma; *f.*, very young discotriæne, side view, *s*, shaft; *g.*, adult discotriæne, surface view *s*, shaft; *h.*, microrhabds.

„ 5. *Petromica massalis*; R.N. 257. Spicules. All ×52.

a., monocrepid desma; *b.–d.*, monaxonid megascleres, showing variation in form.

PLATE V.

Fig. 1. *Staba extensa* : R.N. 167. Spicules.
a.–d., dichotriænes (*sh.* = shaft), × 230 ; *e.*, *e.*, microxea, × 530.

,, 2. *Coppatias reptans* : R.N. 242. Spicules.
a.–c., oxea, × 52 ; *d.*, chiasters, × 530.

,, 3. *Asteropus haeckeli* ; R.N. 219. Spicules.
a., oxeote, × 52 ; *b.*, oxyaster, × 530 ; *c.*, *d.*, sanidasters, × 530.

,, 4. *Cryptotethya agglutinans* ; R.N. 62. Half the specimen, after division in the median plane. Natural size.
ch., choanosome ; *ect.*, ectosome ; *f.b.*, foreign bodies adhering to the surface ; *f.l.*, inner fibrous layer of ectosome ; *f.p.*, finger-shaped process of ectosome ; *x.*, process of ectosome flattened at the end and containing longitudinal canals.

,, 5. *Cryptotethya agglutinans* ; R.N. 62. Spicules.
a., *b.*, oxea, × 52 ; *c.*, chiasters from ectosome, × 230.

,, 6. *Hymedesmia curvistellifera* ; R.N. 320. Spicules.
a., tylostyle, × 230 ; *b.*, *c.*, *d.*, asters, × 530.

,, 7. *Spirastrella tentorioides* ; R.N. 239. Spicules.
a., *b.*, tylostyli, × 230 ; *c.–g.*, spirasters, × 530.

,, 8. *Negombo tenuistellata* ; R.N. 362. Spicules.
a.–c., styli, × 230 ; *d.*, sanidasters, × 530.

,, 9. *Cliona margaritiferæ* ; R.N. 261. Spicules.
a., tylostyle, × 230 ; *b.–d.*, spirasters, × 530 ; *e.*, *g.*, intermediate microscleres, × 530 ; *h.*, *k.*, spined microxea, × 530.

,, 10. *Suberites cruciatus* ; R.N. 315. Spicules.
a., *b.*, tylostyles, × 230 ; *c.–g.*, heads of tylostyles, showing variations, × 530.

PLATE VI.

Xenospongia patelliformis, R.N. 375.

Fig. 1. Entire specimen (young), upper surface, slightly diagrammatic, × 2.
a., projection caused by foreign body ; *m.f.*, marginal fringe of spicules ; *m.p.g.*, marginal pore-grooves ; *o.*, vents ; *r.p.g.*, radiating pore-grooves, feebly developed.

,, 2. Radial vertical section, showing the ectosome (cortex), the sand-free portion of the choanosome, and part only of the sandy layer of the choanosome ; slightly diagrammatic.
cort., cortex ; *d.b.*, dermal brushes of styli ; *ex.c.*, exhalant canal ; *f.b.*, bands of fibrous tissue running inwards from the cortex to the sandy layer ; *m.f.*, marginal fringe of styli ; *m.p.g.*, marginal pore-grooves, showing inhalant pores and canals ; *o.*, vent. ; *s.g.*, sand grains.

,, 3. Small portion of similar section, including the entire thickness of the cortex and a small portion of the choanosome, × 230.
cort., cortex ; *f.b.*, band of fibrous tissue running inwards from the cortex ; *fl.c.*, flagellate chambers ; *scl.*, scleroblasts, containing small asters.

,, 4. Megascleres.
a., *b.*, styli, × 52 ; *b′.*, *b″.*, basal and apical portions of *b*, × 230.

,, 5. Larger microscleres, × 230.
a.–c., various forms of aster ; *d.*, a much-branched aster from the interior of the sponge.

,, 6. Smaller microscleres, × 530.
a.–m., various forms of aster.

PLATE VII. (All the figures from photographs.)

Fig. 1. *Siphonochalina communis*, var. *tenuispiculata* ; R.N. 117, reduced to nearly $\frac{1}{2}$.
,, 2. *Ceraochalina multiformis*, var. *manaarensis* ; R.N. 98, $\times$ about $\frac{4}{7}$.
,, 3. ,, *ceylonica* ; R.N. 5, $\times$ about $\frac{1}{2}$.
,, 4. *Pachychalina spinilamella* ; R.N. 94, $\times$ about $\frac{4}{7}$.
,, 5. *Gelliodes carnosa* ; R.N. 69, $\times$ about $\frac{1}{2}$.
,, 6. *Collocalypta digitata* ; R.N. 74A, nearly natural size.

PLATE VIII. (All the figures from photographs.)

Fig. 1. *Plocamia manaarensis* ; R.N. 107, $\times$ about $\frac{2}{3}$.
,, 2. *Clathria spiculosa*, var. *tessellata* ; R.N. 92, $\times$ about $\frac{2}{3}$.
,, 3. *Phakellia ceylonensis* ; R.N. 34, $\times 1\frac{3}{8}$.
,, 4. *Acarnus ternatus* ; R.N. 105, $\times$ about $\frac{1}{2}$.
,, 5. *Raspailia fruticosa*, var. *tenuiramosa* ; R.N. 100, $\times$ about $\frac{5}{7}$.
,, 6. *Acanthella carteri* ; R.N. 36, $\times$ about $\frac{2}{3}$.

PLATE IX.

Fig. 1. *Strongylophora durissima* ; R.N. 244. Part of dermal skeleton, $\times$ 230.
m., microxea ; *s.*, strongyla.
,, 2. *Toxochalina robusta*, var. *ridleyi* ; R.N. 109. Part of main skeleton in vertical section, $\times$ 230.
o., oxea ; *t.*, toxa.
,, 3. *Gelliodes petrosioides* ; R.N. 146. Spicules, $\times$ 230.—*a.*, *b.*, *c.*, megascleres ; *d.*, sigmata.
,, 4. *Desmacella tubulata* ; R.N. 324. Spicules, $\times$ 230.
a., *b.*, styli ; *c.*, sigmata ; *d.*, trichodragmata ; *e.*, isolated microxeote.
,, 5. *Acanthoxifer ceylonensis* ; R.N. 247. Spicules, $\times$ 230.
a., smooth oxeote ; *b.*, stylus ; *c.*, spined oxeote ; *d.*, trichodragmata.
,, 6. *Gelliodes incrustans* ; R.N. 112. Part of dermal skeleton, $\times$ 230.—*o.*, oxea ; *s.*, sigmata.
,, 7. *Gellius angulatus*, var. *canaliculata* ; R.N. 140. Spicules, $\times$ 230.
a., oxeote ; *b.*, sigmata ; *c.*, toxiform.
,, 8. *Reniera zoologica* ; R.N. 262. Oxea, $\times$ 360.
,, 9. *Petrosia densissima* ; R.N. 138A. Oxea, $\times$ 360.
,, 10. *Reniera pigmentifera* ; R.N. 290. Spicules, $\times$ 360.—*a.*, oxeote ; *b.*, strongylote ; *c.*, *d.*, stylote.

PLATE X.

Fig. 1. *Pachychalina subcylindrica* ; R.N. 292. Part of dermal skeleton, $\times$ 52.
,, 2. ,, R.N. 292. Oxea, $\times$ 360.
,, 3. *Chalina clathrata* ; R.N. 102. Part of skeleton in tangential section near the surface, $\times$ 360.
,, 4. *Ceraochalina retiarmata* ; R.N. 342. Oxea, $\times$ 360.
,, 5. *Chalina subarmigera* ; R.N. 116, about half natural size (dry specimen, from photograph).
,, 6. *Ceraochalina ceylonica* ; R.N. 50. Oxea, $\times$ 360.
,, 7. *Pachychalina brevispiculifera* ; R.N. 110. Oxea, $\times$ 360.
,, 8. *Ceraochalina reticutis* ; R.N. 58. Part of dermal skeleton, $\times$ 360.
o., well developed oxea, lying for the most part outside the horny fibre ; *r.s.*, vestigial oxea, lying in the horny fibre.
9. *Chalina obtusispiculifera* ; R.N. 370. Part of surface skeleton, $\times$ 360.
10. *Trachyopsis halichondrioides* ; R.N. 147. Oxea, $\times$ 230.

PLATE XI.

Fig. 1. *Paresperella bidentata*: R.N. 263A. Spicules, ×530.
a., tylostyle with bidentate apex; *b.*, *b.*, serrated sigmata; *c.*, anisochela, side view; *d.*, anisochela, front view.

„ 2. *Paresperella serratohamata*: R.N. 220C. Spicules, ×530.
a., tylostyle with mucronate apex; *b.*, *b.*, serrated sigmata.

„ 3. *Paresperella*, sp. Gigantic serrated sigma, ×230.

„ 4. *Echinodictyum clathratum*: R.N. 325. Spicules, ×230.
a., large stylus; *b.*, slender stylus; *c.*, *d.*, oxea; *e.*, *f.*, spined tylostyli.

„ 5. *Myxilla tenuissima*: R.N. 234A. Spicules, ×530.
a., polytylote; *b.*, spined tylostyle; *c.*, isochela, front view; *d.*, isochela, side view.

„ 6. *Esperella crassissima*; R.N. 240. Spicules, ×230.
a., tylostyle; *b.*, anisochela, side view; *c.*, anisochela, front view; *d.*, sigmata; *e.*, trichodragmata.

„ 7. *Raspailia hornelli*; R.N. 59. Spicules, ×230.—*a.*, large stylus; *b.*, *c.*, small surface styli; *d.*, *e.*, *f.*, *g.*, oxea; *h.*, *h.*, strongyla; *k.*, *l.*, *m.*, spined subtylostyli.

„ 8. *Histoderma vesiculatum*: R.N. 212A. Part of dermal skeleton, ×230.
o., *o.*, *o.*, oxea; *s.*, *s.*, strongyla.

„ 9. *Histoderma vesiculatum*; R.N., 212A. Isochelæ, ×460.—*a.*, side view; *b.*, front view.

PLATE XII.

Fig. 1. *Spongosorites topsenti*; R.N. 152. Spicules, ×52.
a.–*k.*, various forms of large megascleres; *l.*, two small oxea; *m.*, intermediate form.

„ 2. *Spongosorites* (?) *lamellata*; R.N. 236.
a. b. c., styli, ×52; *d.*, two small oxea, ×52; *e.*, small oxeote, ×230.

„ 3. *Spongosorites* (?) *lapidiformis*; R.N. 145. Spicules, ×79.

„ 4. *Hymeniacidon petrosioides*; R.N. 151. Spicules, ×230.

„ 5. *Thrinacophora durissima*; R.N. 355. Spicules, ×230.
a., stylote; *b.*, oxeote; *c.*, *d.*, trichodragmata.

„ 6. *Thrinacophora agariciformis*; R.N. 160A. Spicules, ×230.
a., *b.*, *c.*, styli; *d.*, *e.*, oxea; *f.*, trichodragmata.

„ 7. *Axinella halichondrioides*; R.N. 75. Spicules, ×230.—*a.*, oxeote; *b.*, *c.*, stylote.

„ 8. *Axinella manus*; R.N. 53. Spicules, ×230.

„ 9. *Agelas ceylonica*; R.N. 312. Spicules, ×230.

„ 10. *Rhabderemia indica*; R.N. 341.
a., *b.*, *c.*, rhabdostyli, ×230; *d.*, minute spined styli, ×530; *e.*, contort sigmata, ×530.

PLATE XIII.

Fig. 1. *Collocalypta digitata*: R.N. 74. Oxeote spicule from body, ×230.

„ 2. „ R.N. 74. Part of transverse section of a digitiform process, ×52.
ax., axial skeleton of spicules and spongin; *d.p.*, position of dermal pores; *ect.*, collenchymatous ectosomal tissue; *l.c.*, longitudinal canals; *sept.*, septum between two longitudinal canals.

„ 3. *Phakellia symmetrica*; R.N. 159. Spicules, ×230.—*a*, *b*, short styli; *c*, oxeote; *d*, long stylus.

„ 4. *Axinella tenuidigitata*; R.N. 202A. Styli, ×79.

„ 5. *Phakellia ceylonensis*; R.N. 34. Spicules, ×230.—*a*, *b*, styli; *c*, *d*, *e*, oxea.

„ 6. *Phakellia crassistylifera*; R.N. 256. Three spicules, ×230.

Fig. 7. *Auletta elongata*: R.N. 73. Spicules, × 79.—*a*, *b*, styli; *c*, oxeote; *d*, *e*, *f*, strongyla.

„ 8. *Leucosolenia coriacea*, var. *ceylonensis*; R.N. 377. Spicules, × 360. *a*, *b*, *c*, triradiates; *d*, portion of oxeote.

„ 9. *Leucosolenia tenuipilosa*; R.N. 158. Spicules, × 360.—*a*, triradiate; *b*, quadriradiate, facial view; *c*, quadriradiate, side view, showing apical ray; *d*, part of oxeote.

„ 10. *Leucandra donnani*: R.N. 186. Spicules, × 79. *a*, *b*, parenchymal triradiates; *c*, *d*, dermal triradiates; *e*, *f*, gastral quadriradiates; *g*, oxeote.

PLATE XIV. (All the figures from photographs.)

Fig. 1. *Hircinia fusca*; part of R.N. 48, × $\frac{2}{3}$.

„ 2. *Hippospongia clathrata*; R.N. 24, × $\frac{11}{16}$.

„ 3. *Euspongia officinalis*, var. *ceylonensis*; R.N. 37A, × about $\frac{2}{3}$.

„ 4. *Spongelia elastica*, var. *crassa*; R.N. 35, × about $\frac{3}{4}$.

„ 5. *Hircinia anomala*; R.N. 13, × about $\frac{2}{3}$.

„ 6. *Phyllospongia papyracea*, var.; R.N. 104A, × $\frac{14}{25}$.

„ 7. *Megalopastas nigra*: R.N. 71, × $\frac{5}{8}$.

PLATE XV.

Fig. 1. *Darwinella simplex*: R.N. 302.—End of primary fibre, enclosed in conulus, × 230.

„ 2. *Darwinella simplex*: R.N. 302.—Portion of primary fibre, in which the pith (*p.*) is partially replaced by fungal (?) filaments (*f.*), × 230.

„ 3. *Megalopastas pulvillus*; R.N. 191.—Portion of skeleton as seen in vertical section, showing the old apices of primary fibres (*ap.*) enclosed in younger portions of the fibres, × 79.

„ 4. Diagrammatic sketch of the general anatomy of the genus *Megalopastas*, based upon vertical sections of a specimen of *M. elegans* (= *Dendrilla elegans*, Lendenfeld) from Port Phillip Heads, Australia, × 52.—*c.*, surface conuli; *e.c.*, embryo capsules; *em.*, embryo; *ex.c.*, exhalant canals; *f.c.*, flagellate chambers; *i.c.*, inhalant canal; *p.f.*, primary skeleton fibres; *p.s.*, pore-sieves; *s.c.*, subdermal cavities; *s.f.*, secondary skeleton fibres.

„ 5. *Megalopastas nigra*; R.N. 161A.—Part of skeleton, as seen in vertical section, including the dermal skeleton (*d.s.*) as well as the main skeleton, × 52.

„ 6. *Megalopastas nigra*; R.N. 161A.—Dermal skeleton, × 52.

„ 7. *Megalopastas nigra*; R.N. 161A. End of primary fibre, showing mode of growth and origin of secondary fibres, × 230.

„ 8. *Megalopastas nigra*; R.N. 161A. Origin of new primary fibre from a secondary fibre of the dermal skeleton, vertical section, × 230.—*c.*, surface conulus; *d.s.*, dermal skeleton; *p.f.*, new primary fibre.

PLATE XVI.

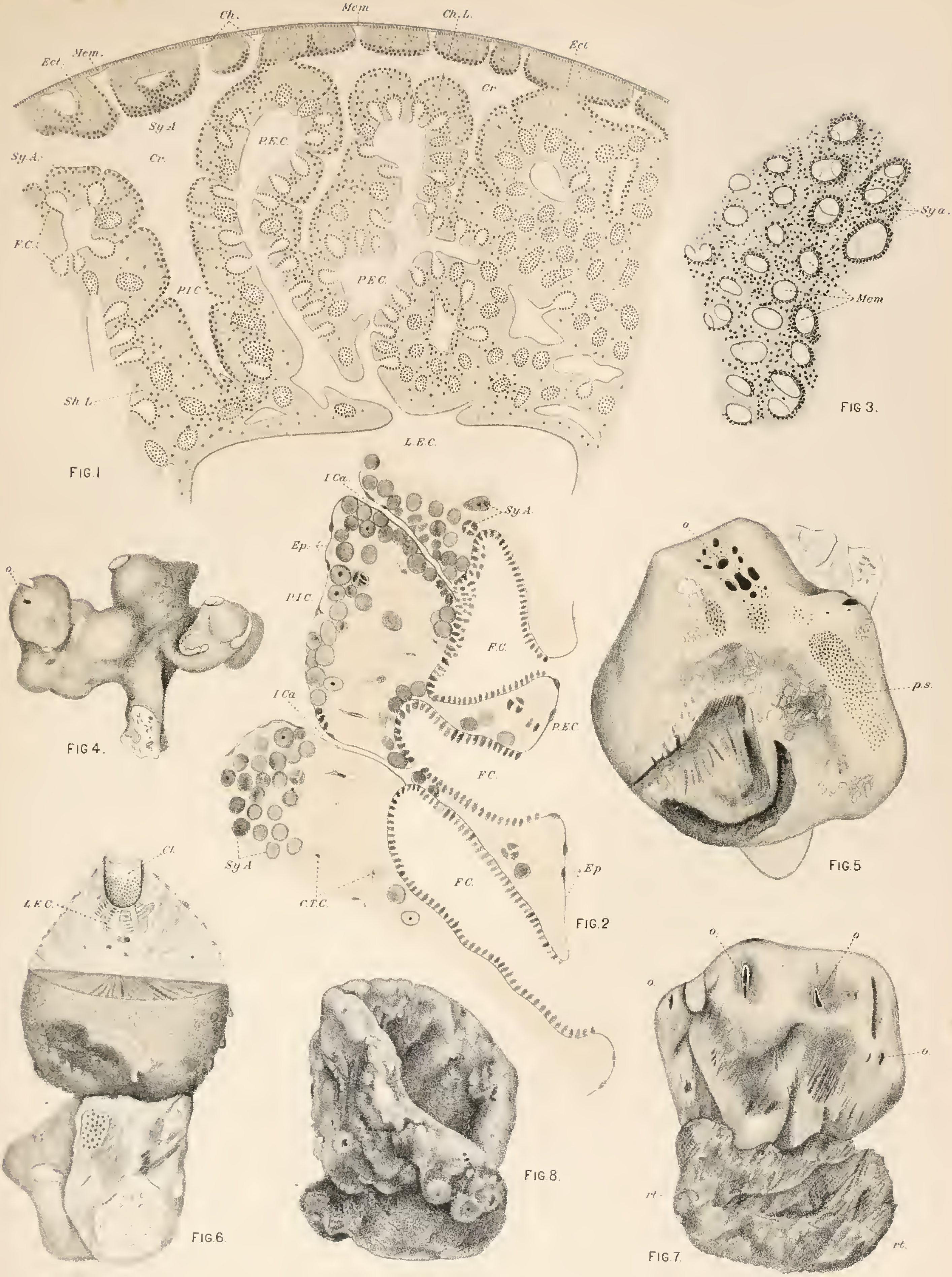
Fig. 1. *Hircinia anomala*; R.N. 82.—Part of skeleton, as seen in transverse section, × 52.

„ 2. *Hircinia tuberosa*: R.N. 88A.—Part of skeleton, as seen in vertical section through the surface, including the sand-cortex (*s.c.*), × 52.

„ 3. *Hircinia schulzei*; R.N. 277.—Part of skeleton, as seen in vertical longitudinal section, × 52.

„ 4. *Aplysina herdmani*; R.N. 340.—Part of skeleton, as seen in vertical section of body, × 79.

„ 5. *Euspongia officinalis*, var. *ceylonensis*: R.N. 101.—Part of skeleton, as seen in vertical section, × 79.



A. Dendy del., Figs 1-7

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FIGS. 1—3, HEXADELLA INDICA, n.sp.; FIG. 4, PLAKINASTRELLA INTERMEDIA, n.sp.; FIG. 5, ECIONEMA CARTERI, n.sp.; FIG. 6, TETILLA POCULIFERA, n.sp.; FIG. 7, TETILLA LIMICOLA, n.sp.; FIG. 8, TAPROBANE HERDMANI, n.sp.

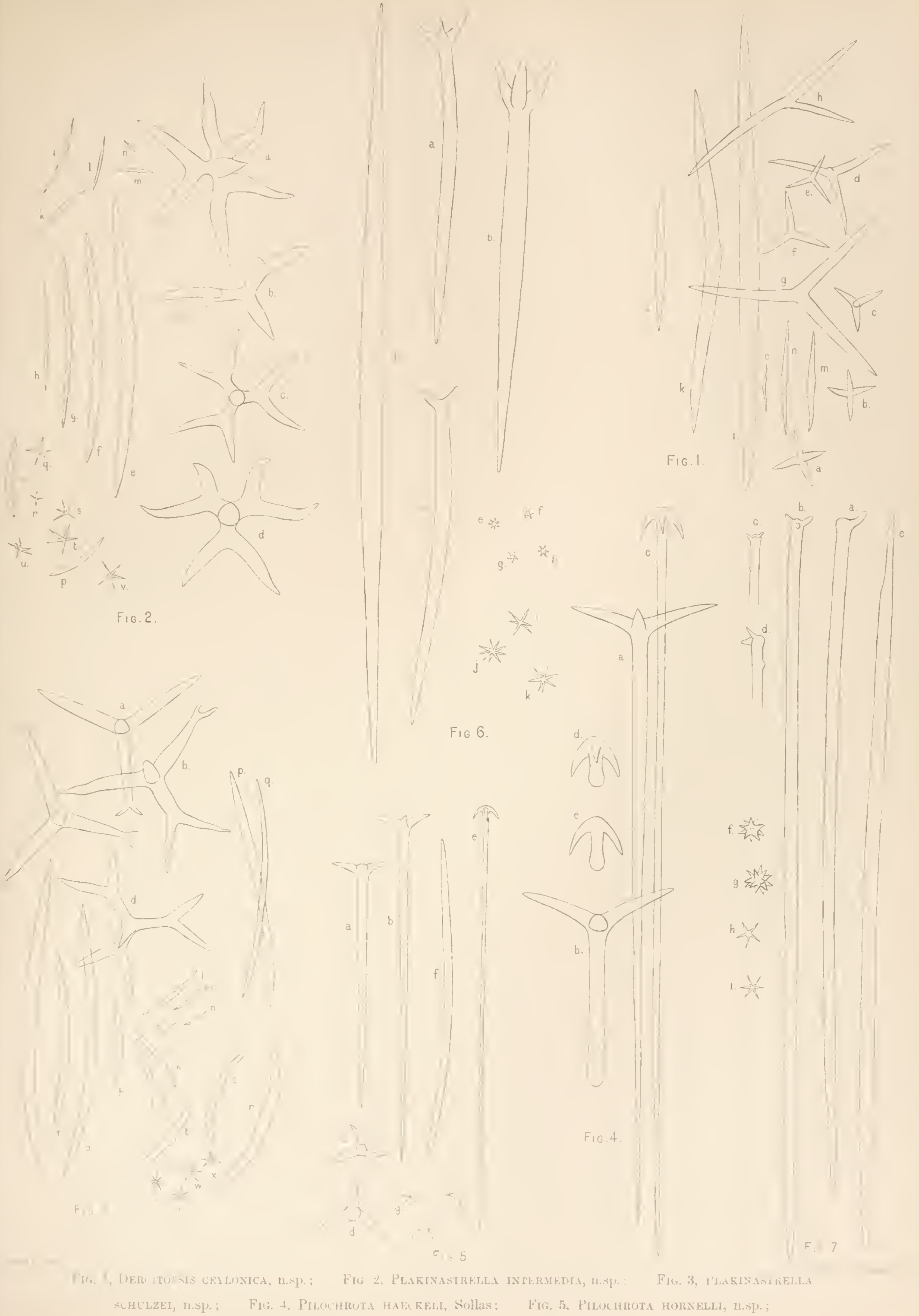

Fig. 1, Dercitopsis ceylonica, n.sp.; Fig. 2, Plakinastrella intermedia, n.sp.; Fig. 3, Plakinastrella schulzei, n.sp.; Fig. 4, Pilochrota haeckeli, Sollas; Fig. 5, Pilochrota hornelli, n.sp.; Fig. 6, Stelletta herdmani, n.sp.; Fig. 7, Stelletta vestigium, n.sp.

FIG. 1, ECTIONEMA CARTERI, n.sp. FIG. 2, ECTIONEMA LAVINIENSIS, n.sp. FIG. 3, 3A, 3B, GEODIA PERUNCINATA, n.sp.; FIG. 4, TETILLA POCULIFERA, n.sp.; FIG. 5, TETILLA ANOMALA, n.sp.; FIG. 6, TETILLA LIMICOLA, n.sp.; FIG. 7, PARATETILLA CINERIFORMIS, n.sp.

A. Dendy del.

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Fig. 1, Craniella elegans, n.sp.; Fig. 2, Taprobane herdmani, n.sp.; Fig. 3, Aciculites orientalis, n.sp.; Fig. 4, Discodermia emarginata, n.sp.; Fig. 5, Petromica massalis, n.sp.

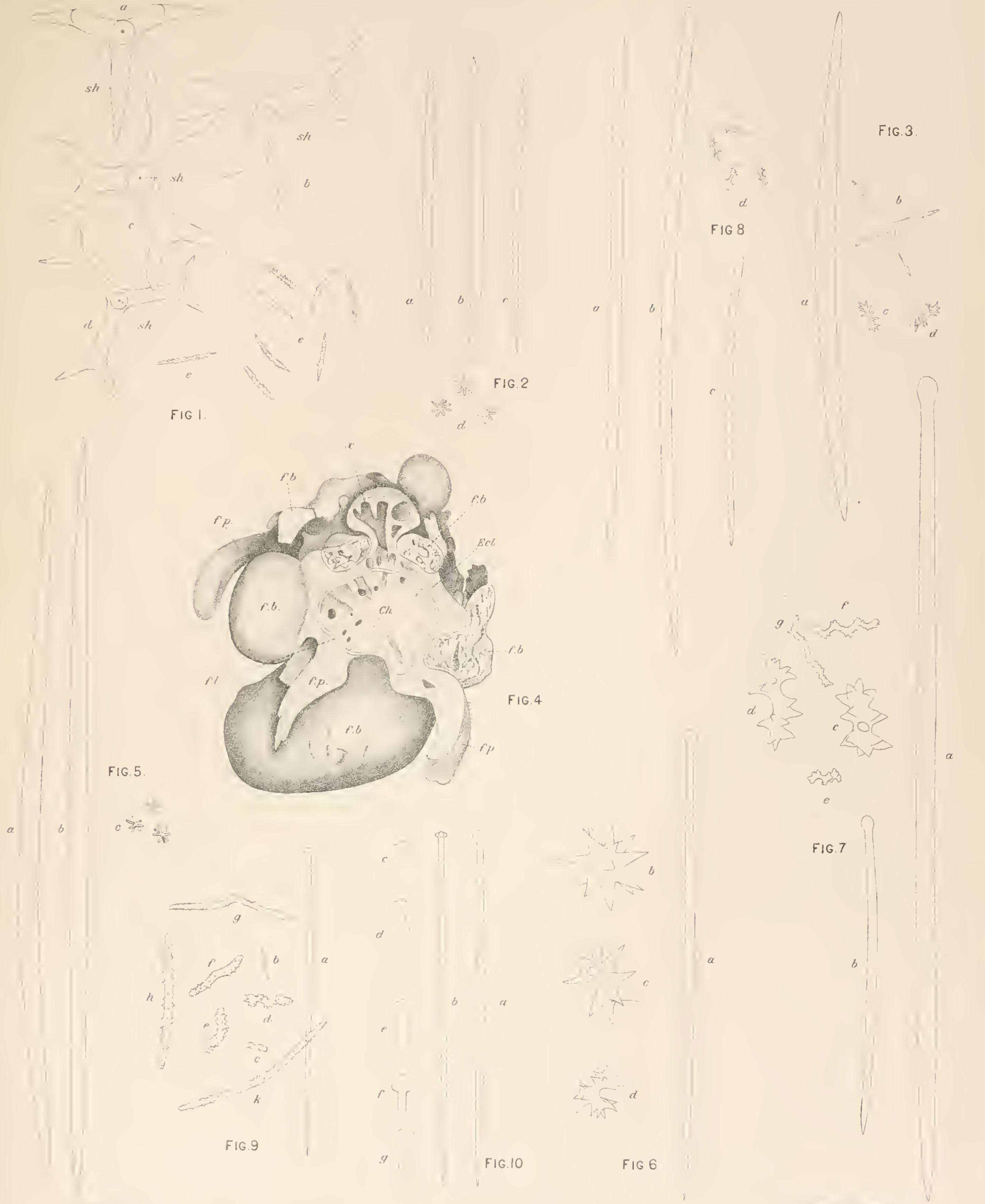
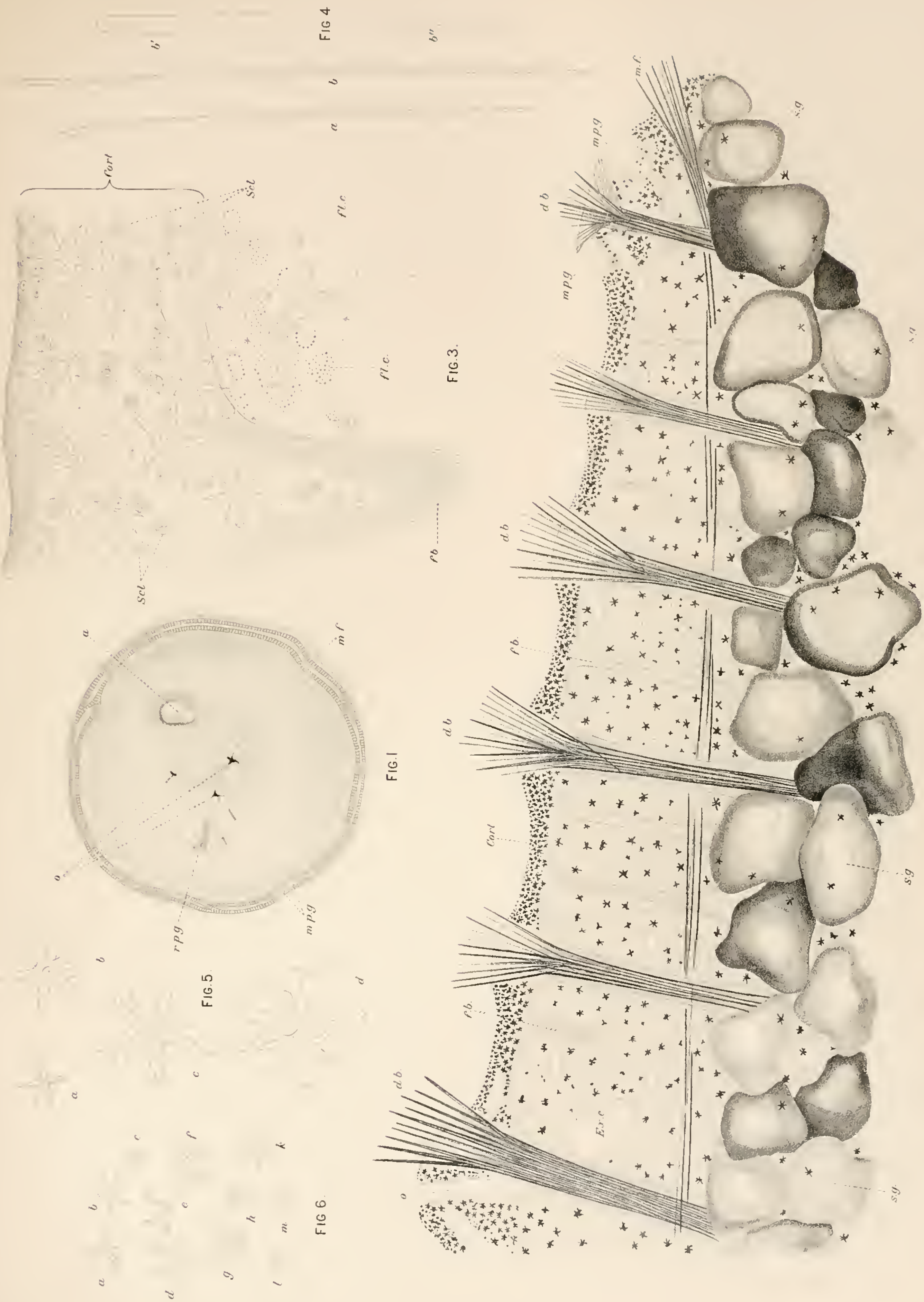


FIG. 1, STŒBA EXTENSA, n.sp.; FIG. 2, COPPATIAS REPTANS, n.sp.; FIG. 3, ASTEROPUS HAECKELI, n.sp.; FIGS. 4, 5, CRYPTOTETHYA AGGLUTINANS, n.sp.; FIG. 6, HYMEDESMIA CURVISTELLIFERA, n.sp.; FIG. 7, SPIRASTRELLA TENTORIOIDES, n.sp.; FIG. 8, NEGOMBO TENUISTELLATA, n.sp.; FIG. 9, CLIONA MARGARITIFERÆ, n.sp.; FIG. 10, SUBERITES CRUCIATUS, n.sp.



XENOSPONGIA PATELLIFORMIS, Gray.

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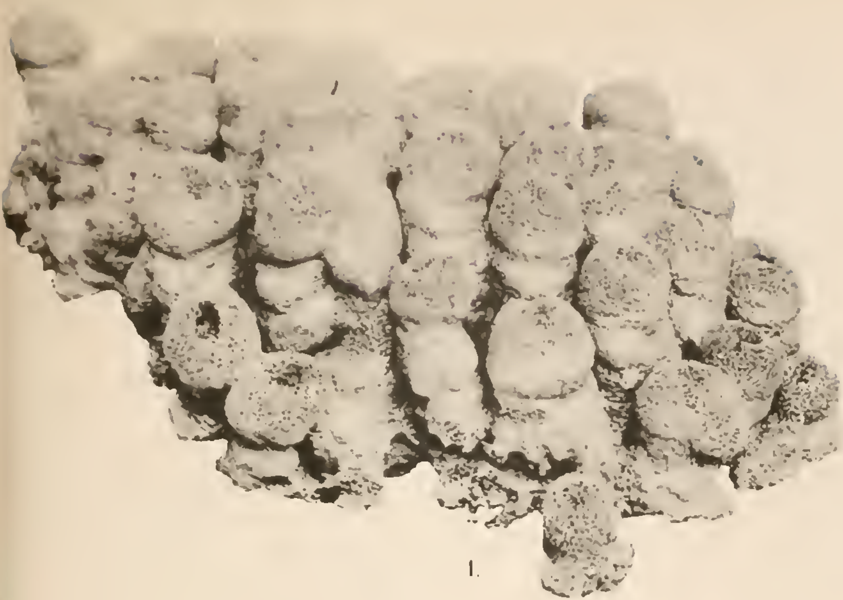

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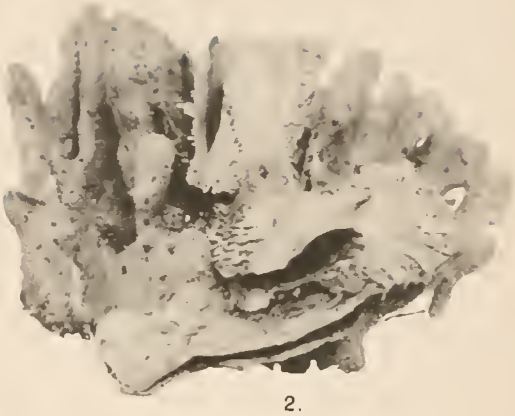

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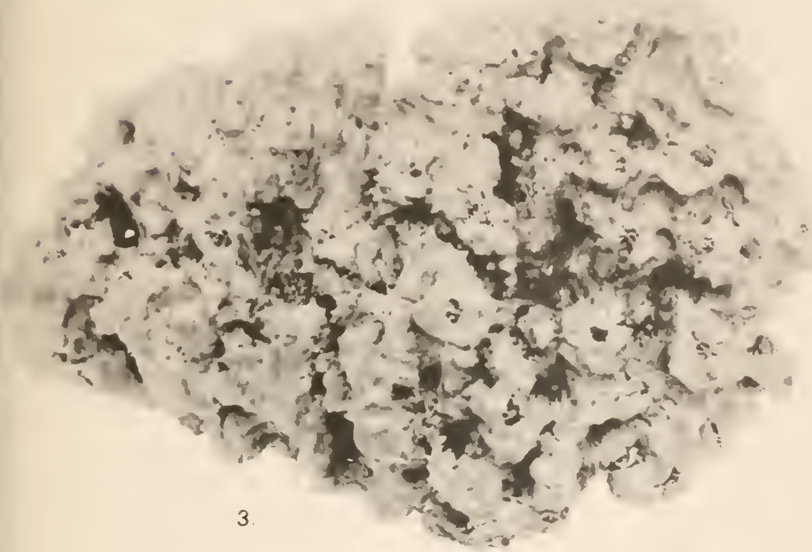

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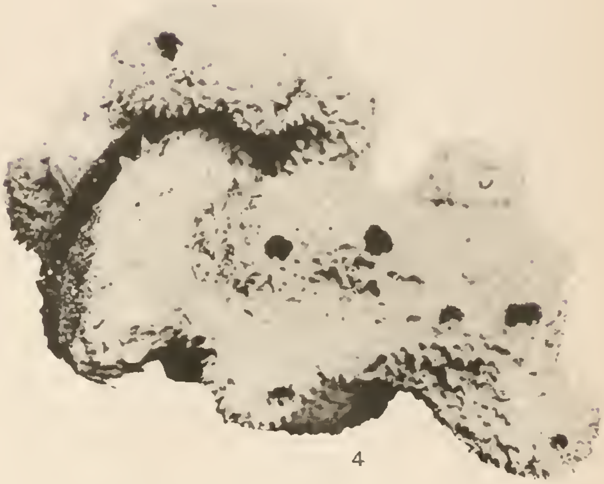

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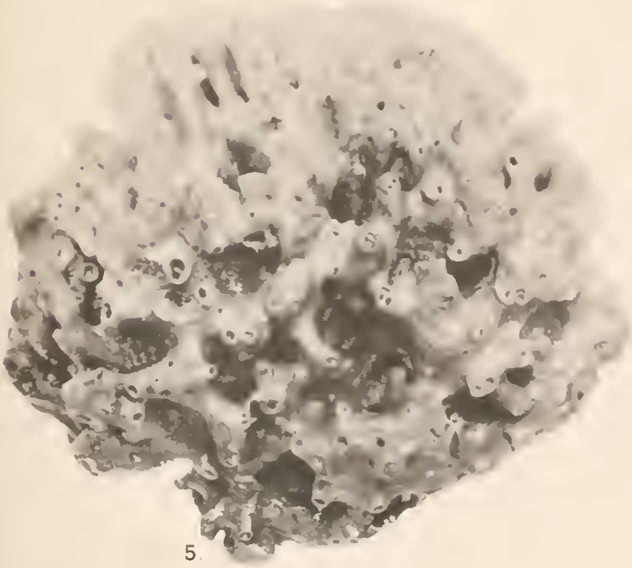

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Fig. 1, Siphonochalina communis, var. tenuispiculata, n.; Fig. 2, Ceraochalina multiformis, var. manaarensis, Dendy; Fig. 3, Ceraochalina ceylonica, n.sp.; Fig. 4, Pachychalina spinilamella, Dendy; Fig. 5, Gelliodes carnosa, Dendy; Fig. 6, Collocalypta digitata, n.sp.

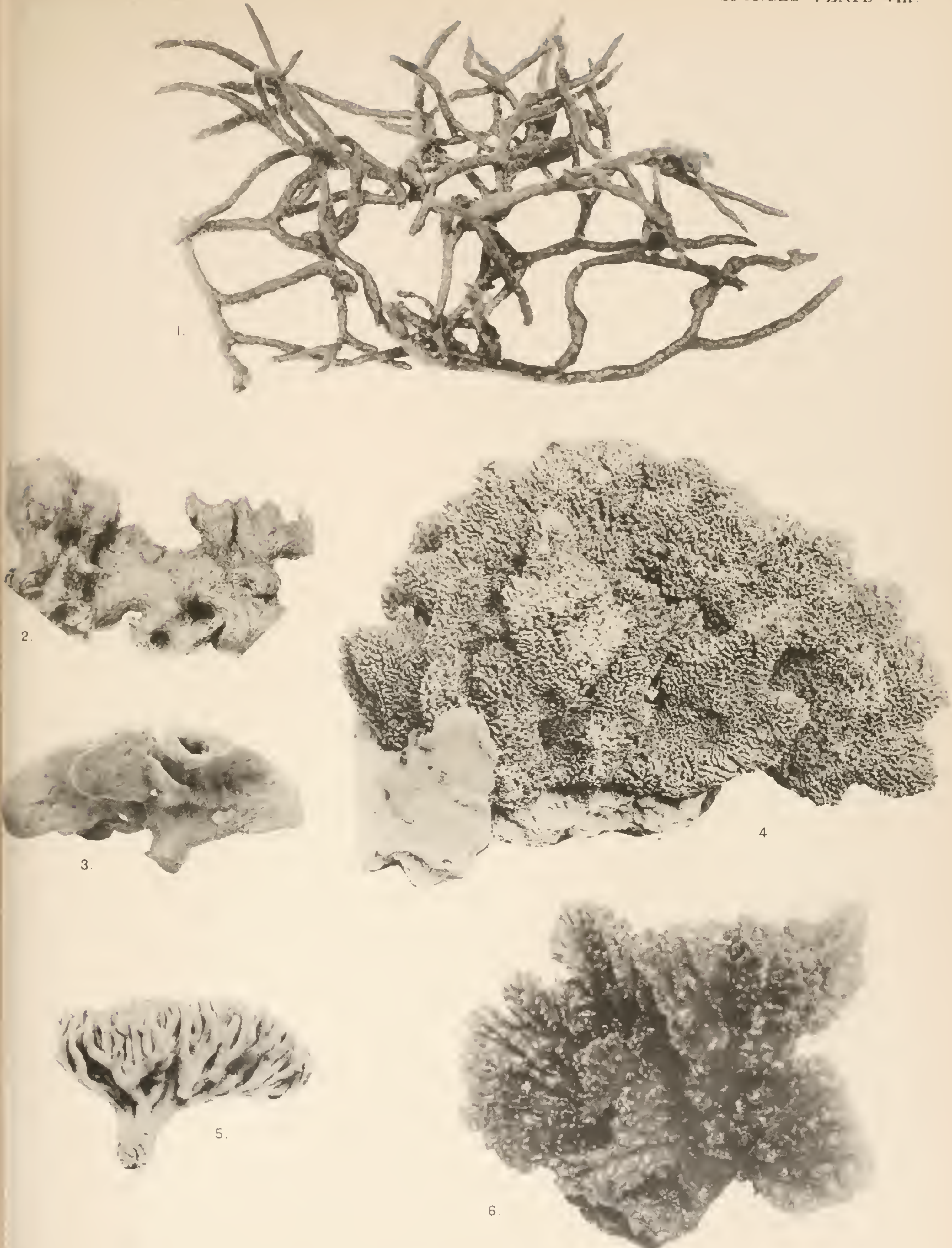
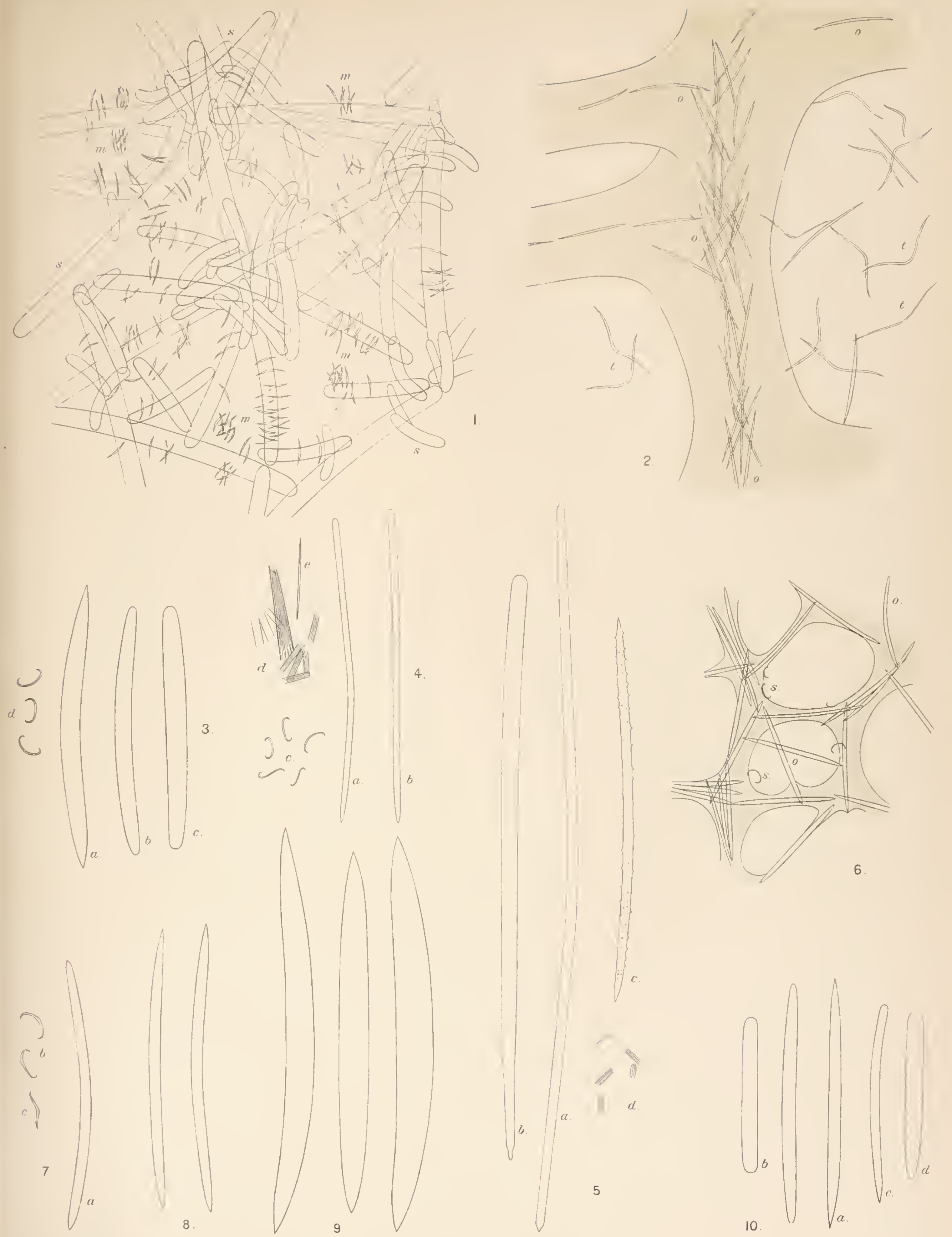
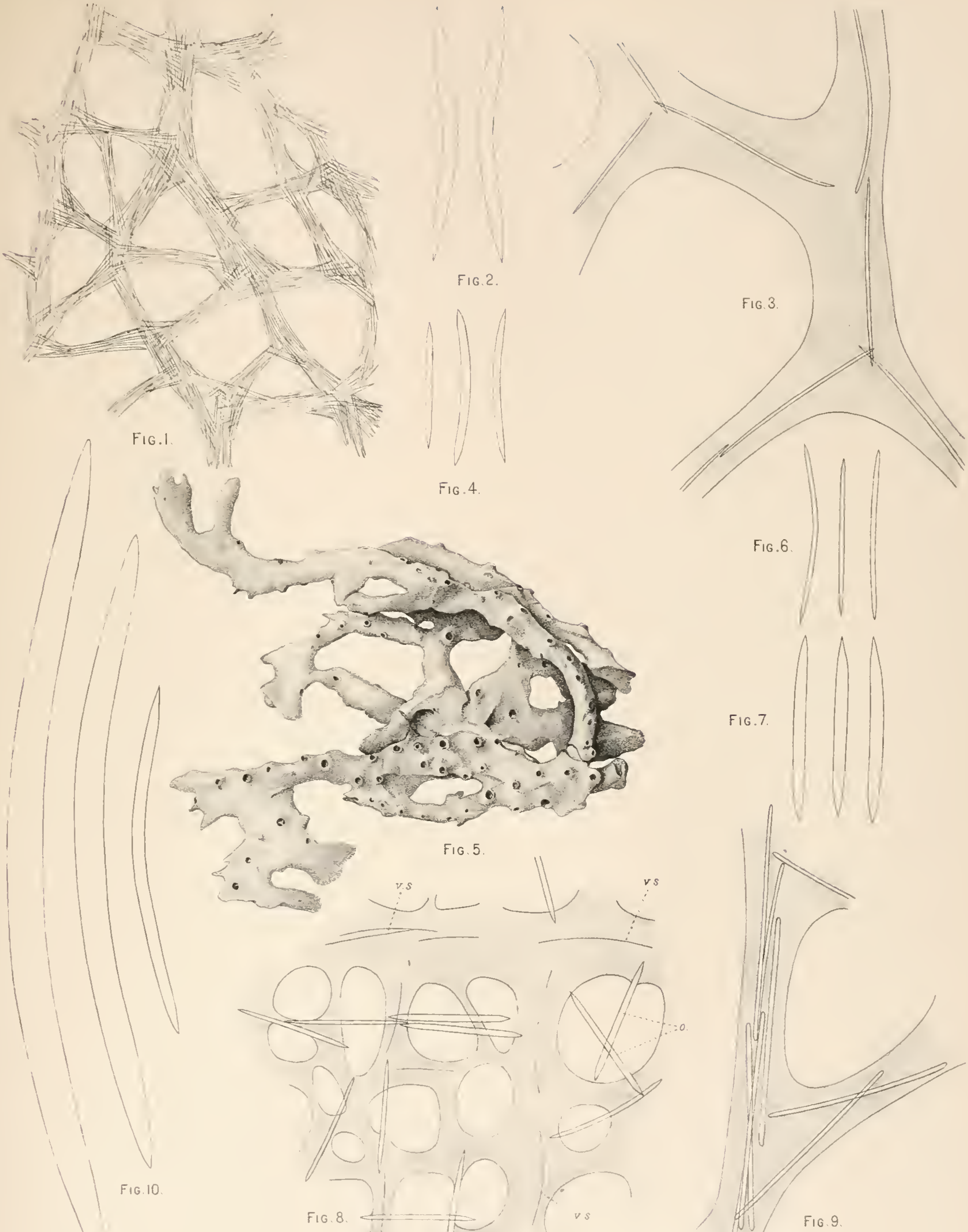


Fig. 1, Plocamia manaarensis (Carter); Fig. 2, Clathria spiculosa, var. tessellata, n.; Fig. 3, Phakellia ceylonensis, n.sp.; Fig. 4, Acarnus ternatus, Ridley; Fig. 5, Raspailia fruticosa, var. tenuiramosa, n.; Fig. 6, Acanthella carteri, Dendy.



A. Dendy del. E. Wilson, Lith. Cambridge

FIG. 1, STRONGYLOPHORA DURISSIMA, n.sp.; FIG. 2, TOXOCHALINA ROBUSTA, var. ridleyi, n.; FIG. 3, GELLIODES PETROSIOIDES, n.sp.; FIG. 4, DESMACELLA TUBULATA, n.sp.; FIG. 5, ACANTHOXIFER CEYLONENSIS, n.sp.; FIG. 6, GELLIODES INCRUSTANS, n.sp.; FIG. 7, GELLIUS ANGULATUS, var. canaliculata, n.; FIG. 8, RENIERA ZOOLOGICA, n.sp.; FIG. 9, PETROSIA DENSISSIMA, n.sp.; FIG. 10, RENIERA PIGMENTIFERA, n.sp.



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Figs. 1, 2, Pachychalina subcylindrica, n.sp.; Fig. 3, Chalina clathrata, n.sp.; Fig. 4, Ceraochalina retiarmata, n.sp.; Fig. 5, Chalina subarmigera (Ridley); Fig. 6, Ceraochalina ceylonica, n.sp.; Fig. 7, Pachychalina brevispiculifera, n.sp.; Fig. 8. Ceraochalina reticutis. n.sp.; Fig. 9, Chalina obtusispiculifera, n.sp.; Fig. 10, Trachyopsis halichondrioides, n.sp.

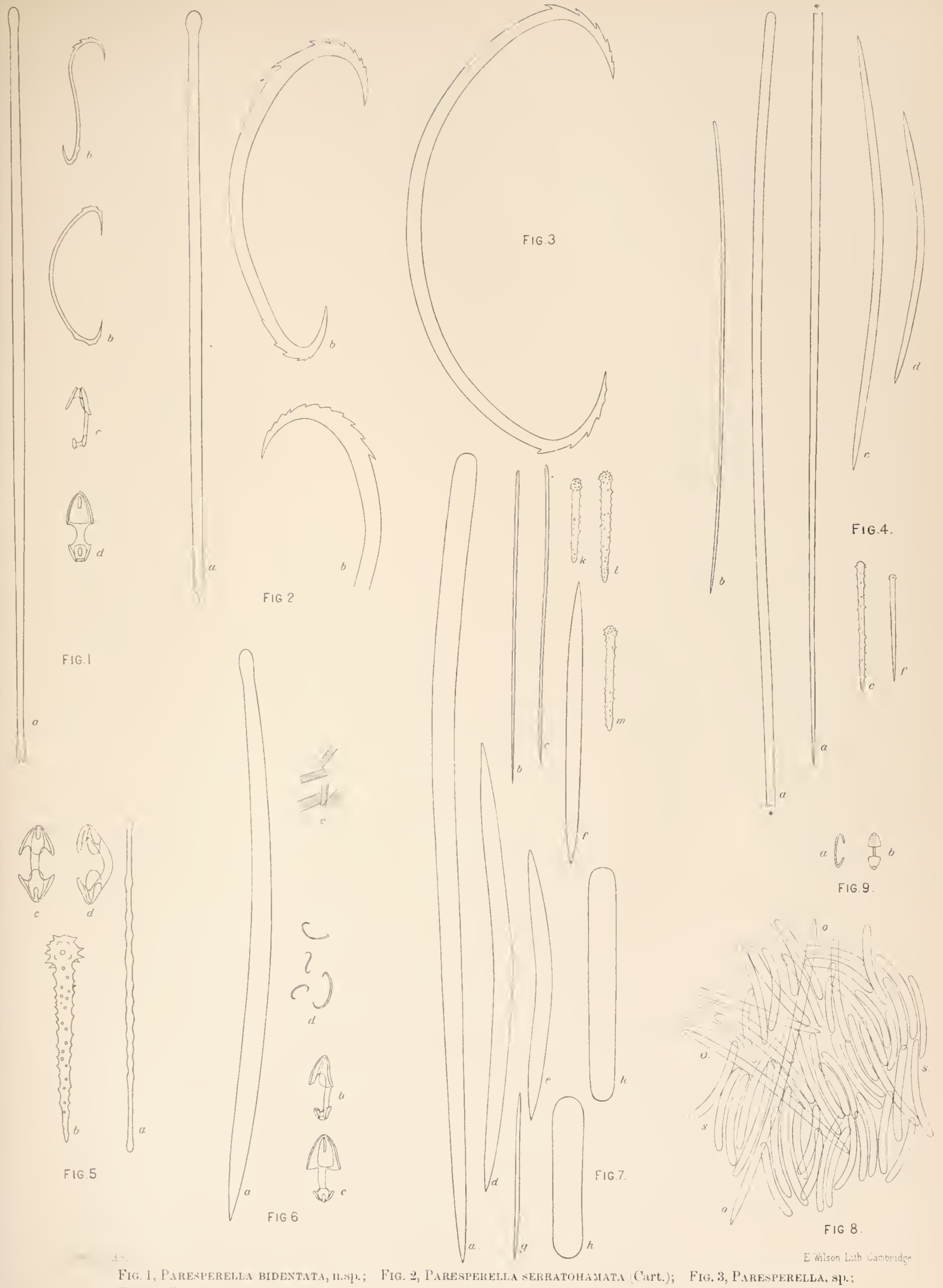

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FIG. 1, PARESPERELLA BIDENTATA, n.sp.; FIG. 2, PARESPERELLA SERRATOHAMATA (Cart.); FIG. 3, PARESPERELLA, sp.; FIG. 4, ECHINODICTYUM CLATHRATUM, n.sp.; FIG. 5, MYXILLA TENUISSIMA, n.sp.; FIG. 6, ESPERELLA CRASSISSIMA, n.sp.; FIG. 7, RASPAILIA HORNELLI, n.sp.; FIGS. 8, 9, HISTODERMA VESICULATUM, n.sp.

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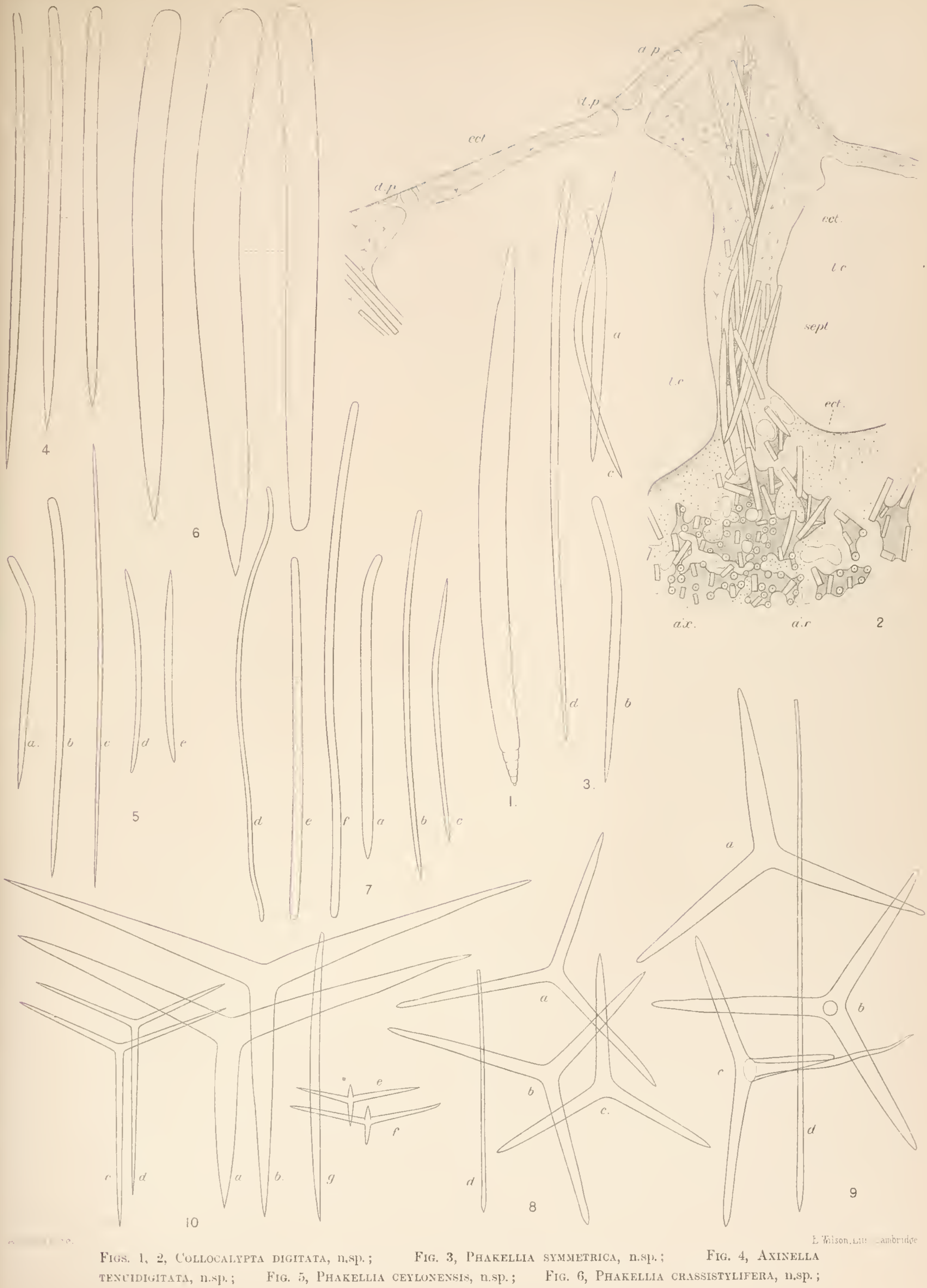
Fig. 1, Spongosorites topsenti, n.sp.; Fig. 2, Spongosorites (?) lamellata, n.sp.; Fig. 3, Spongosorites (?) lapidiformis, n.sp.; Fig. 4, Hymeniacidon petrosioides, n.sp.; Fig. 5, Thrinacophora durissima, n.sp.; Fig. 6, Thrinacophora agariciformis, n.sp.; Fig. 7, Axinella halichondrioides, n.sp.; Fig. 8, Axinella manus, n.sp.; Fig. 9, Agelas ceylonica, n.sp.; Fig. 10, Rhabderemia indica, n.sp.



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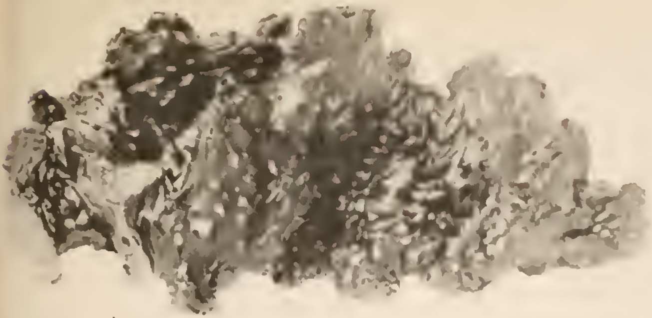
FIGS. 1, 2, COLLOCALYPTA DIGITATA, n.sp.; FIG. 3, PHAKELLIA SYMMETRICA, n.sp.; FIG. 4, AXINELLA TENUIDIGITATA, n.sp.; FIG. 5, PHAKELLIA CEYLONENSIS, n.sp.; FIG. 6, PHAKELLIA CRASSISTYLIFERA, n.sp.; FIG. 7, AULETTA ELONGATA, n.sp.; FIG. 8, LEUCOSOLENIA CORIACEA, var. ceylonensis, n.; FIG. 9, LEUCOSOLENIA TENUIPILOSA, n.sp.; FIG. 10, LEUCANDRA DONNANI, n.sp.



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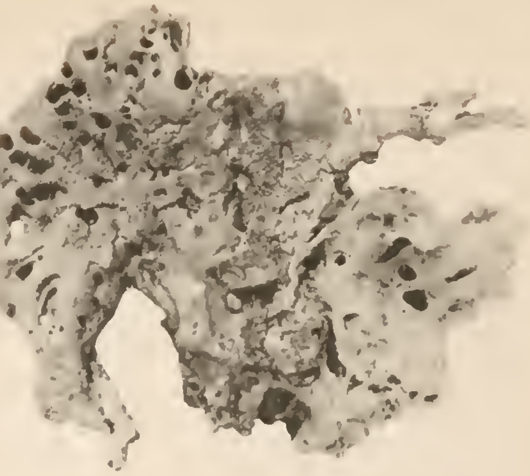

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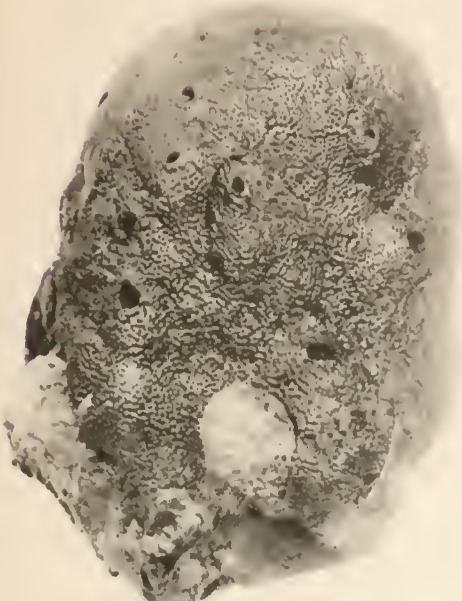

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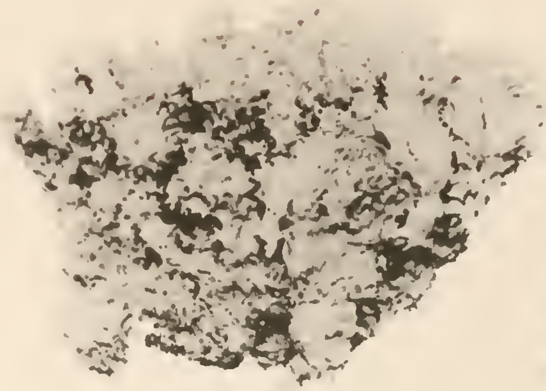

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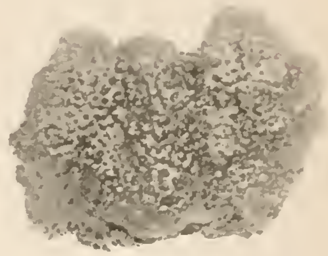

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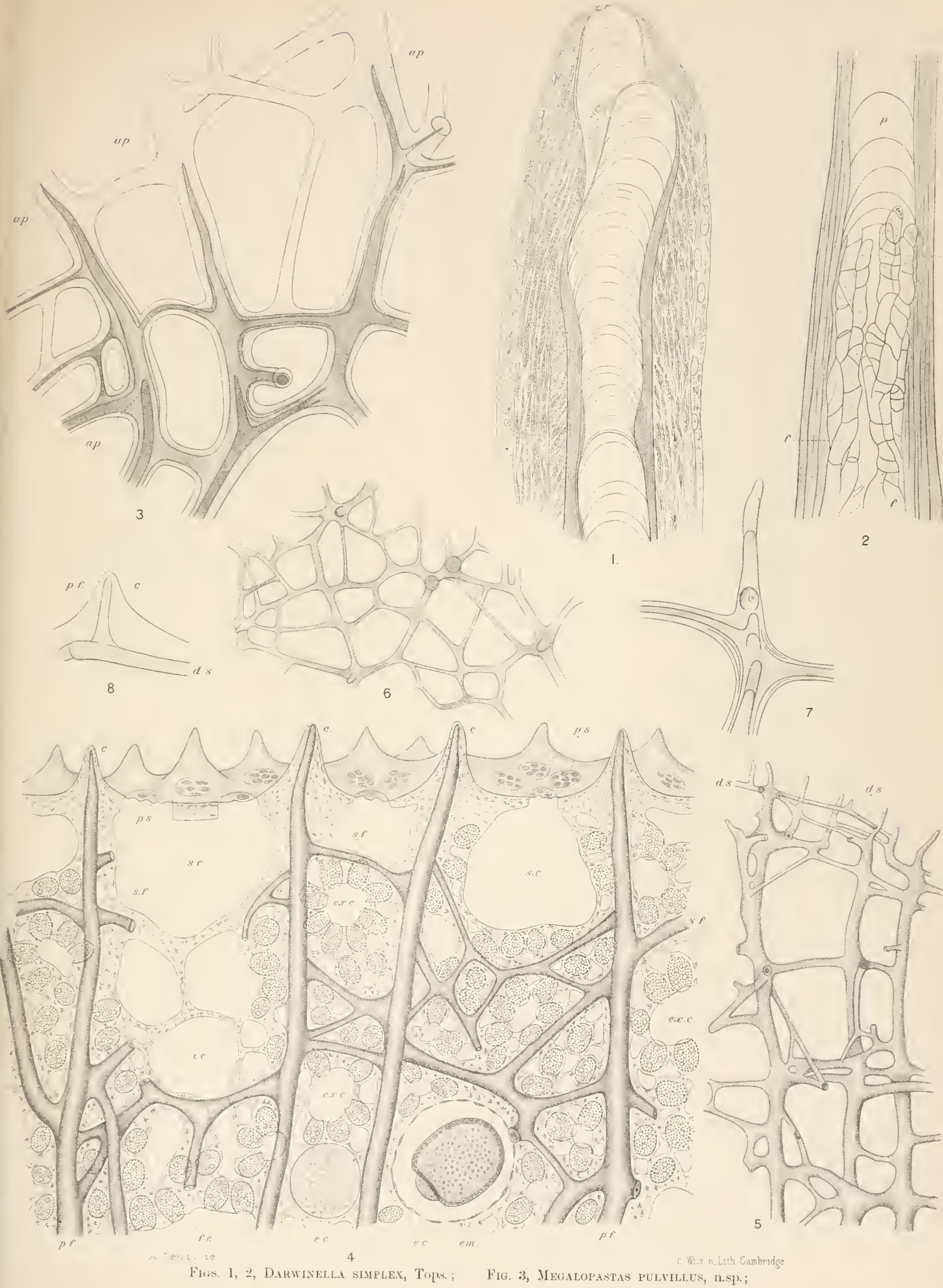
FIG. 1, HIRCINIA FUSCA, Carter; FIG. 2, HIPPOSPONGIA CLATHRATA (Carter): FIG. 3, EUSPONGIA OFFICINALIS, var. ceylonensis, n.: FIG. 4, SPONGELIA ELASTICA, var. crassa, n.: FIG. 5, HIRCINIA ANOMALA, n.sp.; FIG. 6, PHYLLOSPONGIA PAPYRACEA, var.; FIG. 7, MEGALOPASTAS NIGRA (Dendy).



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Figs. 1, 2, Darwinella simplex, Tops.; Fig. 3, Megalopastas pulvillus, n.sp.; Fig. 4, Megalopastas elegans (Lend); Figs. 5--8, Megalopastas nigra (Dendy).

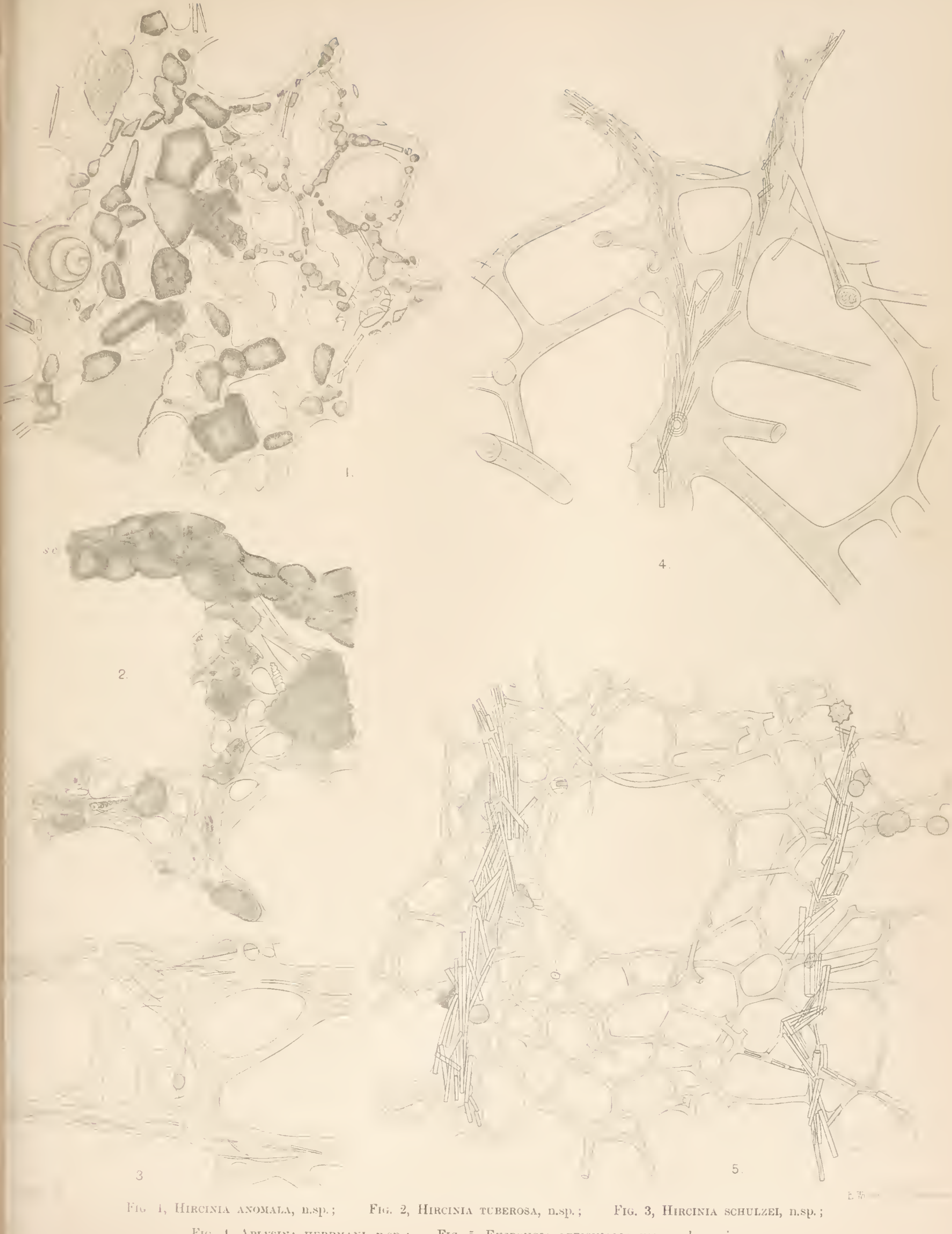

FIG. 1, HIRCINIA ANOMALA, n.sp.; FIG. 2, HIRCINIA TUBEROSA, n.sp.; FIG. 3, HIRCINIA SCHULZEI, n.sp.;
FIG. 4, APLYSINA HERDMANI, n.sp.; FIG. 5, EUSPONGIA OFFICINALIS, var. ceylonensis, n.

REPORT

ON SOME

ALCYONIIDÆ

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902,

BY

EDITH M. PRATT, D.Sc.

[WITH THREE PLATES.]

THIS collection of Ceylon Alcyoniidæ* is remarkably similar to one made by Mr. STANLEY GARDINER some three or four years ago in the Maldive Islands (PRATT, 1903).† The resemblance in many cases is so pronounced as to indicate a very intimate relationship between the Alcyoniid fauna of these islands. The genera *Sarcophytum*, *Lobophytum*, *Sclerophytum*, and *Alcyonium* are common to both localities. These genera are represented in the present collection by 17 species, and of these 9 occur also in the Maldive collection, 5 are new, and 3 have only been recorded hitherto from the Pacific.

The Ceylon collection includes :—

I. Five species of *Sarcophytum:* of these, three are new; one, *S. ehrenbergi*, has been recorded from the Maldives and Red Sea, and one, *S. plicatum*, has been recorded only from the Pacific (Ternate and North Celebes).

II. Two species of *Lobophytum:* one, *L. pauciflorum*, appears to be widely distributed in the tropical and southern sub-tropical waters of the Pacific and Indian Oceans, having been recorded from Tonga, Moluccas, Funafuti, New Britain

* See also the Report on the other Alcyonaria by Professor J. ARTHUR THOMSON, which follows in this volume.—W. A. H.

† See List of Literature on p. 265.

and New Zealand in the Pacific, from the Red Sea, and from the Maldive Islands and Gulf of Manaar in the Indian Ocean. The second species, *L. hedleyi*, has only been previously recorded from the Pacific (Funafuti). Its record from the Gulf of Manaar indicates a wide distribution of this hitherto little-known species.

III. Eight species of *Sclerophytum*: of these three, *S. marenzelleri*, *S. polydactylum*, and *S. densum*, are comparatively well-known species. *S. marenzelleri*, however, has only been before recorded from the Pacific (New Britain and New Hebrides); *S. polydactylum* from the Pacific (British New Guinea, China Seas), the Red Sea, Indian Ocean (Maldives), and now the Gulf of Manaar. *S. densum* is the most common species of the genus, and has a wide geographical range—it is now known from the Pacific (Funafuti, China Seas, British New Guinea), the Indian Ocean (Maldive Islands), and now the Gulf of Manaar.

Four species: *S. gardineri*, *S. palmatum*, *S. querciforme*, and *S. durum*, have been recorded only from the Maldives. One species is new.

IV. Two species of *Alcyonium*, one of which is new, and the other, *A. pachyclados*, is apparently generally distributed in the warm southern and tropical waters of the Pacific and Indian Oceans.

Several specimens of species common to Ceylon and the Maldive Islands vary considerably in size, external form, colour, consistency, size of spicules, &c., so that it was sometimes impossible to determine the identity of a species from a study of superficial characters. When examining a specimen of this family in the preserved condition, it is necessary to note that (1) the size of a specimen may vary according to age or environment; (2) external form is, to a certain extent, dependent on the state of expansion or otherwise of the colony at the time of fixing, and also upon the nature of the fixing re-agent; (3) the colouring matter in Alcyonaria, apart from that of the spicules, is usually acted upon, and in many cases dissolved, by alcohol; (4) the consistency of a colony, and to a certain extent the size of the spicules, may be affected by the use of an acid preservative. When these more or less artificial causes of difference are eliminated, the identification of most species, when based upon general anatomical principles, can usually be determined with considerable ease and accuracy.

List of Species occurring in Professor Herdman's Collection.

Sarcophytum bicolor, n. sp.
,, *oligotrema*, n. sp.
,, *contortum*, n. sp.
,, *plicatum*, Schenk.
,, *ehrenbergi*, Marenzeller.
Lobophytum hedleyi, Whitelegge.
,, *pauciflorum*, Ehrenberg.
Sclerophytum herdmani, n. sp.
,, *marenzelleri*, Wright and St.
Sclerophytum polydactylum, Dana.
,, *gardineri*, Pratt.
,, *palmatum*, Pratt.
,, *densum*, Whitelegge.
,, *querciforme*, Pratt.
,, *durum*, Pratt.
Alcyonium ceylonicum, n. sp.
,, *pachyclados*, Klunzinger.

Sarcophytum bicolor, n. sp.—Plate I., figs. 1 and 2.

Four complete and several fragmentary specimens were taken from the Gulf of Manaar and from the coral-reef at Galle. The largest specimen is incomplete, but is 250 millims. high and 190 millims. broad, and is provided with huge marginal lobes.

One complete specimen is irregularly mushroom-shaped, with four lobes, and is attached basally to hard coral. It is 120 millims. high and the capitulum measures 150 millims. by 85 millims. across its surface. The stalk is 65 millims. high and has a transverse diameter of 96 millims. by 60 millims. The capitulum has a thick marginal seam.

The second complete specimen is very much smaller. It is only 50 millims. high, and the capitulum measures 47 millims. by 29 millims. across its surface (Plate I., fig. 1).

The stalk varies in length in individual specimens; its surface is usually smooth, but here and there are occasional longitudinal wrinkles. In many cases the autozooids may be seen through the transparent body-wall.

The colour (in spirit) varies from a dark slaty grey to a pale brownish-grey. In all specimens the autozooids and siphonozooids are of a beautiful creamy white colour.

Some of the specimens are moderately hard and tough, others are soft and fleshy, while a few are quite brittle. The texture of the species seems to vary with the age of the colony, locality, and state of preservation.

The small complete specimen differs from the larger specimen in the feeble development of the marginal seam, which is very thick in the older colony.

The *Autozooids* are extremely numerous and are usually uniformly distributed over the upper surface of the capitulum. In the largest colony they are most numerous on the upper surface of the marginal seam, where they average 12 to the centimetre, and are few in number or entirely absent on the extreme edge of the seam, where siphonozooids are very abundant. None of the specimens are completely expanded, but anthocodia of partially expanded zöoids are fully 2 millims. in length and 0·5 millim. in diameter.

The tentacles are all contracted, and, although very small, are similar to those of other species. The stomodæum, mesenteries and mesenterial filaments do not apparently differ in any important respect from those of other species, but the specimens are not sufficiently well preserved to permit of histological examination.

The *Siphonozooids* (in spirit), of a beautiful cream colour, are outlined by a network of brown pigment, which also defines the outlines of the canals.

The average superficial diameter of a siphonozooid is 0·3 millim. The stomodæum is well marked and has an average length of 0·28 millim. The mesenteries are similar to those occurring in other species.

The *Canal System* is well marked, but exhibits no specially interesting features, with the exception of the presence in the canals of an orange-brown coloured pigment which may owe its existence to the disintegration of algæ cells, so abundant in many tropical corals (see below).

The *Spicules* are long and slender, and in form are characteristic of the genus (fig. 2). They are smaller in the actively growing superficial tissues than elsewhere. When an autozooid is in a state of contraction, the external aperture is effectually closed by a small conical cap of minute tentacular spicules.

This species exhibits considerable variation in form and consistency, but is characterised externally by the distinctive creamy white autozooids and siphonozooids and the greyness of the remaining portions of the colony.

Sarcophytum oligotrema, n. sp.—Plate I., figs. 3 to 5.

A complete cup-shaped colony attached basally to stony coral was taken in the Gulf of Manaar (fig. 3).

The specimen is almost stalkless and is 42 millims. high. The capitular cup, irregular in outline, is 32 millims. in depth and is 62 millims. by 50 millims. in breadth. The base of the cup is 10 millims. in thickness, the sides are about 5 millims. in diameter near the base, but thin out towards the edge, so that they are wedge-shaped in vertical section. Zooids are only present on the inner surface of the cup. The colour in spirit is of a dirty brownish-grey, with autozooids of a more pronounced brownish hue. The outer surface of the cup is moderately smooth, with few wrinkles. The specimen is moderately hard and tough.

Autozooids are very small, and are relatively very numerous on the sides and edges of the cup, but are somewhat scanty in the middle. As the colony is in a state of extreme contraction, it is impossible to determine the actual size of the autozooids; the young autozooids near the edge of the cup are smaller than elsewhere. The average diameter of a mature autozooid at the surface is about 0·3 millim.

The tentacles, stomodæum, mesenteries and mesenterial filaments do not differ in any essential respect from those of other species. Reproductive organs were not observed.

Siphonozooids are remarkably few in number (fig. 4). Usually only one or two of these zooids occur between two autozooids, but in the middle of the capitulum the number is slightly increased. The average superficial diameter of a siphonozooid is 0·35 millim., the mouth is sunk in a slight depression, and the stomodæum has an average length of 0·25 millim.

The canal system presents no specially interesting features. Transverse ciliated vessels connecting the cœlentera of neighbouring zooids (Pratt, 1903, p. 507, fig. 3) are very numerous.

The spicules, in the form of irregular warted spindles, are extremely small, but are characteristic of the genus. They are from 0·09 millim. to 0·3 millim. in length and from 0·09 millim. to 0·1 millim. in diameter (fig. 5).

This species has a superficial resemblance to *S. roseum*, from which however it differs chiefly in colour, form of spicules, in its abundance of autozooids and paucity of siphonozooids.

Sarcophytum contortum, n. sp.—Plate I., figs. 6 and 7.

Two complete specimens and one fragment were taken from the reef at Galle.

The largest specimen is 47 millims. high. The capitulum has a curiously lobed appearance, somewhat resembling a *Lobophytum*. This is due to the growth inwards of 8 more or less digitate marginal lobes (fig. 6, *c.m.l.*). All the lobes arise from the capitular margin and not from the upper surface of the capitulum as in *Lobophytum*. The convoluted character is not so strongly marked in the two other specimens of the species. The capitulum measures 47 millims. by 35 millims. across its surface. The lobes are somewhat flattened and rise slightly above the level of the true capitular margin. They are from 18 millims. to 30 millims. long and are from 9 millims. to 15 millims. broad at the base. The edges of the lobes curl upwards and slightly inwards (fig. 6, *c.m.l.*). The stalk is 40 millims. high, tapers towards the base and is drawn into furrows by the inward growth of the marginal lobes. Its surface is minutely granular and is marked by few longitudinal wrinkles.

The colony is in a state of extreme contraction, which may, to a certain extent, account for the complication of the marginal folds. All the specimens (in spirit) are of a pale fawn colour. They are hard to the touch, minutely granular, compact, and are readily cut with a knife.

The *Autozooids* are very small, and as they are withdrawn some distance below the surface, it is almost impossible to perceive their external apertures without the aid of a lens. The average surface diameter of an autozooid cavity is 0·25 millim. Autozooids are apparently more numerous in the margin of the capitulum and capitular lobes than elsewhere.

The tentacles, stomodæum and mesenteries with mesoglœal thickenings are similar to those of other species. Ova in several stages of development are present on many of the mesenteries, development proceeding from below upwards, as is usual in these forms. In one instance two series, one a little distance below the other, of developing ova were observed on one mesentary.

The *Siphonozooids* cannot be seen without the aid of a lens. They are fairly numerous, two or three may usually be counted between two autozooids. The average surface diameter of a siphonozooid is 0·3 millim. The stomodæum has an average length of 0·18 millim.

The canal system does not exhibit any specially noteworthy features.

The *Spicules* are of the usual *Sarcophytum* type, and are extremely numerous. They are from 0·3 millim. to 0·4 millim. in length, and from 0·1 millim. to 0·15 millim. in breadth. Occasionally a club with a pointed handle may be seen (fig. 7B).

This species is characterised by the curiously convoluted marginal lobes, the small size of the zoids, the hardness and compact character of the colony.

Sarcophytum plicatum, SCHENK (1896).

Two moderately large colonies of a pinkish-brown colour were taken from Station XXII., 13 fathoms, in Dutch Bay, near Trincomalee.

This species has previously only been recorded from Ternate, but in the zoological laboratories of the Victoria University are two specimens, one taken by Professor HICKSON in North Celebes and the other taken by Mr. J. STANLEY GARDINER at Funafuti (Ellice Islands). The latter has been identified by Miss HILES. This species therefore appears to have a very wide distribution within the tropical belt.

Sarcophytum ehrenbergi, MARENZELLER (1886).

One large and complete specimen was taken on the reef at Galle.

The colony is 50 millims. high, and the capitulum measures 245 millims. by 215 millims. across its surface. The capitular margin is thrown into deep folds.

The specimen is of a dark grey colour, but towards the middle of the capitulum it assumes a lighter shade.

The species has previously been recorded from the Red Sea and from the Maldive Islands (see PRATT, 1903).

Lobophytum hedleyi, WHITELEGGE (1897).

A single complete specimen and a fragment were taken from the reef at Galle; these agree with specimens from Funafuti in all essential respects, and only differ slightly in external form. The complete specimen is short and squat, and is 75 millims. high. The capitulum measures 136 millims. by 115 millims. across its surface. It has a fairly broad marginal seam, and is deeply concave in the middle; the lobes are arranged in fairly regular radiating lines from the middle of the capitulum, and vary in height from 36 millims. to 53 millims. The colony is hard and smooth, the stalk is here and there marked by wrinkles. The specimens in spirit are of a dirty greenish-grey colour with brownish patches. The autozooids are contracted, but in sections are seen to be of a paler shade of grey than the prevailing tint. They are relatively few in number, but are more abundant on the summits of the lobes, where they are from 1 millim. to 2 millims. apart, than in the furrows between the lobes, where they are separated from each other by wide intervals.

The average diameter of a contracted crown of tentacles is about 1 millim. Owing to their extreme contraction it is impossible to distinguish their pinnules. The stomodæum appears to be longer than in the species *L. pauciflorum* or *L. crassum*, but the walls are folded in such a manner that it is impossible to measure the actual length. The mesenteries and mesenterial filaments do not apparently differ from those of other species. Ova, exhibiting several stages of development, are present on the mesenteries of the autozooids. They are from 0·08 millim. to 0·2 millim. in diameter, and each is enveloped in a follicle which, in the largest ova, is 0·03 millim. in thickness.

The *Siphonozooids* are arranged with great regularity in the spaces between the autozooids, and are consequently most numerous where autozooids are fewest. Whitelegge describes the siphonozooids as being numerous and distinct, and states that there may be as many as 12 siphonozooids between two autozooids. On the side of one of the lobes 43 siphonozooids were counted in a straight line between two autozooids, but the distance between the autozooids is not so great on the summits of the lobes, where they are seldom more than 3 siphonozooids apart.

The siphonozooids are extremely well marked in this species, their average surface diameter of 0·27 millim. is slightly less than in the species *L. pauciflorum* and *L. crassum*, but their length is greater than in those species. The average length of the stomodæum is 0·23 millim.

The canal system does not differ in any essential respect from that of other species; transverse ciliated vessels are very numerous, especially near the surface.

Spicules.—The spicules of this species have been described and figured by Whitelegge (1897, p. 217). Those of the cortex are tiny spindles or clubs from 0·12 millim. to 0·15 millim. in length, and from 0·02 millim. to 0·05 millim. in breadth. The more deeply seated spicules are tuberculate spindles, and short, stout, sub-cylindrical spicules. These are from 0·15 millim. to 0·3 millim. in length, and from 0·03 millim. to 0·19 millim. in breadth.

Lobophytum pauciflorum, Ehrenberg (1834).

One fairly large fragment and two young mushroom-shaped colonies were taken from the Gulf of Manaar.

One of the latter was 10 millims. high, with a capitulum 12 millims. by 10 millims. in diameter, and the other was 12 millims. high, with a capitulum 12 millims. by 10·5 millims. in diameter.

This species (see Marenzeller, 1886, and Pratt, 1903) appears to be very widely distributed and has been taken from the Red Sea, New Zealand, Andaman Islands, Tonga, Moluccas, Funafuti, New Britain and the Maldive Islands.

Sclerophytum herdmani, n. sp.—Plate II., figs. 8 and 9.

One complete and several fragmentary specimens were taken from the reef at Galle, and two specimens from the Pearl Banks off Aripu.

The complete specimen from Galle has a much lobed capitulum, the lobes are similar in size, and are regularly arranged on the capitular surface (fig. 8). The colony is 85 millims. high and the capitulum measures 135 millims. by 140 millims. across its surface. The stalk is 70 millims. high and 120 millims. broad. The capitulum has no marginal seam, but passes almost imperceptibly into the stalk. On the wrinkled stalk, some little distance below the capitulum, are three small tubercles which bear zooids on their upper surface (fig. 8, *tu*). This appears to be the only recorded instance of the occurrence of zooid apertures on the stalk. The colour in spirit is pale drab, the summits of the branches have a yellowish tinge. When living, the zooids were of a pale brown colour, which, however, has been dissolved by the spirit preservative.

A specimen from Aripu is smaller. It is 50 millims. high and measures 45 millims. by 35 millims. across the surface of the capitulum, which is seamed at the margin. In spirit the stalk is light brown and the capitulum yellowish-drab. When living, the capitulum was a pale yellowish-green colour.

The fragmentary specimens are of a uniform drab colour. All the specimens are moderately hard, yield slightly to the touch, and are somewhat brittle.

The species is monomorphic. The autozooids appear to be rudimentary. They are extremely small, numerous, and are arranged with great regularity on the capitular surface. The average surface diameter of a contracted autozooid is 0·04 millim. Frequently as many as 20 zooids may be counted in a linear centimetre. It is unfortunate that the preservation of the specimens will not permit of a more complete investigation of the anatomy of this interesting species.

The ventral mesenterial filaments are extremely small, but the dorsal filaments are as well developed as in other species. The superficial and internal canal systems do not differ in any essential respect from those of other species. The endodermal tissues and canals are crowded with zoochlorellæ. The minuteness of the ventral mesenterial filaments and the smallness of the autozooids is doubtless correlated with the extreme abundance of zoochlorellæ, and is discussed in a paper now in the press (PRATT, 1905).

The *Spicules* (fig. 9) are similar in character to those of other species. Tuberculate spicules usually in the form of spindles, but sometimes forked, are comparatively numerous, and average 3 millims. in length and 0·5 millim. in breadth. Clubs sometimes with spiny handles, and spindles set with minute spines, are closely packed near the surface, so as to form an outer crust. The average size of the clubs is 0·09 millim. by 0·04 millim., of the spindles 0·25 millim. by 0·03 millim. A few spiny crosses also occur.

Sclerophytum marenzelleri, WRIGHT and STUDER (1889).

A single specimen of this species was taken in the Gulf of Manaar.

The colony forms an extremely hard cake-like mass, with lobes of varying size arising vertically from the upper surface of the capitulum. The basal attachment consists of hard coral encrusted with Polyzoa and shells. The colony is 93 millims. high; the capitulum has a transverse diameter of 337 millims. by 257 millims; the stalk is 55 millims. in height and is irregular in outline. The capitulum has a well-marked marginal seam and bears numerous conical lobes—many being fully 20 millims. high. A few of the lobes are branched.

The specimen in spirit is of a pale pinkish-brown colour, which originally was doubtless of a more intense hue, as the spirit is of a golden-brown colour. The capitulum is tough in consistency and slightly yielding to pressure; that of the stalk hard, granular and more brittle. Towards the base the stalk is extremely hard owing to the great abundance of spicules in this region.

The spicules are relatively small compared with other species. They are adequately described by WRIGHT and STUDER (1889, p. 251).

The species is monomorphic. The autozooids are all contracted, but appear to be extremely small. They are much more numerous in the lobes than in the furrows between, where they are often from 2 millims. to 4 millims. apart. They are also very scantily distributed on the capitular margin. Owing to the extreme contraction of the autozooids, the pinnate character of the tentacles cannot be distinguished. The stomodæum is comparatively long and has a well-marked siphonoglyph. As in other species, the dorsal mesenteries are of considerable size. There are of course no siphonozooids.

This species has been previously recorded from Api Island, New Hebrides (60 fathoms to 70 fathoms) and Cape Gazelle, New Britain.

Sclerophytum polydactylum (DANA).

One complete specimen and several fragments were obtained from the Gulf of Manaar.

The complete colony is 35 millims. high, the capitulum measures 37 millims. by 22 millims. across its surface. It is smaller, slightly harder and more brittle than the Maldive specimen, but does not appear to differ from it in any essential respect. This species (see PRATT, 1903) has been recorded from the Red Sea, China Strait, British New Guinea, the Maldive Islands and now the Gulf of Manaar.

Sclerophytum gardineri, PRATT (1903).

Three complete specimens were obtained from the Gulf of Manaar.

Two of the specimens (in spirit) are of a beautiful cream colour, while the third is of a pale drab colour. These specimens agree with the type specimen from the Maldive Islands in all essential respects. Two are slightly larger, while the third is of similar size.

This species has been hitherto recorded only from the Maldive Islands.

Sclerophytum palmatum, PRATT (1903).

Two complete and several fragmentary specimens were taken from the reef at Galle and from the Gulf of Manaar.

The complete specimens are small, and from their manner of growth do not appear to be so robust as the type specimen from the Maldive Islands. The fragmentary specimens are from shorter and stouter colonies, and have broader and larger lobes. The zooids are very similar in all the specimens, the tentacles having the double row of pinnules characteristic of the species (PRATT, 1903, p. 526). None of the Ceylon specimens in spirit show the vivid green colour of the type specimen when living, but several of the specimens have a greenish tinge.*

This species has hitherto only been recorded from the Maldive Islands.

Sclerophytum densum, WHITELEGGE (1897).

One very young mushroom-shaped colony (PRATT, 1903, fig. 18) was taken from Gulf of Manaar; two specimens, brown in colour, were taken from the reef at Galle; one reddish-brown specimen from a coral bank in the Gulf of Manaar, and a light brown and a fawn specimen were taken from the reef at Galle.

The light brown specimen is complete, and is comparatively young, having not yet outgrown its early mushroom shape. It is 22 millims. high, and the capitulum measures 46 millims. by 27 millims. across its surface.

The capitulum is concave, with a central depression of 12 millims. Small lobes from 2 to 4 millims. high arise from the middle of the cup, while larger ones from 5 to 6 millims. high occur near the edge.

The fawn-coloured specimen was taken on the reef at Galle. It is 70 millims. high, and the capitulum measures 240 millims. by 200 millims. across its surface. The colony forms a large, hard, cake-like mass, with a more or less vertical short and thick stalk, having almost the same breadth as the capitulum, which has no marginal seam. Lobes are very numerous near the edge of the capitulum, but are few and small in the middle. Zooids are numerous on the lobes, but are scantily distributed over the centre of the capitulum.

This species appears to be the most common as well as the most widely distributed species of the genus. It is known from Funafuti, China Seas, British New Guinea, Maldive Islands, and now from the Gulf of Manaar and Galle.

Sclerophytum querciforme, PRATT (1903).

Two specimens similar in form, size, texture, and apparently in all essential respects, to the specimens from the Maldive Islands, were taken from the Gulf of Manaar.

This species has hitherto only been recorded from the Maldive Islands.

Sclerophytum durum, PRATT (1903).

Four specimens were taken. Three from the Reef at Galle and one from the pearl banks in the Gulf of Manaar.

Three specimens, one complete and two fragmentary, are of a beautiful orange colour (in spirit)—of a deeper shade towards the middle and paling towards the margin. The fourth, a cup-shaped colony, is of a deep cream colour.

As already pointed out (PRATT, 1903, p. 528), specimens of this species from the limited area of the Maldive Islands exhibit great diversity in form and colour. Further modifications in these respects occur in the Ceylon specimens. The cup-shaped colony is similar in form, size, and texture to the cup-shaped Maldive

* Some of these colonies from Ceylon were certainly green when alive.—W. A. H.

specimens. The remaining three specimens, which appear to be very much older, are extremely hard, irregular, mushroom-shaped masses, with convex capitula thinning out towards the edges, set with short frequently laterally compressed lobes, usually arranged in radiating ridges.

The lobed specimen from the Maldive Islands appears to be intermediate in form and age between the cup-shaped specimens and the hard, irregular, mushroom-shaped specimens from Ceylon.

The complete specimen is 47 millims. high and the capitulum measures 92 millims. by 80 millims. across its surface. The stalk is short, broad, laterally compressed and constricted in the middle. It is 25 millims. high and has a diameter at the base of 80 millims by 40 millims. A few of the lobes are branched. Their average height near the middle is 10 millims. All the specimens give off a peculiar pungent odour even in spirit.

Only autozooids are present in this species. They are fairly numerous on the margin of the colony and on the lobes, but are few in number in the furrows between the lobes. All the specimens are hard and granular, owing to the enormous spicules which are very thickly set and extremely abundant.

This species has hitherto only been recorded from the Maldive Islands.

Alcyonium ceylonicum, n. sp.—Plate II., figs. 10 to 12.

A single complete colony was taken from the reef at Galle.

The specimen has an irregularly ridged capitulum and is creamy white in colour. The colony is 60 millims. high and the capitulum measures 75 millims. by 55 millims. across its surface.

It is tough and fleshy in consistency, slightly softer and more fleshy in the middle than near the surface, where the spicules are much more abundant.

The *Zooids* are extremely small and are very numerous (13 or 14 to the centimetre), they are uniformly distributed over the entire upper surface of the capitulum. Measurements across the partially expanded crown of tentacles average 0·6 millim. None of the zooids are completely expanded. The apertures of contracted zooids are so minute as to be almost imperceptible without the aid of a lens. As the tentacles are only partially expanded, it is difficult to distinguish their pinnate character. They are extremely short, the longest measuring only 0·16 millim. in length. The stomodæum averages 0·5 millim. in length and has a moderately large siphonoglyph.

The mesenteries are small, and the musculature only feebly developed. As in many other tropical forms, the dorsal mesenteries have extremely long and well developed filaments, but the ventral mesenteries have no filaments (Plate II., fig. 11, *v.m.*). As in several other instances (PRATT, 1904, in the press), this reduction of the digestive surface is accompanied by an abundance of zoochlorellæ in the superficial endodermal tissues.

The *Spicules* are similar in form (fig. 12) to those of *A. pachyclados*, but are slightly larger than in that species and are much less numerous. They have the form of tuberculate dumb-bells. They are fairly abundant in the superficial tissues, but are scantily distributed in the more deeply seated portions of the colony.

The average size of the spicules is 0·14 millim. by 0·1 millim.

As in other species of *Alcyonium*, there is only one system of canals. This, the internal system, is extremely well developed in the interior of the colony, but becomes less well marked towards the surface of the capitulum. This system consists chiefly of short transverse vessels which connect the cœlentera of the zooids (PRATT, 1903). Owing to the great number of zooids, which in this species penetrate deeply into the interior, the longitudinal canals are comparatively few in number.

This species is characterised by its soft fleshy consistency, its numerous but very minute zooids, the entire absence of ventral mesenterial filaments, accompanied by an abundance of zoochlorellæ in superficial tissues, and the small spicules.

It approaches *A. pachyclados* in the absence of ventral mesenterial filaments and in the form of the spicules. It differs however from that species in the texture of the colony, the minuteness of the zooids and in its less numerous but larger spicules.

Alcyonium pachyclados, KLUNZINGER (1877).

Three complete specimens of this widely distributed species were taken from the Gulf of Manaar.

They are all similar in external form, consistency and colour, but specimens in the Victoria University of Manchester from different localities exhibit considerable variation in these respects. The Ceylon colonies form low, more or less lobate, sessile, encrusting masses, from 10 millims. to 20 millims. high and from 28 millims by 18 millims. and 42 millims. by 23 millims. broad. The capitulum has a more or less convex surface, on which are studded, with varying frequency, the short and broad, rounded or conical lobes; the largest lobe is 7 millims. high and has a basal diameter of 8 millims. by 7 millims. These colonies are very similar in external form and character to specimens from the Maldive Islands (PRATT, 1903), China Strait and New Britain, but differ considerably in colour and manner of growth from the arborescent specimens which have been attributed to this species from the Cape of Good Hope (HICKSON, 1900). The Ceylon specimens are harder and more brittle than the forms I have examined from other localities, this being no doubt attributable to the great abundance of spicules.

The Ceylon specimens (in spirit) are of a creamy-white colour with autozooids of a darker shade, and are similar in this respect to the specimens from China Strait. The Maldive specimen (in spirit) is a pale brownish-grey colour, of a darker shade between the lobes. The specimen from New Britain is a uniform grey colour, while some of the Cape specimens are white, some yellow and others red in colour.

In distribution this species is known from the Red Sea, Maldive Islands, China Strait, New Britain, Cape of Good Hope and now the Gulf of Manaar.

ANATOMICAL NOTES.*

NEMATOCYSTS (figs. 13 and 14).

MOSELEY was unable to find nematocysts in specimens of *Sarcophytum*, and therefore states (1881, p. 119) that they do not occur in this genus. In his description of the occurrence of nematocysts in several members of the Alcyonaria, ASHWORTH (1899, p. 193) records them for *Sarcophytum pauciflorum*. This species, however, is now placed in the genus *Lobophytum*, for which the record of the presence of nematocysts is new. Hitherto they have not been observed in any species of *Sarcophytum*.

On examining several preparations of a single species stained with iron brazilin, some specimens seemed to contain no nematocysts, many contained few nematocysts, and in only a very few instances were they at all numerous. The apparent absence or scarcity of nematocysts in individual members of a species may be attributed to the use of a fixing preservative which permeates the tissues so slowly that the stinging cells are discharged before the colony is fixed. If a rapidly fixing preservative such as an 8 per cent. aqueous solution of hot formalin be employed, the tissues apparently suffer no contraction and the tentacles are found to contain innumerable batteries of nematocysts.

Nematocysts in *Alcyonium digitatum* were first described by HICKSON (1895).

I have been successful in observing nematocysts in all the species of *Alcyonium*, *Sarcophytum*, *Lobophytum*, and *Sclerophytum* which I have examined. They are, however, apparently more numerous in the British species than in the tropical representatives of the family. They always occur in batteries, and are never uniformly distributed in the ectoderm. The most common type is the well-known form occurring in *Alcyonium*. Modifications of this with regard to size, and length and thickness of thread are not infrequent, and may be found in *Sarcophytum roseum* (fig. 13*a*) and *S. glaucum* (fig. 13*c*), and in *Sclerophytum gardineri*. The accompanying table shows that they vary considerably in size in specific members of the family, and are apparently more uniform in this respect in *Alcyonium* and *Lobophytum* than in *Sarcophytum*, where they are from 6μ to 22μ long, and from 2μ to 14μ broad, and in *Sclerophytum*, in which they are from 5μ to 12μ long, and from 2μ to 4μ broad.

Nematocysts attain their greatest size in *Sarcophytum glaucum* (fig. 13*c*), in which species they are comparatively few in number. The thread is extremely short and broad, being usually fully 2μ in breadth. In sections, the internal portion exposed at the cut surface stains more deeply than the external portion of the thread. Within the cell the thread lies loosely and irregularly coiled, there being usually only from 3 to 4 turns of the spiral. The smallest nematocysts occur in *Sclerophytum*

* I have given an account of the physiology and comparative anatomy of the digestive organs of the Alcyonaria in a paper which is in the Press at the time of writing (PRATT, 1905).

durum. In this species they are extremely difficult to see, and are only about 5μ long and 2μ broad.

Throughout the family the thread is apparently unbarbed; nematocysts of *Alcyonium* with discharged threads are figured by HICKSON (1895). The nucleus of the cnidoblast is usually long and curved (fig. 13), and stains very readily. Nematocysts, similar to those occurring in batteries in the tentacles, are frequently to be found in the ectoderm of the mouth disc, in the stomodæum, imbedded in the peripheral portions of the mesenterial filaments, in the endoderm of the canals, and in some cases in the mesoglœa some little distance below the surface. They are extremely rare in the ectoderm covering the general surface of the colony between the zooids.

Genus. Species.	Size of nematocysts.	Author.
Alcyonium digitatum	$7\frac{1}{2}\mu$ by 2μ to 3μ	HICKSON
,, *pachyclados* . . .	8μ to 9μ by 2μ to 3μ	PRATT
Lobophytum pauciflorum . . .	6μ by 2μ	ASHWORTH
,, *validum*	6μ to 7μ by 2μ to $2{\cdot}5\mu$	PRATT
,, *crassum*	$5{\cdot}9\mu$ to $6{\cdot}9\mu$ by 2μ	,,
Sarcophytum roseum	$8{\cdot}9\mu$ to 9μ by 4μ	,,
,, *latum*	6μ by 2μ to 3μ	,,
,, *glaucum*	16μ to 22μ by 10μ to 14μ Thread 2μ broad.	,,
,, *ehrenbergi* . . .	6μ by 2μ	,,
Sclerophytum tuberculosum . .	7μ to 8μ by 2μ	,,
,, *densum*	7μ by 3μ	,,
,, *capitale*	8μ to 9μ by 3μ to $3{\cdot}5\mu$	,,
,, *hirtum* . . .	8μ to 9μ by 3μ to 4μ	,,
,, *gardineri* . . .	12μ by $4{\cdot}5\mu$	,,
,, *durum*	5μ by 2μ	,,
,, *palmatum* . . .	6μ by 2μ	,,
Heteroxenia elizabethæ. . . .	9μ by $2{\cdot}5\mu$	ASHWORTH
Heliopora cærulea	9μ by 2μ to 3μ	MOSELEY
Xenia hicksoni	8μ by 2μ to 3μ	ASHWORTH
Clavularia prolifera	10μ to 15μ by 2μ to 3μ	v. KOCH

TENTACLES.

When the tentacles of *Alcyonium* are expanded, their ectoderm is extremely thin, and is composed almost entirely of batteries of cnidoblasts, columnar interstitial cells, scleroblasts, and a few mucous cells. I have observed no granular gland cells such as occur on the mouth disc. In the ectoderm of the body wall, nematocysts are comparatively few in number, and are rarely seen in the ectoderm covering the colony.

ZOOCHLORELLÆ.

Zoochlorellæ are more or less fully described in a publication now in the Press (PRATT, 1905). In a specimen of *Sclerophytum densum* some of the zoochlorellæ are seen to have lost their cellulose cell walls (fig. 16). In such a case the nucleus, chromatophore, and protoplasm of a cell exhibit unmistakable signs of division. This probably represents an early stage of sporogenesis. Very minute zoochlorellæ (fig. 16, *c.*) are also seen in the canals, but I have been unable to determine the intermediate stages of spore formation.

Yellow Cells.

The more or less rounded cells of a yellow colour which occur in the ectodermal as well as endodermal tissues are to be found in many tropical forms, but are more numerous in the specimens of *Sarcophytum* (Pratt, 1903, fig. 4) than in those of *Lobophytum* and *Sclerophytum*. They appear to be very abundant in certain Madreporaria, and have been described and figured by Duerden (1903, p. 439).

As small portions of yellow granular matter, similar in all respects to the contents of the yellow cells, may be frequently observed in the zoochlorellæ, it is suggested that the yellow cells represent an early stage of sporogenesis. The presence of yellow granular matter may be due to the breaking up of the chromatophores, but this point can only be satisfactorily settled by a systematic study of the life-history of the zoochlorellæ in living corals.

Generative Organs.

Comparatively few specimens in the collection contain generative organs, and in such instances they are entirely of a female character. Hickson (1895, pp. 376–380) has already described the oogenesis, and to a certain extent the spermatogenesis, of *Alcyonium*, and Ashworth (1898, pp. 207–209) has described the spermatogenesis of *Xenia*. In the British *Alcyonium digitatum* the development of the sexual cells occupies a very considerable period, as the ova begin to appear about April or May, and are usually not sexually ripe until December or even later. I have observed the discharge of ripe ova at Port Erin during the early part of April. In the British species the period of the sexually mature condition is extremely short. Apparently the colonies inhabiting a particular district discharge all their ripe ova and spermatozoa almost simultaneously. In tropical members of the family, however, such is not the case.

In his description of the spermatogenesis of *Xenia*, Ashworth (1898, p. 207) states that the spermatozoa closely resemble those of *Alcyonium* in development and structure, but spermatozoa occur in a single specimen in all stages of development, so that the discharge of ripe spermatozoa extends over a considerable period ; this he attributes to the fact that as the coral lives on reefs in the shallow waters of tropical seas, it is not subjected to any great variation in temperature and food supply.

The development of the ovum in *Sarcophytum*, *Lobophytum*, and *Sclerophytum* closely resembles that of *Alcyonium*, and is typically Alcyonarian in character (figs. 17 and 18). Frequently (in specimens of *Sarcophytum latum*, *Sclerophytum durum*, and *Sclerophytum gardineri*), however, ova in several stages of development may be observed on a single mesentery, the development proceeding from above downwards, so that the youngest ova usually occur nearest the lower end of the stomodæum. In a specimen of *Sarcophytum latum*, ova on a single mesentery vary in size from 0·03 millim. to 0·5 millim. in diameter. Two series of developing ova, one a little distance below the other, were observed on a single mesentery in *Sarcophytum contortum*.

On comparing the oogenesis of *Sarcophytum*, *Lobophytum*, and *Sclerophytum* with Ashworth's description of the spermatogenesis of *Xenia*, it would appear that the sexually mature condition, in these tropical genera, extends over a considerably longer period than in the case of corals inhabiting temperate waters. The complete absence of male colonies, and of generative organs in many specimens, in the collection, is very noteworthy. I can offer no explanation, for many of the colonies are of considerable size, and the zooids appear to be mature in every other respect.

In the Alcyonaria generative organs usually occur on the ventral and lateral mesenteries only (fig. 17). In a specimen of *Sclerophytum gardineri*, however, ova occur also on the dorsal mesenteries (fig. 18). They are not connected with the ectoderm of the mesentery, but are borne and supported by lateral outgrowths of the mesenterial endoderm. Ashworth (1898, p. 207) records the presence of spermaria on the dorsal mesenteries of *Xenia*, but these are apparently the only records of their occurrence on these mesenteries in the Alcyonaria. As both forms in which they occur present modifications in other respects, this must be regarded also as a secondary feature, and of no special morphological interest.

Siphonozooids.

I have slight additions to make to the description of the siphonozooids of *Sarcophytum*, *Lobophytum* and *Sclerophytum* already given in a previous publication (Pratt, 1903).

In *Sarcophytum* and *Lobophytum* the siphonozooids are small in comparison with the size of the autozooids, but in *Sclerophytum* they are either very minute (fig. 20) or absent. In all well marked cases of dimorphism the stomodæum is large, usually ciliated throughout, and has a well marked siphonoglyph furnished with long flagella (fig. 19). The dorsal mesenteries are long and have large, grooved and ciliated filaments. Even when of considerable size siphonozooids are usually only slightly contractile, and have only small ventral mesenteries. The specialisation of these zooids to fulfil a circulatory function has been accompanied by a reduction and atrophy of those organs which are concerned in the capture and digestion of food. Throughout the Alcyonaria siphonozooids apparently have no tentacles and their ventral mesenteries no filaments. The increase of the flagellate surface of the stomodæum has been at the expense of the digestive surface. The increased current of sea water within the zooids would carry away the food particles so rapidly, that they would be unable to receive the secretion of the gland cells, which, however, would be rendered so dilute as to be quite useless for digestive purposes. These zooids therefore have become incapable of capturing and digesting food. The increased circulation brought about by their specialisation would relieve the autozooids to a certain extent of that function, hence the feebly marked siphonoglyph in the autozooids of *Sarcophytum* and *Lobophytum*.

The stomodæal ectoderm of the siphonozooids in *Sarcophytum* and *Lobophytum* is composed of the same elements as in the autozooids, but owing to the physiological division of labour they occur in very different proportions.

In the stomodæum of the siphonozooid there is a pronounced increase in the number of flagellate cells, so that the siphonoglyph is proportionately larger than in the autozooid—this is accompanied by a very pronounced reduction in the number of granular gland cells, which are extremely rare in these two genera, but are entirely absent in *Sclerophytum*. The stomodæum of the siphonozooid in *Sarcophytum* and *Lobophytum* consists chiefly of flagellate cells, which constitute the well marked siphonoglyph and the ciliated columnar epithelial cells which line the remaining portion of the stomodæum. Among the latter are interspersed a few interstitial cells, nematocysts, scleroblasts, and a very few gland cells.

Siphonozooids and autozooids frequently communicate with each other by means of short ciliated canals, which differ from the vessels of the canal system in the presence of long columnar endoderm cells provided with fairly long cilia (fig. 22).

In *Sclerophytum* modification of the stomodæal ectoderm has proceeded still further. In this genus the siphonozooids are very much reduced. The stomodæum has neither flagellate cells nor gland cells, but consists in the species *S. densum* and *S. hirtum* (fig. 20) of a short simple tube opening to the exterior and lined apparently by undifferentiated ectoderm cells. In the species *S. palmatum* and *S. capitale* there is no aperture to the exterior ; in *S. durum* and *S. polydactylum*, an aggregation of a very few ectoderm cells is the degenerate representative of the stomodæum in other forms. The stomodæum is entirely unrepresented in *S. gardineri* and *S. querciforme*. Mesenteries are only present in very few cases and are extremely small and very feebly developed (fig. 20 *m*).

Development by Budding.

The siphonozooid buds differ from those which are destined to become autozooids in that their development is arrested at a very early stage, which appears to be constant for the species, and also to a certain extent in development, although the very early stages of both forms of zooids are identical.

In *Sclerophytum* the siphonozooids are extremely small and retain throughout life their intimate connection with the transverse vessels of the canal system from which they originated. In the development of the siphonozooids of *S. densum* a cæcum is formed by an outgrowth from an endodermal canal near the surface of the colony. This is accompanied by a multiplication and aggregation of the ectoderm cells at the surface, immediately opposite the cæcum (fig. 20). These cells arrange themselves so as to form a tube, usually one cell in thickness, which is at first blocked by a plug of mesoglœal-like substance (*pl.*). Rudiments of mesenteries frequently appear (*m.*), and by the removal of the plug an aperture is formed to the exterior. If a bud is destined to become an autozooid, mesenteries appear at a very early stage and usually attain a considerable size before the completion of the stomodæum or formation of the tentacles. My study of the development of the buds is yet incomplete, but there can be no doubt of the ectodermal origin of the stomodæum and the endodermal origin of the mesenteries. I have not yet worked out the origin of the ventral mesenterial filaments.

Canal Systems.

The canal systems of the Alcyonaria have been described by Hickson (1895) for *Alcyonium*, Moseley (1881) for *Sarcophytum*, Ashworth (1898) for *Xenia*, and Pratt (1903) for *Lobophytum* and *Sclerophytum*.

The canals in *Alcyonium* are very similar to each other in form and structure, but very irregular in their course; there appear to be no large vessels which maintain a course parallel to the periphery or to the longitudinal direction of the zooids, so that it is impossible to divide the canals into superficial and internal systems as in *Sclerophytum*. The vessels of the canal system are most numerous near the surface—in the deeper portions of the colony they are very sparingly distributed and are confined to the basal portions of the secondary polyps and the adjacent portions of their neighbours (Hickson, 1895, p. 362, Plate 37, fig. 8).

In *Sclerophytum* the superficial and internal canal systems are extremely well marked throughout the colony; near the base the internal system is very complex, owing to the branching and anastomosing of numerous vessels. In the presence of two systems of canals, and in their manner of distribution, *Sclerophytum* resembles *Xenia*.

The canal system of *Sarcophytum* is very similar to that of *Lobophytum*, and differs from *Sclerophytum* and *Xenia* in the absence of a superficial system, and in the fact that the principal longitudinal vessels are direct prolongations of the cœlentera of the siphonozooids.

New canals frequently arise as outgrowths from pre-existing vessels in the following manner :—One or more endoderm cells wander from a canal into the mesoglœa and divide and multiply to form a strand of cells; the individual cells of the strand multiply and form a fairly solid cord of endoderm, which usually remains attached to the canal from which it grew. Eventually a longitudinal splitting occurs and the lumen of the canal is formed (fig. 23).

This investigation of the Ceylon Alcyoniidæ has been carried out in the Zoological Laboratories of the Victoria University of Manchester. I am greatly indebted to Professor Hickson for much valuable advice and kind assistance in my work.

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EXPLANATION OF PLATES.

List of Reference Letters.

amb.c., amœboid cell in mesoglœa.
ap.c., aperture of canal.
au., contracted autozooid.
b.cn., battery of nematocysts.
c.m.l., capitular marginal lobe.
e.au., expanded autozooid.
c.c., cœlenteric cavity.
cap., capitulum.
cap.mar., capitular margin.
cl., clubs.
col.end., columnar endoderm.
c.v., ciliated vessel.
d.m.f., dorsal mesenterial filament.
ect., ectoderm.
end., endoderm.
end.b.w., endoderm body-wall.
end.can., endodermal canals.
g.v., germinal vesicle.
in.m.sp., inter-mesenterial space.
l.m.f., lateral mesenterial filament.
l. lobe.
m., mesentery.
m.ap., mouth aperture.
mar.lob., marginal lobe of capitulum.
mg., mesoglœa.
mg.b.w., mesoglœa body-wall.
mg.c., mesoglœal cells.
mg.d., dense layer of mesoglœa surrounding siphonozooids.
nuc., nucleus.
ov., ovum.
s., stomodæum.
si., siphonozooid.
sp., spicule.
sp.h., hole left by spicule after decalcification.
st., stalk.
tent., tentacle.
tr.s.c., transverse superficial canal.
tu., tubercle-like zooid on the stalk.
v.m., ventral mesentery.
v.m.f., ventral mesenterial filament.
y.au., young autozooid.
yk., yolk of ovum.
zo., *zx.*, zoochlorellæ.

PLATE I.

Fig. 1. *Sarcophytum bicolor*, n. sp.—Drawing of the smaller specimen, which has no capitular marginal seam. Autozooids and siphonozooids are of a beautiful creamy white colour, the remaining portion of the colony being dark grey. × 2.

Fig. 2. *Sarcophytum bicolor*, n. sp.—Different forms of spicules. × 60.

Fig. 3. *Sarcophytum oligotrema*, n. sp.—Drawing to show cup-like form of colony. × $1\frac{1}{3}$. The autozooids on the margin are smaller and relatively more numerous than in the middle of the capitulum. Siphonozooids are very few in number in this species.

Fig. 4. *Sarcophytum oligotrema*, n. sp.—Surface view of a decalcified fragment of the capitulum, about an inch from the margin, to show the relative abundance of autozooids and of siphonozooids. × 27.

Fig. 5. *Sarcophytum oligotrema*, n. sp.—Three warted spicules. × 60.

Fig. 6. *Sarcophytum contortum*, n. sp.—Drawing to show the complicated folding inwards of the capitular marginal lobes (*c.m.l.*). All these lobes arise as marginal ingrowths and not, as in *Lobophytum* and *Sclerophytum*, from the general surface of the capitulum. Autozooids and siphonozooids in this specimen can only be seen with the aid of a lens and are, therefore, not indicated in the drawing. × $1\frac{1}{3}$.

Fig. 7. *Sarcophytum contortum*, n. sp.—Three warted spicules. × 60.

PLATE II.

Fig. 8. *Sclerophytum herdmani*, n. sp.—From a photograph, showing the zooids on the stalk. About $\frac{1}{2}$ nat. size.

Fig. 9. *Sclerophytum herdmani*, n. sp.—Drawings of the different forms of spicules found in this species. *a.b.c.* × 7. *d.e.f.* × 60.

Fig. 10. *Alcyonium ceylonicum*, n. sp.—From a photograph. About $\frac{1}{2}$ nat. size.

Fig. 11. *Alcyonium ceylonicum*.—A contracted autozooid showing 2 large dorsal mesenterial filaments and a ventral mesentery which has no filament. × 60.

Fig. 12. *Alcyonium ceylonicum*.—Three spicules characteristic of the species. × 140.

Fig. 13. Nematocysts of *a*. *Sarcophytum roseum*.—Actual size $8 \cdot 5\mu$ by $4 \cdot 5\mu$.
b. *Sclerophytum densum*.—Actual size 6μ by $4 \cdot 5\mu$.
c. *Sarcophytum glaucum*.—Actual size 20μ by 12μ.
d. *Lobophytum pauciflorum*.—Actual size 7μ by $2 \cdot 5\mu$.

The nematocysts of *Sarcophytum glaucum* are enormous. The thread is loosely coiled within the cell. The internal portion of the thread stains more deeply than the external.

Fig. 14. *Alcyonium digitatum* (British).—Drawing of an extended living tentacle, showing the batteries of nematocysts and the single bi-lateral row of pinnules (*b.cn.*). Cam. luc. × 26.

Fig. 15. *Lobophytum pauciflorum*.—An autozooid tentacle, showing the asymmetrical arrangement of pinnules. × 60. Cam. luc. The tentacles of the tropical species are usually much smaller than those of the British species (fig. 14).

Fig. 16. *Sclerophytum densum*.—Zoochlorellæ: *a* and *b* show early stages of sporogenesis. The cellulose cell walls have disappeared, and the protoplasm and nuclei of the cells show unmistakable signs of division. In *b* the division is more complete than in *a*. *c* represents two very young zoochlorellæ. I have been unable to observe the intermediate stages between *b* and *c*. *a* × 1300, *b* × 1600, *c* × 1200. Cam. luc.

PLATE III.

Fig. 17. *Sclerophytum gardineri.*—Transverse section through a ventral mesentery bearing a typical Alcyonarian ovum. × 930. Cam. luc.

Fig. 18. *Sclerophytum gardineri.*—Transverse section showing the unusual occurrence of two young ova on a dorsal mesentery. × 930. Cam. luc.

Fig. 19. *Lobophytum pauciflorum.*—Transverse section through a siphonozooid just below the surface. All the columnar cells lining the stomodæum are ciliated, but those of the siphonoglyph are more closely packed and have very long flagella. The endoderm is greatly distorted owing to the presence of zoochlorellæ. × 80.

Fig. 20. *Sclerophytum densum.*—Longitudinal section showing stages in development of siphonozooids, Si_1, Si_2, Si_3, by budding. Si_1 is the youngest and is formed as a bud from the endodermal canal leading from Si_3, and by an aggregation of ectodermal cells to form the stomodæum, which in the section consists at this stage of only two cells. A plug of mesoglœa at this stage closes the mouth aperture. Si_2 is an older bud. The development of the stomodæum has advanced, but the mouth aperture is still closed. Si_3 is a siphonozooid which has attained its normal development in this species. The mouth aperture is present and a very rudimentary mesentery (*m.*) is seen on the right. × 600.

Fig. 21. *Sclerophytum densum.*—Longitudinal section through a developing autozooid. The mesenteries are fairly well developed before the mouth aperture and tentacles are formed. Only one mesentery is indicated in the drawing. × 360.

Fig. 22. *Lobophytum pauciflorum.*—Transverse section showing the ciliated communication between two siphonozooids. The endoderm cells differ from those lining the cœlenteron in that they are long, columnar, and are provided with fairly long cilia. × 600.

Fig. 23. *Sclerophytum densum.*—Drawing showing the formation of an endodermal canal by the splitting of a solid cord of cells. × 700.

FIG. 1.

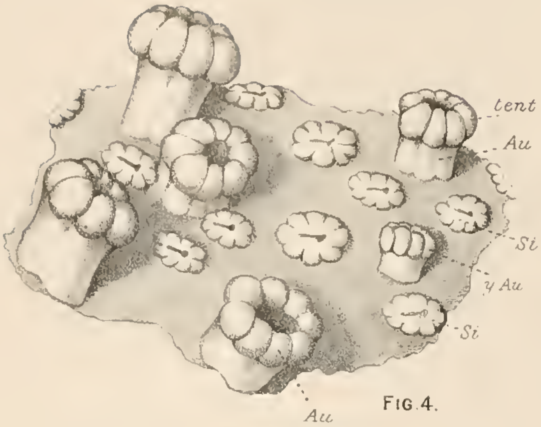


FIG. 4.

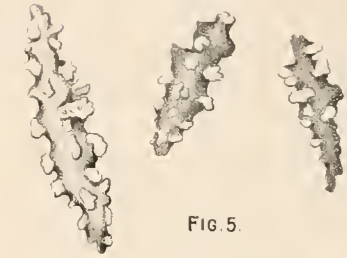


FIG. 5.

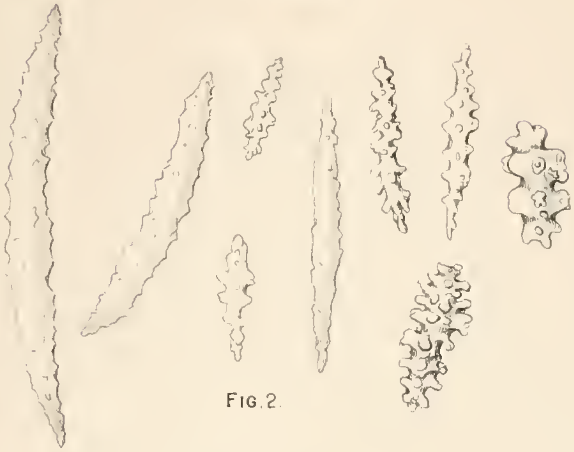


FIG. 2.

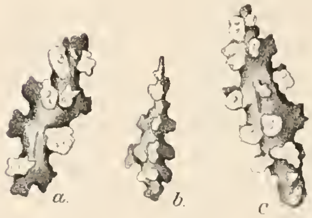


FIG. 7.

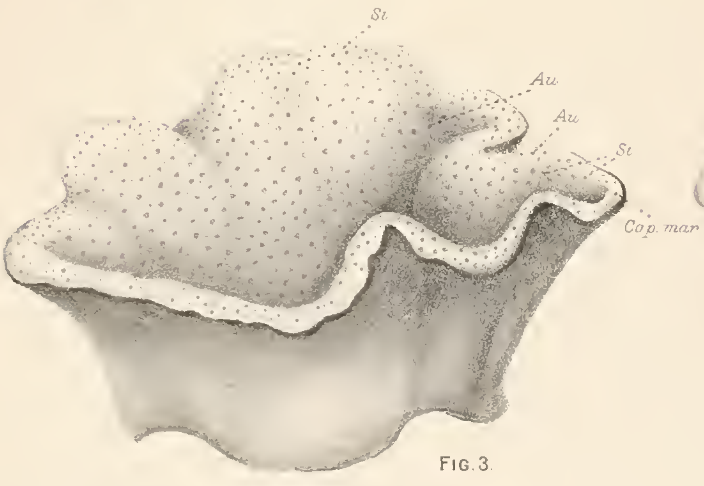


FIG. 3.

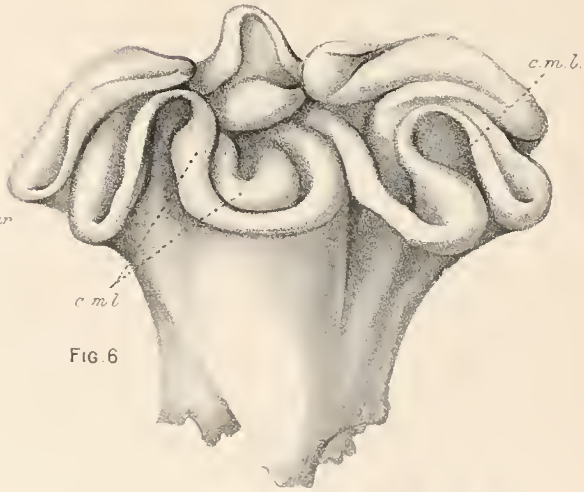


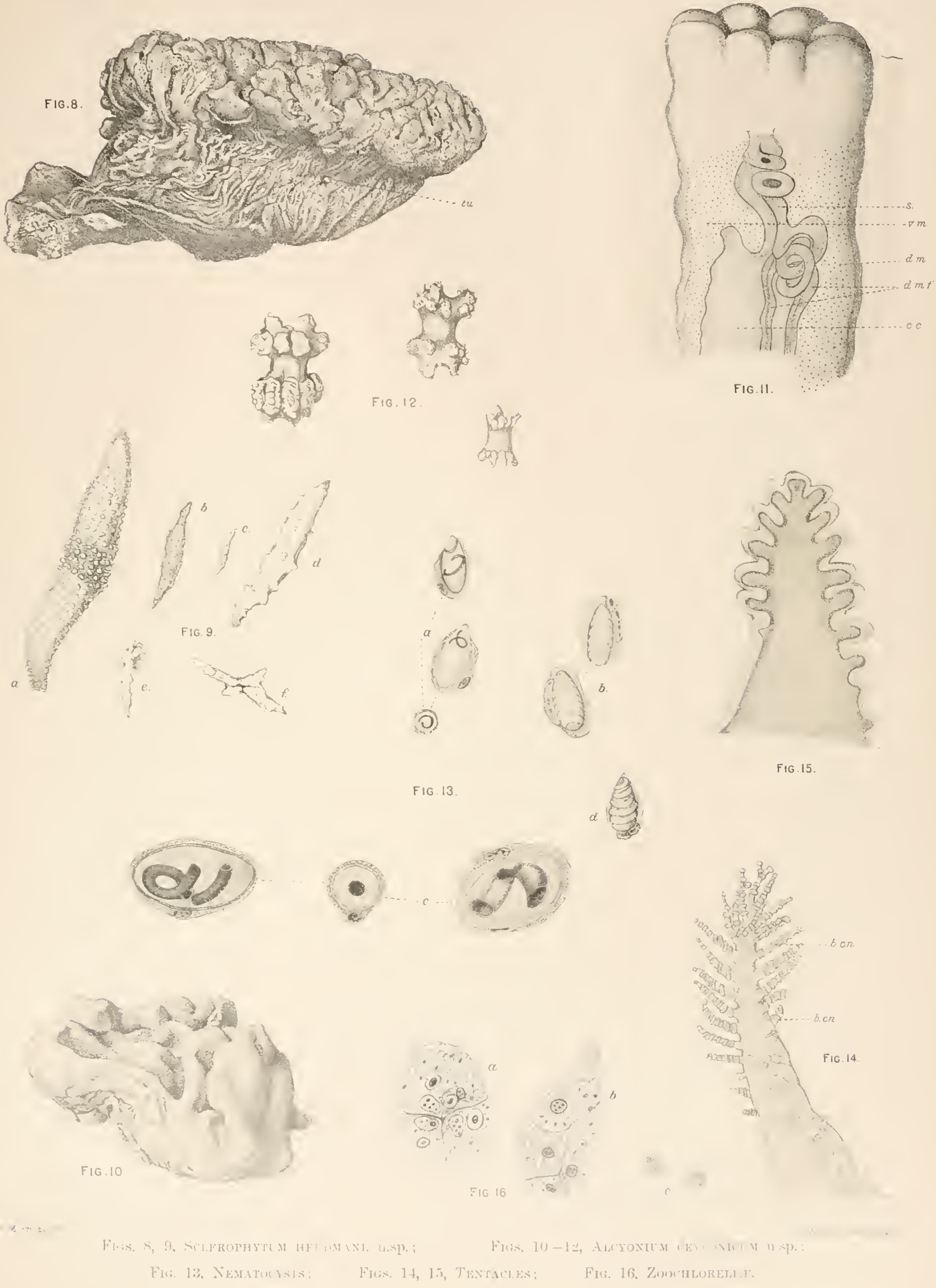
FIG. 6

Fig. 1, 3 & 6 ... E. M. Pratt del.

W... Cambridge

FIGS. 1, 2, SARCOPHYTUM BICOLOR, n.sp.; FIGS. 3–5, SARCOPHYTUM OLIGOTREMA, n.sp.;

FIGS. 6, 7, SARCOPHYTUM CONTORTUM, n.sp.



FIGS. 8, 9, SCLEROPHYTUM HERDMANI n.sp.; FIGS. 10–12, ALCYONIUM CEYLONICUM n.sp.;
FIG. 13, NEMATOCYSIS; FIGS. 14, 15, TENTACLES; FIG. 16, ZOOCHLORELLÆ.

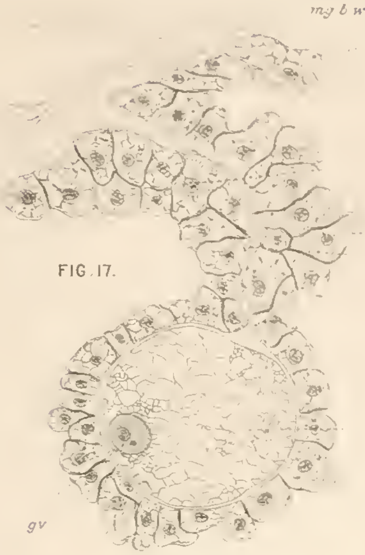


FIG. 17.

FIG. 18.

FIG. 21.

FIG. 20

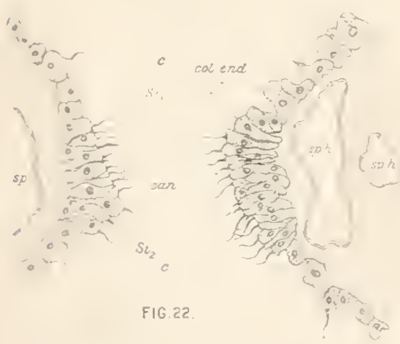


FIG. 22.

FIG 19.

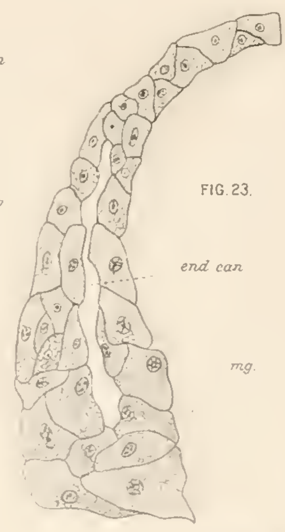


FIG. 23.

REPORT

ON THE

ALCYONARIA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

PROFESSOR J. ARTHUR THOMSON, M.A., UNIVERSITY OF ABERDEEN,

AND

W. D. HENDERSON, M.A., B.Sc., CARNEGIE SCHOLAR,* UNIVERSITY OF ABERDEEN.

[WITH SIX PLATES.]

THE rich collection of Ceylonese Alcyonarians† here reported on was made in 1902 from the Pearl Oyster Banks in the Gulf of Manaar, by dredging within the 100-fathom line off Trincomalee and off Galle, and in adjacent littoral areas. The localities are more precisely referred to in Professor HERDMAN'S "Narrative" in Part I. of the general Report (1903).

As only a few Alcyonarians from Ceylon have been previously recorded, *e.g.*, by THURSTON‡ (1890) and RIDLEY§ (1883), Professor HERDMAN found an almost fresh field, which his faunistic genius recognised as extraordinarily rich. We have not been able to exhaust the material which his skilful collecting has garnered. His collection

* It is more than a formal duty to make grateful acknowledgment of the assistance of the Carnegie Trust: Mr. HENDERSON did part of his share in this Report as a Carnegie Scholar, and I received from the Trust £30 towards the expenses of preparations and drawings.—J. A. T.

† The "fleshy" Alcyoniidæ, *e.g.*, *Alcyonium*, *Lobophytum*, *Sarcophytum*, *Sclerophytum*, are reported on separately by Miss EDITH M. PRATT, D.Sc. (see this volume, p. 247).

‡ THURSTON'S list is as follows:—*Echinogorgia pseudosasappo*, *E. sasappo*, *E. cerea*, *E. furfuracea*, *Plexaura flabellum*, *Juncella juncea*, *Gorgonia (Leptogorgia) miniacea*, *Gorgonella umbella*, *Suberogorgia suberosa*, *Pteroeides javanicum*, *Pt. esperi*, *Virgularia juncea* and *Lituaria* sp.

§ RIDLEY'S list is as follows:—*Alcyonium polydactylum*, *A. submurale*, *Sarcophytum pauciflorum Spongodes* sp., *Rhizoxenia* sp., *Menacella reticularis*, *Echinogorgia pseudosasappo*, *Plexaura flabellum*, *Juncell juncea*, *Suberogorgia verriculata*, *S. suberosa*, and (?) *Corallium nobile*.

is "*littoral*" in the wide sense, but it may be noted that the explorations of the "Investigator" show that the *deep water* off Ceylon is also very rich in Alcyonarians. In reporting on Professor HERDMAN'S collection, we have had to deal with at least 75 species, representing at least 40 genera. About 32 of the species seem to us to be new, and the number might have been considerably increased if we had exercised less restraint. Our restraint in multiplying species has been mainly due to the ignorance that obtains in regard to the internal structure of many Alcyonarian types—an ignorance that cannot be removed without specimens specially preserved for histological purposes. Wonderfully diagnostic as spicules often are, they have been used too confidently and liberally in the establishment not only of species, but of genera, and a secure natural classification of Alcyonarians is still far to seek. Moreover, in some of the forms which we have studied, *e.g.*, *Spongodes*, there is great specific variability both as regards spiculation and branching. As an astounding illustration of diversity of spiculation in a single species, we may refer to our description of the form which we have called *Echinogorgia multispinosa*, n. sp.

Before proceeding to the systematic report, we may call attention to a few facts of general interest :—

(*a*) Very striking is the frequent illustration of "convergence," *i.e.*, the occurrence of superficially similar forms which are not in reality nearly related. Thus, on one occasion, three similar bright red forms were collected in one haul and loosely bound together with thread. An examination of this small parcel disclosed three species belonging to separate genera—*Keroeides gracilis*, *Verrucella rubra*, n. sp., and *Telesto rubra*. Equally marked is the resemblance between *Echinomuricea indo-malaccensis*, RIDLEY, and *Echinogorgia pseudosasappo*, KÖLLIKER, to which RIDLEY calls attention (1883, p. 235), and many other examples might be given.

(*b*) We have compared the Ceylon collection with two others entrusted to us, one made in the Indian Ocean by Major A. ALCOCK, F.R.S., the other made at Zanzibar by Mr. CYRIL CROSSLAND, M.A., and we find that the three collections have extremely little in common. This is mainly because ALCOCK'S collection was from deep water, and CROSSLAND'S chiefly from close in-shore, but it may also indicate that many Alcyonarians have a restricted local distribution. There is also a great difference between the collection here discussed and those made off the Maldives by Mr. GARDINER, and off New Britain, New Guinea, &c., by Dr. WILLEY. It may be of interest to note that three Alcyonarians brought from Patani (Siam) by Mr. NELSON ANNANDALE and Mr. H. C. ROBINSON are unrepresented in HERDMAN'S collection (though included in this report), viz., *Telesto trichostemma*, *Astromuricea ramosa*, n. sp., and *Juncella trilineata*, n. sp.

(*c*) Some of the distributional facts, on the other hand, point in a different direction, showing that species occur in Ceylonese waters which enjoy a wide range elsewhere. Thus the exceedingly beautiful *Primnoa ellisii* is known from the

Mediterranean and from off the Andaman Islands, and *Gorgonia capensis* is known from the Cape and further south. In many respects the Ceylonese Alcyonarian fauna is, *as regards genera*, remarkably cosmopolitan. Few naturalists, however, have contrived to collect so exhaustively as Professor HERDMAN did in his Ceylon expedition.

(*d*) There is in some species great variability in colour, in mode of branching, in dimensions of spicules, and in the proportionate numbers of different forms of spicules. In illustration we may refer to *Spongodes pulchra*, n. sp., *Spongodes bicolor*, WRIGHT and STUDER, *Chironephthya variabilis*, HICKSON, *Bebryce hicksoni*, n. sp., *Verrucella flexuosa*, RIDLEY. In many cases we have given details in regard to these variations, partly as a contribution to the data of variability in general, and partly to facilitate a future revision of species. It can hardly be doubted that many of the Alcyonarian species, *e.g.*, of *Xenia*, *Spongodes*, *Scirpearella*, *Juncella*, and *Verrucella*, are in a state of evolutionary flux, and yet it is at present difficult to reduce the number of species. As we have had numerous specimens of many of the apparently most variable forms, we have not felt justified in regarding these as instances of merely individual variation.

(*e*) As a simple illustration of the way in which even these Alcyonarians may interact with the life of such animals as pearl oysters, we may refer to *Clavularia margaritiferæ*, n. sp., which spreads on the pearl oyster shell, and to the occurrence of young pearl oysters attached to Alcyonarians, *e.g.*, to the branches of *Heterogorgia* sp. Not a few specimens, *e.g.*, *Nephthya lobulifera*, were found attached to dead pearl oyster shells.

(*f*) We have had the pleasure of confirming in *Gorgonia capensis* Professor S. J. HICKSON'S interesting discovery of viviparity.

It may be convenient to place here a classified list of the species reported on :—

ALCYONARIA (EXCLUDING MOST OF THE ALCYONIIDÆ).

ORDER I.: STOLONIFERA.

FAMILY: Clavulariidæ.

**Clavularia margaritiferæ*, n. sp.

FAMILY: Xeniidæ.

Xenia ternatana, SCHENCK.
" *umbellata*, SAV.

ORDER II.: ALCYONACEA.

FAMILY: Alcyoniidæ.

**Bellonella indica*, n. sp.

FAMILY: Nephthyidæ.

Nephthya chabrolii, AUD., var. *ceylonensis*, n.
" *lobulifera*, HOLM.
**Nephthya ceylonensis*, n. sp.
**Eunephthya purpurea*, n. sp
**Paraspongodes striata*, n. sp.
**Capnella manaarensis*, n. sp.
**Spongodes pulchra*, n. sp.
" *bicolor*, WRIGHT and STUDER.
" " " " var. *ceylonensis*, n.
" " " " var. *dubia*, n.
* " *aurantiaca*, n. sp.
" *rosea*, KÜKENTHAL.
" *armata*, HOLM., var. *ceylonensis*, n.
" *dendrophyta*, WRIGHT and STUDER.
" *splendens*, KÜKENTHAL.

* The forms with an asterisk are reported as new.

FAMILY: Siphonogorgiidæ.

**Paranephthya pratti*, n. sp.
Chironephthya variabilis, HICKSON.
Siphonogorgia pustulosa, WRIGHT and STUDER.
„ *miniacea*, KÜKENTHAL.
„ *köllikeri*, WRIGHT and STUDER.

ORDER III.: PSEUDAXONIA.

FAMILY: Briareidæ.

Solenocaulon tortuosum, GRAY.

FAMILY: Sclerogorgidæ.

Keroeides gracilis, WHITELEGGE.
Suberogorgia verriculata, ESPER.

ORDER IV.: AXIFERA.

FAMILY: Primnoidæ.

Primnoa ellisii, v. KOCH.

FAMILY: Muriceidæ.

**Acanthogorgia media*, n. sp.
„ *muricata*, VERRILL, var. *ceylonensis*, n.
* „ *ceylonensis*, n. sp.
**Astromuricea ramosa*, n. sp.
Echinomuricea indo-malaccensis, RIDLEY.
* „ *ceylonensis*, n. sp.
Echinogorgia pseudosasappo, KÖLLIKER.
* „ *multispinosa*, n. sp.
**Heterogorgia verrilli*, n. sp.
**Bebryce hicksoni*, n. sp.
**Acamptogorgia atra*, n. sp.
„ *spinosa*, HILES.
„ „ var. *ceylonensis*.
**Acis indica*, n. sp.
* „ *alba*, n. sp.
„ *orientalis*, RIDLEY.
* „ *ceylonensis*, n. sp.
**Muricella ramosa*, n. sp.
* „ *ceylonensis*, n. sp.
„ *nitida*, VERRILL.
„ *complanata*, WRIGHT and STUDER.

FAMILY: Plexauridæ.

Plexaura prælonga, var. *typica* (RIDLEY).
„ „ „ *elongata*, n.
„ *antipathes*, var. *flexuosa*.

FAMILY: Gorgonidæ.

Lophogorgia lutkeni, WRIGHT and STUDER.
* „ *rubrotincta*, n. sp.
**Lophogorgia irregularis*, n. sp.
Leptogorgia australiensis, RIDLEY, var. *flavotincta*.
„ „ „ „ *perflava*.
„ (?) sp.
**Stenogorgia ceylonensis*, n. sp.
Gorgonia capensis, HICKSON.
Rhipidogorgia sp.

FAMILY: Gorgonellidæ.

**Scirpearella aurantiaca*, n. sp.
* „ *divisa*, n. sp.
„ sp. α.
„ sp. β.
„ sp. γ.
Scirpearia sp.
Junceella gemmacea, VALENCIENNES.
„ *juncea*, PALLAS.
„ *fragilis*, RIDLEY.
„ „ „ var. *rubra*, n.
* „ *trilineata*, n. sp.
**Verrucella rubra*, n. sp.
„ *flexuosa*, KLUNZ., var. *aurantiaca*, n.
„ „ var. *gallensis*, n.

ORDER V.: STELECHOTOKEA.

SECTION I.: ASIPHONACEA.

FAMILY: Telestidæ.

Telesto rubra, HICKSON.
„ (*Carijoa*) *trichostemma*, WRIGHT and STUDER.

SECTION II.: PENNATULACEA.

FAMILY: Umbellulidæ.

Umbellula sp.

FAMILY: Virgularidæ.

Virgularia multiflora, KNER.
„ *loveni*, KÖLLIKER.
* „ *tuberculata*, n. sp.
„ sp.

FAMILY: Pennatulidæ.

**Halisceptrum periyense*, n. sp.
„ *gustavianum*, HERKLOTS.
Pteroeides lacazei, var. *spinosum*, KÖLLIKER.

FAMILY: Veretillidæ.

Cavernularia obesa, VALENCIENNES.
**Stylobelemnoides herdmani*, n. gen. et sp.

* The forms with an asterisk are reported as new.

DESCRIPTION OF THE SPECIES.

ORDER I.: STOLONIFERA.

FAMILY: CORNULARIIDÆ.

Clavularia margaritiferæ, n. sp.—Plate III., fig. 8.

The stolon consists of a number of thin and narrow branching threads, forming a network on the surface of a pearl-oyster shell. The strands of the stolon vary in breadth from 0·4 millim. to 0·6 millim. They do not form any membranous expansion. The polyps arise vertically from the branches of the stolon at intervals of 2 millims. to 2·5 millims.; there does not seem to be any interpolation of new polyps among the older.

The polyps measure 3 millims. in height, with a distal diameter of 0·9 millim., and a proximal of 0·5 millim. to 0·65 millim. They are thus broader than the stolon branches, *cf. Clavularia reptans*, HICKSON (1895). They have, in all cases, their crowns retracted; there is no indication of longitudinal grooves or lines.

The walls of the polyps and of the stolons show thickly crowded spicules of minute size (0·06 millim. to 0·07 millim. × 0·03 millim. to 0·04 millim.) interlocked by their wart-like projections, *cf. Clavularia flava*, HICKSON (1895). Most of the spicules are substantial rods bearing blunt wart-like projections often in a whorl of four towards each end. The short and simple tentacles, bearing a few blunt pinnules (not sufficiently fixed to allow of precise examination) are supported by numerous longitudinally disposed elongated and curved rods, which may measure 0·1 millim. in length. They are smooth and only occasionally bear projections. All the spicules are colourless, and the whole colony is white in its preserved condition.

Locality:—Pearl banks, Gulf of Manaar.

FAMILY: XENIIDÆ.

Xenia ternatana, SCHENCK.

A single specimen attached to a sandy worm-tube, with polyps in three groups, agrees on the whole with *Xenia ternatana*, SCHENCK, notably in having only two rows of pinnules on each side of the tentacles, and about 18 slender pinnules in each row, as also in the measurements of the polyp-body and of the tentacles.

Xenia umbellata, SAV.

Attached to the substratum of another specimen, which we unfortunately omitted to note in the business of assortment, there was a species of *Xenia* which appears to be referable to *X. umbellata*. The locality was low water at Pamban. We assume that the presence of only two species of *Xenia* in the collection simply means that Professor HERDMAN'S work was outside the *Xenia*-zone. There must be many species of *Xenia* in Ceylon.

ORDER II.: ALCYONACEA.*

FAMILY: ALCYONIIDÆ.

The genera *Sarcophytum*, *Sclerophytum*, *Lobophytum*, and *Alcyonium* are discussed in Miss PRATT'S Report, this volume, p. 247. There has been left to us to describe what seems to be a new species of the little-known genus *Bellonella*.

Bellonella indica, n. sp.—Plate VI., fig. 5.

A small cylindrical specimen of a crimson-vermilion colour with yellow calyces and white polyps. It is attached to a fragment of rock and stands 24 millims. in height, with a basal diameter of 10 millims. and an apical diameter of 6 millims. The lower half is a sterile trunk, the upper half bears crowded polyps, whose white colour contrasts well with the red of the general cœnenchyma and the rich yellow of the calyces. Many of the calyces measure 1 millim. in diameter, and the interval between them is often the same. Smaller forms occur among the larger, but there is no evidence of dimorphism of zooids. The margin of the calyx is neatly 8-lobed, and here and there the white polyps are expanded. The tentacles, which seem to run somewhat markedly to a triangular point, bear on each side about 18 finger-like pinnules. A longitudinal cut shows the large longitudinal canals traversing the bright red cœnenchyma, and the eight longitudinal strands in each canal stand out sharply as bright white lines.

The spicules of the cœnenchyma are of an orange-red to yellowish colour, mostly like knobbed capstans, or double clubs with large warty heads, or double wheels with a very slight constriction between them. They form a granular pavement over the surface and densely fill the cœnenchyma. In the sterile trunk there seem to be no double clubs in the strict sense; the form is more like a knobbed dumb-bell with an exceedingly slight and short constriction in the middle. In all cases the warts are few, large, and blunt. The spicules are thus unlike the fusiform echinate forms reported as characteristic of *Bellonella*, but the genus has not been well defined, and it may be noted that two isolated polyps showed a few colourless or faintly yellowish fusiform spicules with a few thorns. It is not certain, however, that these belonged to the polyp; they may have been artificial inclusions.

The following measurements of the typical spicules were taken, length and breadth, in millimetres:—

0·08 × 0·06 (0·04 at middle); 0·06 × 0·06 (0·04 at middle); 0·06 × 0·045; 0·06 × 0·04; 0·05 × 0·04 (0·03 at the middle); 0·045 × 0·0375 (0·025 at the middle).

The specimen is very different from *Bellonella* (*Cereopsis*) *bocagei*, SAV. KENT, and *B. variabilis*, STUDER, but neither of these agrees conspicuously well with GRAY'S

* Exclusive of the Alcyoniidæ described by Miss PRATT (this vol., p. 247).

original definition. GRAY's description of *Bellonella granulatum* ('Proc. Zool. Soc.,' 1862, p. 35) is unfortunately short and vague. He speaks of the "angular tips" of the calyces; he figures longitudinal furrows on the stem, and these features are here absent. It seems better, therefore, to start afresh with a new species.

Locality :—Deep water south of Galle.

FAMILY: NEPHTHYIDÆ.

SUB-FAMILY: SPONGODINÆ.

Nephthya chabrolii, AUD., var. **ceylonensis**, n.

To this species, known to include several varieties (KÜKENTHAL, 1903, p. 157), we refer a specimen which differs from ordinary forms of *N. chabrolii* in being dull greyish-white, and in having a "Stützbündel" spicule projecting beyond the polyp for 0·5 millim. The following comparison with KÜKENTHAL's description of *N. chabrolii* may serve to illustrate dimensional variability.

	Polyp.		Polyp spicules.		Stem spicules.	
	Length.	Breadth.	Length.	Breadth.	Length.	Breadth.
	millims.	millims.	millims.	millims.	millims.	millims.
KÜKENTHAL's measurements.	0·5 to 0·7	0·5 to 0·7	0·08 to 0·45	0·015 to 0·06	1·1 to 1·9	0·12 to 0·26
HERDMAN's specimen . . .	0·6 ,, 0·7	0·6 ,, 0·65	0·15 ,, 0·35	0·02 ,, 0·06	0·65,, 2	0·16 ,, 0·26

For description, see HOLM (1895).

Locality :—Pearl banks, Gulf of Manaar, March, 1902, and DONNAN's Paar.

Nephthya lobulifera, HOLM.

From an elongated base attached to an oyster shell there rise 7 main branches apparently flaccid in character, bearing numerous lobes of unequal size and variable arrangement. On these the polyps occur in groups often united by a few individuals scattered in the intervening spaces. The polyps are light yellow and stand out prominently against the general white colour of the colony. They measure 0·7 millim. to 1·3 millims. in length. The "Stützbündel" spicules are strong, slightly curved, warty spindles up to 1·9 millims. in length; the three longest project beyond the polyp. The polyp spicules measure 0·06 millim. to 0·25 millim., and the stem spicules 1·1 millims. to 1·95 millims. in length. For description, see HOLM (1895).

Locality :—1½ miles off Old Dutch Modragam Paar, Gulf of Manaar.

Nephthya ceylonensis, n. sp.—Plate I., fig. 4.

A small rigid colony fixed to a stone rises to a height of 38 millims., giving off three lobes crowded with polyps. The general colour of the lower part of the stem is greyish-white, but in the region of the polyps the colour is light violet, and the polyps themselves are canary-yellow. The lower part of the stem has a stiff leathery character and a granular appearance; the upper part is entirely covered with large spicules which are for the most part disposed longitudinally.

The polyps occur in small almost contiguous groups or singly. Each is an elongated cylinder, standing at right angles to the "Stützbündel," measuring 1·2 millims. in length by 0·8 millim. in breadth.

The spicules of the lower part of the stem consist of short thick spindles (1·1 millims. to 1·4 millims. in length by 0·1 millim. to 0·2 millim. in breadth), sometimes bifurcate or trifurcate at one end, and also of triradiate and quadriradiate forms. All exhibit numerous blunt warts.

In the upper part the spicules are spindle-shaped, covered with numerous spines, and tinged with violet. Some of them are forked at one end, and a few give off a short branch about the middle of their length. They vary in length from 1·1 millims. to 2·4 millims., and in breadth from 0·1 millim. to 0·18 millim. Those of the "Stützbündel" measure 1·55 millims. to 1·8 millims. There is only a slight projection beyond the polyp.

The polyp spicules are very small, deeply tinged with yellow, measuring 0·4 millim. by 0·08 millim.

Eunephthya purpurea, n. sp.—Plate I., fig. 3; Plate V., fig. 5.

This species is represented by several specimens which present a striking appearance owing to the contrast between the yellow polyps and the purple-red of the stem and branches. The stem is large and flaccid, and gives off numerous small branches and twigs. The superficial cœnenchyma is rough, and has a granular appearance due to the arrangement of the numerous small spicules. The twigs, however, have a different appearance, for there the spicules are longer and are mainly disposed transversely. Two good specimens measured in centimetres,—11 × 7 and 12 × 3.

The spicules of the lower part of the stem are very short, irregularly branched rods with prominent spines. They measure 0·1 millim. in length by 0·08 millim. in width. The spicules of the twigs and the tip of the stem are slender spindles, varying in length from 0·23 millim. to 0·25 millim. and in breadth from 0·02 millim. to 0·023 millim.

The polyps are scattered over the stem and branches, occurring either singly or in small groups. They are yellow in colour, and they contrast well with the red colour of the twigs and branches. The length of the polyps is 0·9 millim. to 1 millim. and the width varies from 0·5 millim. to 0·6 millim. The polyp spicules are very small yellow spindles with prominent warts and spines. Their measurements are 0·14 millim. to 0·3 millim. in length and 0·015 millim. to 0·03 millim. in breadth. Below the anthocodial part of the polyp there is a collar formed of several rings of spicules, red in colour, which measure from 0·5 millim. to 0·7 millim. in length by 0·04 millim. to 0·06 millim. in breadth.

Localities :—Pearl banks off Aripu, Gulf of Manaar; and deep water off Galle.

Paraspongodes striata, n. sp.—Plate II., figs. 2 and 7.

A specimen without "Stützbündel," with no spicules in the canal walls, and polyps disposed in well-defined bundles must be referred to the genus *Paraspongodes* (see Kükenthal, 1896).

The colony studied stands 67 millims. high by 49 millims. in maximum breadth; the general colour is whitish. A short substantial stem gives off three main branches which divide and re-divide, so that the appearance of an irregular corymb of umbels results. The average length of a terminal branch is 4 millims. The polyps occur in bundles of 6 to 7, and these bundles are grouped to form an umbel. A much finer specimen, which was left at Liverpool, measured 22 centims. in height, 11 centims. before the first branching, and 4 centims. across at the base.

The superficial cœnenchyma of the branches is deeply striated transversely, we may almost say ringed, and is tough in character; on the main stem the surface is irregularly wrinkled and rough in texture.

The polyps vary in length from 1·1 millims. to 2·3 millims., and in breadth from 0·65 millim. to 0·9 millim. They are supported by spindle-shaped spicules uniformly disposed in contiguous longitudinal rows, and measuring 0·18 millim. to 0·6 millim. in length by 0·04 millim. to 0·06 millim. in breadth. The tentacles measure 0·6 millim. in length, and two or three pairs of plump pinnules are visible.

In the cœnenchyma the spicules are minute but very numerous. They occur as rough spindles or rods irregularly branched, and also as what may be called irregular stars. They vary in length from 0·09 millim. to 0·16 millim., and in breadth from 0·03 millim. to 0·06 millim.

Locality :—Deep water outside pearl banks, Gulf of Manaar.

Another larger specimen, 169 millims. in length by 69 millims. in maximum breadth, from the same locality seemed at first different.

It had a relatively much longer stalk with basal rhizoid branches; it showed greater transparency of texture, less abundant superficial spicules, less marked transverse wrinkling, and a larger number (7 to 11) of polyps in each bundle. Closer examination showed essential agreement as to spicules, polyps, tentacles, &c. The measurements for this specimen show considerable variation, as the following table indicates :—

Polyps.		Polyp spicules.	
Length.	Breadth.	Length.	Breadth.
millims.	millims.	millims.	millims.
1·2	0·8	0·6 0·63	0·05 0·05
1·3	0·85	0·7	0·05
0·9	0·7	1·0 0·9	0·10 0·08
1·0	0·8	0·25 0·18	0·016 0·03

Capnella manaarensis, n. sp.—Plate II., fig. 4 ; Plate V., fig. 14.

A specimen without "Stützbündel," with numerous spicules in the canal walls, and with the polyps arranged not in bundles but in conical lobes or catkins, we refer to the genus *Capnella*, as reconstructed by KÜKENTHAL (1902).

The colony is fairly rigid and stands 79 millims. high by 75 millims. in maximum breadth. The general colour is a greyish-white or a dirty white. A short stem gives off several main branches, which in their ultimate divisions give rise to polyp-bearing lobes or catkins.

The superficial cœnenchyma of the branches and the main stem is rough in texture and has a stringy appearance owing to the arrangement of the spicules.

The polyps have an average length of 0·95 millim. by an average breadth ot 0·65 millim. They are supported by spindle-shaped spicules which are arranged longitudinally, and vary in length from 0·29 millim. to 0·55 millim. and in breadth from 0·04 millim. to 0·08 millim.

In the cœnenchyma the spicules are spiny spindles. They are usually straight or curved, but several show a bifurcation at one end, or give off a short branch near their middle point. They show considerable variation in size, measuring from 0·5 millim. to 1·35 millims. in length and 0·10 millim. to 0·16 millim. in breadth.

Locality :—Pearl banks off Aripu, Gulf of Manaar.

Spongodes pulchra, n. sp.*—Plate I., fig. 5 ; Plate V., fig. 10.

This species is represented by many specimens, 3 of which give the following measurements :—

* The third instalment of Professor W. KÜKENTHAL'S "Versuch einer Revision der Alcyonarien" ('Zool. Jahrb.,' xxxi., 1905, pp. 503–726, 7 pls., and 61 figs.) appeared while this report was being passed for press, and it could not be utilised. He splits the old genus *Spongodes*, with which one is loth to part, into the two new genera *Dendronephthya* and *Stereonephthya*, with 90 species to the former and 8 species to the latter. Everyone will welcome KÜKENTHAL'S important contribution to the study of a difficult and polymorphic genus, but what is gained by trying to do away with the old title *Spongodes*, which is practically equivalent to *Dendronephthya*, just as *Spongodia* is to *Stereonephthya?* KÜKENTHAL has studied

	(A.)	(B.)	(C).
Total height	66 millims.	66 millims.	36 millims.
Length of trunk	14 ,,	13 ,,	9 ,,
,, ,, head	52 ,,	53 ,,	27 ,,
Maximum width of same .	39 ,,	43 ,,	21 ,,

The trunk or bare part of the stem is granular in appearance and leathery in texture. In (B.) and (C.) it is greatly wrinkled, owing to the large canals and the weak partition walls between.

The branching is very profuse, the stem giving off a large number of primary branches which break up into secondaries, and these in their turn into the twigs bearing the polyps. The twigs or tertiary branches bear the polyps in corymb-fashion, so that they all reach the same level, and owing to the large number of the polyps the stem and branches are completely hidden.

The polyps are arranged in groups of 4 to 6, and they in their turn are aggregated into larger bundles. They are red, with markedly white tentacles. Although some of the spicules close to the polyps become a little stronger, none of them project, so that the colony has not the slightest appearance of being spiny.

The surface of the stem is rough to the touch and has a granular appearance. In the primary and secondary branches, however, the spicules appear more prominently and give the surface an irregular stringy appearance, and finally they take an almost longitudinal arrangement in the twigs.

In (A.) the stem, primary and secondary branches are almost white, while in (B.) and (C.) they are yellow. In (A.) the twigs are white, but become pinkish below the polyps, while in (B.) and (C.) they are yellowish, but also become pink below the polyps. Thus there is considerable colour-variation.

The spicules of the trunk are very short and furnished with long spines. They are very varied in shape—short rod-like bodies, 3-rayed stars, and irregular crosses. In all, however, the spines are well developed. They measure, length by breadth, in millimetres, as follows :—$0{\cdot}15 \times 0{\cdot}1$; $0{\cdot}2 \times 0{\cdot}05$; $0{\cdot}20 \times 0{\cdot}1$; $0{\cdot}5 \times 0{\cdot}15$. All these measurements include the spines, which often measure $0{\cdot}04 \times 0{\cdot}02$; $0{\cdot}03 \times 0{\cdot}02$; and $0{\cdot}045 \times 0{\cdot}01$.

The spicules of the stem and branches are long slender spindles, usually curved or bent and covered by fairly prominent spines. They measure, length by breadth, in

213 specimens in all, but in many cases he only studied one (32) or two (21). He makes 30 new species, some of which may correspond to those here described as new, though we have not been able as yet to satisfy ourselves as to any identity. We venture to predict, however, that further study of this prolific genus, whether it be called *Spongodes* or *Dendronephthya*, with say ten specimens of each species, will *increase* the number of quite distinct species, and will *lessen* the number of closely adjacent species, reducing them to varietal forms. Even on a single colony there is often great diversity, and the impression of great lability is increased when we compare different specimens of the same species collected on the same date from the same locality.—J. A. T.

millimetres, as follows:—1·05 × 0·56; 0·55 × 0·06; 0·73 × 0·04; and 0·47 × 0·05. The longest reach a length of 1·7 millims., 1·6 millims., and 1·5 millims.

The specimens differ markedly from all the previously described species of this large and difficult genus.

Locality:—Station LXVI., off Mutwal Island, 10 to 35 fathoms; Cheval Paar, Gulf of Manaar.

Spongodes bicolor, WRIGHT and STUDER.

This species is represented by a fairly large complete colony, which consists of a short trunk and a long head, formed by a large number of branches given off on all sides. The base is formed of numerous rhizoid-like offshoots, which are attached to grains of sand, to sponge spicules, and to particles of shells.

The stem is soft and flaccid, and gives off flabby branches on all sides. The majority of the lower branches are flattened, the flattening taking place not from above downwards but from side to side.

The stem and branches have thin semi-transparent walls with numerous fine spicules scattered all over, some of them projecting so as to give the surface a pubescent appearance. The measurements of the polyps and of the spicules agree with those given by WRIGHT and STUDER (1889).

Locality:—Deep water off Galle.

Spongodes bicolor, WRIGHT and STUDER, var. **ceylonensis,** n.

The trunk of this specimen is very short, and does not seem to be distinctly marked off from the stem except in the spiculation.

Small branches are found coming off to within a few millimetres of the lower end of the trunk. The spicules are more distinct in the stem and give a net-like appearance to its surface, while the surface of the trunk is granular.

Two of the lower branches are flattened from above downwards and nearly surround the stem, but just below the two spaces left between them there are two ordinary branches.

The polyps are red, with white tentacles, and a "Stützbündel" spicule projects behind each polyp.

The colour of the trunk, stem, and branches is a yellowish-white, that of the polyps and twigs being red; the lower part of the twig may be yellowish.

This form differs from *Spongodes bicolor* in several respects, but yet comes very near it.

Spongodes bicolor, WRIGHT and STUDER, var. **dubia,** n.—Plate V., fig. 13.

Another variety is represented by a specimen measuring 71 millims. in height and 61 millims. in maximum breadth. It may be a portion of a larger colony or an entire colony in which the base is wanting.

The stem is flaccid and gives off branches almost to the base, the lower branches are flattened and give off ordinary branches from their upper surfaces.

The polyps are arranged in umbels of 10 to 13 polyps. The polyps are white, but have a red appearance, owing to the spicules; the tentacles have white or colourless spicules.

The spicules of the stem are long, slender, colourless spindles covered with spines, and varying in length from 1·55 millims. to 0·6 millim., and in width from 0·12 millim. to 0·08 millim. The spicules of the terminal twigs and polyps are slender spindles, yellowish-red in colour and thickly beset with spines. They vary in length from 0·1 millim. to 1·65 millims., and in breadth from 0·02 millim. to 0·09 millim.

As this form agrees in many respects with *Spongodes bicolor*, we have ranked it provisionally as a variety.

Spongodes aurantiaca, n. sp.—Plate I., fig. 9; Plate V., fig. 6.

In this species the trunk is long, stiff, leathery in character, and granular in appearance, but the individual spicules become evident at the upper end.

The stem is divided into two main branches, from which the primary and secondary branches arise. The four lowest branches are flattened from above downwards, and so form a complete collar to the trunk. They are also recurved, so that they hide the upper part of the trunk. Their edges are very much divided, and they carry the polyps singly on the edges. From their upper surface spring ordinary branches. The other branches stand at right angles to the stem, but the upper ones are directed obliquely upwards.

The polyps are borne singly at the ends of the twigs, and also in bundles of 6 to 7, all reaching the same level. They are white in colour and backed by strong "Stützbündel" spicules.

The colony presents a striking appearance, due to the marked contrast between the orange-coloured stem and branches and the white polyps. The trunk is orange-coloured at the upper end, but it gradually becomes a whitish-grey as the lower end is reached.

The "Stützbündel" spicules vary in length from 2·7 millims. to 3·3 millims., while the stem and branch spicules vary from 0·5 millim. to 2·1 millims. in length.

Spongodes rosea, Kükenthal—Plate V., fig. 1.

What we regard as a variety of this species is represented by a stiff colony, with a bare stalk very much shrunken, owing to the large canals and the thin partitions between them. Height of colony, 70 millims.; length of stalk, 22 millims.; diameter of same, 11 millims.

The lower branches, 6 in number, are flattened from above downwards, breaking up at their edges into single polyps and groups of polyps, and giving off cylindrical branches from their upper surfaces. Immediately above these the stem gives off a large branch which repeats the structure of the stem. Over the whole surface of stem and branches smaller branches are given off which also branch.

The colour of the stem is greyish-white below, white above, while the smaller branches are orange-coloured. The polyp-cups are a dark purple-red, the tentacles white.

The surface texture of the specimen presents two quite different aspects. On the bare stalk the surface has a granular appearance caused by the large number of very small closely packed spicules which grow larger as the upper part of the stalk is reached. On the branch-bearing part, and also on the branches, a stringy appearance is produced by the larger spicules.

The polyps occur in bundles of 4 to 8. The projecting spicules are usually red throughout, but sometimes the lower part is yellow. The spicules are as follows:—

(*a.*) *Of polyps and terminal twigs.*—Yellow, or red, or partly yellow, partly red, covered by numerous small spines; Stützbündel, 2·6 millims. × 0·17 millim.; polyp spicules, 0·03 millim. × 0·04 millim.; others, 1·5 millims. × 0·1 millim., 1·7 millims. × 0·12 millim.

(*b.*) Of the stem, upper part.—Similar to those of (*a.*), but the majority are colourless, or very faintly tinged with yellow. Spines more prominent and appear rougher.

(*c.*) Of the bare lower part of stem.—Shorter, thicker, and with more prominent spines than (*a.*) and (*b.*). Spines more numerous and of greater diameter than the above. The spicules of (*c.*) measure 0·76 millim. to 0·69 millim. × 0·16 millim., 0·42 millim. × 0·18 millim., 0·26 millim. × 0·10 millim. Many of the spicules in (*c.*) are in the form of crosses. In several an X-shaped marking is seen as if the 4 arms of the cross were dovetailed into one another.

Another specimen similar in appearance to the above has its branching *restricted to one plane.*

In its texture and flattened branches, &c., it agrees with the above. The tentacles are white, but owing to their state of retraction they do not show so much. The base of attachment shows the rhizoid outgrowths frequent in *Spongodes* and allied genera.

While these specimens do not rigidly correspond to the description given of *Spongodes rosea*, the resemblance is too close to warrant separation.

Localities:—Deep water outside pearl banks, Gulf of Manaar; and Trincomalee.

Spongodes armata, HOLM, var. **ceylonensis,** n.—Plate I., fig. 6.

This foliate divaricate colony consists of a cylindrical barren trunk, attached at its base by means of rhizoid outgrowths to sand and fragments of Mussel shells, and a much branched upper portion which forms an irregularly oval-shaped head. Everywhere spicules project, thus giving a spiny appearance to the head portion. The little violet coloured polyp heads contrast well with the orange coloured twigs.

	Specimen A.	Specimen B.
Length of trunk (bare part of stem) .	21 millims.	32 millims.
Diameter of same	10 ,,	13 ,,
Length of head	52 ,,	55 ,,
Maximum width of same	32 ,,	41 ,,

The trunk (or bare part of the stem) has a leathery rigid character and a rough granular appearance. It is slightly thicker at the top, and at its lower end gives off thin rhizoid-like outgrowths. In specimen B these are also given off for a short distance up the trunk.

The stem gives off larger and smaller branches, and divides at the tip into 2 or 3 branches. It appears longitudinally streaked, owing to the disposition of the large spicules. The lower branches are flattened (6 in one, 4 in the other). The others rise at right angles to the stem, the upper ones being directed obliquely upwards. Some of the lower ordinary branches are slightly flattened. The 4 to 6 flat branches are recurved and directed downwards.

Locality :—Deep water off Galle.

Spongodes dendrophyta, Wright and Studer.

This species is represented by several specimens, one of which is evidently a young form. The base of attachment consists of rhizoid-like outgrowths. The lowest branches are flattened from above downwards, and bear the polyps on the edge of the flattened portion. The appearance of the stem in the older specimens is quite granular, but this gives place in the younger form to a slightly stringy appearance, due to the spicules being larger. In the older specimens the polyps are more markedly arranged in bundles, while they have a tendency to stand singly in the younger. Several of the lower branches are colourless, and there is a great variability in the colour of the spicules.

The geographical range of this species is worthy of note, as its previous record is from the Philippines.

Locality :—Gulf of Manaar.

Spongodes splendens, Kükenthal—Plate I., fig. 2.

This species is represented by numerous stiff and rigid colonies. The following measurements are taken from two of them :—

	A.	B.
Length of trunk	29·5 millims.	17 millims.
Diameter of same	13·5 ,,	12 ,,
Length of head	69 ,,	30 ,,
Maximum width of same	61 ,,	40 ,,

The stem in its lower portion is tough and rigid in character and granular in appearance, which in the upper portion gives place to a streaked appearance due to the larger spicules being disposed for the most part longitudinally.

The lowest branches, two in number, are flattened from above downwards, and are bent downwards so as to hide the upper portion of the trunk. The other branches are more or less cylindrical and rise at right angles to the stem, the uppermost being directed obliquely upwards. The secondary branches give rise to the twigs which bear umbels of 6 to 8 divergent stipitate polyps.

The lower portion of the stem has a yellowish-white colour, the upper portion of the stem and the branches are yellow, while part of the twigs and the polyp spicules are brick red to dull red in colour. Several of the spicules consist of a colourless sheath surrounding a central core of a deep yellow to orange-yellow which extends for about half the length of the spicule.

The spicules vary very much in the specimens. The "Stützbündel" spicules vary in length from 2·9 millims. in some to 2·2 millims. in others, and even to 1·5 millims. The stem spicules vary from 0·75 millim. to 2·3 millims. in length, but in one specimen they reach 4·5 millims. in length. The polyp spicules also show considerable variation, but it does not cover such a range as in the others.

Some other specimens correspond more closely than the above do to previous descriptions of this species. It appears to us that many of the species of *Spongodes* are exceedingly variable, and we have therefore refrained from accentuating minor differences.

Locality :—Cheval Paar ; pearl banks, Gulf of Manaar.

SUB-FAMILY : SIPHONOGORGINÆ.

Paranephthya pratti, n. sp.—Plate II., fig. 6 ; Plate V., fig. 18.

A peculiar specimen with only the basal attachment missing was included in the collection. We are indebted to Miss PRATT for a figure and the following notes.

The colony, which is apparently young, is small and measures as follows :—

Height 21 millims. ; stalk 15 millims.

Breadth of stalk, 13 millims. to 11 millims., of capitulum, 24 millims. to 20 millims.

The capitulum is lobate, with deep grooves between the digitate lobes.

The lobes (7 in number) are digitate and are comparatively large. The largest is 13 millims. in height by 7 millims. to 5 millims. in diameter. The smallest is 3 millims. in height by 5 millims. to 4 millims. in breadth. Some of the lobes are beginning to branch dichotomously.

The capitula are dotted with minute tubercles, and when observed under the microscope have a curious polyzoon-like appearance. These tubercles indicate the presence of the zooids which are small, degenerate in character, and are so overgrown with minute spicules as to be only slightly contractile. They have apparently only rudiments of tentacles. The mesenteries are crowded with brown cells which are probably zoochlorellæ. In many cases there appears to be no aperture to the exterior.

The colony is extremely hard, the surface being rough and granular to the touch. The colour of the spirit specimen is medium brownish-grey, which becomes deeper towards the base of the stalk.

There is no doubt that this interesting form is near *Paranephthya capitulifera*, WRIGHT and STUDER; but it is a quite distinct species.

Chironephthya variabilis, HICKSON.

This species is represented by a magnificent specimen, measuring 21 centims. by 20 centims. The base measures 3·5 centims. by 4 centims. There is a very marked "weeping willow" appearance, as almost all the twigs are pointing downwards. This is probably the finest specimen of its kind that has been hitherto obtained. There are also numerous fragments, and one or two specimens which may be complete young forms.

The colour is very variable in the different specimens and even in the different parts of the same specimen. In several fragments the general cœnenchyma is white with red spots here and there on the surface; in others it is yellowish-white with red spots. When the general cœnenchyma is white in colour, a pinkish tinge becomes gradually more marked in the branches until it finally predominates, thus giving the tips of the branches and twigs a deep pinkish-red colour. In the specimens with a yellowish-white general cœnenchyma the pinkish tinge increases as before, but in this case the tips of the branches have an orange colour. In other cases the tips of the branches may be pinkish-red with the projecting edges of the calyces an orange-yellow.

There is also great variation in the colour of the polyp spicules; in some the spicules of the crown and points are red, in others they are yellow, while in others the crown spicules are red and the point spicules orange-yellow. Considerable variation is also found in the measurements of the crown and the point spicules; so great is the range of variation, in fact, that they do not appear to be of any value as a specific distinction. The crown spicules vary in one specimen from 0·24 millim. to 0·5 millim. in length, and the point spicules from 0·3 millim. to 0·55 millim. in length, while in the same specimen the breadth of the crown spicules varies from 0·026 millim. to 0·06 millim.

Locality:—Deep water off Galle; Pearl banks, Gulf of Manaar.

Siphonogorgia pustulosa, WRIGHT and STUDER.

Locality:—Ceylon seas.

Siphonogorgia miniacea, KÜKENTHAL.

Locality:—Ceylon seas.

Siphonogorgia köllikeri, Wright and Studer—Plate I., fig. 7.

Locality :—Deep water off Galle.

In the examination of the specimens in the collection belonging to the genera *Chironephthya* and *Siphonogorgia* the following distinction suggested by Hickson (" Fauna of Maldives, 1900 ") has been adopted : "That the name *Chironephthya* be retained for the species or facies with a form and mode of branching resembling that of the genus *Nephthya*, with anthocodiæ rarely completely retracted in preserved specimens and with four principal spicules arranged *en chevron* in the points of the anthocodiæ ; and that the name *Siphonogorgia* be retained for species or facies of more massive *Gorgonia*-like form of growth, with anthocodiæ capable of complete retraction within the general cœnenchym and with spicules irregularly placed or arranged in a *fan-like* manner in the points of the anthocodiæ." While adopting this suggestion we have been impressed by the great similarity of the two genera. There are many reasons for thinking that they ought to be merged in one.

Order III. : PSEUDAXONIA.

Family : BRIAREIDÆ.

Solenocaulon tortuosum, Gray.

The collection includes magnificent specimens of a brilliant red *Solenocaulon*, probably a variety of *S. tortuosum*. We have studied a representative piece about 8 inches in length.

The substantial axis, measuring 5 millims. in diameter at the base of the specimen, is composed of closely packed colourless spinose needles, all of the same type, varying from 0·4 millim. to 1 millim. in length by 0·016 millim. to 0·018 millim. in breadth, and thus much longer than those measured by Hickson. When boiled with caustic potash the axis remains coherent, but crumbles readily. In a section 20 nutritive canals are seen between the cœnenchyma and the axis across the base of the specimen. Towards the top of the stem the axis gradually decreases in size and finally disappears. The rest of the stem forms a continuous tube with large lateral openings, the margins of which are prolonged into the slender polyp-bearing branches. These are mainly directed away from the side bearing the axis ; they often measure 17 millims. in length by 2 millims. in breadth.

The cœnenchyma of the tubular stem contains (*a.*) colourless needles from 0·4 millim. to 0·7 millim. in length by 0·018 millim. in width, with few and short spines ; (*b.*) shorter and broader rods (0·28 millim. to 0·4 millim. in length by 0·06 millim. to 0·07 millim. in width), both coloured and colourless, thickly beset with rough wart-like projections ; and (*c.*) coloured somewhat irregular ovals (0·1 millim. to 0·12 millim. by 0·06 millim. to 0·07 millim.), covered with blunt tubercles. The coloured spicules are pale yellowish-red ; and an orange variety occurs among the other brilliant red specimens.

The polyps are white, and are for the most part restricted to the twigs. A few occur on the stem on the side away from the axis. The polyp-spicules are arranged in a crown with slightly projecting triangular points. Each point consists of about 7 spicules, the longest median one being supported by three on each side. Below these running transversely are the rows of crown spicules. All the spicules are colourless warty spindles, varying in length from 0·2 millim. to 0·6 millim., and in breadth from 0·02 millim. to 0·08 millim. The verrucæ are truncated cones, with a height of 1 millim. to 2 millims., and a basal diameter of 2 millims. A small crab was found in the lumen of the tubular stem.

Localities :—Station LIX., 6 to 9 fathoms ; deep water outside banks, Gulf of Manaar ; Periya Paar, 9 fathoms ; deep water off Galle.

Keröeides gracilis, WHITELEGGE.

This species is represented by a complete colony and several fragments. The complete specimen stands 85 millims. in height, with a maximum width of 56 millims. The verrucæ alternate on the sides of the stem and branches. They are low and conical in shape, 1 millim. in height and in basal diameter. The cœnenchyma is thin, smooth, and filled with large closely packed compound-tuberculated spicules.

The irregularity of the spicules is fairly well marked and agrees with WHITELEGGE'S description. By transmitted light they are of a bright red brick colour.

The spicules are on the whole slightly larger than those of WHITELEGGE'S specimen. The measurements obtained were :—(1) For the spindles, 1·4 millims. to 2·2 millims. in length by 0·2 millim. to 0·5 millim. in width ; (2) Irregularly shaped spicules of verrucæ up to 1·6 millims. in length by 0·5 millim. in width ; (3) Spicules of the axis from 0·3 millim. to 0·6 millim. in length.

With the exception of the slightly larger measurements of the spicules, the specimen approximates very closely to that described by WHITELEGGE (1897), and also to that described by Miss HILES (1899).

Locality :—Deep water off Galle, Ceylon.

Previously recorded from :—Milne Bay, British New Guinea, depth 20 fathoms, and Funafuti, Ellice Islands.

FAMILY : SCLEROGORGIDÆ.

Suberogorgia verriculata, ESPER.

Several incomplete specimens, mostly about 7 centims. by 5 centims., forming networks in one plane. One colony with its base complete has a height of 9 centims. In a portion measuring 5·5 centims. by 3·5 centims., there were 22 complete meshes and 11 incomplete meshes. The meshes differ widely in size, but 7 millims. by 5 millims. is a size which occurs very frequently. The average thickness of branch is 1·5 millims. The colour is brown or drab, and the general texture of the cœnenchyma is granular.

The verrucæ are thickly crowded and occur all round the branches. They project very slightly and have a diameter of 1 millim. They are often separated about 1 millim. from one another. The verruca is a truncated cone, in some cases like a widely open crater, in other cases with eight spiculated lobes projecting inwards like small sepals in an almost open bud. A low-power view shows that there are eight opercular coverings formed from spindle-shaped spicules.

Careful dissection of the included polyp, under low power, shows a cylindrical body with eight vertical external muscle-strands and with a low conical apex. Around the base of this apex there seems to be a ring of horizontally disposed spindles in two or three rows, and from this there arise the eight triangular converging opercular coverings, with spicules more or less at right angles to those of the basal ring. But the specimens were extremely brittle, and the gentlest touch of the dissecting needle almost invariably shivered the microscopic architecture.

The extremely calcareous sclerogorgic axis is densely packed with more or less spindle-like spicules embedded in the matrix of horny fibres. It varies from 1 millim. to 2 millims. in diameter.

The cœnenchyma spicules are mostly minute spindles with numerous regularly arranged blunt tubercles; a common measurement is 0·1 millim. to 0·125 millim. in length by about 0·025 millim. in maximum thickness. There are also minute warty double clubs or capstans, with a very short middle zone and broad disc-like ends; they measure about 0·025 millim. by 0·02 millim. Some of the spindles have very few tubercles.

We have given these details to supplement the previous descriptions of *Suberogorgia verriculata*, to which, we believe, these specimens must be referred.

Locality :—Deep water off Galle.

Another specimen is 281 millims. in height and 134 millims. in maximum breadth, but this does not represent the full size of the specimen, as a part has been broken off the main stem. The branching is confined to one plane, and there is a very complete anastomosis of the branches, thus giving rise to a fine reticulate fan-shaped colony. The chief branches rise at an acute angle and are directed upwards, and assume a position roughly parallel to the main stem. The tips of the branches are clavate.

The polyps come off from all sides of the stem and branches and appear to be spirally arranged in some parts. They are completely retractile, and in the specimen they are all withdrawn within the small verrucæ.

The spicules are small spindles with prominent rough warts, larger spindles and minute double wheels or capstans. The measurements length by breadth in millimetres are as follows :—

Capstans, 0·037 × 0·02 ; 0·035 × 0·02 ; 0·03 × 0·02.

Slender spindles with few warts, 0·09 × 0·018 ; 0·15 × 0·02 ; 0·10 × 0·03.

Other spindles, 0·10 × 0·03 ; 0·12 × 0·037 ; 0·16 × 0·045.

The axis measures 6·4 millims. in diameter at the base.

We were at first inclined to record this specimen as a new species of *Suberogorgia*, but further study has convinced us that it is only a variety of *S. verriculata*.

[*Note.*—FAMILY: CORALLIIDÆ. RIDLEY reported with some hesitation the alleged occurrence of a specimen of *Corallium rubrum* on the Ceylon shore. It is interesting, therefore, to record that Professor HERDMAN found in deep water (34 fathoms) off Galle a specimen which he named *Corallium* (?). It was scarlet in colour, with yellow polyps, and measured about an inch in length. The sketch in his note-book suggests a young specimen of the noble coral, but the unsatisfactory point is that the specimen has not been found in the collection.]

ORDER IV.: AXIFERA.

FAMILY: PRIMNOIDÆ.

Primnoa ellisii, VON KOCH.

This beautiful species is represented by two specimens, the larger of which measures 68 millims. in height by 39 millims. in maximum width. The specimens agree with the description given by VON KOCH (1890), and the measurements obtained are in *absolute* accord with those given by him.

The geographical distribution of the species is interesting, ranging as it does from the Mediterranean to the Andaman Isles. The exact localities from which it has been recorded are: The Gulf of Naples and the coast of Sardinia in the Mediterranean; deep water off Galle, Ceylon; and the Andaman Sea, 275 to 45 fathoms (ALCOCK'S "Investigator" Collection).

Acanthogorgia media, n. sp.—Plate II., fig. 8; Plate III., fig. 7.

The specimens are similar to *A. ridleyi* in mode of branching and in the arrangement of the polyps but they are like *A. muricata*, HILES, in the disposition of the spicules on the calyces. But they do not seem referable to either species, or to any other whose description is known to us. In the figure on Plate III. the gracefulness of the colony has been inadequately represented.

The dimensions of the polyps are as follows:—

Height	1·3 millims.	1·1 millims.	0·8 millim.
Diameter at base . .	0·95 millim.	0·95 millim.	0·7 ,,
,, ,, apex . .	0·8 ,,	0·8 ,,	0·6 ,,

The polyps and the cœnenchyma of the stem and its branches have many projecting spicules. Round the apex of the polyp a number of spicules project. The polyps are arranged in some parts opposite one another, in other parts spirally. The arrangement is complicated by the interpolation of smaller polyps between the older ones. The branching is irregular and not confined to one plane. On the whole, the branching is alternate. The distances between branches varies from 8 millims. to 2 millims., and even to 1 millim. The axis measures 0·35 millim. in its thickest part, is brownish-yellow in older, yellow in younger portions, and is chambered. The spicules are long slender spindles, with few warts, and tri- and quadri-radiate stars. Among the spicules a considerable number are seen with an abrupt bend and one arm long in comparison to the other (golf-club-like). In these there is a poor development of the warts, the long shaft being free from the warty protuberances for a considerable portion of its length, while the short head has a good number of rough warts.

The spicules measure, length by breadth, in millimetres :—

Projecting opercular spicules, 0·4 × 0·05 ; 0·45 × 0·04 ; 0·4 × 0·045.

Ordinary spindles, 0·5 × 0·036 ; 0·3 × 0·04 ; 0·6 × 0·045.

Quadri-radiate forms, 0·25 × 0·15 ; 0·25 × 0·02 ; arms about 0·1 millim. in length.

Tri-radiate forms, 0·3 × 0·25 ; the arms being about 0·12 millim. in length. Some apparently sex-radiate and quinque-radiate forms occur.

Locality :—Trincomalee.

Acanthogorgia muricata, Verrill, var. **indica**, n.—Plate IV., fig. 11.

As a variety under this species we rank a beautiful complete colony, which has a height of 78 millims. and a maximum width of 105 millims.

The basal attachment is a flat spreading portion from which the main stem rises.

The axis is dark brown in colour, fading to a light yellow in the younger part. It is covered with close set furrows at the base, and at that point has a diameter of 3 millims., but it becomes extremely thin at the ends of the branches. The branching is very profuse and is confined to one plane, but the type of branching gives the main stem a slightly zig-zag arrangement.

The calyces are densely crowded all round the stem and branches. They measure from 2·5 millims. to 3 millims. in height and have a basal diameter of 0·9 millim. and a width of 1·1 millims. to 1·2 millims. at the crown. At the free end of the calyces there are 8 projecting spicules. The cœnenchyma on the stem and branches is very thin.

The specimen comes near *Acanthogorgia spinosa*, but differs from it in having only 8 single projecting spicules, while *A. spinosa* has 8 groups of 2 or 3. The spicules also differ slightly. It agrees closely with *A. muricata* except for slight differences in the polyps and spicules. The species *A. muricata* illustrates wide distribution ; it has been previously recorded from Barbados and Funafuti. See Hiles (1899), p. 48.

Locality :—Trincomalee.

Acanthogorgia ceylonensis, n. sp.—Plate IV., fig. 6 ; Plate V., fig. 12.

This species is represented by one specimen which measures 55 millims. in maximum height and 30 millims. in maximum width. The branching is both alternate and opposite and is confined to one plane. The polyps are arranged in threes or in twos or in loose spirals. The verrucæ vary in height from 0·6 millim. to 0·7 millim. and are placed at intervals of about 1 millim. The spicules are arranged on the verrucæ in 8 rows *en chevron*. The figure (Plate IV., fig. 6) is unfortunate in exaggerating the thickness of the stem and branches.

The spicules are of two types: (1) spindles which vary in length from 0·5 millim. to 0·6 millim. and have an average diameter of 0·04 millim.; and (2) quadri-radiate forms which measure length by breadth in millimetres as follows: 0·08 × 0·06, 0·13 × 0·12, 0·14 × 0·12. We have been unable to refer this specimen to any of the described species.

Locality:—Trincomalee.

Astromuricea ramosa, n. sp.—Plate I., fig. 8; Plate V., fig. 17.

A beautiful deep crimson colony, 8 centims. in height by 4 centims. in maximum breadth, but lacking its basal portion. Most of the numerous branches spread out laterally, but a few project forwards and a few backwards. Most of the branches arise at an acute angle and rapidly attain a vertical direction, giving off short secondary branches, almost always to the outside. The almost uniform thickness is 2 millims.; there is a slight swelling at the tips.

The surface of the cœnenchyma is rough with stellate spicules; the slightly prominent verrucæ (about 1 millim. in diameter) occur all round the axis; from their summits the yellowish polyps are projecting (about 0·5 millim. in diameter). The horny axis is bright yellow, with apparent longitudinal striation; it has a basal diameter of 1 millim.

The crimson spicules are mostly irregular, warty stars, with 4, 5, 6, or more rays. Some of the measurements taken are 0·2 millim. by 0·15 millim.; 0·2 millim. by 0·2 millim.; 0·3 millim. by 0·3 millim.; 0·3 millim. by 0·2 millim.

There are some irregular triangles, numerous discs, too irregular to be called stellate, and some small double wheels.

A few straight or curved spindles of diverse dimensions occur, 0·3 millim. by 0·03 millim.; 0·4 millim. by 0·05 millim.; 0·25 millim. by 0·1 millim.; 0·2 millim. by 0·025 millim.

The species is nearly related to *Astromuricea theophilasi*, Germanos, but is quite distinct. There is superficial resemblance to *Echinogorgia pseudosasappo*.

Locality:—Off Patani (Annandale and Robinson).

Echinomuricea indo-malaccensis, Ridley.

This species is represented by a single specimen, from the upper part of which the cœnenchyma has been rubbed off. The specimen measures 57 millims. in total height.

The basal attachment consists of a flat, spreading portion, from which the stem arises. The axis is dark in colour in the older parts, but becomes lighter in the younger branches. Branches arise from all sides of the larger branches, but the primary branches arise from the stem in one plane. The arrangement of the branches gives the colony a bushy appearance.

The specimen agrees closely with the description of *Echinomuricea indomalaccensis* given by RIDLEY (1884). There are several differences, however, thus (1) the verrucæ in this specimen are fully twice as long as in RIDLEY'S, they measure 0·8 millim. instead of 0·3 millim. in height; (2) the verrucæ spicules with ramifying basal portion vary in this case from 0·7 millim. to 0·9 millim. in length instead of a maximum length of 0·65, as given by RIDLEY. For discussion of four known species, see HEDLUND (1890), pp. 14 and 15.

Locality :—Pearl banks, Gulf of Manaar.

Previously recorded from Port Curtis, 5 fathoms to 11 fathoms; Port Molle, 12 fathoms to 20 fathoms; Warrior Reef, Torres Straits, Australia.

Echinomuricea ceylonensis, n. sp.—Plate VI., fig. 6.

Colony much branched in one plane, 11 centims. in height by the same in breadth at its broadest part. The colour is reddish-chocolate to crimson. The polyps may occur all round the branches, but in one specimen they are absent from the concave side of the plane of ramification. There is no regularity in the manner in which the branches arise from the stem. The verrucæ, which project almost at right angles, are about 1 millim. in height. The whole surface of the verrucæ and of the branches is rough with the sharp projecting points of crimson spicules, which are sometimes imbricating. Within the verruca cup there is a distinct special cone of tapering spicules forming an opercular covering. The polyps are entirely retracted. The horny axis is almost black at the base, about 1 millim. in breadth; it tapers to a breadth of 0·35 millim. near the tips of the twigs, where it shows a horny yellow colour. The cœnenchyma is relatively thin. The following types of spicule occur :—

(*a*) Numerous roughly triradiate forms, with a usually tuberculate main spine and with irregular foliaceous and ramifying expansions connecting the two other rays; 0·3 millim. to 0·5 millim. in length by 0·275 millim. to 0·3 millim. in breadth at base are common measurements; (*b*) irregular approximately stellate forms; and (*c*) curved spindles and boomerangs bearing a few tubercles and spines and sometimes forked or irregularly trifid at one end.

Locality :—West of Periya Paar.

Echinogorgia pseudosassapo, KÖLLIKER.

A single specimen of a crimson-red colour. It rises from a spreading base, about 15 millims. by 5 millims., and consists of two branches, about 50 millims. and 20 millims. in height. The longer branch gives off a branch at its base and another a third of the way up; the shorter branch gives off a branch near its end. The diameter varies from 2 millims. to 3 millims. It is probably a young specimen.

The surface is very rough owing to the sharp projecting points of the large spicules.

There are practically no verrucæ. The polyps appear yellowish, and the mouth is seen in most cases as a very precise oval aperture.

The red spicules are very variable :—

(1.) Fusiform, pointed at both ends, with distant tubercles; common lengths are 0·2 millim., 0·3 millim., 0·4 millim.

(2.) Larger fusiform, with tubercles and a few teeth, up to 0·7 millim.

(3.) Large and variable "Blattkeulen," often roughly triangular, with a shaft often divided into tubercled branches and a foliar expansion with 2 to 5 teeth; some measure 0·6 millim. in length.

(4.) Irregular stellate forms, with transitions to irregular discs; 0·2 millim. by 0·3 millim. is a common size.

(5.) Triradiate to hexradiate forms, with transitions to the stellate type.

The spiculation is not quite in agreement with the description and figures given by WRIGHT and STUDER, but the differences do not seem important.

Echinogorgia multispinosa, n. sp.—Plate VI., fig. 1.

An imperfect colony, branching irregularly in one plane without anastomosis, 11 centims. in height by 6 centims. in breadth. The horny axis measures 3·5 millims. in diameter at the base. Some of the twigs bear galls. The surface of the cœnenchyma is finely granular and of a cream-white colour. Verrucæ occur mostly on the sides of the branches, and are almost quite absent from the convex surface of the plane of ramification. In some regions they are crowded, almost touching one another, in other parts they are separated by intervals varying from 2 millims. to 4 millims. A few spines project slightly round the margin of the verruca opening, and there is an opercular covering with small spicules arranged in eight rays. Under low power the surface is seen to be uniformly covered with what seem to be tuberculate spindles irregularly arranged. When these spindles are examined an extraordinary diversity of form is disclosed.

(1.) Large tuberculate or spiny spindles, straight or curved, 0·4 millim. in length by 0·1 millim. in maximum breadth; some show a prominent spine on one side.

(2.) Small tuberculate spindles, 0·2 millim. by 0·05 millim.

(3.) Small almost smooth spindles, 0·2 millim. in length by 0·05 millim.; 0·3 millim. by 0·05 millim.; 0·275 millim. by 0·04 millim.

(4.) Slender boomerangs, 0·35 millim. by 0·05 millim.

(5.) Irregular tuberculate and denticulate clubs, 0·4 millim. by 0·2 millim.; 0·45 millim. by 0·15 millim.

(6.) Foliate clubs, 0·4 millim. in length by 0·2 millim. at broadest part; 0·3 millim. by 0·2 millim.; 0·275 millim. by 0·2 millim.

(7.) Irregularly-shaped warty scales with denticulate margins, *e.g.*, 0·3 millim. by

0·2 millim.; 0·25 millim. by 0·2 millim.; 0·2 millim. by 0·2 millim.; 0·25 millim. by 0·15 millim.

(8.) Almost stellate scales, 0·25 millim. by 0·25 millim.; 0·15 millim. by 0·15 millim.

(9.) Warty triradiate forms, 0·25 millim. by 0·2 millim.; 0·2 millim. by 0·13 millim.; 0·2 millim. by 0·2 millim.

(10.) Tetraradiate forms, 0·23 millim. by 0·1 millim.; 0·25 millim. by 0·15 millim.

The variety of spicules is greater than we have seen in any other Alcyonarian.

Heterogorgia verrilli, n. sp.—Plate VI., fig. 2.

A handsome branched colony, greyish-black in colour, 20 centims. in height by 8 centims. in maximum breadth. The short common stem, from which two main branches arise, is 5 millims. in diameter. The branches are generally alternate, and there is a tendency to swelling at the tips of the twigs. The surface of the cœnenchyma appears granular and bears many sponge spicules. The verrucæ are usually, but not constantly, disposed on the sides of the branches; they are conical warts under 1 millim. in height. In some cases the upper part of the anthocodia protrudes from the cone, and is seen to bear spindle-shaped spicules. In the retracted state a whorl of spindles is seen projecting vertically outwards within the margin of the crater-like verruca. The characteristic spicules of the cœnenchyma are more or less regular, bluntly tuberculate crosses of varying dimensions, *e.g.*, 0·1 millim. by 0·1 millim.; 0·2 millim. by 0·2 millim. There are also tuberculate double clubs and rough discs of various sizes, like crosses with the arms scarcely discernible.

The specimen, apparently a Muriceid, is very difficult to locate; we have referred it to Verrill's genus *Heterogorgia* ('Am. Journ. Sci.,' xlv. (1868), p. 413).

Bebryce hicksoni, n. sp.—Plate III., fig. 1; Plate VI., fig. 9.

An imperfect specimen, irregularly branched in one plane, about 6·5 centims. in height by 6·5 centims. in breadth. There are four branches, measuring about 2 millims. to 2·5 millims. in diameter, which is thicker than the main stem at its base (1·5 millims.). There is distinct flattening of the branches and twigs. The cortex has a smoothly granular punctate appearance and a greyish-white colour. The verrucæ, which are disposed mainly on the sides of the branches and twigs, usually with intervals of 2 millims. to 2·5 millims. separating an adjacent pair on the same side, are truncate rounded cones, crater-like when the polyps are dislodged. In many cases the anthocodiæ of the polyp project at the apex of the cone, and are supported by triangular strands of small spicules longitudinally and transversely disposed. Under low power the superficial spicules appear like rounded grains of sand or like fish-roe, each grain appearing as if it had a clear nucleus surrounded by a whitish rim. Higher magnification shows that there are multi-lobate warty spheroidal discs, some of which show a short central boss projecting inwards; the diameter of the disc varies considerably, 0·1 millim., 0·15 millim., 0·2 millim., and 0·25 millim.

In some cases the boss is borne on a distinct stalk, and this type measures 0·25 millim. in height by 0·2 millim. in the diameter of the disc Some small spicules are capstan-like, double clubs in fact, and various transitional forms show a gradual reduction of one-half of the capstan till only a boss is left, or not even that.

In the polyps there are curved tuberculate spindles, 0·25 millim. in length.

The spicules are so characteristic that we have no hesitation in referring this specimen to the genus *Bebryce*, and it cannot be identified with *B. mollis*, von Koch (1887), or *B. studeri*, Whitelegge (1897), or *B. philippii*, Studer. Hickson has reported *Bebryce*, sp. (?) from the Maldives; *B. mollis* is Mediterranean; *B. studeri* was obtained at Funafuti; *B. philippii* from the Arafura Sea—a remarkable distribution.

This seems to be a somewhat variable species, and the five specimens obtained differ considerably in general appearance, in the degree of prominence assumed by the verrucæ, in their distance apart, and in the shapes and sizes of the spicules. In all cases, however, the characteristic *Bebryce* spicules are unmistakable.

In a fragment of a greyish colour, 23 millims. in length, with two short branches, the verrucæ are usually about 1 millim. apart, along one line, and seem to occur equally all round the branches. Their diameter is 1 millim., and that of the light brown non-calcareous axis is the same.

We made a study of two other specimens. The more complete of the two represents a young colony, the other is a fragment of a large colony. In both the branching is confined to one plane, the branches and twigs being given off at an angle which varies little from a right angle. The branches grow out for a short distance in this direction and then bend upwards.

The tips of the twigs and the branches are clavate, but in one or two cases they are flattened. The two specimens present a greenish appearance, due to the presence of a siliceous sponge on the branches. The sponge has covered each branch with a thick coating, through which the tips of the verrucæ are seen. The spicules of the sponge are monaxonial and are oxytylotes.

The general cœnenchyma is thin and granular in appearance, and is composed of small spherical or irregularly oval bodies covered with numerous rough warts. There are also some more definite spindles, but they are very few in number.

The axis is horny and black in the lower parts, becoming lighter in colour in the twigs and younger portions of the branches. The axis is marked by irregular ridges and has a core of lighter coloured material. This core diminishes in size with the age of the portion of the axis. It is crossed by a number of bands, thus appearing to be chambered, and a longitudinal section shows a number of curved lamellæ crossing the core at about equal distances.

The verrucæ occur in the younger portions on all sides of the twigs and branches, but in the older portions they are confined more or less to the lateral faces. They are small and seem to be conical in shape. After carefully cutting away the sponge, we found that the verrucæ were conical and truncated.

There is no differentiation between the spicules of the general cœnenchyma and those forming the verrucæ; in both cases they are mostly oval or spherical discs covered with rough warts and sometimes with an internal boss. There are also some rough warty spindles. The spicules measure, length by breadth in millimetres, as follows :—

(1.) Globular discs, 0·1 × 0·1 ; 0·14 × 0·14 ; 0·14 × 0·08 ; 0·11 × 0·105.
(2.) Spindles, 0·26 × 0·038 ; 0·12 × 0·025 ; 0·16 × 0·03.

The colour of the colony when devoid of the sponge is a greyish-white.

Acamptogorgia atra, n. sp.

This species is represented by a complete colony, measuring 211 millims. in height and 98 millims. in maximum width.

The axis is horny, almost black at the base, but light brown in the younger branches. The stem is almost of the same diameter throughout its whole length. It measures 4 millims. in diameter at the base and 3·9 millims. at the tip of the main branch. The branching is confined to one plane. The branches arise at a right angle, but soon turn upwards and run roughly parallel with the main stem.

The polyps are restricted to the lateral edges of the stem and branches, but here and there they appear either on the back or on the front. They stand out almost perpendicularly to the stem and branches at intervals of about 2 millims. Each branch bears close to its tip 3 or 4 polyps, none of which can be said to occupy the end of the branch.

The colony is black in colour, though it presents a greyish appearance owing to its being closely coated with a sponge.

Locality :—Ceylon seas.

Acamptogorgia spinosa, Hiles.

This species is represented by several colonies, two of which give the following measurements :—

	(A.)	(B.)
Height of colony	76 millims.	74 millims.
Maximum width of same . .	39 ,,	42 ,,

A finer, but much weathered specimen afterwards found in the collection measured 15 centims. by 15 centims.; it was branched in one plane and showed much anastomosis.

The polyps on the branches vary from 0·6 millim. to 0·7 millim. in length and from 0·5 millim. to 0·6 millim. in diameter. In a few of the polyps a height of 0·9 millim. may be reached. The spicules in the present specimens are slightly larger than in

Acamptogorgia spinosa, but even then the relation of length to breadth is almost the same. The specimens agree with *Acamptogorgia spinosa* in axis, colour, and thickness, and in the chambered central core. For description, see HILES (1899).

Locality :—Deep water off Galle.

Acamptogorgia spinosa, var. **ceylonensis**, n.—Plate I., fig. 1.

This variety is represented by one complete colony and a colony in which the base is wanting. The complete colony has the following measurements:—Maximum height 114 millims. and maximum breadth 176 millims., while the incomplete one measures 154 millims. in maximum height and 142 millims. in maximum width. The colony is fan-shaped, caused by the profuse branching which is strictly confined to one plane. Anastomosis of the branches is, however, common.

The stem is dark in colour near the base, but gradually becomes lighter in the younger parts of the stem and branches. The axis in the stem and principal branches is oval in shape, the longest diameter being perpendicular to the plane of branching, but it gradually becomes more cylindrical in shape in the younger branches and in the younger part of the stem.

The cœnenchyma is thin and allows the axis to shine through; it presents a very rough appearance under the lens.

The verrucæ are arranged on three sides of the axis, they have a series of spines projecting round the mouth, and have a maximum height of 0·8 millim. and a maximum diameter of 0·6 millim.

A few expanded polyps were found at the end of a branch, but almost all were withdrawn within the verrucæ and showed a tentacular operculum, conical in shape, formed by the spindle-shaped spicules which lie on the aboral surface of the tentacles.

The spicules are (1) triradiate, with large irregular processes in the angles which often fuse, thus leaving plate-like portions with perforations; (2) a modified form of the triradiate with a long arm, which gradually thickens and then gives off two smaller arms from the thicker end; and (3) spindles and club-shaped half-spindles, curved or straight, either with very rough projections or fairly smooth.

Locality :—Deep water off Galle.

Acis indica, n. sp.—Plate II., fig. 3; Plate V., fig. 7.

The colony is large and fan-shaped, rising to a height of 149 millims. and having a maximum width of 167 millims. From a conical base, which has a flat spreading margin and is attached to a mass of worm-tubes, the short main stem arises. At a distance of 14 millims. from its origin, where it has a diameter of 3·5 millims., it divides into two principal branches. The branching is for the most part confined to one plane, but several of the smaller branches and twigs arise at right angles to the principal plane of branching. The branching is very profuse and at several points shows anastomosis of the branches, but this is by no means common. The branches are cylindrical, but there are traces of slight flattening in the plane of branching. The twigs arise usually at right angles to the branches, and their tips as well as those of the branches are slightly clavate.

The polyps are small and are scattered over the whole surface of the stem and branches. In no place can it be said that they are confined to three surfaces, nor can any attempt at lateral arrangement be seen. The verrucæ are very small and the polyps can be completely retracted within them. The edges of the verrucæ show a variable number of spines which project above the slightly conical operculum formed by the tentacular spicules when the polyps are withdrawn.

The superficial cœnenchyma of the stem and the branches presents a striking appearance, due to the arrangement of the large flat whitish spicules and to their being outlined against the darker ground-colour of the stem and branches.

The spicules of the general cœnenchyma are flat and multituberculate, varying very much in size and shape. The tubercles are low and rough and very numerous. Many of the larger spicules extend the whole distance between two adjacent polyps, and sometimes even exceed this length. They fall into three groups, fairly distinct in shape: (*a*) large modified fusiform spicules, which taper more or less towards the ends and measure from 0·9 millim. to 3 millims. in length by 0·25 millim. to 0·45 millim. in breadth; (*b*) squamous or scale-like spicules, often with slightly lobed margins, which measure from 0·8 millim. to 1·1 millims. in length by 0·4 millim. to 0·6 millim. in breadth; and (*c*) large modified squamous spicules, consisting of a flattened tuberculate basal portion and of a projecting part which forms the projecting spine of the verrucæ. They measure, in length by breadth in millimetres, as follows:—0·7 × 0·5; 0·6 × 0·4; 0·5 × 0·3.

In the polyps there are slender spindle-shaped and club-shaped spicules. They are often slightly curved and either taper to both ends or are blunt and rounded at one end and pointed at the other. Many of these exhibit fairly prominent spines towards the thicker end. They vary considerably in size, being from 0·3 millim. to 0·5 millim. in length and from 0·02 millim. to 0·06 millim. in breadth. They are found chiefly in the tentacles, where they form an operculum to the retracted polyp; but an incomplete and irregular crown or collar is formed by them at the base of the tentacles.

In colour the spicules vary from white to semitransparent, while the whole colony has a whitish-brown appearance.

This species differs from *Acis pustulata* in not having violet-coloured opercular spicules and in the branches not being compressed in the plane of branching. It also differs from *Acis orientalis* in having the polyps on all sides of the stem and branches and in the branching not being confined to one plane.

Locality:—Deep water off Galle.

Acis alba, n. sp.—Plate III., fig. 9; Plate V., fig. 4.

This species is represented by a complete colony which gives the following measurements:—Height of colony, 127 millims.; maximum width of same, 115 millims.; diameter of axis at base, 2·5 millims.

The basal attachment consists of a flat plate-like expansion from which the main stem rises. The stem reaches a height of 26 millims. and then divides into two principal branches, but branching is represented between this point and the base by a stump. The branches are given off at an angle which closely approaches a right angle; they soon turn upwards, however, and run roughly parallel to the main branches. The tips of the branches and the twigs are sometimes slightly clavate. The colony presents a fan-shaped appearance, due to the branching being strictly confined to one plane.

The axis is horny, greyish-black in colour in the older parts, and amber-yellow in the twigs and younger portions of the colony. It is cylindrical and marked by a number of irregular ridges in the lower part.

The polyps occur on all the faces of the stem and branches, and are arranged so that they give the appearance of three or four irregular lines. The verrucæ are small, slightly conical in shape, with a blunt tip and fairly wide base. They are covered by spicules similar to those of the cœnenchyma. In several cases a verruca seems to occupy the tip of a branch or twig.

The general cœnenchyma is thin and granular in appearance, the surface appearing scaly owing to the arrangement of the large flat spicules.

The spicules appear to be in two layers, the outer consisting of thick irregularly shaped flattish spicules, closely covered with rough warts, while the inner layer consists of spindles often with blunt ends and more irregularly formed spicules. The measurements, length by breadth in millimetres, are as follows:—

(1.) The outer layer, $0·48 \times 0·23$; $0·5 \times 0·4$; $0·43 \times 0·29$; $0·45 \times 0·2$; $0·2 \times 0·1$.

(2.) The inner layer, $0·25 \times 0·07$; $0·18 \times 0·05$; $0·22 \times 0·08$; $0·14 \times 0·04$; $0·12 \times 0·04$.

The appearance of two layers may be due to the fact that the flattish spicules are thicker and so stand up above the level of the other spicules. If this be so, then the spicules are in one layer only.

Towards the base of the tentacle on the aboral surface two slender converging spicules are present and at their base one or more transversely placed, thus giving a triangular arrangement of spicules at the base of each tentacle.

Galls are present on several of the branches, mostly caused by cirripedes.

The colour of the colony is greyish-white.

Localities:—Trincomalee; deep water off Galle.

Acis ceylonensis, n. sp.—Plate VI., fig. 3.

A small specimen, 4 centims. in height, with five branches, three of which are broken. The stem measures 2 millims. in diameter at the base and is scarcely reduced in thickness higher up. Verrucæ occur all round and have the form of truncated cones, about 0·5 millim. in height and about 1 millim. in diameter at the base. The intervals between them vary greatly, from 2 millims. to almost nil. The surface is covered with pebble-like spicules predominantly oval in shape and neatly fitted together like a mosaic of rounded fragments, which show almost no trace of overlapping or imbrication. Smaller oval scales occur outside the verrucæ and spindles project very slightly from within.

The large cœnenchyma spicules are mostly warty irregular ovals, but some are almost rectangular and others are like flint axe-heads.

They give the following measurements in length and breadth in millimetres:— 0·55 × 0·35; 0·5 × 0·32; 0·4 × 0·3.

Various kinds of spindles occur: (*a*) large thick forms, very warty, measuring 0·3 millim. by 0·15 millim., 0·45 millim. by 0·175 millim.; (*b*) long thin curved or straight forms, with smaller tubercles or almost smooth, measuring 0·5 millim. by 0·03 millim., 0·45 millim. by 0·03 millim.; and (*c*) minute warty spindles, 0·06 millim. by 0·02 millim.; 0·08 millim. by 0·02 millim.

Besides these forms there are others which approach the club-type, and are probably modifications of the large spindles.

Locality:—Deep water off Galle.

Acis ceylonensis, n. sp., var. **imbricata,** n.

Another specimen, measuring 4 centims. in height, with only hints of branches, showed a general superficial resemblance to *Acis ceylonensis*, n. sp., except that the large cœnenchyma spicules were much less regular in form and were much imbricated. An examination of the spicules showed the following forms:—

(1.) Large, modified fusiform, elaborately tuberculate, of very various dimensions, *e.g.*, 0·5 millim. by 0·25 millim.; 0·65 millim. by 0·4 millim.; 1 millim. by 0·5 millim.; without the monticular prominences characteristic of *Acis orientalis*.

(2.) Large rounded or almost oblong tuberculate scales, of various dimensions, *e.g.*, 0·35 millim. by 0·4 millim.; 0·5 millim. by 0·45 millim.

(3.) Tuberculate clubs, with the ends often much swollen, often 0·45 millim. in length by 0·2 millim. in maximum width; 0·35 millim. in length by 0·2 millim. in maximum width.

(4.) Tuberculate spindles, about 0·35 millim. to 0·4 millim. in length by 0·1 millim. in breadth, some 0·25 millim. in length by 0·05 millim. in breadth.

This specimen obviously differs markedly in the details of its spiculation from that which we have named *Acis ceylonensis*, but it may be sufficient to erect a variety within the species. Until more data accumulate it seems quite impossible to tell how far marked differences in spiculation can be relied on as specific.

Locality:—Trincomalee.

Acis orientalis, Ridley.

This species is represented by three complete specimens, of which the largest measures 136 millims. in height by 86 millims. in maximum breadth. The specimens agree with the description given by Ridley [1882 (II.), pp. 126–128].

The terminal branches reach a length of 45 millims. to 50 millims., and the tips of the branches and twigs are clavate, measuring 3·5 millims. to 4 millims. in diameter, and are occupied by three polyps.

The axis measures 3 millims. at the base, but in branches which have a diameter of 2·6 millims. it measures only 0·5 millim. or 0·45 millim. in diameter.

The spicular measurements agree very closely with those given by Ridley (1882), the differences being so slight as not to be of any importance. We may perhaps, having found other Ceylonese species of *Acis*, quote Ridley's note :—" The occurrence of this otherwise West-Indian genus in the Indian Ocean, and in its western portion in particular, has a peculiar significance for the student of geology, as showing that a communication probably existed between these two areas at a period later than that at which the genus was differentiated from the main stem of the family."

Locality :—Deep water off Galle.

Previously recorded from Mauritius, 80 fathoms.

Muricella ramosa, n. sp.—Plate III., figs. 2 and 3.

The colony is branched in one plane, and forms a beautiful network with abundant anastomoses. The branches and twigs are given off, sometimes opposite, sometimes alternate, at an angle which varies little from a right angle. One of the specimens, though not complete, measures 170 millims. in height and 273 millims. in maximum width.

The axis is black in colour in the lower part, but becomes brownish-yellow in the tips of the branches and in the twigs. It is rather irregular in shape, being somewhat oval shaped, the longer diameter being at one place in the plane of branching, at another place at right angles thereto. The general cœnenchyma is thin and practically composed of warty spindles which may be either straight, curved, or slightly **S**-shaped.

The verrucæ are small and vary greatly in appearance. A number of spicules horizontally arranged form the lower part of the verruca, and a number of longitudinally disposed spicules form the upper part. The appearance of the upper set of spicules varies according to the stage of retraction of the anthocodial part of the polyp. The spicules composing the verrucæ do not differ from those of the general cœnenchyma except in size. They are smaller, but are as closely covered with warts as the other spicules.

The polyps are arranged on the stem and branches in what appear to be short spirals, but on some of the twigs they assume a more or less bilateral disposition.

The spicules are thick spindles, either straight or curved, or slightly **S**-shaped, covered with numerous rough warts. Their measurements, length by breadth in millimetres, are as follows:—1·6 × 0·2; 0·8 × 0·14; 1·3 × 0·2; 0·9 × 0·16; 0·25 × 0·06; 0·1 × 0·02; 2·1 × 0·26.

In the complete colony the outer spicules *often stretch the whole distance between the polyps*. In certain conditions of the polyps there appear to be 8 projecting spicules on each calyx.

Localities:—Deep water outside pearl banks, Gulf of Manaar; and deep water off Galle and onwards up West Coast of Ceylon.

Muricella ceylonensis, n. sp.—Plate VI., fig. 4.

The colony is branched in one plane, with a strong tendency to anastomosis even between twigs of different main branches. It measures 12 centims. in height by 8 centims. in breadth. Most of the twigs arise at right angles from the main branches and almost all the short ones remain perpendicular. Many arise in opposite pairs, others are alternate, and in other regions the twigs may be restricted for an inch or more to one side of the branch. A common interval between the origin of two adjacent branches on the same side is 4 millims. The verrucæ stand out prominently at right angles to a height of about 0·5 millim., and the interval between two on the same side is on the average 1 millim. The surface of the colony is covered with huge white spicules readily visible to the naked eye. Spicules slightly curved at the base run up the sides of the verruca, and their tips project at the mouth. The black horny axis measures 2 millims. in diameter at the base, it tapers to a diameter of 0·1 millim. at the tips of the twigs, and in these delicate parts it shows a brownish tint. The general colour of the colony is grey. In another specimen measuring 8 centims. by 6 centims. the colour was whiter owing to the more densely packed large spicules; there was *no hint of anastomosis*, and the perpendicular mode of branching was not so pronounced.

The spicules, which are longitudinally disposed, are straight or curved, densely tuberculate spindles, the largest of which seem here and there to be disposed in definite strands or lines. They vary in size from 3·5 millims. to 0·35 millim.

Compared with *M. ramosa* this species is much less thickly branched; it shows much less anastomosis, it bears polyps at wider intervals, and has larger spicules.

Muricella nitida, Verrill.

This species is represented by a colony with a maximum height of 105 millims. and a maximum width of 80 millims. The base consists of a broad flattened portion from which the fan-shaped colony rises. The axis is dark brown, almost black in colour in the lower parts, but it becomes yellowish in the upper portions of the branches and in the twigs. It has a basal diameter of 2 millims.

The branches, which are confined to one plane, come off at an angle which approaches a right angle and then bend upwards, so that they appear to be parallel to one another. The younger branches and twigs often present a pinnate appearance, which is sometimes disguised by a larger development of one of the branches. The stem and branches are flattened in the plane of branching, and the tips of the twigs form blunt broad expansions due to the two divergent terminal polyps.

The polyps are more or less confined to the lateral edges of the branches; they are all withdrawn, but their tentacular portions are yellowish in colour.

The spicules vary in length from 0·9 millim. to 1·65 millims., and in breadth from 0·1 millim. to 0·2 millim.

The colour of the colony is a deep coral-red; and the spicules of the cœnenchyma are visible to the naked eye.

The specimen presents close resemblances both to *Muricella perramosa* and *M. nitida*, but because of the greater resemblance in the arrangement of the polyps and the more marked coral-red colour, it was thought best to place it under *M. nitida*.

Locality :—Ceylon seas.

Muricella complanata, WRIGHT and STUDER.

This species is represented by a fragment of a colony, consisting of the lower part of the stem with basal attachment, and a branch bearing secondary branches or twigs. The basal attachment consists of a slightly conical spreading portion, from the summit of which the stem arises. The stem measures 2·2 millims. near the base, and at a distance of 11 millims. from the base the first branch, which is represented by a fragment, was given off. The secondary branches or twigs are given off at right angles, and may reach a length of 25 millims. to 37 millims.

The polyps are arranged on the lateral edges of the stem and branches, and are directed some to the front and some to the back. On the whole they are arranged alternately, but this is not quite constant. The polyps measure 0·95 millim. in height by 0·74 millim. in width, and are contained within verrucæ which measure 0·35 millim. in height by 0·8 millim. to 1 millim. in width at the base.

The stem is of a violet tint with yellow polyps and verrucæ, but this tint gives place gradually on the twigs to an orange-yellow. The tips of the twigs end in two divergent polyps, and this expansion measures 3 millims. in width.

The spicules of the cœnenchyma vary in length from 0·7 millim. to 1·3 millims., and in breadth from 0·1 millim. to 0·16 millim. They are straight spicules covered with warts.

This specimen, though not agreeing with *Muricella complanata* in every detail, may be included in this species, which is variable in the colour and the size of its spicules.

We studied a second specimen of a more pronounced violet colour and with much larger spicules. It was a complete colony which is attached to a piece of coral, and measures 68 millims. in height and 53 millims. in maximum width. The basal attachment consists of a flattened portion spreading over the surface of the coral. The stem measures 2 millims. at the base, and at a height of 17 millims. the first branch is given off. The branching is confined to one plane, the primary branches being given off almost at a right angle. They in turn give off secondary branches or twigs at an angle which approximates even more closely to a right angle.

The verrucæ are placed on the lateral edges of the stem and branches, and are arranged more or less alternately. They are conical and abruptly truncated, with usually a few of the spicules projecting at the opening. The spicules in the calyces are much smaller than those of the general cœnenchyma.

The colour of the whole colony is a beautiful violet tint, with the tentacles of the polyps yellowish in colour.

The spicules of the cœnenchyma are spindle-shaped, either straight or curved and sometimes broad and flat in comparison to their length, or bluntly rounded at the two ends. They can be divided into two fairly distinct types:—

(1.) The larger spicules with rough warts, which vary from 0·7 millim. to 2·7 millims. in length and from 0·075 millim. to 0·32 millim. in width; and

(2.) The smaller spicules with warts more pointed than rough, which vary in length from 0·11 millim. to 0·55 millim., and in width from 0·03 millim. to 0·05 millim.

Another very beautiful form with large violet and colourless spicules seems at first sight very different from the foregoing species and variety. This is mainly due, however, to the fact that there is a prominent opercular covering of small but very conspicuous rose-red spicules sometimes disposed in eight rays.

Localities:—West of Periya Paar, Gulf of Manaar; deep water off Galle and onwards up West Coast of Ceylon.

Family: PLEXAURIDÆ.

Plexaura prælonga, var. **typica** (Ridley).

Plexauroides prælonga (Wright and Studer).

This species is represented by one specimen, which reaches a height of 425 millims. The branching is confined to one plane and forms an irregular dichotomy. The main stem is 4 millims. in diameter at its base, tapering to 3 millims. at its termination, thus agreeing with the measurements given by Wright and Studer.

The verrucæ are numerous and irregularly scattered and the polyps are completely retractile. The cœnenchyma is comparatively thin and very friable. The spicular measurements are the same as those given by Wright and Studer. The colour is a deep brownish-red in spirits.

Locality:—Outside pearl banks, Gulf of Manaar.

Previously recorded from Port Curtis, 5 fathoms to 11 fathoms; Port Denison, 4 fathoms; and Station 186, Cape York, 8 fathoms. (See Wright and Studer (1889), '"Challenger" Reports,' vol. xxxi.: Ridley (1884), '"Alert" Expedition,' p. 339, Plate xxxvi., fig. F, and Plate xxxviii., fig. *g*, *g'*.)

Plexaura prælonga, Ridley, var. **elongata**, n.

Several incomplete specimens, dull crimson in colour, with two or three elongated cylindrical branches, 3 millims. to 4 millims. in diameter and up to 30 centims. in length. The axis, blackish-brown, 1 millim. to 2 millims. in diameter, is entirely horny. The surface of the colony is covered with the pore-like apertures of the polyps; around each aperture the spicules are disposed in a ring 0·3 millim. to 0·5 millim. in diameter.

The most characteristic spicules are very variable discs, "Blattkeulen," 0·4 millim. to 0·5 millim. in length, with a rounded foliaceous expansion (0·3 millim. in breadth) at one end and an irregular ramification at the other. The surface of the disc bears a few large blunt tubercles. When the thin foliaceous expansions are broken off, the rest of the spicule may be described as irregularly stellate. Actually stellate forms also occur, and 3- to 6-rayed forms are represented. A few tuberculate spindles occur here and there.

As regards types of spicules, this form resembles *Plexaura prælonga*, but the details of the "Blattkeulen," the rough cortex and the crimson colour, and some other features, mark it as quite distinct from Ridley's varieties *typica* and *cinerea*.

Plexaura antipathes, Klunzinger, var. **flexuosa**, n.

To a variety of this species we refer two specimens, the larger of which measures 120 millims. in height and the same in width. The colonies are bush-shaped and very profusely branched, with the branching not confined to one plane. The branches are sometimes thickened during a part of their length, while all are swollen at the tip into a knob or club-shaped portion, which measures from 2 millims. to 3 millims. in diameter.

The polyps are scattered over the whole surface of the stem and branches. No projecting calyces are present, but the position of the polyp is marked by an oval or circular opening, round which the cœnenchyma is slightly raised.

The axis is thick at the base, measuring 3·5 millims. in diameter, but it becomes slender and thread-like at the tips of the branches. The colour is a dark brown, very little difference being seen throughout the whole ramifications of stem and branches. The base consists of a broad, flat, spreading portion, from which in one specimen several stems rise in addition to the main stem.

The spicules are short, many branched, rod-like needles or small spherical bodies, which bear many protuberances. They measure, length by breadth in millimetres, as follows:—$0{\cdot}12 \times 0{\cdot}08$; $0{\cdot}12 \times 0{\cdot}10$; $0{\cdot}14 \times 0{\cdot}08$; $0{\cdot}15 \times 0{\cdot}10$; $0{\cdot}20 \times 0{\cdot}08$.

The colour of the colony is a dirty greyish-white, with a light brownish tinge in many places.

Though differing slightly from *Plexaura antipathes*, yet the differences are not sufficient to warrant the formation of a new species. See Hiles (1899), pp. 51–2; Whitelegge (1897), pp. 317–8.

Locality: Gulf of Manaar.

Lophogorgia lutkeni, Wright and Studer.—Plate III., fig. 6.

This species is represented by many pieces of colonies; the largest piece measures 33 centims. in height by 38 centims. in breadth, and has three main branches. It measures 18 millims. across at the base, narrows to 12 millims., and expands again to 28 millims. where the branches arise. The axis is dark brown in colour with a lighter coloured central core. It is very calcareous as well as horny and measures fully 2 millims. at the lower end of the branch which we studied. It has two shallow grooves which correspond to the two grooves on the stem and the branches. The branching is usually confined to one plane and is fairly profuse. In the largest specimen one of the branches comes off from the main stem almost at right angles to the plane ot branching, but it bends over almost directly and comes to lie in that plane. In this specimen, also, several of the secondary branches rise in a similar manner to the above. In the other specimens, however, the branching is strictly confined to one plane. The stem and the branches are flattened in the plane of branching and are marked on the flat sides by a narrow winding groove or furrow which is continued along the flattened surfaces of the secondary branches. The tips of the branches and twigs are almost cylindrical. In the twigs the nutrient canals occur all round, but in the larger branches and in the stem they correspond to the grooves on the flattened surfaces.

The polyp-bearing surface is divided into two lateral bands by means of the two grooves. On both of the bands the polyps occur in irregular rows. Verrucæ can scarcely be said to be present, as the general cœnenchyma seems only to be slightly raised at the point where the polyp issues. On the polyp being retracted, the edge of the pore-like opening curves in and forms a star-shaped figure in which the rays are slightly variable. The slight thickening at the point of issue of the polyp seems more marked in some of the specimens than in others.

The polyps are either completely or partially withdrawn into the general cœnenchyma; the expanded part in the case of those partially withdrawn is white in colour. On the body of the polyp there are eight bands of spicules running up towards the base of the retracted tentacles. In each band the spicules, which are numerous, are arranged *en chevron*.

The spicules are spindle-shaped, but slightly flat in appearance, and sometimes curved and with fairly large prominent projections. They measure (*in situ*) from 0·18 millim. to 0·2 millim. in length. They are colourless.

The general cœnenchyma of the stem and the branches is thick, measuring about 1 millim. in depth, and friable in texture. In colour it is yellowish, with darker brownish patches scattered over the whole surface. It is composed of short spindle-shaped spicules with rough wart-like projections arranged in whorls, the whorls varying in number with the size of the spicules.

They measure, length by breadth in millimetres, as follows:—$0·1 \times 0·04$; $0·12 \times 0·04$; $0·14 \times 0·05$; $0·14 \times 0·02$; $0·13 \times 0·035$; $0·14 \times 0·06$.

The specimens agree with the description of *Lophogorgia lutkeni* in most respects, *e.g.*, the branching, the flattening, the absence of verrucæ, the disposition of the polyps and nutrient canals. On the other hand, there are some peculiarities: (1) there is a distinct groove and not a wavy line; (2) the spicules of the general cœnenchyma are smaller in the Ceylon specimens; and (3) the pore-like openings left by the retracted polyps form star-like figures, not slits.

These differences do not seem important enough to warrant us in separating it from *L. lutkeni*.

To this species two other fragments belong. The larger measures 168 millims. in height and has a diameter of 5 millims. at the lower end of the main stalk. These two specimens differ from those described above in having no projections of the cœnenchyma at the point of issue of the polyps. The openings left by the polyps when withdrawn are more like slits than in the former specimens. The specimens are also more brick-red in colour. In every other respect they agree with the specimens above described. As the two sets of specimens come from the same locality we are furnished with a good example of individual variation.

Locality :—Cheval Paar, Gulf of Manaar.

Lophogorgia rubrotincta, n. sp.—Plate IV., fig. 12.

The base of the colony is expanded for 25 millims. on a shell; the branching is approximately in one plane; the measurements are about 100 millims. in height by a maximum of 30 millims. in breadth; the longest branches are about 30 millims. in length; the primary branches arise irregularly on the two sides of the main stem and some give off secondary branches. As regards spicules and polyps, it seems to be a *Lophogorgia*. Most of the cœnenchyma spicules are rough spindles; 0·1 millim. by 0·04 millim. is a common measurement, but many are much smaller. On the median line of each flattened surface of the stem and its branches there is a line of red spicules making a characteristic feature in contrast to the general orange-yellow. If it be not worthy of recognition as a new species, it is a very distinctive variety.

Lophogorgia irregularis, n. sp.—Plate VI., fig. 7.

An irregularly branching specimen of a dirty white colour, about 3 centims. in maximum breadth by 1·5 centims. in height. The extraordinarily quaint mode of branching may be described as somewhat antler-like, but the tips of the branches are mostly bent downwards. The branches expand, constrict, and re-expand in a peculiar way, and there is considerable flattening in the general plane of branching. The polyps occur all over, completely retracted within slightly prominent rounded verrucæ, which are closest together and best defined towards the ends of the branches. Many of the verrucæ measure about 1 millim. in diameter, but the aperture of the polyp on the apex of the gently rounded elevation is usually very much less (about 0·25 millim.).

The axis is black in colour and seems to be non-calcareous. It measures 2 millims. in breadth at the base, soon expands to 4 millims., and then narrows again. It is markedly flattened. Towards the ends of the branches, which measure about 3 millims. in greatest breadth, the axis is thread-like, brown in colour, and very flexible. The cœnenchyma is thick, its texture recalls that of *Iciligorgia;* several sections through a branch showed three large longitudinal canals symmetrically disposed close round the axis.

The spicules are broad spindles, 0·2 millim. by 0·1 millim.; narrow spindles; clubs; and double clubs.

Locality:—Pearl banks, Gulf of Manaar.

Leptogorgia australiensis, Ridley, var. **flavotincta**.—Plate IV., fig. 10.

This species is represented by numerous complete specimens, which differ considerably in size, the largest being 154 millims. in height and 130 millims. in maximum breadth. In all the specimens the cœnenchyma is rubbed off near the base, thus exposing the axis to view. The axis rises from a flat spreading basal portion, it is black in colour and slightly oval in shape, measuring 2·2 millims. in diameter at the base, but becoming lighter in colour and thread-like in form in the tips of the branches and in the pinnæ. It is horny in texture and very tough. The branching is confined to one plane, and each of the branches has a pinnate appearance. On the main stem and branches there is a distinct groove running up both the surfaces, thus dividing the polyp-bearing part into two lateral bands. In some parts it seems as if the groove had disappeared and left a ridge in its place. Some of the specimens show galls.

The verrucæ are arranged on the two lateral faces of the branches and the pinnæ in two alternating rows. They are scarcely elevated above the level of the general cœnenchyma, and their openings are slit-like in shape, the slit running parallel to the long axis of the branch.

In every respect the specimens agree with the description given by Ridley (1884). The spicules in the present specimens seem on the whole to be smaller than those measured by Ridley either for the species itself or for any of the varieties, varying, as they do, from 0·09 millim. to 0·16 millim. in length, and from 0·04 millim. to 0·05 millim. in breadth. Few of the spicules, however, attain the latter dimension in breadth.

The colour of the specimen, not agreeing exactly with any of the colours given for the species, may be best described as deep crimson. The yellow verrucæ stand out conspicuously in the younger branches, and also in two young colonies (Station I.) 30 millims. in height.

Localities:—Cheval Paar, Gulf of Manaar; Station I., off Negombo, 12 to 20 fathoms; deep water off Galle and onwards to Colombo.

Previously recorded from Torres Straits (see Ridley, 1884, p. 342, Plate 36).

Leptogorgia australiensis, Ridley, var. **perflava**—Plate IV., fig. 10.

This variety is represented by a complete colony which has a maximum height of 80 millims. and a maximum width of 88 millims. The type of branching agrees very closely with that described, even to the pinnate arrangement of some of the pinnæ themselves. The groove or furrow is more tortuous than in Ridley's description, and in several places it shows the transition between a groove and a ridge. The size and the arrangement of the verrucæ, and their manner of opening by longitudinal slits, are all in close agreement with Ridley's descriptions. The axis just above the flat spreading basal portion has a diameter of 1·35 millims.

The spicules are spindle-shaped, with whorls of warts, distinct free spaces being visible between the whorls near the middle portion of the spicule. Their measurements, length by breadth in millimetres, are as follows:—0·12 × 0·04; 0·15 × 0·05; 0·11 × 0·04; 0·16 × 0·04; 0·17 × 0·03; 0·08 × 0·04.

In this specimen the spicules show a greater range in size than is found in the specimen described by Ridley.

Neither in this variety nor in the variety described above can any trace be found of the double-headed spicules which Verrill has described. They are almost certainly, as Ridley has suggested, pieces of broken fusiform spicules.

A point of some interest in regard to the varieties described above is, that the spicules of the crimson variety are wholly crimson and the spicules of the yellow variety are wholly yellow. In no case can any trace of both red and yellow spicules be found in one specimen. Ridley, however, found that red spicules occurred in the cortex of the yellow varieties, and that in the cortex of the main branches of the red form there were almost, if not quite, as many yellow as red spicules. We have examined our specimens very carefully, and it may be that we have here the initiation of a more definite splitting up of the species into distinct colour-varieties.

Leptogorgia (?) sp.

We have been unable to come to a definite decision in regard to an interesting form which we rank provisionally with the genus *Leptogorgia*. It is represented by an incomplete specimen showing two branches arising from a common basal portion. The longest branch is 84 centims. in length, 2 millims. to 2·5 millims. in breadth, and gives off two short branches at an acute angle. The branches are flattened, the edges show a crenate row of gentle elevations and depressions indicating the position of the verrucæ and the minute intervals between them. The colour is greyish with a tint of vandyck brown; the texture of the cœnenchyma appears smooth to the naked eye, finely granular under the hand lens. The axis measures 0·85 millim. across at its base, and a surprising feature is its markedly calcareous composition.

The spicules are:—(*a*) Small warty double spindles, measuring in length by maximum breadth in millimetres, 0·08 × 0·025; 0·1 × 0·025; 0·15 × 0·03; 0·16 × 0·04; and (*b*) minute warty double clubs, 0·03 × 0·02; 0·05 × 0·03; 0·075 × 0·03; 0·08 × 0·03.

Stenogorgia ceylonensis, n. sp.—Plate II., figs. 1 and 1A; Plate V., fig. 9.

This new species is represented by two complete colonies, which measure as follows:—

	(A.)	(B.)
Height of colony	125 millims.	73 millims.
Maximum width of same . . .	117 ,,	76 ,,

The colonies are fan-shaped and, on the whole, branched in one plane. The basal attachment consists of a broad, flat, plate-like portion which spreads over the surface of the object to which it is attached. From the basal portion the short main stem arises and soon divides into a number of principal branches. These give off secondary branches, which in their turn give rise to twigs of similar structure. The branches are, on the whole, given off in one plane, but several of the smaller branches and twigs come off in a different plane. The tips of the branches and twigs consist of flat expansions formed by two divergent terminal polyps; the expansion in many cases measures as much as 4 millims. from side to side.

The axis is horny, rigid in the lower part, but flexible and light brown in colour in the younger branches and twigs.

The verrucæ are very abundant on the branches and twigs, a little less numerous on the principal branches. They are cylindrical in shape, and measure, length by breadth in millimetres, as follows:—1·9 × 1·2; 1·5 × 1·1. They occur on all sides of the branches and twigs, and may be said to occur in short spirals which are closely crowded on the branch or twig. When the polyps are withdrawn the verrucæ present all the phases between a mere pore with a lobed margin and a minute 8-rayed star, in proportion to the extent of the retraction.

The cœnenchyma is thin and is easily rubbed off. It is mainly composed of short rough spindles closely covered with warts and spines. They are light yellow to deep yellow in colour, and measure, length by breadth in millimetres, as follows:— 0·4 × 0·08; 0·5 × 0·10; 0·41 × 0·079; 0·5 × 0·08.

The colour of the colony is a chocolate-brown.

Locality:—Trincomalee.

Gorgonia capensis, Hickson.

Several complete specimens and many fragments belong to this species. Two of the complete specimens measure 428 millims. and 439 millims. respectively in length. The basal attachment is in the form of a flat, plate-like expansion, from which the thread-like axis arises.

The axis is dark brown to black in colour, very tough and flexible, never measuring more than 0·5 millim. in diameter. In the larger complete specimen it has a basal diameter of only 0·15 millim. The branching is not profuse, the one specimen having two branches, the other only one, though in some of the broken fragments several branches are present.

The cœnenchyma is moderately thick, both on the main stem and on the branches, the terminations of which are knob-like. The colour is practically white, not yellow as in HICKSON's specimens.

Verrucæ are absent, the position of the polyps being marked by oval-shaped openings.

The spicules agree in measuring not more than 0·2 millim.

From these specimens it has been possible to corroborate HICKSON's discovery of viviparity in this species, but the disc-like embryos only measured 0·4 millim. by 0·39 millim. in size. Here we may be allowed to note our discovery of embryos in *Juncoptilum* sp., from ALCOCK's Indian Ocean collection.

Localities:—Station I., off Negombo, 12 fathoms to 20 fathoms; deep water off Galle and onwards to Colombo, hauls off Kaltura and off Mount Lavinia.

Previously recorded from 10 miles south of Cape St. Blaize (HICKSON, 1902).

Rhipidogorgia (?) sp.

A large fan-shaped reticulate colony was found, but so much weathered that secure identification was impossible.

FAMILY: GORGONELLIDÆ.

Scirpearella aurantiaca, n. sp.—Plate IV., fig. 7; Plate V., fig. 15.

The collection included several portions of what seems a new species of this genus. We have studied a fork-shaped fragment which has a total length of 366 millims. The lower part of the colony is wanting, but the axis at the point where it divides measures 2 millims. in diameter. It is cylindrical in shape, very calcareous and smooth in the one branch, but marked by two or three slight winding grooves in the lower part of the other. The general colour of the branches is yellowish-white. A larger specimen, 470 millims. in length, bore a small comatulid on one of its branches.

The verrucæ occur on all sides of the branches. They are conical in shape, truncated at the tip, and measuring 2 millims. in maximum height and 1·5 millims. in basal diameter. In colour they resemble the stem in the lower part, but the tip is orange-yellow, thus standing out against the general colour of the branches. The edges of the oral end curve inwards, and all stages from an opening with an 8-lobed margin to a simple pore-like opening and finally to a completely closed tip may be seen.

The polyps are all completely withdrawn into the cœnenchyma. The general cœnenchyma is yellowish-white in colour, granular in texture, and only of medium thickness. It is practically composed of spindles and double clubs.

The spicules are small in size, and measure, length by breadth in millimetres, as follows:—

(1.) Spindles, 0·06 × 0·02; 0·08 × 0·02; 0·085 × 0·03.

(2.) Double clubs, 0·055 × 0·03; 0·07 × 0·04; 0·06 × 0·04.

This specimen does not agree with any described species of *Scirpearella*, but comes nearest to *Scirpearella rubra*, with which, however, we cannot identify it.

Locality :—Deep water outside pearl banks, Gulf of Manaar.

Scirpearella divisa, n. sp.—Plate VI., fig. 8.

A fragment of a reddish-orange colony with four branches, 7 centims. in height, about 2 millims. in diameter. The verrucæ are very low and gently rounded; towards the end of the highest branch, where they are closely crowded and very distinct, the arrangement appears to be in four rows with a suggestion of a spiral; in the older parts the verrucæ are very inconspicuous, not close together, and somewhat irregularly disposed. There are two enormous cirriped galls, the broadest almost 1 centim. across. The cœnenchyma is finely granular, almost smooth to the naked eye. The axis is very calcareous, light yellow in colour, with ten shallow grooves on the part examined. It measured there about 1·4 millims. in diameter out of the total branch diameter of 2 millims. Thus the thickness of the cœnenchyma is very moderate.

The spicules are chiefly minute, warty, double clubs, measuring 0·04 millim to 0·06 millim. in length, but usually 0·05 millim.; most are yellowish, a minority colourless. The bare middle part of the double club is very short. There are also yellowish and uncoloured warty spindles, measuring 0·1 millim. in length by 0·02 millim. in maximum breadth.

Scirpearella sp. *α*.

One specimen with a length of 307 millims. The stem is divided at a distance ot 39 millims. from the flat base, and is flexible. Prominent verrucæ occur all round the stem in rows. The axis is deeply grooved in the lower part, but the grooving is hardly noticeable higher up.

The fragment approaches *Scirpearella moniliforme*, but differs in colour and in predominance of warty clubs over spindles, and in not having shallow verrucæ.

Scirpearella sp. *β*.

Another fragment, measuring 205 millims. in length. Verrucæ scarcely prominent, polyps white, a longitudinal white line is seen on one side. The axis is horny and very calcareous, faintly and irregularly marked by grooves.

The spicules, length by breadth in millimetres, are as follows :—

Stellate forms, $0·06 \times 0·05$; $0·07 \times 0·06$.

Double clubs, $0·06 \times 0·03$.

Spindles, $0·06 \times 0·02$; $0·08 \times 0·025$.

This does not agree with any of the formerly described species.

Scirpearella sp. *γ*.

Another fragment which measures 258 millims. in length is included in the collection.

The stem has a groove on one side, and on the side directly opposite there is a bare strip. The polyps are in three rows on each side of the groove. The verrucæ are very small.

The following measurements were taken :—

Diameter of stem at lower end, 3·2 millims.

,, axis ,, ,, 2 ,,

,, stem at upper ,, 2 ,,

The spicules measure, length by breadth in millimetres, as follows :—

Spindles, 0·06 × 0·03 ; 0·07 × 0·03.

Double clubs, 0·05 × 0·04 ; 0·06 × 0·04.

Double spindles, 0·06 × 0·04 ; 0·05 × 0·035.

Scirpearia, sp. (?)—Plate IV., fig. 1 ; Plate V., fig. 16.

This specimen is a fragment without the base. It measures 410 millims. in length and divides at a distance of 38 millims. from its basal end into two long whip-like branches.

The axis is deeply grooved. There is a median bare space on each side. The polyps are darker in colour than the stem.

The spicules measure, length by breadth in millimetres, as follows :—

Double clubs, 0·06 × 0·04 ; 0·063 × 0·04. Darker coloured, 0·08 × 0·025 ; 0·07 × 0·02. In its spicules it is quite distinct from any *Juncella*.

It may seem of little service to suggest problematical species based on a study of fragments, but as we have given some description of each, our procedure is probably preferable to that of some other students of Alcyonacea, who have given names nude of any description.

Our impression is that the elongated forms of *Scirpearella*, *Juncella*, and the like, so monotonous in general appearance, so perplexingly diverse when one gets beneath the surface, are subject to great variability. The same remark applies to *Spongodes*, *Acis*, *Muricella*, *Verrucella*, and many other Alcyonarians.

Juncella gemmacea (Valenciennes)—Plate IV., figs. 4 and 5.

There are several specimens of this species in the collection. The finest one was 3 feet 7 inches in length, with a yellow basal expansion 3 centims. across, and with a stem measuring 9 millims. in diameter at the base. The stem increased to 12 millims. in diameter, and 10 millims. was a fair average. The lateral lines were spirally twisted. Another specimen measures 193 millims. in length and tapers from 7 millims. in diameter at the base to 4·5 millims. at the tip ; another measures 292 millims. in length with a basal diameter of 4 millims. The thickest piece measured 9 millims. in basal diameter, the axis alone amounting to 5 millims., and had an apical diameter of 3 millims. The side-line on either side of the stem is distinct. The axis is longitudinally grooved.

The spicules agree with those described and figured in the '"Challenger" Report, and are (*a*) unsymmetrical double clubs, and (*b*) double stars. The measurements, length by breadth in millimetres, are of (*a*), $0·12 \times 0·04$; $0·11 \times 0·04$; $0·10 \times 0·04$; and of (*b*), $0·10 \times 0·06$. A few single clubs and rough needles were seen.

The colour of the specimens in spirit is bright red with tints of orange when closely examined; the polyps appear white.

Locality :—Gulf of Manaar; Vankali Paar; Muttuvaratu.

Previously recorded from Red Sea; Torres Straits; Queensland and Mermaid's Straits, N.W. Australia.

Juncella juncea, Pallas.

The collection includes numerous fragments of various species of *Juncella*, more numerous than we could examine; some of these belong to *Juncella juncea* which Ridley reported from Ceylon (1883).

Juncella fragilis, Ridley.

This species is represented by several fragments, in which the axis is marked by longitudinal grooves or striæ. In some of the fragments the verrucæ measure nearly 2 millims. in height and the axis has a diameter of 1 millim., while in the other fragments the verrucæ are much smaller and the axis measures 2 millims. in diameter. The spicular measurements in the one set of fragments are almost identical with those previously given for *Juncella fragilis*, but in the other set they measure as follows, length by breadth in millimetres :—

Unsymmetrical clubs, $0·08 \times 0·03$; $0·065 \times 0·03$.

Double clubs, $0·08 \times 0·04$; $0·075 \times 0·03$.

Juncella fragilis (Ridley), var. *rubra*, n.

This species is also represented by one complete specimen on which this new variety has been founded. The specimen shows no trace of branching, and measures 508 millims. in length. It is long and flexible, and tapers very gradually throughout its entire length to the pointed apex. The cortex is thick and red coloured, with numerous reddish-brown verrucæ. There is no trace of a lateral line or groove throughout the entire length of the stem, but the cortex has been rubbed off the lower part.

The verrucæ are numerous and closely appressed, measuring about 1 millim. in height. The axis is grooved and very flexible, measuring 3 millims. in diameter at the base and becoming hair-like near the tip where the stem measures 2 millims. in diameter. The base consists of a broad flat plate which has a diameter of 14 millims.

The spicules are double clubs and double stars, which measure, length by breadth in millimetres, as follows :—

Double clubs, $0·08 \times 0·03$; $0·087 \times 0·04$.

Stars, $0·05 \times 0·03$; $0·06 \times 0·03$.

The specimen approximates closely to the description of *Juncella fragilis* given by Ridley (1884). The only marked differences are in the colour and in the diameter of the axis at the base. The larger diameter can be easily accounted for by the large size of the specimen, 508 millims. But it seems useful to record a new colour variety.

Locality:—Gulf of Manaar.

Previously recorded from Port Denison, Queensland; 4 fathoms.

Juncella trilineata, n. sp.

Height of specimen 238 millims. It is sparingly branched in one plane, the first branching occurring at a height of 67 millims. There is a distance of 16·5 millims. between this and the next branching. The colony is exceedingly flexible and very graceful. The base is wanting, but the stem at its lower end measures 3·5 millims. in diameter.

Polyps arise in three different bands, leaving three narrow bare strips, each of which has in its centre a slight rib or keel. Under each bare strip lies a large longitudinal canal. The axis shows longitudinal grooves.

The polyps, which measure from 1·1 millims. to 1·5 millims. in height, are arranged in transverse rows of 3 or 4, but many smaller polyps occur which break this regularity.

The spicules resemble those of *Juncella gemmacea* in several of their forms. Unsymmetrical clubs, length by breadth, 0·08 millim. by 0·03 millim.; 0·065 millim. by 0 03 millim.; 0·07 millim. by 0·04 millim.; 0·07 millim. by 0·03 millim.

Double stellate forms, 0·08 millim. by 0·04 millim.; diameter of spindle, 0·02 millim.
,, ,, ,, 0·09 ,, ,, 0·035 ,, ,, ,, 0·02 ,,

Locality:—Patani, Siam.*

Verrucella rubra, n. sp.—Plate IV., fig. 13; Plate V., fig. 8.

A fragment of a colony, which has a total height of 98 millims. and a maximum width of 69 millims., appears to require the establishment of a new species. The base and the lower part of the colony is wanting, and many of the branches seem to be without the upper portion.

The axis, which measures 2·25 millims. in diameter at the lower end, is greyish-brown in colour, with a white central core, very calcareous, rigid, and brittle.

The branching of the colony is very profuse and is confined to one plane. The branches and twigs are given off at a right angle or at a close approximation thereto. There does not appear to be any fixed arrangement in the branching.

* This specimen, along with two others (*Astromuricea ramosa*, n. sp., and *Telesto trichostemma*), was given to me on a visit to Professor Herdman's laboratory by Mr. Nelson Annandale, who asked that it might be incorporated in this Report.—J. A. T.

The verrucæ are small, low, conical, wart-like bodies. They are confined on the whole to the lateral faces, but on the older branches, and on some parts of the stem and of the twigs, they seem to be scattered over three surfaces.

The general cœnenchyma is thin and easily rubbed off (in several places the axis is laid bare); it is mainly composed of double clubs, spindles, and double spindles. The spicules are covered with large rough warts, which are arranged in whorls. The spicules measure, length by breadth in millimetres, as follows:—

Double clubs, 0·10 × 0·047; 0·09 × 0·05; 0·09 × 0·06.

Spindles, 0·10 × 0·035; 0·08 × 0·03; 0·09 × 0·035.

Double spindles, 0·07 × 0·04; 0·08 × 0·04; 0·06 × 0·035.

The colour of the specimen is a bright crimson.

Locality:—Gulf of Manaar.

Verrucella flexuosa, Klunzinger, var. **aurantiaca**, n.—Plate III., fig. 4; Plate IV., fig. 8.

This form is represented by several complete specimens and many fragments. One complete colony has a height of 210 millims. and a maximum width of 180 millims.; another is 74 millims. by 80 millims. The colonies rise from a flat portion which spreads over the surface of a stone. In the largest specimen branching begins at the base, in a smaller the stalk rises to a height of 30 millims. before it gives off the first branch. In the lower portion of the stalk, which has a diameter of 2 millims., there are no polyps present. The verrucæ begin to appear at a height of 14 millims. from the base, but they are not abundant in the older basal region. There are numerous galls.

The branching is profuse and confined to one plane. The branches are given off at various angles—acute for some of the main branches, and almost always a right angle for the minor branches or twigs.

The tips of the branches and the twigs are sometimes slightly flattened in the plane of branching. The branches and the twigs come off very irregularly.

The verrucæ on the younger portions of the branches and on the twigs are somewhat more numerous towards the lateral edges, but on the stem and the older portions they occur all round. The verrucæ are conical in shape and truncated, measuring about 0·75 millim. in height and having a basal diameter of 1 millim.

The general cœnenchyma is granular in appearance, not of great thickness, and composed of spicules in the form of spindles and double clubs. They measure, length by breadth, in millimetres, as follows:—

Spindles, 0·08 × 0·03; 0·07 × 0·02; 0·10 × 0·04; 0·08 × 0·02.

Double clubs, 0·065 × 0·04; 0·08 × 0·04; 0·08 × 0·045.

The specimens described here approach very closely to *Verrucella flexuosa*, Klunzinger, but as this species appears to be very variable, it may be useful to class them as an orange variety.

In another specimen the branching was not at all in one plane; in another there was abundant anastomosis.

Locality:—West of Periya Paar.

Verrucella flexuosa, var. **gallensis**, n.—Plate III., fig. 9; Plate V., fig. 11.

This variety is represented by a slightly damaged colony and several large and small pieces of colonies. The complete specimen has a height of 47 millims. and a maximum diameter of 53 millims. The basal attachment consists of a flat plate-like spreading portion from which the main stem rises. The stem is rigid and brittle, very calcareous in nature, and rises to a height of 13 millims. before it gives off the first branch. The branches are given off at right angles and they in their turn give off branches in a similar manner. The tips of the twigs and branches are occupied by two divergent polyps which gives them a slightly flattened appearance. The branches are given off in an irregularly alternate manner from the main stem and from the larger branches. The branching is confined to one plane. The colour varied from rose-red to vermilion.

The verrucæ are blunt and conical shaped, measuring 0·7 millim. in height and having a basal diameter of 0·8 millim. to 1 millim. They are confined to the lateral surfaces of the stem and branches, but are directed a little more to one surface than to the other. They are arranged in such a way that the verrucæ on the one lateral face alternate with the verrucæ on the other face.

The general cœnenchyma is very thin and is composed of spindles, double clubs and double spindles.

This variety is represented by a large number of fragments, mostly small. The branching in some of the fragments is confined to one plane, but in others the branches are given off on all sides. The axis is cylindrical, white in colour and very calcareous. In the several fragments it shows considerable differences in diameter.

The verrucæ are small, conical shaped, with a wide base. They measure 0·5 millim. in height and have a basal diameter of fully 1 millim. They occur all round the main stem or branch and also on the other branches, but on portions of the older branches and on the younger branches they are more or less confined to the lateral surfaces.

The general cœnenchyma is thin and is chiefly composed of spindles and double clubs. They are covered by whorls of rough warts. In the double clubs there is a very short bare shaft in the middle. Their measurements, length by breadth in millimetres, are as follows:—

Spindles, $0·10 \times 0·04$; $0·08 \times 0·03$; $0·10 \times 0·03$; $0·12 \times 0·03$.

Double clubs, $0·08 \times 0·06$; $0·10 \times 0·04$; $0·07 \times 0·04$; $0·085 \times 0·04$.

Localities:—Deep water off Galle; Gulf of Manaar.

Verrucella sp. (?).

A small fragment, from which several branches are given off in one plane, measures 63 millims. in height.

The axis is very calcareous and brittle.

The polyps on the main stem or branch are more or less restricted to the lateral edges, but on the younger branches they occur on the four surfaces in such a way that they all alternate and appear as if arranged in a spiral manner. They are contained in verrucæ which are small, slightly conical and truncated at the top. The polyps themselves are all withdrawn into the verrucæ, but they present yellowish-white apices at the opening of the verrucæ. Towards the base of the tentacles on the aboral surface two or three pairs of spicules are arranged *en chevron*, and at their bases a few are arranged transversely so as to form a collar. These spicules are short warty spindles, either straight or slightly curved.

The cœnenchyma is thin and is composed of two layers of spicules, the outer layer being coloured and giving the characteristic colour to the colony, while the inner layer is colourless.

In the coloured layer the spicules show a considerable range in shades, varying from a light to a deep amber tint.

The spicules are spindle-shaped, thick in comparison to length, or slender, and covered with rough warts. The coloured, or outer layer, contains the bigger spicules. Their measurements, length by breadth in millimetres, are as follows:—

(*a.*) Coloured, 0·3 × 0·075; 0·4 × 0·08; 0·22 × 0·05; 0·11 × 0·05; 0·10 × 0·03; 0·08 × 0·02.

(*b.*) Colourless, 0·14 × 0·04; 0·175 × 0·04; 0·10 × 0·035; 0·28 × 0·025.

Order V.—STELECHOTOKEA.

Section I.—ASIPHONACEA.

Family: TELESTIDÆ.

Telesto rubra, Hickson.

This species is represented by two fragments, one of which (A) measures only 30 millims. in height.

Specimen A agrees closely with the description given by Hickson. Thus, in the basal portion of the youngest calyces, the spicules are fused to form tubes, the axis has eight longitudinal ribs, and prolonged boiling in caustic potash does not disintegrate it.

Specimen B seemed at first sight to have a black axis, but this was found to be due to *débris* which had collected in the hollow tube.

The whole surface of specimen (A) is covered by an encrusting sponge, which has completely destroyed the cœnenchyma. The spicules of the sponge are monaxonial and triaxonial.

Locality:—Trincomalee.

Telesto (Carijoa) trichostemma, Wright and Studer.

This species is represented by one specimen, which agrees with the description given by Wright and Studer.

The spicules are of two distinctly marked types :—

(1.) Long slender spicules with few lateral processes, often bifurcated at the end;

(2.) Strong, relatively broader spicules, with prominent lateral processes which interlock and form a felted covering.

They measure, length by breadth in millimetres, as follows :—

(1.) 0·3 × 0·02 ; 0·28 × 0·019 ; 0·15 × 0·012 ; 0·26 × 0·014.

(2.) 0·2 × 0·03 ; 0·25 × 0·02 ; 0·23 × 0·03.

The distance between the bifurcations at the ends of the spicules of type (1) often measured 0·02 millim.

Locality : Patani (Siam). This was one of Mr. Nelson Annandale's three specimens already referred to.

Section II. : PENNATULACEA.

Family : UMBELLULIDÆ.

Umbellula, sp.

The collection included* a small specimen, doubtless a young colony, of a species of *Umbellula*. As the specimen is a poor one, we have not studied it in any detail. We may refer to our forthcoming report on Professor Alcock's "Investigator" collection of deep-sea Alcyonacea from the Indian Ocean, which includes numerous Umbellulids of large size.

Family : VIRGULARIIDÆ.

Virgularia multiflora, Kner.

The specimen representing this species is fragmentary. It consists of a piece of the rachis, which seems to come from the lower portion of the colony. It measures 51 millims. in length and has 20 pairs of pinnules. The pinnules are crescent-shaped, 3 millims. in breadth and 2 millims. in height, with 11 polyps on each. The axis is white, almost perfectly cylindrical, with a pitted appearance on the surface and with a diameter of 1·2 millims. The specimen agrees very well with the description given by Kölliker. The following comparison will show the close similarity between the specimens :—

	Kölliker's.	Herdman's.
Breadth of pinnule	3·3 millims. to 4 millims.	3 millims.
Height ,, ,, ...	2 millims.	2 ,,
Number of polyps in a pinnule .	11 to 15	11.
Diameter of axis	1·29 millims.	1·2 millims.

Locality :—Trincomalee.

* From Station LX., Gulf of Manaar, 20 to 30 fathoms. See Professor Herdman's "Narrative," this Report, Part I. (1903), p. 75.

Virgularia loveni, Kölliker.

This species is represented by three fragments, the largest of which measures 106 millims. in length, and appears to consist of nearly the whole rachis, while the other two fragments represent the upper portions of two specimens.

The axis shows slight differences in form; in one it is cylindrical, in another quadrangular, with two of the sides rounded, while in the third it returns to the cylindrical shape, but with one surface slightly flattened. It is covered by transverse ridges or by tubercles, which gives it a pitted appearance. On the prorachidial face of the rachis there is a well-defined narrow groove. The diameter of the axis is 1·5 millims.; the rachis measures 106 millims. in length by 5·3 millims. in width.

The pinnules are folded so as to form a double S-shaped figure. They are almost touching one another near the tip, but lower down they stand considerably apart (3·5 millims.). They vary from 3·5 millims. to 4·8 millims. in breadth, and from 2 millims. to 2·5 millims. in height. The polyps are well defined, arranged in one row on the pinnule, and vary in number from 19 to 24.

The specimens agree with the description of *Virgularia loveni* given by Kölliker (1872), although there are a few slight differences.

Locality:—Trincomalee.

Virgularia, sp.—Plate IV., fig. 2.

The collection includes two fragments which approach *Virgularia loveni*. As they may be young forms, in regard to which little is known, and as they are only fragments, we have been content to give a brief description. The measurements are stated in the following table:—

	Rachis.		Pinnules.		Number of polyps on pinnule.	Number of rows.	Axis diameter.	Stalk diameter.
	Length.	Width.	Breadth.	Height.				
	millims.	millims.	millims.	millims.			millims.	millims.
(A.) . . .	53	4·5 to 5·5	4·8	2·5	23	1	1·5	2
(B.) . . .	56	4·5 ,, 5·5	4·7	2·4	24	1	1·5 (white in colour).	2

The pinnules are folded so as to form a double S-shaped figure. The polyps are well defined. There is a distinct groove on the prorachidial surface which measures 0·4 millim. from edge to edge.

At the tip the pinnules are almost touching, but lower down the distance between them is 3·4 millims.

The axis is almost rectangular in one specimen, with two shorter sides slightly rounded. In the other it is almost circular, but one surface is slightly flattened. In both cases it is covered by tubercles, which gives it a characteristic appearance. The tip of the axis is blunt.

A third specimen gave the following measurements :—

Total length.	Stalk.		Rachis.		Number of polyps.	Number of rows.	Zooids.
	Length.	Width.	Length.	Width.			
millims. 57	millims. 22·7	millims. 1·5	millims. 34·3	millims. At base 2, half-way up 3, near top 5.	26	1	Occurring over the whole surface of rachis. Brownish colour.

Specimen is club-shaped and tapers gradually from base till it reaches maximum width at a point near the tip of rachis.

Abundant spicules both in the stalk and in the rachis.

Calyx ridged.

A distinct groove runs the whole length of the rachis.

Locality :—Trincomalee.

Virgularia tuberculata, n. sp.—Plate II., figs. 5 and 9.

This species is founded to include six fragments which it was found impossible to place under any of the known species. The fragments are very incomplete and are not in good preservation. The two largest specimens are 110 millims. and 81 millims. in length.

The axis is cylindrical and presents a characteristic pitted appearance, due to the tuberculated structure of the surfaces. The tubercles appear at some parts to be irregularly arranged, at other parts to be arranged in whorls. The colour of the axis is a deep coral red shading into a yellowish-red. The diameter is 0·6 millim.

One of the fragments represents the lower part of the rachis, while other two represent the upper extremity. In the lower part the pinnules are small and appear as ridges, which run across the lateral surfaces of the rachis. The polyps are borne in one row on the edge of the pinnule and number six on each pinnule. Higher up the pinnules become more mature, larger, and separated by a longer interval. They present a quite different appearance, becoming slightly crescent-shaped. The polyps are somewhat barrel-shaped and are quite distinct, except for a small portion at their bases, which are fused together to form the pinnule.

The cœnenchyma is very thin, but on the pararachidial surface it is produced into two ridges, on which the siphonozooids are found. Their arrangement cannot be exactly ascertained, but they seem to form an interrupted line on each of the ridges, and also occur either singly or in small groups below each pinnule.

The polyps on the separated parts vary from barrel- to flask-shape in the retracted condition, and measure in this state from 0·5 millim. by 0·4 millim. to 0·65 millim. by 0·4 millim. In their expanded condition they are more cylindrical in shape and measure 0·9 millim. by 0·4 millim. They still present a slightly swollen appearance about the middle of their length.

The six fragments represent parts of the rachides of at least three different specimens. In no case is there any part of the stalk left, so that it is impossible to give any idea of its shape and size.

Locality :—Trincomalee.

FAMILY : PENNATULIDÆ.

Halisceptrum periyense, n. sp.

The collection included a couple of specimens of what appears to be a new species of *Halisceptrum*. Both specimens were complete and the natural colour is recorded by Professor HERDMAN as pink and white.

The lower portion of the stalk is curved and stands at right angles to the axis of the rachis, with its lower extremity marked by a ball-shaped swelling. The stalk passes almost imperceptibly into the lower portion of the rachis, which forms a long spindle-shaped swelling marked by two narrow **V**-shaped lines of pores, one on each lateral surface. The upper part of the rachis bears the pinnules, which show a marked difference in appearance. On the upper portion they are fairly large and show well-marked polyps on a wavy outline, while on the lower part they are reduced to straight ridges across the lateral faces of the rachis. The proportion of the mature to the immature pinnules is rather striking, there being in one specimen 14 mature to 53 immature, and in another 10 mature to 36 immature.

The pinnules in the immature state have the polyps arranged in one row, but soon the pinnule begins to get folded and the polyps begin to alternate, thus giving the appearance of multiple rows of polyps. The distance between the origins of the pinnules is 2·5 millims. in the case of the mature, but the immature lie almost touching one another. The pinnules are translucent, and they show a stringy appearance when held between the eye and the light.

The prorachidial surface of the rachis is free from pinnules and is marked by a distinct narrow groove. This groove fades away and disappears entirely between the immature polyps.

We add a table of measurements of the two specimens. There is in each a single row of polyps on the pinnules, but they alternate in arrangement so as to appear like two or more rows.

	Stalk.		Rachis.		Pinnules.		Number of polyps on each lower pinnule.	Distance between origins of pinnules.
	Length.	Width.	Length.	Width.	Breadth.	Height.		
	millims.	millims.	millims.	millims.	millims.	millims.		millims.
(A)	41	3	78	6·5	3·3	3·1	29 to 31	2·5
(B)	36	2·2	49	6	3	2·8	28 ,, 30	2·5

Locality :—Periya Paar, Gulf of Manaar, $9\frac{3}{4}$ fathoms.

Halisceptrum gustavianum (Herklots).

This species is represented by one complete specimen. Of the 23 millims. forming the stalk the lower 11 millims. consist of nothing but the axis which tapers to a point. At the upper end of the 11 millims. the axis has a diameter of 1·3 millims. and is cylindrical in shape.

In the rachis the stalk becomes grooved and approximates to a quadrangular shape. A groove is distinctly seen in the prorachidial face of the rachis, but this fades away and disappears in the lower part of the rachis.

The pinnules show a large number of polyps which appear to be arranged in a number of rows. In the immature pinnules the polyps are in a single row, but they soon begin to alternate, and in the mature pinnules they seem to be in six rows. The number of mature pinnules is very small compared with that of the immature, the numbers being 16 pairs to 40 pairs.

Pinnules : Breadth, 2·5 millims. ; height, 2·5 millims.

Distance between origins of pinnules, 4 millims.

Length of whole colony, 86 millims.

Locality : Station LII., Gulf of Manaar, 3 to 6 fathoms.

Pteroeides lacazei, var. **spinosum**, Kölliker.

This species is represented by a fragment only of the upper portion of the rachis, measuring about 36 millims. in length, with 15 pinnules on one side, 16 on the other.

The principal measurements are as follows :—Width of rachis, 48 millims. ; breadth of pinnule, 20 millims. ; height of pinnule, 12 millims. ; number of main rays, 12.

There is a single row of zooids running down the centre of the meta-rachidial surface.

The wart-like termination of the rachis is almost completely hidden between the two uppermost pinnules. The rachis seems to have been swollen towards the tip and the fragment seems to be a part of the swelling.

The zooid plate is basal. The pinnules are marked by a number of V-shaped black markings on their margins. The polyps are situated both on the upper and on the lower surface of the pinnule, but they are more abundant on the upper surface.

This specimen resembles *Pteroeides lacazei*, var. *spinosum*, in having one row of zooids, in the termination of the axis, in the number and composition of the main rays and in the texture of the pinnules.

Locality:—Station XXI., Back Bay, Trincomalee, 8 to 12 fathoms; Station LXIII., West of Periya Paar, 40 fathoms.

Family: VERETILLIDÆ.

Cavernularia obesa, Valenciennes.

This species is represented by a number of specimens obtained from shallow water in the northern part of the Gulf of Manaar. The largest specimen is evidently only the upper portion of a large colony. The part measures 61 millims. in height, and has a diameter which varies from 10 millims. near the tip to 17 millims. near the lower end. In shape it is irregularly elliptical.

The autozooids are scattered over the surface, and the parts not occupied by the autozooids are thickly beset with siphonozooids. The position of the autozooids, which are all retracted, is marked by bluish- to brownish-black spots.

A cross-section in the lower part shows four large central canals which run parallel to the long axis of the specimen and are apparently continuous. Radiating from the central part thus formed numerous canals can be seen, some of which run down to the central canals, others end blindly, and others join with one another. Some of the larger canals seem to open into one or other of the four central canals.

The spicules are perfectly smooth rods, with blunt ends, some cut abruptly across, others slightly tapered and rounded.

Another specimen, which is quite complete, probably belongs to the same species. It has a total length of 53 millims. and a rachidial diameter of 7 millims. near the tip. The rachis is slightly elliptical in cross-section, but becomes almost cylindrical near the tip. The whole surface not occupied by the autozooids is covered by numerous minute wart-like bodies which represent the upper parts of the siphonozooids.

The autozoöids occur scattered over the whole surface, and all are almost completely withdrawn. The incurved tentacles are just visible on the surface as brownish- to bluish-black circles. There is a marked difference between the autozooids in size, but this is probably due to a difference in the state of retraction.

The stalk is marked off from the rachis by an abrupt diminution in size, and it, with the lower part of the rachis, is marked by a number of grooves which run parallel to the length of the specimen.

Localities:—Station LII., near Vankali Reef, Gulf of Manaar, 3 to 6 fathoms; and Cheval Paar.

Stylobelemnoides, n. gen.

Veretillid with polyps over the whole surface; spicules long, rod-like spindles; axis cylindrical; calyces with 8 double rows of spicules.

Stylobelemnoides herdmani, n. sp.—Plate III., fig. 5; Plate IV., fig. 3.

The specimen is a broken club, 32·5 millims. in length, 2·8 millims. in breadth at thickest upper part, 2 millims. at lower end. The axis is straw coloured, square, with somewhat prominent angles, 0·85 millim. in thickness. The whole surface of the club is covered with small rod-like spicules, which form tubular calyces with 8-lobed apertures. The polyps are arranged all round the club, in two intersecting (but not exact) spirals. They form nine irregular rings. The siphonozooids fill up the interstices, and no bare streak is left.

The radial disposition of the polyps indicates a Veretillid; that they cover the whole surface indicates a Veretillean. As the limy bodies are long rod-like spindles, the specimen must be near *Stylobelemnon.*

But it differs from *Stylobelemnon* in many ways: *e.g.*, the axis is round not square; the calyces show 8 double rows of spicules; and the spicules are much larger, 2·25 millims. in length.

Under a magnification of 32 diameters the surface is seen to be closely covered with small straight spicules, among which the siphonozooids can be seen.

The polyp calyces are built up of similar spicules very closely packed together, and lying with their long axes parallel to the length of the calyx, thus forming a stiff protective case.

The spicules are present both in the cutis and in the deeper tissue.

Locality:—Trincomalee.

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EXPLANATION OF PLATES.

PLATE I.

Fig. 1. Expanded polyps of *Acamptogorgia spinosa*, var. *ceylonensis*, n. × 25.
„ 2. *Spongodes splendens.* × 20.
„ 3. *Eunephthya purpurea*, n. sp. × 20.
„ 4. *Nephthya ceylonensis*, n. sp. × 20.
„ 5. *Spongodes pulchra*, n. sp. × 20.
„ 6. *Spongodes armata*, var. *ceylonensis*, n. × 20.
„ 7. *Siphonogorgia köllikeri.* × 4.
„ 8. *Astromuricea ramosa*, n. sp. × 12.
„ 9. *Spongodes aurantiaca*,* n. sp. × 20.

PLATE II.

Fig. 1. *Stenogorgia ceylonensis*, n. sp. × 12.
„ 1A. Branching of *Stenogorgia ceylonensis*, n. sp. Nat. size.
„ 2. *Paraspongodes striata*, n. sp. × $1\frac{1}{2}$.
„ 3. *Acis indica*, n. sp. × 15.
„ 4. *Capnella manaarensis*, n. sp. × 15.
„ 5. *Virgularia tuberculata*, n. sp. × 20.
„ 6. *Paranephthya pratti*, n. sp. × 25.
„ 7. *Paraspongodes striata*, n. sp. × 15.
„ 8. *Acanthogorgia media*, n. sp. × 20.
„ 9. *Virgularia tuberculata*, n. sp. × 12.

PLATE III.

Fig. 1. *Bebryce hicksoni*, n. sp. × 12.
„ 2. Branching of *Muricella ramosa*, n. sp. Nat. size.
„ 3. *Muricella ramosa*, n. sp. × 8.
„ 4. *Verrucella flexuosa*, var. *aurantiaca.* × $2\frac{1}{2}$.
„ 5. *Stylobelemnoides herdmani*, n. gen. et sp. × 5.
„ 6. *Lophogorgia lutkeni.* × $1\frac{1}{2}$.
„ 7. *Acanthogorgia media*, n. sp. × 20.
„ 8. *Clavularia margaritiferæ*, n. sp., spreading on an oyster shell. × 2.
„ 9. *Acis alba*, n. sp. × 12.

PLATE IV.

Fig. 1. *Scirpearia* sp. Nat. size.
„ 2. *Virgularia* sp. × $1\frac{1}{2}$.
„ 3. *Stylobelemnoides herdmani*, n. gen. et sp. × 2.
„ 4, 5. *Juncella gemmacea.* Nat. size.
„ 6. *Acanthogorgia ceylonensis*, n. sp. × 3. The stem and branches have been made much too substantial.

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* This has been by mistake printed *S. flabellifera* on the plate.

Fig. 7. *Scirpearella aurantiaca*, n. sp. Nat. size.
,, 8. *Verrucella flexuosa*, var. *aurantiaca*, n. Nat. size
,, 9. *Verrucella flexuosa*, var. *gallensis*, n. Nat. size
,, 10. *Leptogorgia australiensis*. × 2.
,, 11. *Acanthogorgia muricata*, var. *indica*, n. Nat. size
,, 12. *Lophogorgia rubrotincta*, n. sp. × 2.
,, 13. *Verrucella rubra*, n. sp. Nat. size.

PLATE V

Fig. 1. *Spongodes rosea*.
,, 2. *Muricella ramosa*, n. sp.
,, 3. *Acanthogorgia muricata*, var. *indica*, n.
,, 4. *Acis alba*, n. sp.
,, 5. *Eunephthya purpurea*, n. sp.
,, 6. *Spongodes aurantiaca*, n. sp.
,, 7. *Acis indica*, n. sp.
,, 8. *Verrucella rubra*, n. sp.
,, 9. *Stenogorgia ceylonensis*, n. sp.
,, 10. *Spongodes pulchra*, n. sp. (From stem and branches only.)
,, 11. *Verrucella flexuosa*, var. *gallensis*, n.
,, 12. *Acanthogorgia ceylonensis*, n. sp.
,, 13. *Spongodes bicolor*, var. *dubia*, n.
,, 14. *Capnella manaarensis*, n. sp.
,, 15. *Scirpearella aurantiaca*, n. sp.
,, 16. *Scirpearia* sp.
,, 17. *Astromuricea ramosa*, n. sp.
,, 18. *Paranephthya pratti*, n. sp.

PLATE VI.

Fig. 1. *Echinogorgia multispinosa*, n. sp. × 15.
,, 2. *Heterogorgia verrilli*, n. sp. $\frac{2}{3}$ nat. size.
,, 3. *Acis ceylonensis*, n. sp. × 12.
,, 4. *Muricella ceylonensis*, n. sp. $\frac{2}{3}$ nat. size.
,, 5. *Bellonella indica*, n. sp. × $2\frac{1}{4}$.
,, 6. *Echinomuricea ceylonensis*, n. sp. $\frac{2}{3}$ nat. size.
,, 7. *Lophogorgia irregularis*, n. sp. Nat. size.
,, 8. *Scirpearella divisa*, n. sp. Nat. size.
,, 9. *Bebryce hicksoni*, n. sp. $\frac{2}{3}$ nat. size.

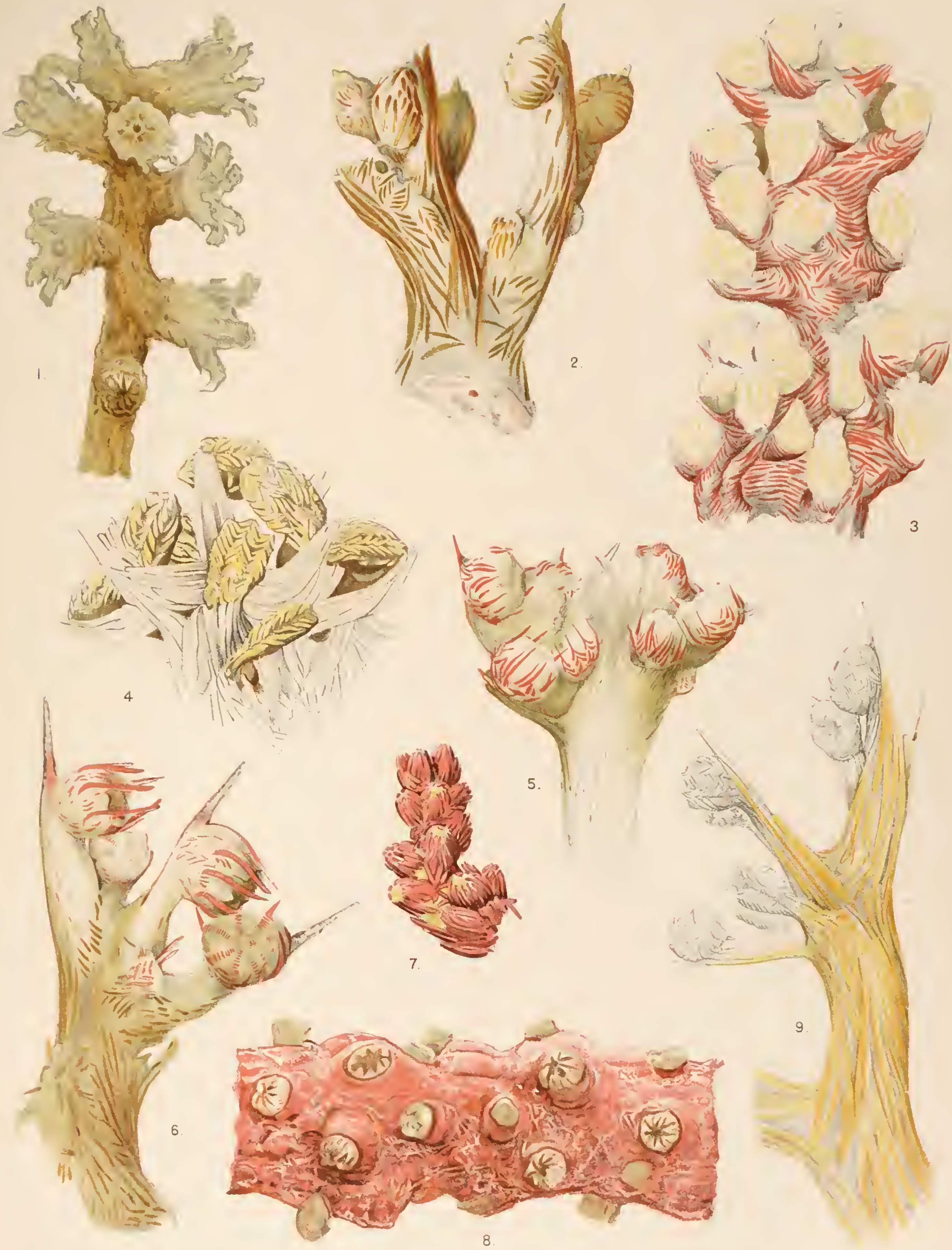
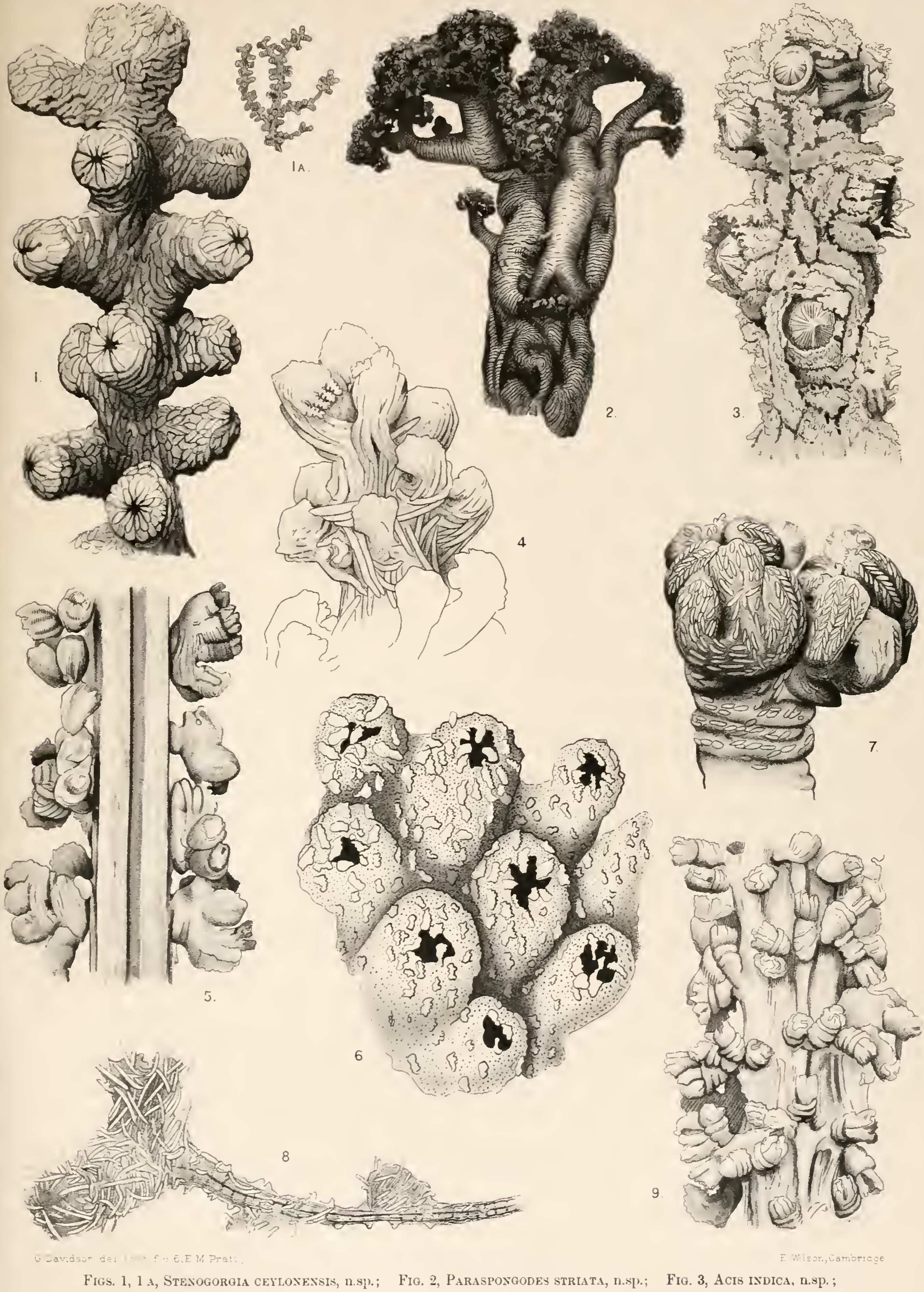


FIG. 1, ACAMPTOGORGIA SPINOSA, var. ceylonensis, n.; FIG. 2, SPONGODES SPLENDENS; FIG. 3, EUNEPHTHYA PURPUREA, n.sp.; FIG. 4, NEPHTHYA CEYLONENSIS, n.sp.; FIG. 5, SPONGODES PULCHRA, n.sp.; FIG. 6, SPONGODES ARMATA, var. ceylonensis, n.; FIG. 7, SIPHONOGORGIA KÖLLIKERI; FIG. 8, ASTROMURICEA RAMOSA, n.sp.; FIG. 9, SPONGODES FLABELLIFERA, n.sp.



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FIGS. 1, 1 A, STENOGORGIA CEYLONENSIS, n.sp.; FIG. 2, PARASPONGODES STRIATA, n.sp.; FIG. 3, ACIS INDICA, n.sp.; FIG. 4, CAPNELLA MANAARENSIS, n.sp.; FIG. 5, VIRGULARIA TUBERCULATA, n.sp.; FIG. 6, PARANEPHTHYA PRATTII, n.sp.; FIG. 7, PARASPONGODES STRIATA, n.sp.; FIG. 8, ACANTHOGORGIA MEDIA, n sp.; FIG. 9, VIRGULARIA TUBERCULATA, n.sp.

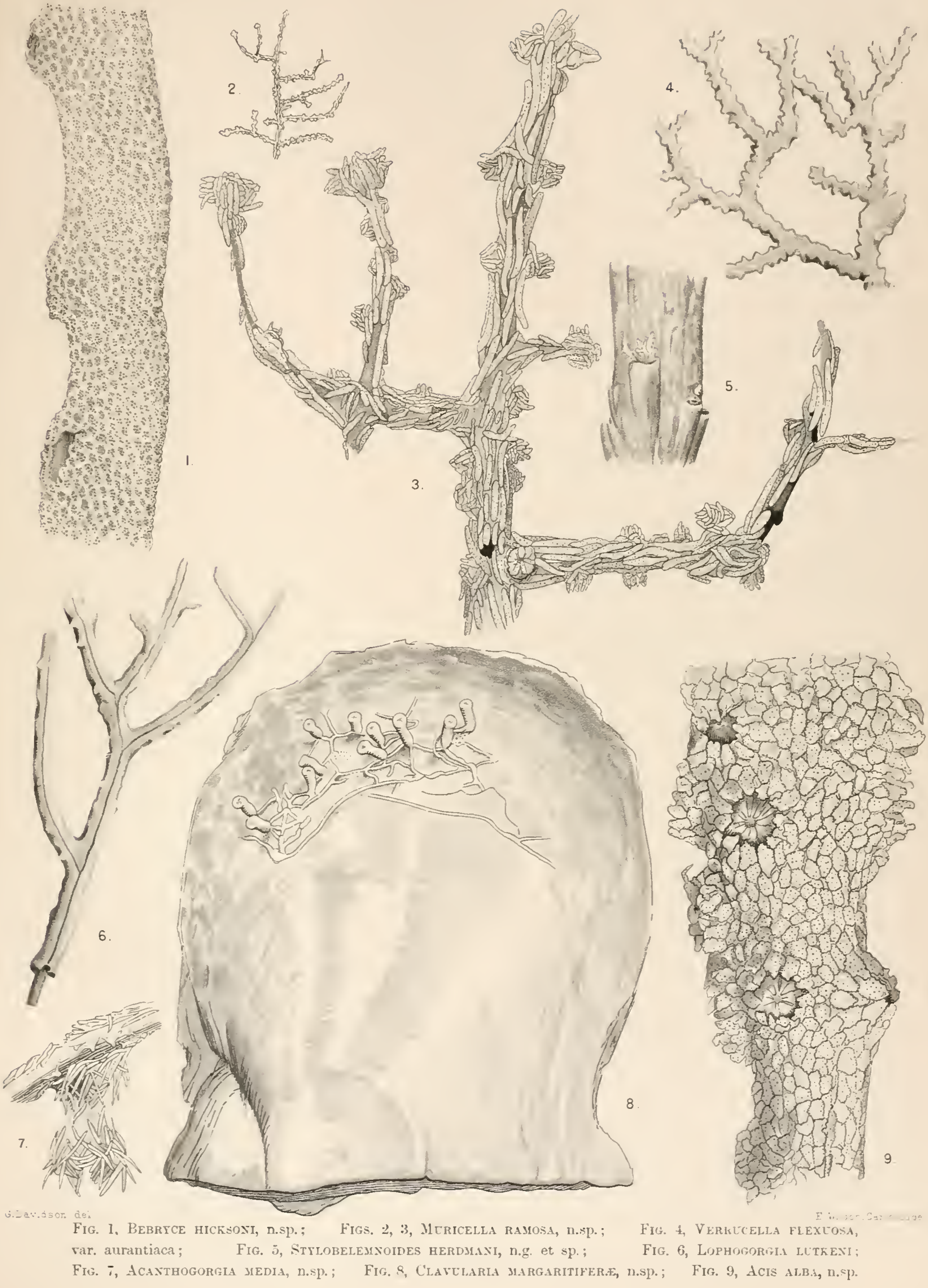

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FIG. 1, BEBRYCE HICKSONI, n.sp.; FIGS. 2, 3, MURICELLA RAMOSA, n.sp.; FIG. 4, VERRUCELLA FLEXUOSA, var. aurantiaca; FIG. 5, STYLOBELEMNOIDES HERDMANI, n.g. et sp.; FIG. 6, LOPHOGORGIA LUTKENI; FIG. 7, ACANTHOGORGIA MEDIA, n.sp.; FIG. 8, CLAVULARIA MARGARITIFERÆ, n.sp.; FIG. 9, ACIS ALBA, n.sp.

FIG. 1, SCIRPEARIA, sp.; FIG. 2, VIRGULARIA, sp.; FIG. 3, STYLOBELEMNOIDES HERDMANI, n.g., et.sp.; FIGS. 4, 5, JUNCELLA GEMMACEA; FIG. 6, ACANTHOGORGIA CEYLONENSIS, n.sp.; FIG. 7, SCIRPEARELLA AURANTIACA, n.sp.; FIG. 8, VERRUCELLA FLEXUOSA, var. aurantiaca, n.; FIG. 9, VERRUCELLA FLEXUOSA, var. gallensis, n.; FIG. 10, LEPTOGORGIA AUSTRALIENSIS; FIG. 11, ACANTHOGORGIA MURICATA, var. indica, n.; FIG. 12, LOPHOGORGIA RUBROTINCTA, n.sp.; FIG. 13, VERRUCELLA RUBRA, n.sp.

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SPICULES

(For list of Species see Explanation of Plates)

Fig. 1, Echinogorgia multispinosa, n.sp.; Fig. 2, Heterogorgia sp.; Fig. 3, Acis ceylonensis, n.sp.; Fig. 4, Muricella ceylonensis, n.sp.; Fig. 5, Bellonella indica, n.sp.; Fig. 6, Echinomuricea ceylonensis, n.sp.; Fig. 7, Lophogorgia irregularis, n.sp.; Fig. 8, Scirpearella divisa, n.sp.; Fig. 9, Bebryce hicksoni, n.sp.

REPORT

ON THE

OPISTHOBRANCHIATE MOLLUSCA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH SIX PLATES.]

THERE are about 50 species of Opisthobranchs in the collection, and of these 16 are now described as new to science.

The Report is divided into two sections, I. NUDIBRANCHIATA and II. TECTIBRANCHIATA, with an Appendix containing (1) *Onchidium* and (2) *Marsenia*.

I. NUDIBRANCHIATA.

The collection of Nudibranchs made by Professor HERDMAN in Ceylon and handed over to me for identification amounts to 30 species. Of these 9 must be described as new, 12 are fairly well known tropical species, 4 are now identified with species previously described by ABRAHAM or by QUOY and GAIMARD, but of which little was known, and 5 are too small to identify satisfactorily.

The list of species is as follows :—

Hervia ceylonica, n. sp.
Galvina producta, n. sp.
Eolis sp. ?
,, sp. ?
Doto sp. ?
Melibe fimbriata, A. and H.
Scyllæa pelagica, L.
Pleurophyllidia formosa, KEL.

Linguella cinerea, n. sp.
Hexabranchus marginatus (Q. and G.).
Discodoris labifera (ABR.).
Platydoris inframaculata (ABR.).
,, *speciosa* (ABR.).
,, *herdmani*, n. sp.
,, (?) *spinulosa*, n. sp.
Halgerda punctata, n. sp.
Thordisa (?) *caudata*, n. sp.
Chromodoris reticulatus, PSE.
,, *tenuilinearis*, n. sp.
Casella cincta, BGH.
Ceratosoma cornigerum, GRAY.
,, *ornatum*, BGH.
Doris sp. ?
,, sp. ?
Doriopsis aurea, Q. and G.
Phyllidia varicosa, LEUCK.
,, *nobilis*, BGH.
Ægires villosus, n. sp.
Trevelyana bicolor, A. and H.
Kalinga ornata, A. and H.

It is, perhaps, premature to institute comparisons between the Nudibranch fauna of Ceylon and those of other localities, as so little is known comparatively of the distribution of the group in the warmer seas, and as the identification of spirit specimens from written descriptions is attended with great uncertainty.

The capture of four species of Eolids and a *Doto* on the hanging oyster cages is of interest, as it seems to show that absence or rarity of these families in tropical seas is, perhaps, due more to the difficulty of finding them than to their actual scarcity, the larger and more showy Dorids attracting the attention of collectors to the exclusion of more insignificant forms.

There has been but little work done in the past on Ceylonese or Indian Nudibranchs. Dr. KELAART, in 1859 (**3**) (**4**), described 33 species of *Doris* from specimens collected in Ceylon, but his descriptions are based mainly on the colour and texture of the living animal. ALDER and HANCOCK (**5**), in examining a collection of Nudibranchs from Madras, re-discovered six of KELAART'S species with the aid of his original drawings, and added 32 more, besides recording three others previously described.

Of more recent works should be mentioned a paper by COLLINGWOOD on Nudibranchs from the Eastern seas (**8**) and a list of the Dorididæ in the British Museum Collections by ABRAHAM (**7**), who there describes the external characteristics of a number of spirit specimens. Reference should also be made to the work of Sir CHARLES ELIOT, who has published papers on the Nudibranchs and Tectibranchs of Samoa, the Maldives and Laccadives, and East Africa (**11**) (**12**) (**13**).

Most, however, of the adequate descriptions of Oriental Nudibranchs are due to the long-continued work of Dr. RUDOLPH BERGH, culminating in the magnificent series of papers in SEMPER'S 'Reisen im Archipel der Philippinen.'

In working out the collection no attempt has been made to investigate the anatomy of the specimens beyond what seemed to be necessary for their identification.

In conclusion, I should like to express my thanks to Professor HERDMAN for his kindness in allowing me to work out this collection and use his notes, and for the facilities which he afforded me, and also to Mr. E. A. SMITH for kindly allowing me to examine the Nudibranchs preserved in the British Museum Collections.

NUDIBRANCHIATA CLADOHEPATICA

FAMILY: ÆOLIDIIDÆ.

SUB-FAMILY: CRATENIINÆ.

Hervia ceylonica, n. sp.—Plate I., figs. 1 to 5.

Amongst the Nudibranchs obtained from oysters hung over the ship's side, in the Gulf of Manaar, were 12 specimens of a small Eolid, length 8 millims., which seems to belong to the genus *Hervia.* This genus is closely allied to *Cratena,* and is distinguishable externally by the large tentacles, smooth rhinophores, grouped papillæ, and produced anterior angles of the foot; and internally by the single series of arched teeth strongly denticulate on either margin.

The specimens here described have the body pale and semi-translucent, the papillæ with fawn-coloured hepatic contents, probably faded, long and slender, with distinct white cnidogenous sacs. They are arranged in 5–6 irregular transverse rows, the first row widely separated from the rest. The tentacles are long, very thick at the base, and tapering evenly to a point. The rhinophores are short, slender, and smooth, the eyes being visible at their base. The anterior angles of foot are moderately produced, the tail slender and moderately long (Plate I., fig. 1).

The jaws are of the usual shape in the Cratenidæ, with rather short cutting edge, irregularly denticulate. The radula has a single row of arched teeth, with an acute apex and 5 strong lateral denticulations on either side (Plate I., fig. 2).

The genital organs did not show any sign of armature.

BERGH refers three species to this genus, two from the Mediterranean, and one, *H. rosea,* BGH., from Amboyna; and in addition to these ALDER and HANCOCK (**5**) have described another species from Ceylon, under the name of *Eolis militaris,* which appears to be undoubtedly a *Hervia,* though BERGH (**9**), probably by an oversight, refers it to *Coryphella.* It is distinguishable from the present species by its much larger size and the possession of 7 lateral denticulations on the radula teeth.

KELAART has given names to 8 species of *Eolis* from Ceylon, but his descriptions are so vague as to be practically worthless.

SUB-FAMILY: TERGIPEDINÆ.

Galvina producta, n. sp.—Plate I., figs. 6 to 9.

In company with the last-mentioned species was one specimen whose characters, with one exception, agree with those of the genus *Galvina.*

Length, 9·5 millims., papillæ inflated, tapering, constricted below the tips, which are somewhat opaque, hepatic contents vesicular-looking, rhinophores moderately long, tentacles short, anterior angles of foot produced.

Colour, faded, a light transparent brown without markings; hepatic contents whitish-yellow; jaws and teeth as in the genus *Galvina*. The median teeth of the radula robust, with short point, and 5, sometimes 6, lateral denticles. This species differs from the other members of the genus in having the anterior angles of the foot produced, but otherwise it is a typical *Galvina*. All hitherto recorded Galvinæ are either Atlantic or Mediterranean, with the exception of *G. exigua*, which BERGH (**15**) has recorded from the Pacific. This adds the Gulf of Manaar.

Eolis, spp. ?

There are two other small Eolids, representing two different species, in the collection, both from the oyster cages hung over the ship's side in the Gulf of Manaar, which are too small to identify. One of these, length 4 millims., is, perhaps, a *Hervia*. It has the anterior angles of the foot produced, the tentacles long and slender, the rhinophores small; the papillæ are crowded, long and slender, with acute white cnidogenous tips and dark greenish-black contents. The body colour is a transparent reddish-yellow.

The other specimen, length 4 millims., has the papillæ in 5 distant transverse rows; the larger papillæ are ringed in a manner that recalls the genus *Zatteria*, described by Sir C. ELIOT (**11**, p. 62) from Zanzibar specimens. The rhinophores are moderately large and rugose, the tentacles small and the anterior angles of the foot produced.

FAMILY: DOTONIDÆ.

Doto, sp. ?

One specimen of a *Doto*, length 2·5 millims., too small to identify, was obtained from the above-mentioned oyster cages in the Gulf of Manaar. Externally it bears a close resemblance to *D. pinnatifida*, MONT., the form, coloration, and black spots on the papillar tubercles being in agreement with that species.

BERGH (**9**, p. 795) has recorded a species of *Doto* (*D. indica*) from Mauritius, to which it is possible that the specimen should be referred.

FAMILY: TETHYMELIBIDÆ.

Melibe fimbriata, ALD. and HANC.

There are three specimens of this species from separate localities on the West Coast of Ceylon. One from off Negombo, one from Periya Paar, 9 fathoms, and one from Chilaw Paar, 11 fathoms. As usual, they are in a very imperfect state, having lost several of their dorsal papillæ.

Professor HERDMAN notes in his diary the colour of the living animal as follows: "Pale amber brown, in front, with brownish papillæ and white spots—clear, gelatinous." This species, as was first pointed out by ALDER and HANCOCK (**5**), and subsequently confirmed by Sir CHARLES ELIOT (**11**), differs from the rest of the genus in having no trace of labial or buccal armature.

M. fimbriata is found throughout the Indian Ocean.

FAMILY: SCYLLÆIDÆ.

Scyllæa pelagica, LINN.

Amongst the nudibranchs found on the oyster cages which were kept hung over the ship's side from February 15 to March 15, 1903, in the Gulf of Manaar, were two specimens of *Scyllæa* which agree fairly closely, both in general appearance and also in form of radula and jaws, with *S. pelagica*. Externally they also rather closely resemble *S. marmorata*, ALD. and HANC., from Madras, agreeing with it in the rounded dorsal wings and slight development of the caudal ridge, but it seems to me that there are hardly sufficient grounds for regarding the latter as a distinct species.

The colouring of the Ceylon specimens, the largest of which measures 3·0 centims., is mainly due to large irregular areas of light-brown stellate chromatophores, amongst which are vacant pale blotches. There are scattered dark spots formed by aggregations of stellate chromatophores which seem to correspond to sub-dermal patches of pigment and also a few small ocellated spots, the centre formed of contracted brown chromatophores, possibly of a different colour during life, and the surrounding paler area of very finely-branched chromatophores. These ocelli occur on the sides and in a row down the centre of the back.

The body bears a few small colourless tubercles. The buccal mass and, more noticeably, the œsophagus are pigmented with brown stellate chromatophores.

FAMILY: PLEUROPHYLLIDIIDÆ.

Pleurophyllidia formosa, KEL.—Plate I., figs. 14 to 16; Plate II., fig. 1.

One specimen from northern part of the Gulf of Manaar.

Length of preserved specimen 5·2 centims., width 4 centims., width of foot 2·3 centims. Colour an opaque greyish-brown, paler on the sides of the foot, with remains of black pigment between the dorsal ridges and on the dorsal surfaces of the tentacle shield.

The form of the animal corresponds closely to the figure given by BERGH (**10**, plate i., fig. 1). The tentacle shield is broad, with thin projecting upper margin. The back is marked with about 36 slightly raised longitudinal lines, larger and smaller ones irregularly alternating.

The gill lamellæ are about 5 millims. in length, and lie in a crowded transverse band, which runs at about right angles to the direction of the anterior lateral lamellæ. The lateral lamellæ are numerous, about 50, and run transversely from the body almost to the margin of the mantle, the direction of the anterior ones being somewhat diagonal.

The jaws (Plate I., fig. 14) are powerful, of a dark horn colour, and of the usual form. The radula (Plate I., figs. 15 and 16) consists of 70 rows of 140–1–140 teeth. The median tooth is very broad (0·3 millim. × 0·12 millim.), with four lateral denticles and a strong, rather blunt median point with toothed margins, the basal pair of denticulations being very large. The 1st lateral tooth is strong, with a broad somewhat rectangular base and an irregularly serrulate or smooth outer margin. In the 2nd tooth the margins are smooth and the point entire. The 3rd tooth has a small sub-apical denticle on the outer margin. This denticle is found on all the teeth outwards till the outermost one is reached; it increases in size outwards, so that the lateral teeth are for the most part bifid or, in a few cases, trifid. The outermost tooth is simple. This specimen differs slightly as to its radula from that examined by BERGH, in which the apical denticulation begins on the 5th tooth and is absent from the 3–6 outermost. It agrees, however, in other respects. The other Ceylon species, *P. ceylanica*, has, like *P. formosa*, the lateral teeth bidentate, but differs in having a much smaller number of lateral teeth and in having the outermost teeth finely serrulate.

Linguella cinerea, n. sp.—Plate I., figs. 10 to 13.

A single specimen of this species was dredged 10 miles north of Cheval Paar.

Length about 1·5 centims., width 1·4 centims., width of foot 0·9 centim.

Mantle moderately smooth, of a greenish-grey colour, which is denser on the head and front of cloak. The margin of the cloak studded with distant tubercles marked with a ring of grey, becoming larger towards the centre of the back and merging into irregular raised areas separated by deeply pigmented grey furrows.

Lateral margin of underside of mantle with a band of opaque yellow cnidopores, 2 to 3 deep. Lateral lamellæ about 32, slightly oblique.

Radula of 35 rows, formula 46–1–46. The central tooth (Plate I., fig. 10) has a median spine with 3 lateral serrulations, and 3 lateral denticulations. The 1st lateral tooth with about 9 denticulations on the outer edge. The teeth increase in length outwards, the number of denticulations decreasing (Plate I., fig. 12), and the two outermost teeth being smooth (Plate I., fig. 13).

The jaw plates (Plate I., fig. 11) of the usual form, strongly curved (in the figure they are flattened out), of a dark horn colour.

This species seems outwardly to come rather near to *L. sarasinica*, BGH., from Ceylon, but differs in not having the tubercles densely crowded on the mantle edge. The radula also is very different both in form and number of teeth.

NUDIBRANCHIATA HOLOHEPATICA.

DO RIDIADÆ CRYPTOBRANCHIATÆ.)

SUB-FAMILY: HEXABRANCHIDÆ.

Hexabranchus marginatus, Q. and G.

There are in the collection two specimens of *Hexabranchus*, both from Periya Paar, which I think it is probable belong to this species. One specimen is very small, length only 1·1 centims., the other is somewhat larger, length 3·5 centims., but both fall far short of the size usually attained by members of the genus, and are probably immature.

Professor HERDMAN'S notes, referring to the larger specimen, are "scarlet and white, swimming species," and "red blotched with white, especially at sides of mantle." The spirit specimen is somewhat depressed, of a dirty semi-translucent white colour. The mantle wide and thin and frilled at the margins, total width 2·4 centims., free margin 0·55 centim. The free edge of the mantle in front of the head is 2·5 millims. wide and has a smooth entire margin.

Rhinophores far apart, of the usual shape, with about 28 lamellæ. Tentacles large, flattened, with crenated margins. Branchiæ in 6 groups surrounding the short tubular anus.

The jaws are powerful, with about 8 transverse ridges.

The radula has about 32 rows of teeth, the formula being 46–0–46. The innermost 2–3 teeth on each side are imperfect.

The identification of species of *Hexabranchus* from preserved specimens is, as both BERGH and ELIOT (**12**) have remarked, a matter of difficulty, but in this instance there seems little doubt that the specimen is *Hexabranchus marginatus*, as the white marginal blotches, crenate margin to tentacles, and distinct anal tube, as well as the agreement of the radula, seem to indicate.

COLLINGWOOD'S *Albania formosa* (**8**, p. 132), from Formosa, seems to be undoubtedly the same species, as also, perhaps, ALDER and HANCOCK'S "Undescribed species of a new genus apparently related to *Goniodoris*," from Madras (**5**, Plate XXXIII., fig. 20).

SUB-FAMILY: DISCODORIDIDÆ.

Discodoris labifera (ABR.).—Plate I., figs. 17 and 18.

There are three small specimens of *Discodoris*, one from the pearl banks off Aripu and two from Cheval Paar, which I doubtfully refer to the above species. The animal is quite unrecognisable from ABRAHAM'S original description (**7**); but on examination of what appeared to be the type specimen in the British Museum, I found that, making allowance for difference of size, it agreed fairly well in external features with the Ceylon specimens. The British Museum specimen is undoubtedly a *Discodoris*, as the partially protruded buccal armature is distinctly visible, though there is no mention of this in ABRAHAM'S description. There are also in the British Museum collection some unnamed specimens from South Africa which apparently belong to the same species.

The Ceylon specimens measure about 1·6 centims. in length, and the width of the most symmetrical is 0·95 centim. The colour of the Aripu and one of the Cheval Paar specimens is a dirty greyish-brown. The other Cheval Paar specimen, though much distorted, has preserved its colour and texture better than the rest. It is of a slaty blue-grey colour above and below. The mantle has a number of moderate brownish spots, absent from the centre and extreme margin. The underside of the mantle and foot are finely dotted with brown. The mantle is covered with fine tubercles, somewhat pointed, giving it a slightly pilose appearance ; this is not so marked in the other specimens. The branchiæ are 6 in number, compoundly pinnate. The branchial opening is placed far back and has the form of a transverse slit. The jaws are of the usual form, made up of blunt rods ; colour, a pale brownish-straw. Radula with 18 rows, the last two immature, formula 26–0–26, the teeth increasing in size gradually outwards (Plate I., fig. 18), the outermost four teeth again rapidly decreasing (Plate I., fig. 17).

ABRAHAM's original specimen of *D. labifera* came from the Seychelles Islands.

SUB-FAMILY: PLATYDORIDIDÆ.

Platydoris inframaculata (ABR.).—Plate II., figs. 2 to 7 ; Plate III., figs. 8, 9.

Amongst the Nudibranchs obtained at Galle is one well-preserved specimen of *Platydoris*, which is, I think, referable to the above. The general appearance, markings, and tuberculation of the mantle of the type specimen from Amboyna preserved in the British Museum agree fairly well, but it is impossible to decide with certainty upon the identity of closely allied species of *Platydoris* without an examination of the radula and the usually very characteristic armature of both penis and vagina.

The ground colour of the Ceylon spirit specimen is pale reddish-brown, the mantle having a few irregular dark rusty markings formed by minute reticulations round the tubercles ; the lower surface of the mantle bears large circular purplish-black blotches, rather larger and fewer than in the type specimen. The mantle is much depressed and covered with minute, close-set, spiculose tubercles. The rhinophore pores are slightly raised. The branchiæ are 6 in number, large, 3-pinnate surrounding the long, tubular anus, partially retracted into a wide, deep collar (Plate II., fig. 3). The total length of the animal is 4·7 centims., width 3 centims., width of foot 1 centim.

The radula consists of 44 rows ; there are 70 lateral teeth on each side and no median tooth. The teeth are simply hooked, increasing in size outwards (Plate II., fig. 4 ; Plate III., figs. 8 and 9).

The retracted penis (Plate II., figs. 5 and 7) is armed internally with numerous hook-bearing discs, crowded and rather large below, becoming smaller and more distant as it passes upwards, and taking the form of small prickles on the glans. The vaginal wall bears 6 stout, chitinous discs (Plate II., fig. 6) arranged in opposing pairs. These discs are peltate, the boss being formed of 5–6 rounded nodules, and the whole surface being finely granulated. They measure 0·65 millim. in diameter. The size of the largest penial discs is about 0·19 millim. by 0·155 millim.

Platydoris speciosa (ABR.).—Plate II., figs. 8 to 12, and Plate III., fig. 10.

The type of this species from Amboyna is, like the preceding, preserved in the British Museum, and has been described by ABRAHAM (7), but nothing is known of the form of its radula or genital organs. A specimen of *Platydoris* from the Gulf of Manaar appears to belong to this species. Its length is 5·7 centims., width 4·5 centims., width of foot, much contracted, 0·9 centim. The mantle is very wide, covered above with closely-set, minute tubercles with radial spicules. The ground colour of the specimen is an opaque muddy brownish-grey. The mantle is marked above with collections of small, purplish-brown spots, irregularly placed over the whole surface.

The lower sides of the mantle are marked with large, purple-brown, circular blotches, with smaller ones on the side of the body. The rhinophore pores have their margin slightly raised. The branchial pore is 6-lobed, stellate, tightly closed over the retracted branchiæ. The walls of the pore are moderately high. The branchiæ are 6 in number, compoundly pinnate surrounding the long tubular anus, the margin of which is crenulated.

The radula (Plate II., figs. 8 to 10; Plate III., fig. 10) contains 46 rows, with about 58 teeth on either side of the naked rachis. The teeth are simple, hooked, decreasing in size slightly towards the centre of the radula. Compared with those of the previous species, they are somewhat smaller and much more slender.

The penis (Plate II., figs. 11 and 12) is armed as usual with hooked discs, rather large and closely set below, much smaller surrounding the glans, which bears a few still smaller spines. The armature of the vagina, owing to an accident during examination, could not be noted.

This, or the preceding species, may perhaps prove to be identical with the *Doris formosa* or *Doris elliotti* described by ALDER and HANCOCK from Madras, but this cannot be determined without an examination of specimens in their natural colours.

Platydoris herdmani, n. sp.—Plate II., figs. 13 to 17.

A single specimen of this species was taken at Galle, and three others, without recorded locality, are in the collection. Length 3 centims., width 1·4 centims., width of foot, edges approximated, 0·4 centim., height 0·5 centim., length of foot 2·1 centims.

The mantle is large, minutely tuberculate, with its edges thin and very much frilled. Its centre is marked by a large, irregular, pale reddish-brown blotch, spotted with darker, and breaking up into smaller spots towards the margins of the mantle.

The extreme margin of the mantle is marked by a series of black sub-dermal spots, equally visible from above and below. The under side is very faintly dotted with pale brown, the margins of the foot being marked with darker brown.

The ground colour is a waxy flesh colour. The texture of the body is stiff and brittle, the spicules are numerous, small, slightly roughened, and arranged in dense, closely-packed, stellate clusters. The branchial and rhinophoral pores are raised and closed, not distinctly stellate. The tentacles are comparatively large and conical. The foot is very narrow, with its margins approximated in all the specimens.

The radula consists of 44 rows with no median tooth and about 70 lateral teeth on each side increasing gradually outwards from the centre. The outermost tooth is rudimentary, without a lamina, the 2nd is fringed, the 3rd broad and flattened with a slightly denticulate edge, the 4th normal.

The penis is armed with comparatively few small, distant, hooked plates which are not found on the glans. The vagina bears four large chitinous hooks arranged in pairs one above the other on opposite sides of the lumen. This species belongs to quite a different group of the genus from that of the two preceding. It appears to be distinct from any described species, though approaching somewhat to *P. angustipes*, Bgh., from the Antilles.

Platydoris (?) spinulosa, n. sp.—Plate II., figs. 20 to 23; Plate III., figs. 1 to 3.

There is one specimen of an apparently undescribed Dorid from 10 miles north-east of Cheval Paar, which I have provisionally referred to the genus *Platydoris*, though it differs from it in some particulars.

Its length is 2·8 centims., width 1·9 centims., height 0·8 centim. The mantle is wide with straight entire margin, covered above with moderate unequal tubercles placed fairly widely apart on the centre of the back and more closely near the margin, but not crowded anywhere. The largest tubercles lie in an irregular ring, 3 to 4 deep, parallel to and some distance from the edge of the mantle, the centre and margin being occupied by smaller tubercles. The tubercles are rounded or slightly conical, spiculose, the ends of the spicules protruding distinctly. There are also larger spicules arranged in reticulating bundles between the tubercles.

The foot is contracted and rather narrow, the front margin bilaminate and divided. The tentacles are very small, pointed and recognisable with difficulty.

As to colour, Professor Herdman has made a note in his diary on a specimen from this locality which I think there is little doubt refers to the species in question. "Flat red Doris, 1 inch, spotted with dark purple on under-side, wide mantle." There is little trace of colour remaining, the ground colour is white above and below, and the larger tubercles surrounding the centre of the mantle have each a faint light brown ring, the under-side is rather thickly spotted with darker brown, the spots having a deep nucleus and a fainter halo; their diameter varies from 0·5 millim. to 1·5 millims. The rhinophores are white, the branchiæ yellowish, shaded with brown internally at their base, rachides white. The branchiæ are 6 in number, tri-pinnate, the branches small, the rachides long and thick, joined at the base and each with a median groove exteriorly. The branchial pore is raised, circular but not produced into a tube. The rhinophoral pores are slightly raised.

The radula (Plate III., figs. 1 to 3) differs somewhat from that usually found in *Platydoris* on account of the rapid decrease in size inwards of the innermost 14 teeth.

The number of lateral teeth on each side is 48, the 6 or 7 outermost being fringed instead of simply hooked. The penis seems to have been armed as in *Platydoris* with hooked plates, but the preparation was unfortunately mislaid before examination. The vagina (Plate II., figs. 22 and 23) is very strongly armed with two longitudinal rows of peltate discs, very convex, the boss formed of a single powerful spine; there are about 16 discs on each side opposite each other, but not arranged in pairs. They are largest in the centre of the rows and become much smaller towards each end.

The stomach (Plate II., fig. 21) is of an unusual structure, the intestine leaving it medio-dorsally instead of anteriorly, as is usual. The radula sac is long and curved upwards on the left side of the œsophagus (Plate II., fig. 20).

This species differs from the usual type of *Platydoris* in the long radula sac, form of the radula, structure of stomach and larger size of dorsal tubercles. It agrees with it in its general flattened form and genital armature. It is probable that an examination of further specimens will make it clear that a generic distinction exists.

Sub-family: DIAULULINÆ.

Halgerda punctata, n. sp.—Plate III., figs. 4 to 7.

There are in the collection (Gulf of Manaar) two specimens of a moderately large glabrous Dorid with the mantle raised into tubercles, more or less connected by ridges, for which I propose the above name. I have placed it in the genus *Halgerda*, as it agrees in most points with the single known species *Halgerda formosa*. Professor Herdman's notes describe what must be this species as follows:—"Dorid, W. of Donnan's Paar, 29 faths., March 11th, 1902; pale whitish-grey, rather translucent, with yellow papillæ on mantle, and purple spots on foot and a few also on mantle."

The ground colour of both the preserved specimens is white on both sides of the mantle, and on the foot. The mantle is flecked with a few black spots, which measure from 0·5 millim. to 1·5 millims. in diameter, appearing to be of tougher consistency than the rest of the body, and to extend to a slight depth. In one specimen there are only four such spots, very small, near the posterior end, but in the other they are more numerous, about twenty, arranged more or less symmetrically. There is a pinkish tinge on the apices of some of the tubercles. The under-side of the body of both specimens is marked with black spots similar to those found on the notæum, but more numerous, especially on the specimen which is more spotted above. The size is about the same in both specimens: length about 3 centims., width 2·8 centims., height 1·5 centims. The mantle is glabrous, moderately tough, and bears numerous large blunt tubercles arranged in more or less diagonal lines connected by ridges which form an irregular triangular network. This arrangement is much more distinct in one specimen (figured on Plate III., fig. 4) than in the other, which has much fewer tubercles, and in which the ridges are almost obsolete. The branchial opening is circular and measures about 0·6 millim. in diameter, its edges are thin and raised into a collar with smooth even margin. The rhinophoral pores are oval, placed longitudinally with even edges somewhat raised. The pseudo-peritoneum is of a blackish-brown colour. The foot is moderately wide: in the preserved specimen it is much contracted and measures 0·45 centim. across. It is bi-lipped in front, the anterior lip bifid. The head is small, the tentacles very small and apparently tubercular.

The branchiæ (Plate III., fig. 6) are 4 in number and tri-pinnate, the anterior pair larger, the posterior pair shorter and divided deeply into two main branches. The rachides are rather thick, white on the outer side and black interiorly. The lamellæ are black. The anus is rather long and tubular, white with a black crenulate margin. The rhinophores are stout, with black lamellated tips and thick white base.

The radula sac is unusually long and curved towards the left side. The radula consists of 50 rows of hooked teeth; the lateral teeth on each side number about 50, a median tooth being absent. The 20 innermost teeth (Plate III., fig. 5) are very small, increasing outwards; the 3 outermost teeth (Plate III., fig. 7) are small and thin, but not fringed or denticulate. There is no buccal armature, but the buccal tube has a stiff chitinous lining in which were embedded several grapnel-shaped sponge spicules.

The penis and vagina are as far as could be made out unarmed. The stomach and gut were both crowded with tapering rod-shaped spicules roughened at the apex and slightly bent at the base.

This species agrees with Bergh's diagnosis of the genus *Halgerda* in the following particulars: The smooth leathery mantle raised into tubercular ridges, the bi-lipped foot, small tentacles, small number of branchiæ, absence of jaws, long curved radula sac, radula without median tooth and with the innermost teeth markedly smaller, unarmed penis and vagina. The genus *Dictyodoris*, though placed by Bergh in a different sub-family, also approaches it in some respects.

Halgerda formosa from Mauritius differs from the species now described in having more numerous and apparently narrow dorsal ridges, and in having two outermost teeth of the radula on either side denticulate. It is marked with crimson spots and yellow lines, and Professor Herdman states that the black spots found on *H. punctata* are purple during life.

Thordisa (?) caudata, n. sp.—Plate II., figs. 18 and 19.

I have provisionally placed this species in the genus *Thordisa*, though one of the most noticeable features of the genus, the villose mantle, is absent.

A single specimen was taken to the south-east of Cheval Paar in February, 1902. The length of the animal is 2·9 centims., width 1·1 centims., height 1·6 centims.; the contracted foot is 0·8 centim. wide. The colour is a creamy white without markings, the rhinophores grey, the branchiæ white.

The body is elevated, evenly rounded; the mantle well developed posteriorly, slightly longer than the foot, the postero-lateral margins bent inwards towards the foot; the distance from the branchial opening to the end of the mantle 0·8 centim. The branchial opening is oval, transversely placed, measuring 5 millims. by 3 millims., its edges raised into a low smooth collar. The edges of the rhinophore pores are slightly raised. The texture of the mantle is firm and spiculose, it is covered with rather small but not very crowded low truncated or flattened tubercles with the ends of the spicules showing through their surface. The front margin of the foot is bilobed, the head is small, the tentacles very small and flattened.

The radula (Plate II., figs. 18 and 19) consists of about 38 rows. The lateral teeth on each side number 39. The 10 innermost teeth are rather small, hooked, and have a minute denticulation on the outer side. The three outermost teeth are small, the two outermost being fringed and the next simply hooked.

There are both salivary and ptyaline glands present on the buccal mass.

The penis and vagina are unarmed, but it is possible, since the genital organs bear a great resemblance to those of *Jorunna*, that the presence of a stylet may have been overlooked.

Sub-family: CHROMODORIDINÆ.

Chromodoris reticulatus, Pease.

One specimen of the above (= *Chromodoris alderi*, Collingwood) was taken at a depth of 45 fathoms in the Gulf of Manaar, in February, 1902.

The colour when living, as noted by Professor Herdman, was "white speckled with red-brown; bright yellow border. Gills dark red and white; long white tail."

The colour of the preserved specimen is a pale orange-yellow, with fine reddish markings and reticulations, the latter rather wider towards the margin. Branchiæ simply pinnate, light red, with two deep red lines running up the inside of the rachis. Rhinophores dark red. Margin of mantle with faint narrow orange line. General colour effect reddish-orange, darkest anteriorly. Length of preserved specimen 2·8 centims., width 1·8 centims., height 1·8 centims., width of foot 1·1 centims. The free margin of mantle is narrow, turned up posteriorly, with median posterior notch. Branchiæ 24, arranged in two spirals as in *Casella*. Pseudo-peritoneum tough, white, but without nodules.

The radula corresponds very well with the figures given by Bergh for *C. reticulatus*, and the labial armature is formed of bifid rods, as noted by him.

I think that there is little doubt but that this species is both the *C. reticulatus* of Pease (**6**, p. 205), and the *D. alderi* of Collingwood (**8**).

The figure given by Collingwood is more like it than that which Bergh gives after Garrett, and shows the notch at the end of the mantle which Bergh does not allude to. The number of branchiæ is given by Bergh as 9 to 15, and by Collingwood as 12, but this seems to be of no specific importance in the genus.

I have no drawing of the form assumed by the animal when alive, but the shape of the preserved specimen approaches so near to *Casella* that, taken with the manner of arrangement of the branchiæ, it raises a doubt as to whether the distinction between the genera *Chromodoris* and *Casella* can be preserved or rather whether the line of separation has not been drawn in the wrong place.

Chromodoris tenuilinearis, n. sp.—Plate III., figs. 11 to 15.

There is a single specimen of the above, taken on the Cheval Paar.

The length of the preserved specimen is 2·5 centims., its width 0·6 centim. and its height 0·8 centim. The mantle is smooth, long and narrow, slightly wider than the foot and not reaching as far as it posteriorly. The foot has its margins adpressed and extends behind the body for 0·4 centim.; width of the body 0·5 centim.

The ground colour is a dirty transparent white. The mantle is marked by intersecting diagonal broken lines of a pale greyish-green colour (Plate III., fig. 11). The sides of the foot are marked with traces of similar lines.

The branchiæ are 8 in number, long, slender and limp, simply pinnate, issuing from a collar about 1 millim. high. The rhinophores are long, slender and colourless.

The radula consists of 66 rows, formula 71–0–71. One or two of the innermost teeth on each side are trifid, the rest bifid. There is a trace of a median tooth on the rachis. The outermost tooth is a flat plate with median notch, the 2nd tooth is slightly hooked and distinctly bifid.

The jaws are strong, divided into 3 parts, one median and two lateral. They are made up of hooked plates regularly arranged in alternating rows.

There was no further examination of the animal made. The markings are of a rather unusual type in the genus *Chromodoris*, in which they usually consist of brightly-coloured lines parallel to the sides of the mantle or longitudinally arranged, or else of spots.

The armature of the jaws and radula are paralleled in several species, notably in *C. semperi*, Bgh. (**9**, p. 482, plate lii., figs. 1 and 2; plate liii., figs. 13 and 14), in which they are almost identical.

Casella cincta, Bgh.

One specimen from Muttuvaratu Paar, length 2·3 centims., has its colour fairly well preserved. It is of a dark claret or plum colour, fairly uniform, with a dark green margin to the mantle and, less evidently, to the foot.

The branchiæ are about 28 in number, simply pinnate, reddish with a dark green rachis. They are arranged apparently in two spirals, one on each side of the anus. Anterior to the anus is one gill plume distinctly larger than the rest.

The rhinophores are finely laminate, plum coloured, with a tinge of green at the tips.

The radula contains about 140 rows, formula about 63–1–63. The teeth are hooked, with from 8 to 10 fine lateral denticulations on the outer side. The innermost lateral tooth is denticulated on both sides.

The labial armature is formed of bent rods with pointed tips slightly hooked.

Professor HERDMAN'S notes contain a sketch of the animal in a living state which shows very well the characteristic shape, and very closely corresponds with the figure of *C. cincta* given by BERGH (**9**, plate lxxviii., fig. 9). Professor HERDMAN describes the colours in the living animal as follows :—" Pink with green edgings ; edge of foot and mantle white, then a marked green line, then inside that a yellow band, then a pink and white dotting covers the rest. Branchiæ in two spirally arranged tufts ; four large processes in front."

Ceratosoma cornigerum, GREY (?).

It is difficult to name with any certainty preserved specimens of *Ceratosoma* unless the colour of the living animal has been noted, as the radula and jaws of all the described species are almost identical and the external form is liable to a considerable amount of variation. There are in the collection three specimens of *Ceratosoma*, all very small, under 2 centims., which I have doubtfully referred to the above species. They vary considerably in the length of the dorsal horn, but agree in having the line of separation between the back and sides marked by a not very prominent ridge, which is not produced into lateral lobes. They are of a uniform cream colour, one specimen, from south-east of East Cheval, being distantly spotted with opaque white dots. The other two specimens were taken at Talaivillu Paar and $\frac{1}{2}$ mile south-east of Dutch Modragam Paar, respectively.

[**Ceratosoma ornatum**, BGH.]

In Professor HERDMAN'S notes there is a description with accompanying sketch of a species of *Ceratosoma*, but the specimen to which it refers has apparently not been preserved, or has disappeared from the collection. There is no doubt, however, that the species is *C. ornatum*, which has been described by BERGH from a specimen taken in Amboyna (**9**, p. 946).

Professor HERDMAN'S description, which is fuller than that given by BERGH, is as follows : " Spotted all over with yellow on a pale mauve ground, deeper on dorsum, getting to white on foot, with deep mauve or purple edgings to the front and lobes. Horn with mauve edgings on pale ground ; tail with yellow spots on mauve. Head with yellow spots on white. Front of foot with mauve spots on white. Rhinophores brown at base, violet at tip, laminated. Anus violet edged. Gills white at base, yellow in middle, brown at tip. Off Galle, 34 fathoms, February 18th, 1902."

The capture of a small violet-spotted specimen on March 8, 1902, towards the north of the Gulf of Manaar, is also noted, but the specimen is absent. This may be an undescribed species, as none of the described species are violet spotted, except as subsidiary to other coloration.

Doris, spp. ?

There are several small very much depressed Dorids from the east of the Gulf of Manaar and the south end of Cheval Paar which I have not been able to identify. They appear to belong to two closely allied species. One is represented by 8 specimens from the Gulf of Manaar and 2 from Cheval Paar. The largest specimen measures 1·1 centims. by 0·8 centim. The back is covered with uniform, blackish-brown, very minute marbling or reticulation. The ground colour of the Manaar specimens is a mahogany-brown, probably owing to the action of spirit; of the Cheval specimens, pale brownish-grey. The radula in the largest specimen consists of 45 rows of 18–0–18 teeth; in a specimen measuring 0·8 millim. by 0·5 millim. it is 39 rows of 16–0–16. The innermost 6 or 7 teeth are bifid at the apex, the rest are simply hooked. From the margin of the radula the first 4 teeth increase in size, and from the fourth to the centre again decrease regularly and rapidly.

The foot is moderately broad; its front margin not distinctly bilobed, but sharply folded inwards in the middle line, the fold being flattened and fitting into a recess in the under-surface of the notæum. The tentacles, which are minute and pointed, appear to be attached to the sides of this recess. The notæum is tough and densely spiculose; the branchial pore is small and 6-lobed. An examination of the gonads failed to show any armature.

The other species resembles the above in form and in structure of the front of the foot, but the markings are more minute and diffuse. It is represented by 2 specimens from Cheval Paar, the largest measuring 1·2 centims. by 1 centim., most of this size being taken up by the wide margin of the notæum.

The radula consists of 42 rows of 24–0–24 teeth, and, except for the inner teeth being simple instead of bifid, closely resembles the first-mentioned species.

Family: DORIOPSIDÆ.

Doriopsis aurea (Q. and G.).

The Doriopsidæ are only represented by a single species, *D. aurea*, of which one specimen was taken off Karativo on March 10th, 1902.

The colour, when alive, as noted by Professor Herdman, is "orange red with brown orange spots, those along margin of mantle pale blue." The same coloration, though much fainter, was noticeable in the spirit specimen, the orange red having become yellow.

Quoy and Gaimard, in the "Voyage de l'Astrolabe" (**1**, p. 265, plate xix., figs. 4 to 7), give a figure and description of *Doris aurea*. It is described as orange-red with white spots (blue spots ringed with white in the figure) scattered over the back, "parsemé en dessus" (in the figure they are represented as in three rows, one median and two lateral), branchiæ 5, compoundly pinnate; back elevated; smooth rhinophores with 15 lamellæ and a distinct longitudinal ridge (in figure); length a little over

2 inches. It was taken in fairly deep water off Jervis Bay, Tasmania. The description, though not perfectly in agreement with the Ceylon specimen, yet is sufficiently near to make the identification most probable.

Doris aurita, GOULD (**2**, p. 299, fig. 394), is similarly coloured, but has 8 branchiæ.

The same type of coloration is also found in a Tectibranch, *Pleurobranchus punctatus* and it would be interesting to discover whether these similar markings, occurring in different groups, were associated with a similar habitat, or were merely fortuitous.

FAMILY: PHYLLIDIIDÆ.

Phyllidia varicosa, LMK.

There is a single specimen of the above, taken on Muttuvaratu Paar. The colour of the spirit specimen is as follows:—Mantle of a deep bluish-black; tubercles with a halo of faint bluish-white; their tips with a purplish tinge. The tubercles are roughly of two sizes, large and small; there is a line of tubercles down the centre of the mantle, each large tubercle alternating with two small ones, the edges of their halos just touching. There are 2 ill-defined rows of more distinct large tubercles on either side, the smaller tubercles being scattered irregularly around them. The margin is occupied with very small crowded tubercles arranged irregularly 2 to 3 deep.

The underside of both mantle and foot is a dark greyish-black. There is no median black line on the sole of the foot.

This species is widely distributed throughout the Indian Ocean and has, according to BERGH, been recorded from Ceylon by KELAART (**3**) under the name of *Phyllidia ceylanica.*

Professor HERDMAN'S notes contain references to the capture of another *Phyllidia*, probably this species, at Periya Paar. It is described as being of a "rich dark green colour with prominent bright yellow papillæ; edge of mantle yellow all round; foot dark green."

Phyllidia nobilis, BGH. (?).—Plate III., figs. 16 and 17.

There is in the collection a small specimen of *Phyllidia* or *Phyllidiella*, taken off Talaivillu in April, 1902. I have been unable to distinguish satisfactorily between these two genera, and have been compelled to adopt Sir C. ELIOT'S view (**12**) that the distinction cannot be maintained.

The length of the spirit specimen is 2·5 centims., width 1·25 centims., width of foot 0·7 centim. The tentacles are short, pointed, placed close together at base, divergent, laterally grooved. The lateral branchial lamellæ are about 60 in number, triangular. The margin of the mantle is white, moderately narrow, bearing very small tubercles. Inside this is a very narrow black line bearing a few tubercles, entire in front, slightly broken behind. The centre of the mantle is of a bluish-white colour bearing white knobbed tubercles and marked by 3 black bands which take the form of a three-pronged fork directed backwards. The outer branches of the fork are parallel to the margin and on the outer side bear three short branches projecting at right angles and nearly reaching to the margin. The innermost prong of the fork is shorter than the 2 outer and bears 3 white tubercles. A very slight alteration of the white bands in *P. nobilis*, as figured by BERGH, would produce the pattern here described. It may be, however, that it should be referred to the variety of *P. varicosa* figured by BERGH (**9**, plate XXV., fig. 7). The underside of the Ceylon specimen is of a pale bluish-grey with 3 to 4 lateral ill-defined black spots.

(DORIDIDÆ PHANEROBRANCHIATÆ.)

SUB-FAMILY: POLYCERINÆ.

Aegires villosus, n. sp.—Plate III., figs. 18 to 22.

One specimen (Plate III., fig. 18) of the above, length 0·9 centim., was taken to the north-west of Cheval Paar. The body is elevated, with a medio-dorsal bunch of long clavate processes or elongated tubercles (Plate III., fig. 19) surrounding the branchial pore; two of these processes are slightly branched. There are two irregular lateral lines of slightly clavate tubercles on each side of the body, and small tubercles are crowded on the nape of the neck. There are longitudinal patches of purplish-brown pigment lying between the tubercles on the back and sides. The ends of the tubercles are shaded with brown. The ground colour is a dirty greyish-white. The surface of the body and tubercles is densely spiculose, the spicules projecting and giving the animal under slight magnification a densely pilose appearance.

Rhinophore sheaths (Plate III., fig. 20) with 3 outer moderately long tubercles, and 1 small inner tubercle. The radula shows that the specimen is evidently immature, it contains only 12 rows with 16 simply hooked teeth (Plate III., fig. 22) on each side. The jaws are not developed, but the chitinous collar shows slight lateral thickenings and a well-marked upper jaw (Plate III., fig. 21).

This genus has previously been known only from the Atlantic and Mediterranean.

Trevelyana bicolor, ALD. and HANC.

One specimen of what appears to be this species was found on Galle coral reefs in August, 1902; length, 1·2 centims. The colour has been lost and the skin is transparent, showing the internal organs. The liver occupies the posterior two-thirds of the body and is of a bluish-grey colour. The branchiæ are 12 in number arranged in a circle round the anus on the centre of the back. The area of skin surrounding the branchiæ is more opaque than elsewhere, which seems to suggest that it is of a different colour during life. There is a branching white arrangement, probably vascular, anteriorly on the surface of both sides of the body. The rhinophores are retracted. The size and number of branchiæ of this specimen seem to point to its being *T. bicolor*. The radula was not examined.

Kalinga ornata, Ald. and Hanc.—Plate III., figs. 23, 24.

A small specimen, length 2·5 centims., was taken 10 miles north of Cheval Paar. Professor Herdman has made the following note on its coloration when alive: "Pale grey, nearly transparent, with red internal organs showing through, and beautiful red papillæ on surface of body. Rhinophores lamellated at tip and coming from fringed sheaths. Colourless papillæ on body. Branchiæ tri-pinnate."

Bergh (**9**, pp. 959 to 962) has given a full account of the anatomy of this species with the exception of the radula, which was missing in his specimen owing to the pharynx having been everted through the front of the foot. Curiously enough, Professor Herdman's specimen had suffered an almost similar misfortune, the whole buccal mass having been everted through the mouth opening, so that the radula lay along the under-surface of the everted organ. The teeth (Plate III., figs. 23 to 24) are very numerous and all similar. Their shape is remarkable, each tooth having three long curved pointed cusps. They are arranged in about 130 rows, the radular formula being 90–0–90. There is no median tooth, but the rachis bears at intervals a few very small spurious teeth. The innermost tooth on each side differs slightly from the rest in having the inner spine slightly shortened; the outermost tooth is a flat plate, the 2nd and 3rd have traces of a single hook, the 4th has two hooks, and the 5th three. The teeth increase in size gradually from the margin inwards to the centre. The teeth in the specimen examined were widely separated from each other, perhaps owing to the stretching of the radula.

II. TECTIBRANCHIATA.

There are in the collection 17 species of Tectibranchs, 7 of which are here described as new to science.

Of those already known, two, *Philine aperta* and *Doridium depictum*, are well-known Atlantic or Mediterranean species; two, *Aplysia cornigera* and *Dolabrifera maillardi*, have been identified on the strength of the resemblances of the shells, as nothing seems to have been published on the animals themselves; the rest are fairly well-known Indian Ocean or Pacific species. The list of species is as follows:—

Philine aperta, Linn.
Doridium marmoratum, Smith.
„ *depictum* (Ren.), var.
Aplysia cornigera, Sow.
„ *elongata*, Pse.
„ *intermedia*, n. sp.
Phyllaplysia albomaculata, n. sp.
„ *pellucida*, n. sp.
Aplysiella mollis, n. sp.
Dolabrifera maillardi, Desh.
„ *marginata*, n. sp.
Dolabella scapula, Martyn.
Notarchus indicus, Schweig.
„ *ceylonicus*, n. sp.
Pleurobranchæa brocki, Bgh.
Pleurobranchus citrinus, R. and L.
„ *hornelli*, n. sp.

In an Appendix, I place:—

Onchidium verruculatum, Cuv., and *Marsenia perspicua* (Linn.).

Family: PHILINIDÆ.

Philine aperta, Linn.—Plate IV., fig. 1.

This is one of the most abundant species in the collection. It is represented from the Gulf of Manaar, Galle, deep water off Galle, Trincomalee, off Kaltura, the pearl banks off Aripu, and south of Modragam—in all 42 specimens, of which 33 came from the Gulf of Manaar. The specimens vary considerably in appearance owing to their different degrees of contraction, but the shells are identical in texture and almost so in shape. The shells (Plate IV., fig. 1) are of a moderately elongated oval form with a smooth somewhat opalescent surface, and agree with *P. angasi*, from Australia; but I do not think that the slight difference in form between these shells and those of British specimens of *P. aperta* can be regarded as amounting to a specific distinction. There was no constant difference to be noted between the gizzard plates and those of the typical *P. aperta*, though in most cases the ventral plate was more asymmetrical and the ends of the lateral plates more produced.

The radula was as in *P. aperta*.

Bergh (**12**) has recorded *P. aperta* as occurring not uncommonly in the Gulf of Siam, and it seems not improbable that it has a cosmopolitan distribution, and is represented by local races in many places; as such perhaps may be:—*P. vaillanti*, *P. erythræa* (though that species is said to be distinguished by the peculiar serration of its gizzard plates), *P. angasi*, *P. orientalis*, *P. caurina*, *P. vitrea* and *P. coreanica*.

Doridium marmoratum, Smith.

One specimen from the Gulf of Manaar should, I think, be referred to *D. marmoratum*. Its length is 2·2 centims., width 1·1 centims.; length of head shield 1·3 centims., width 1·1 centims. The ground colour is a dark brownish plum with numerous small pale oval or circular spots, those on the foot being rather larger than those on the rest of the body. The margins of the foot and the front margin of the head shield are marked with a bluish-black line. The sole of the foot is slightly darker than the rest of the body. The lateral margins of the foot are closely adpressed to the sides of the animal. The head shield appears to be emarginate posteriorly, owing to its posterior extremity being turned up. The gill protrudes through the mantle slit on the posterior end of the body, probably owing to an injury, as the specimen is in rather bad condition, the pharynx having been everted through a rupture in the front of the head shield and the shell crushed to fragments. *D. marmoratum* has only been recorded from Torres Straits (**7**).

Doridium depictum (Ren.), var.

A small specimen dredged on Periya Paar, in 9 fathoms, had the following coloration, as noted by Professor Herdman, while alive, "brown, mottled with pale green, and having two yellow lines from the head backwards; front edge of foot blue, lobe of mantle over gill paler, with edging of violet." In the spirit specimen the markings are as described, but the blue and green colours have disappeared; the ground colour is a pale brown.

The length of this specimen is 1·45 centims., width 1·05 centims., length of head shield 0·9 centim., width 0·85 centim. The shell was very much broken. The foot is pale, without markings, its margins are only slightly incurved.

There is nothing in the form of the animal to separate it from *D. depictum* of the Mediterranean, and, as that species is known to be extremely variable as regards coloration, I have recorded the Ceylon specimen as a variety.

Family: APLYSIIDÆ.

There appears to be a great amount of uncertainty as to the extent of the genera *Dolabrifera*, *Aplysiella* and *Phyllaplysia*, each author using the names with a different meaning. The distinctions have been based mainly on the form of the animal, which must vary considerably in the same species in preserved specimens. I have not material sufficient to throw any light on the matter, and have for convenience merely used the names in the following manner:—

Aplysiella.—Specimens with short median mantle slit, swollen body and broad foot.

Phyllaplysia.—Specimens with depressed body, median mantle slit and broad foot; shell in this and the preceding genus resembles that of *Aplysia*.

Dolabrifera.—Specimens with moderately depressed body, broad foot, posterior mantle slit and bat-shaped shell.

The circum-œsophageal nerve ring shows the same type in all, the commissures being short, the cerebro-pedal being almost as long as the cerebro-visceral. In the two species of *Dolabrifera* which occur in the collection there is a resemblance in the radulas in the fact that the inner cusp of the lateral teeth is always smaller than the outer.

Aplysia cornigera, Sow.—Plate IV., figs. 2 to 7.

It is impossible, on account of the many vague descriptions, with or without figures, which have been published, to say with certainty what name should be applied to what appears to be the common Ceylon species of *Aplysia*. I have identified it as *A. cornigera*, Sow, on account of the resemblance to the shell of that species, of which only the shell is known. It is represented in the collection by seven specimens, two from the Gulf of Manaar, two from the pearl banks off Aripu, one from the pearl banks off Manaar and two without definite locality.

The coloration of these specimens is a groundwork of fine reticulating brownish-olive lines, with clear spaces here and there, as in *A. punctata*. There are also small black spots, about 1 millim. in diameter, scattered over the surface of the body. The amount of pigment on the inner side of the pleuropodia varies; usually there is very little, and it is almost absent in some specimens.

The length of a well-preserved specimen was 6·3 centims. The pleuropodia were free to within from 5 millims. to 8 millims from the end of the foot. The excurrent mantle siphon was moderately produced, from 5 millims. to 10 millims. in length. The tentacle flaps were mostly flattened, but varied according to the amount of contraction. The mantle foramen was closed in some specimens, but the mark of its position was apparent; in others it was about 2 millims. in diameter. The markings and clear spots showed a sort of radial arrangement round the foramen. The hyaline gland (Plate IV., fig. 6) consisted of a group of large globular cells lying beneath the sub-dermal muscle layer and penetrating it at intervals. There was no sign of a single common duct. The gland in appearance resembled a bunch of grapes attached laterally to the muscle layer, and would seem to be intermediate in form between the two types of gland described by BLOCHMANN (6) as occurring in *Aplysia*, since the cells appeared to open separately on the surface or else two or three into a common opening.

The shell (Plate IV., fig. 4) is thin, with a fragile calcareous layer; the inside is opalescent, of a delicate pale pink tint; the outside is glossy, pale whitish-brown, with distant growth ridges.

The radula (Plate IV., figs. 2, 3, 5) consists of about 40 rows of 21–1–21 teeth of the usual form; the 16th and 17th from the centre have rudimentary hooks and the four outermost teeth consist of flat plates. The labial armature is made up of blunt rods.

A. pulmonica, GOULD, from Samoa, may perhaps prove to be the same as this species, but seems to be separated by having the pleuropodia fused for a larger proportion of their length.

Aplysia elongata, PEASE—Plate IV., figs. 9 to 12.

A specimen of the above was taken on Jokkenpiddi Paar in April, 1902.

The length of the preserved specimen is 1·2 centims., height 0·9 centim. The colour is an opaque whitish fawn with brownish markings irregularly arranged, leaving vacant spots, and in addition a fairly uniform but rather distant spotting of opaque white pigment. The eyes are distinctly visible, the skin over them being devoid of pigment. They lie lateral to and a short distance from the base of the rhinophores. The rhinophores (Plate IV., fig. 10) are tubular and split for about $\frac{3}{4}$ of their length; they resemble greatly a hare's ear in appearance. The tentacles are much shorter than the rhinophores and are split to the base. The inside of both rhinophores and tentacles is strongly pigmented. The pleuropodial lobes are short, meeting behind the mantle siphon; they are slightly pigmented with light brown on the inside. The mantle is transparent and colourless except for a black line along the margin of the mantle foramen. The latter is large and oval, measuring 5·5 millims. by 3·5 millims. The shell (Plate IV., figs. 11 and 12) is large, strong, opaque and deep, with well-marked growth ridges and overhanging adnate callus hood; it measures 9·5 millims. by 7 millims. Judging by the size of the shell and the way in which it has been forced out of the mantle cavity, the whole animal is very much contracted.

The radula (Plate IV., fig. 9) is of an orange-yellow colour and contains 34 rows of 13–1–13 teeth, the 4 outermost being imperfect.

This specimen agrees very closely with *A. elongata* from the Sandwich Islands, the very large mantle foramen and large strong shell with well marked callus being very characteristic.

Besides the above there are in the collection 2 specimens from Chilaw Paar which are most probably young examples of *A. elongata*. They resemble the Jokkenpiddi specimen in form, but differ in being semi-transparent and colourless except for a narrow black edge to the rhinophores, tentacles, front of foot, mantle foramen and posterior part of pleuropodia. The shell is membranous with a very delicate white calcareous layer which has mostly disappeared.

The radula has only 27 rows, the teeth being as in the larger specimen; the lengths of the two Chilaw specimens are 1·3 millims. and 1·1 millims. respectively.

Aplysia intermedia, n. sp.—Plate IV., fig. 8.

There is a single well-preserved specimen ot *Aplysia* from S. Cheval Paar which does not fit in with any of the published descriptions. It combines the opposite characters of a large mantle foramen and long free pleuropodia.

Length of the preserved specimen 1·8 centims., width 1·4 centims., height 1 centim., length of foot 1·6 centims., distance from fusion of pleuropodia to end of foot 2·4 millims., mantle pore 4·25 millims. by 3 millims., length of mantle siphon 2 millims. Colour of living animal, green; colour of spirit specimen, greyish; general effect made up of fine recticulating broken black lines of the usual *Aplysia* type, following no regular plan; mantle with black specks rather concentrically than radially arranged. The mantle foramen has not a black edge.

The tentacles are large, produced anteriorly into broad labial flaps. The shell is large (1·1 centims. long), thin and membranous; calcareous layer only present as a few small patches at the apex of the shell.

The radula (Plate IV., fig. 8) consists of 30 rows of 16–1–16 teeth, the 3 outermost being without hooks. The teeth resemble those of *A. elongata* in form.

Phyllaplysia albomaculata, n. sp.—Plate IV., figs. 13 to 16; Plate VI., fig. 6.

I have thought it best to create new species for this and the two following forms, rather than run the risk of identifying them incorrectly with any of the many vaguely described species which are in existence. The single specimen of *P. albomaculata* was taken south of Adam's Bridge, 30 fathoms, in March, 1902. Professor HERDMAN notes concerning it: "Olive brown spotted with white, foot paler, little spiky papillæ on mantle," accompanying his note with a sketch which shows the living animal in configuration and proportions almost exactly as in the preserved specimen.

The total length is 2·8 centims., width 1·5 centims., height 0·7 centim.

The form of the animal (Plate VI., fig. 6) is an oval, produced anteriorly to form the head. It is very much depressed. The foot is conterminous with the body laterally and posteriorly; anteriorly it extends beyond the head on either side.

The branchial slit is situated rather nearer the right side, the margins not closing over the slit. The tentacles and rhinophores are of moderate size, tubular and slit as usual. The eyes are distinctly visible in front of the rhinophores. The surface of the back is dotted with little spiky papillæ, simple or compound. The shell (Plate IV., fig. 15) is calcareous, very fragile, white with a slight brownish tinge, striated by growth lines and with a small but well-marked embryonic spine (Plate IV., fig. 16).

The radula (Plate IV., figs. 13 to 14) has 32 rows of 44–1–44 teeth. The teeth, as is usual in the genus, have two broad spatulate cusps and a small basal denticulation. In the 2nd and 3rd innermost teeth the inner cusp is distinctly larger than the outer; in the 4th they are about of equal size, and from the 5th outwards the outer cusp is the largest. The nature of the buccal armature was not noted.

Phyllaplysia pellucida, n. sp.—Plate IV., figs. 17 to 21; Plate VI., fig. 12.

There are, in the collection, 2 specimens of a smooth flattened *Phyllaplysia* from Chilaw Paar, for which I propose the above name. They are of a gelatinous consistency, semi-translucent and colourless. The length of the largest specimen (Plate VI., fig. 12) is 1·7 centims., width 1·5 centims., height 0·7 centim.

The foot is as wide as the body. The head is very much contracted, with short tentacles and rhinophores. The branchial slit, length 6 millims., lies rather nearer the right side, the right margin overlapping the left, except posteriorly, where the slit is open. The surface of the body is smooth. The eyes are not visible in the preserved specimens.

The radula (Plate IV., figs. 17, 19 to 21) consists of about 30 rows of 30–1–30 teeth. The teeth are of the usual form, with two main cusps and a smaller accessory one. From the 1st to the 10th tooth from the centre the innermost cusp is the largest, and from the 11th to the 25th the outermost. The five outermost teeth are slender, curved, and simple. The labial armature (Plate IV., fig. 18) is made up of square rods with denticulate inner margins.

The shell (Plate V., fig. 1) is of the same form as in *Aplysia*. It is thin and membranous, with a very slight calcareous layer which comes off at a touch. It measures 7·8 millims. by 5·3 millims. An embryonic spine was not noted, but it may have crumbled away.

Aplysiella mollis, n. sp.—Plate IV., figs. 22 to 26; Pl. V., figs. 2, 3; Pl. VI., fig. 11.

There are two specimens from South Cheval Paar.

The length of the larger specimen is 2·4 centims., width 1·2 centims., width of foot 1·3 centims., height 1·0 centim., length of branchial slit 1·0 centim., front of head to commencement of branchial slit 1·2 centims.

The colour of the preserved specimens is white, semi-opaque. They are of soft, wrinkled, and of a somewhat flabby consistency.

The animal (Plate VI., fig. 11) is moderately swollen, *Aplysia*-like in form, with short branchial slit. Over the surface of the back are scattered small spiky papillæ, much fewer in one specimen than in the other. The rhinophores are moderately long, of the usual form. The tentacles are short, split as usual, and flattened. There is a slight development of labial flaps. The eyes are distinctly visible.

The shell (Plate V., figs. 2 and 3) is shaped as in *Aplysia*. It is membranous, with a very brittle, opaque white calcareous layer covered with small nodules.

The radula (Plate IV., figs. 22 and 24 to 26) consists of 33 rows of 48–1–48 teeth, the inner cusp being the larger in the 1st to 4th tooth from the centre and the outer cusp the larger from the 5th tooth outwards. The outermost 5 or 6 teeth are narrow, curved, and simple. The labial armature (Plate IV., fig. 23) is made up of rods, bent and bifid at the tips.

Dolabrifera maillardi, Desh.—Plate V., figs. 4 to 10.

One specimen from Muttuvaratu Paar, 8 fathoms, March 1902.

The original species of Deshayes was only described from the shell which came from Réunion (5). His description and figure agree fairly accurately with the shell of the Ceylon specimen. The preserved specimen (Plate V., figs. 4 and 5) is smooth, somewhat plump, moderately elongate, of a dirty white colour. Its length is 1·9 centims., width 1·3 centims., height 0·9 centim. Professor Herdman's notes contain a sketch of the living animal and state, "Port-wine colour, with a limited number of white spots having each a spiky papilla rising from its centre."

The foot is as broad as the body, with its margins slightly frilled. It does not extend beyond the body posteriorly. The body is elevated posteriorly and slopes forward somewhat, as in *Dolabella*. The branchial slit is short and narrow, length 0·6 centim. It commences at about the posterior third of the body and runs backwards. The tentacles and rhinophores are tubular and slit externally.

The radula (Plate V., figs. 6, 7, and 10) consists of 35 rows of about 62–1–62 teeth. The median tooth has a central cusp, and two lateral cusps on each side. The innermost teeth of the lateral rows have two large hooked cusps, and a small basal cusp on the outer side. This basal cusp is found on about the 20 innermost teeth, after which it disappears. The outermost teeth are long, slender, and bifid at the tips.

The shell (Plate V., figs. 8 and 9), length 4·6 millims., has an embryonic spine just below the apex, the apex itself being formed by a flattened plate or callus.

The labial armature is made up of blunt rods.

This species may perhaps prove to be identical with one of the many forms described by PEASE from the South Pacific (**3**), (**4**).

Dolabrifera marginata, n. sp.—Plate V., figs. 11 to 15.

One specimen dredged on South Cheval Paar.

The length of the preserved specimen is 1·95 centims., width 1·3 centims., height 0·75 centim. The form of the body is ovate, somewhat narrower in front, the body passing into the head without a distinct neck (Plate V., fig. 11). The branchial slit is situated far back, about 4 millims. from the posterior end of the body. The slit is 7 millims. in length, open at both ends, the right pleuropodial margin being lapped over the left in the centre. The genital furrow is well marked. The margin of the foot extends beyond the body laterally and posteriorly, forming a frill 1·5 millims. wide. The body is smooth, the skin being somewhat tense. The rhinophores and tentacles are short, tubular, and slit as usual. The eyes are visible in front of the rhinophores.

The shell (Plate V., fig. 15) is very thin and membranous, of the same form as in *D. maillardi*, but perfectly transparent except for a chalky powder over parts of its surface which rubs off at a touch. The apex of the shell was injured in extraction, so it could not be ascertained whether an embryonic spine was present or not. It is probable that this species has not been already described, as the shell is not well fitted for preservation in a conchological cabinet.

The radula (Plate V., figs. 12, 13, 14) is of the same type as in *D. maillardi*, but the lateral teeth are not so slender. It consists of 37 rows of 57–1–57 teeth.

Dolabella scapula, MART.—Plate V., figs. 16 and 17.

There are three specimens of this, the common species of *Dolabella* of the Indian Ocean; one from South-east Modragam and two from south of Adam's Bridge.

The coloration of the preserved specimens consists in a faded yellowish-white ground colour mottled over the body and foot with irregular olive-brown blotches. Professor HERDMAN notes of another specimen from S. of Cheval, 6½ fathoms: "Chestnut brown in general effect, yellowish basis mottled with red and brown, many yellow tags or spines all over, broad flat foot rather paler." In the preserved specimens the body was covered sparsely with short fringed papillæ, longest on the margin of the posterior disc. These papillæ were most numerous in the largest specimen, which measured 4·8 centims. in length, and almost absent from the smallest.

Some of the published descriptions state that *D. scapula* is uniformly coloured, but this is probably a matter of individual variation. The shell of the Ceylon specimens agrees with that of *D. scapula*, having kindly been compared with specimens in the British Museum by Messrs. E. A. SMITH and E. R. SYKES.

The radula consists of 44 rows of about 120–1–120 teeth, those near the centre being simply hooked (Plate V., fig. 17), while towards the margin the hook becomes a long scythe-shaped blade (Plate V., fig. 16).

Notarchus indicus, Schweig.

I have, on account of the resemblance of the radula to the figures given by Bergh (**11**, plate vii.), referred to this species 20 little immature specimens of *Notarchus*, from Ceylon. The largest of these measured 1·2 centims. in length. The label indicating the exact locality where they had been taken has unfortunately been lost.

Notarchus ceylonicus, n. sp.—Plate V., figs. 18 to 23.

There is in the collection one specimen of *Notarchus*, from $\frac{1}{2}$ mile east of Dutch Modragam Paar, for which I propose the above name.

The form of the body (Plate V., fig. 18) is ovate, very plump, and inflated, except as regards the head. The foot is moderately wide and pointed behind. There is no shell. The branchial slit is short, length 6 millims. The length of the animal is 3·3 centims., width 2·1 centims., height 1·6 centims., width of foot 1·1 centims.

The surface of the body and head bears numerous small fringed papillæ which occur more thickly on the head, probably owing to its contraction. The rhinophores and tentacles are fringed with similar papillæ. Very small labial processes are present.

The radula (Plate V., figs. 20 to 23) consists of 30 rows of 33–1–33 teeth, the first 8 rows being imperfect. The first 5 teeth from the centre have four lateral denticles on the outer edge, the following 9 three denticles, the basal denticle being small and blunt, and becoming hard to recognise at a little distance from the centre. The next 4 teeth have two lateral denticles. From the 18th to the 24th tooth the distal denticle only persists, and the 9 outermost teeth are smooth and scythe-shaped, thus differing from those in *N. indicus*, which are serrulate.

Family: PLEUROBRANCHIDÆ.

Pleurobranchæa brocki, Bgh.—Plate V., figs. 24 to 28.

It is with some doubt that I refer to this species a well preserved specimen of *Pleurobranchæa*, which was taken 5 miles north of Cheval Paar in March, 1902.

The colour of the preserved specimen is an opaque brownish-yellow, due evidently to its preservation in spirit. On the mantle and upper surface of the hinder parts of the foot there are rusty-brown markings in coarse irregular reticulations, occupying to some extent the furrows on the mantle.

The form of the body (Plate V., figs. 24 and 25) approaches the Mediterranean species *P. meckelii*. The total length is 3·2 centims., width (of foot) 1·7 centims., height 1·1 centims., length of mantle 2·6 centims., width 1·5 centims., length of foot behind body 0·7 centim., length of gill from genital papilla 1·2 centims., height of caudal papilla 3·5 millims.

The mantle is not very large, reaching beyond the body, both laterally and posteriorly, for about 1 millim. and rather more over the gill. The foot is somewhat wider than the mantle laterally, and reaches considerably beyond it posteriorly. The tail is somewhat pointed and bent upwards, terminating in a little conical caudal papilla. The frontal margin of the mantle is beset with two rows of minutely tuberculate papillæ; there are 7 of these in the upper row and 6 in the lower. There are also very small scattered intermediate tubercles along the margin, which is laterally produced on either side into a tentacular appendage. The gill has 36 lamellæ, each of them pinnate; it reaches to the level of the end of the mantle.

The rhinophores as usual rise from the mantle and are split down the outer margin.

The surface of the mantle is not distinctly tubercular, but is furrowed and rough, owing perhaps to contraction. The foot, mantle and body walls are very muscular and tough. The intercrossing of the muscle bands gives the appearance of a woven material, particularly on the inner surface of the foot after removal of the viscera.

The genital openings are separate. The vaginal pore has a short tubular opening at the commencement of the gill rachis. The penis is retracted, its opening directed forwards and lying about 1 millim. in front of the female opening. The anus lies dorsal to the membrane which attaches the free end of the branchial plume.

The jaws are made up of hexagonal rods (Plate V., fig. 27), the edges of the inner marginal rods being very irregularly denticulate. Teeth of radula (Plate V., figs. 26 and 28) in about 29 rows, formula 56–0–56. No sign of a median tooth was seen. Form, as figured by BERGH for *P. brocki* (**11**). Shell absent.

The colour of the Ceylon specimen differs considerably from that described by BERGH, which was of a reddish-brown with darker reticulations. VAYSSIERE mentions a specimen of the same colour, but says that the pigment is superficial, and easily rubbed off, which may account for its absence on this occasion.

Pleurobranchus (Berthella) citrinus (RUPP and LEUCK.).—Plate VI., figs. 7 to 10.

There are 3 specimens of *Pleurobranchus* apparently belonging to this species which were taken at Jokkenpiddi Paar, Cheval Paar and to the South-east of East Cheval respectively. They differ slightly in colour and appearance, the Jokkenpiddi specimen being of an opaque brownish-yellow and considerably more contracted than the others, which are white, rather translucent and plump. The South-east of East Cheval Paar specimen, which is the best preserved of the 3, measures 1·7 centims. by 1·05 centims. Its height is 0·5 centim. The mantle is elevated, somewhat inflated, a little wider than the foot, covering the head, and slightly emarginate in front. Its colour is a transparent white with opaque white dots. When examined under a lens of moderate power, the white spots are seen to be subdermal opaque flask-shaped structures tapering towards the surface and surrounded by distinctly marked clear hexagonal areas. The surface of the mantle is smooth. The gill is short and compact, length 0·7 centim., without rachidian tubercles. The lamellæ number about 25. The front of the foot is divided into two lips by a transverse furrow, the lower lip being the largest. The furrow does not extend laterally. The labial flap is produced on either side into 2 very short tentacles split laterally at their extremities.

The rhinophores are close together and rather short, tubular and split as usual. The genital openings are close together at the commencement of the gill, but not surrounded by a common investment. The penis is retracted.

The shell, length 0·5 centim., lies well forward at about the anterior third of the body; the apex is pale, with embryonic spiral well marked; the expanded portion is of a horny yellow colour, strong, with well-marked longitudinal and transverse striæ. The teeth are of the usual type in *Berthella*, as defined by VAYSSIÈRE (9), knife-shaped, with strongly denticulated edges. They bear about 14 denticulations.

The colour of the living animal as noted by Professor HERDMAN is "brilliant orange, with white dots in little systems on the back." This differs somewhat from RUPPEL'S description of *P. citrinus* as "pale lemon yellow, with large whitish irregular spots," but as they agree otherwise there does not seem sufficient grounds for separating them. *P. angasi*, SMITH, from Port Jackson, agrees in many ways with this species, but has only 16 gill lamellæ. The figures of *P. oblongus*, AUD., given by SAVIGNY, are very like the Ceylon specimens and the figure of the shell of that species shows an evident attempt to represent an embryonic spiral.

KELAART (2) has recorded this species as being of common occurrence in Ceylon; he gives the colour as orange spotted with white.

Pleurobranchus hornelli, n. sp.—Plate VI., figs. 1 to 5.

There are in the collection some specimens of *Pleurobranchus* which I have not been able to identify with any of the described species, and for which I accordingly propose the above name. These are 7 specimens, 6 of which were taken by Mr. HORNELL from a buoy-rope at Galle in July, 1902, and one on Galle coral-reef in August, 1902. Their colour, as far as is preserved, is a dirty white ground colour, with the mantle covered with fairly close reticulations of brownish-purple. The length of the largest specimen is 1·8 centims., width 1·2 centims., height 1·0 centim. The mantle is about equal to the foot in front and behind, and a good deal wider laterally. It is tuberculate, but the tubercles are indistinct, being crowded together so as to produce a level surface (Plate VI., fig. 5), the margins of the tubercles being only noticeable on account of the previously mentioned purple reticulation which occupies the space between them. In the Galle coral-reef specimen, which seems in a different state of preservation from the rest, the apex of each tubercle is raised into a small papilla.

The foot is moderately broad, with the front margin divided into two lips by a transverse furrow. The upper lip is much thinner and somewhat shorter than the lower. The furrow is continued laterally down one margin as far as the commencement of the gill and to an equal distance on the other side. The pedal gland is well developed in the Galle coral-reef specimen, but hardly noticeable in the others.

The tentacular shield is well developed, but not produced into tentacles laterally. The anterior portion of the lateral margins is grooved. The rhinophores are moderately long and split as usual. The gill is moderately long, 1 centim. in the largest specimen, reaching to the end of the body, bipinnate, the rachis with two rows of tubercles, pinnæ 25–26, pinnules about 16.

The genital openings are close together at the base of the gill and appear to be surrounded by a common investment. The shell (Plate VI., fig. 1) is very thin, with an opaque white calcareous coating very fragile and easily rubbed off. It seems to be very faintly striated in the lines of growth. It is situated at about the anterior third of the mantle and is distinctly visible through it as a white patch ; its length in a specimen of 1·5 centims. is 2·9 millims. by 1·9 millims. The shell has an ill-defined membranous edge without calcareous coating. The radula in one specimen examined consisted of 46 rows of about 70–0–70 teeth, the inner teeth being simply hooked (Plate VI., fig. 3), the outermost rod-like (Plate VI., fig. 2), slightly bent. The jaws are rather broader than usual, measuring 1·12 millims. by 2·35 millims. ; they are made up of plates of the usual form (Plate VI., fig. 4), with two lateral denticles at the apex, a large distal and a smaller proximal one.

APPENDIX.

Family : ONCHIDIIDÆ.

Onchidium verruculatum, Cuv.—Plate VI., figs. 13 to 22.

There is one specimen of this widely distributed species, very well preserved, from the Gulf of Manaar. The length is 3·1 centims., width 3·4 centims., height 2 centims., width of foot 1·5 centims. The colour of the preserved specimen is grey, with irregular purplish-brown blotches over the back.

The back is completely covered with simple and compound tubercles of differing sizes. The simple tubercles are most numerous and vary in size from an extreme minuteness to about 1·2 millims. in diameter. The compound tubercles measure about 1·5 millims. in diameter and are made up of from 5 to 7 simple tubercles. On the posterior fourth of the back are about 10 branchial tubercles, which appear to be made up of from 20 to 40 short papillæ crowded together. These apparently represent frondose processes in the living animal. There are only 6 ocular tubercles in the Ceylon specimen, all situated on the anterior half of the body. They bear from 2 to 5 ocelli in a slightly depressed pit on their summit. The general effect of the tuberculation resembles that seen in *Archidoris tuberculata*.

The loop of the intestine follows the same course as figured by Plate for the species, being much less curved than in the closely allied *O. tumidum*.

The male gonads (Plate VI., fig. 17) agree fairly closely with PLATE's description. The penis rod is long and slender, the glans short and closely covered with minute hooks about 0·04 millim. in length.

The length of the "cartilaginous" rod is 16 millims., that of the spinulose glans 1·8 millims. The dart sac with its ampulla is of the usual form, the ampulla long and rather narrow and sharply curved at its anterior end, where it overlies the œsophagus. The length of the ampulla is 10 millims., the distance from the ampulla to the papilla of the dart sac 8 millims. The dart (Plate VI., fig. 13) is straight, regularly tapered; length 2·8 millims. Its free extremity shows a slight curve and has a solid lateral lip.

The radula (Plate VI., figs. 19 to 22) is of a pale yellow colour very slightly chitinised. It is made up of 60 rows of 83–1–83 teeth of the usual form. The central tooth is slightly broader than long; the lateral teeth, except those close to the middle line, are produced downwards into a broad adze-shaped hook and upwards into an irregular thin tongue, which takes part in their attachment to the radula ribbon.

The contents of the stomach consisted of quartz sand grains and a quantity of white flocculent matter, amongst which a few Foraminifera were noticed.

Onchidium verruculatum is very widely distributed in the Indian and Pacific Oceans, occurring from the East Coast of Africa and the Red Sea to Japan and Australia.

FAMILY: MARSENIADÆ.

Marsenia perspicua (LINN.)—Plate VI., figs. 23 to 26.

There are eleven specimens of *Marsenia* in the collection, most of them from Cheval Paar and its neighbourhood and the remainder from South-east Modragam, Gulf of Manaar, and Galle. Externally they are not to be distinguished from the common *M. perspicua* of European waters, with which species also the radula (Plate VI., figs. 24 to 26) and shell are in close agreement. The largest specimen, one of those from South-east Modragam, is a female, and measures 2·5 centims. by 2·2 centims., the shell (Plate VI., fig. 23) measuring 1·6 centims by 1·2 centims. These measurements are somewhat in excess of those usually attained by European specimens, but the difference in size and locality does not seem to warrant the use of a separate specific name.

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EXPLANATION OF PLATES.

The figures, with the exception of Plate II., figs. 2, 3, 13, 14, 17, 20, and 21; Plate III., figs. 4, 11, 16, 17, and 20; Plate V., figs. 4, 5, 11, 18, 24, and 25; Plate VI., figs. 6, 8, 11, 12 and 14, were all drawn with the aid of a camera lucida.

PLATE I.

Fig. 1. *Herria ceylonica*, n. sp., side view of animal. × 9.
,, 2. ,, ,, 3 teeth from radula, dorso-lateral view. × 470.
,, 3. ,, ,, tooth from radula, seen from above. × 470.
,, 4. ,, ,, jaw plate. × 83.
,, 5. ,, ,, cutting edge of jaw plate. × 340.
,, 6. *Galvina producta*, n. sp., median tooth with one of side plates. × 700.
,, 7. ,, ,, 4 teeth from radula, with side plates, lateral view. × 350.
,, 8. ,, ,, view of under-side of head.
,, 9. ,, ,, jaw plate, restoration from crushed specimen. × 55.
,, 10. *Linguella cinerea*, n. sp., median and 2 lateral teeth from radula. × 340.
,, 11. ,, ,, jaw plate. × 16.
,, 12. ,, ,, lateral tooth from radula, 39th from median. × 340.
,, 13. ,, ,, 2 outermost teeth from radula. *a* = outermost. × 340.
,, 14. *Pleurophyllidia formosa*, Kel., jaw plate. × 8·3.
,, 15. ,, ,, outer tooth from radula. × 285.
,, 16. ,, ,, median and 2 lateral teeth from radula. × 285.
,, 17. *Discodoris labifera*, Abr., 4 outermost teeth from radula. × 330.
,, 18. ,, ,, innermost teeth, *a* = rachis of radula. × 330.

PLATE II.

Fig. 1. *Pleurophyllidia formosa*, Kel., lateral teeth from radula, 8th to 13th from middle. × 136.
,, 2. *Platydoris inframaculata* (Abr.), under-side, anterior.
,, 3. ,, ,, branchiæ and collar.
,, 4. ,, ,, teeth from radula, middle of lateral row. × 132.
,, 5. ,, ,, armature of penis. × 29.
,, 6. ,, ,, discs from vagina. × 29.
,, 7. ,, ,, upper part of penis.
,, 8. *Platydoris speciosa* (Abr.), lateral teeth from radula, 70th to 74th from middle. × 132.
,, 9. ,, ,, worn teeth from lateral row of radula. × 110.
,, 10. ,, ,, lateral tooth, side view. × 110.
,, 11. ,, ,, lower portion of penis, showing armature. × 35.
,, 12. ,, ,, upper portion of penis, with glans. × 35.
,, 13. *Platydoris herdmani*, n. sp., view of under-side, anterior. × 2.
,, 14. ,, ,, dorsal view. × 1·5.
,, 15. ,, ,, outermost teeth of radula, 15th and 16th rows. × 370.
,, 16. ,, ,, penis, upper portion. × 25.
,, 17. ,, ,, ,, and vagina.
,, 18. *Thordisa* (?) *caudata*, n. sp., innermost teeth of radula. *a* = rachis. × 305.
,, 19. ,, ,, 5 outermost teeth of radula. × 305.

Fig. 20. *Platydoris spinulosa*, n. sp., dorsal view of bulbus pharyngeus.
,, 21. ,, ,, stomach, dorsal view.
,, 22. ,, ,, vagina, after treatment with caustic potash. × 15.
,, 23. ,, ,, opposite plates from vagina. × 60.

PLATE III.

Fig. 1. *Platydoris spinulosa*, n. sp., lateral teeth from radula, 36th and 37th from middle. × 300.
,, 2. ,, ,, innermost 4 teeth. *a* = innermost. × 300.
,, 3. ,, ,, outermost 8 teeth. × 300.
,, 4. *Halgerda punctata*, n. sp., lateral view of animal. × 2.
,, 5. ,, ,, outermost 4 teeth from radula. × 300.
,, 6. ,, ,, arrangement of branchiæ.
,, 7. ,, ,, innermost teeth of radula. *a* = rachis. × 300.
,, 8. *Platydoris inframaculata* (Abr.), innermost teeth of radula. *a* = rachis. × 100.
,, 9. ,, ,, 3 outermost teeth. × 300.
,, 10. *Platydoris speciosa* (Abr.), 4 outermost teeth. × 300.
,, 11. *Chromodoris tenuilinearis*, n. sp., animal, dorsal view.
,, 12. ,, ,, median teeth from radula. *a* = rachis. × 480.
,, 13. ,, ,, 3 outermost teeth from radula. *a* = outermost. × 480.
,, 14. ,, ,, 3 teeth from middle of lateral row. × 480.
,, 15. ,, ,, elements of jaw plate. *a* = side view of one. × 480.
,, 16. *Phyllidia nobilis*, Bgh. (?), animal, dorsal view. × 2.
,, 17. ,, ,, head and front of foot.
,, 18. *Ægires villosus*, n. sp., animal, lateral view from right. × 7.
,, 19. ,, ,, tubercles surrounding branchial pore, from left side.
,, 20. ,, ,, rhinophore sheath.
,, 21. ,, ,, buccal collar. × 31.
,, 22. ,, ,, lateral teeth from radula. × 310.
,, 23. *Kalinga ornata*, A. and H., median teeth. *a* = rachis. × 310.
,, 24. ,, ,, lateral teeth. *a* = innermost. × 310.

PLATE IV.

Fig. 1. *Philine aperta*, Linn., shell. × 2.
,, 2. *Aplysia cornigera*, Sow., teeth from radula, median and 2 lateral. × 127.
,, 3. ,, ,, 5th and 6th teeth from centre of radula. × 127.
,, 4. ,, ,, shell. × 2.
,, 5. ,, ,, teeth from radula, 12th from centre to margin. × 127.
,, 6. ,, ,, section of hyaline gland. × 52.
,, 7. ,, ,, gill. × 2.
,, 8. *Aplysia intermedia*, n. sp., median tooth from radula. × 340.
,, 9. *Aplysia elongata*, Pse., median tooth from radula. × 340.
,, 10. ,, ,, lateral view of head.
,, 11. ,, ,, shell, ventral. × 7.
,, 12. ,, ,, shell, lateral. × 7.
,, 13. *Phyllaplysia albomaculata*, n. sp., teeth from radula, median to 6th lateral. × 310.
,, 14. ,, ,, 6 outermost teeth from radula. × 310.
,, 15. ,, ,, shell, ventral. × 7·5.
,, 16. ,, ,, apex of shell showing spire.

Fig. 17. *Phyllaplysia pellucida*, n. sp., 19th to 22nd lateral teeth from radula. × 320.
„ 18. „ „ rods from jaw plates. × 310.
„ 19. „ „ median and 2 lateral teeth from radula. × 320.
„ 20. „ „ 9th to 12th lateral teeth from radula. × 320.
„ 21. „ „ 7 outermost teeth from radula. × 310.
„ 22. *Aplysiella mollis*, n. sp., lateral teeth from radula, 6th and 7th from margin. × 310.
„ 23. „ „ rods from jaw plates.
„ 24. „ „ 3rd to 5th teeth from centre of radula. × 310.
„ 25. „ „ 32nd to 35th teeth from centre to radula. × 310.
„ 26. „ „ median and 1st lateral teeth from radula. × 310.

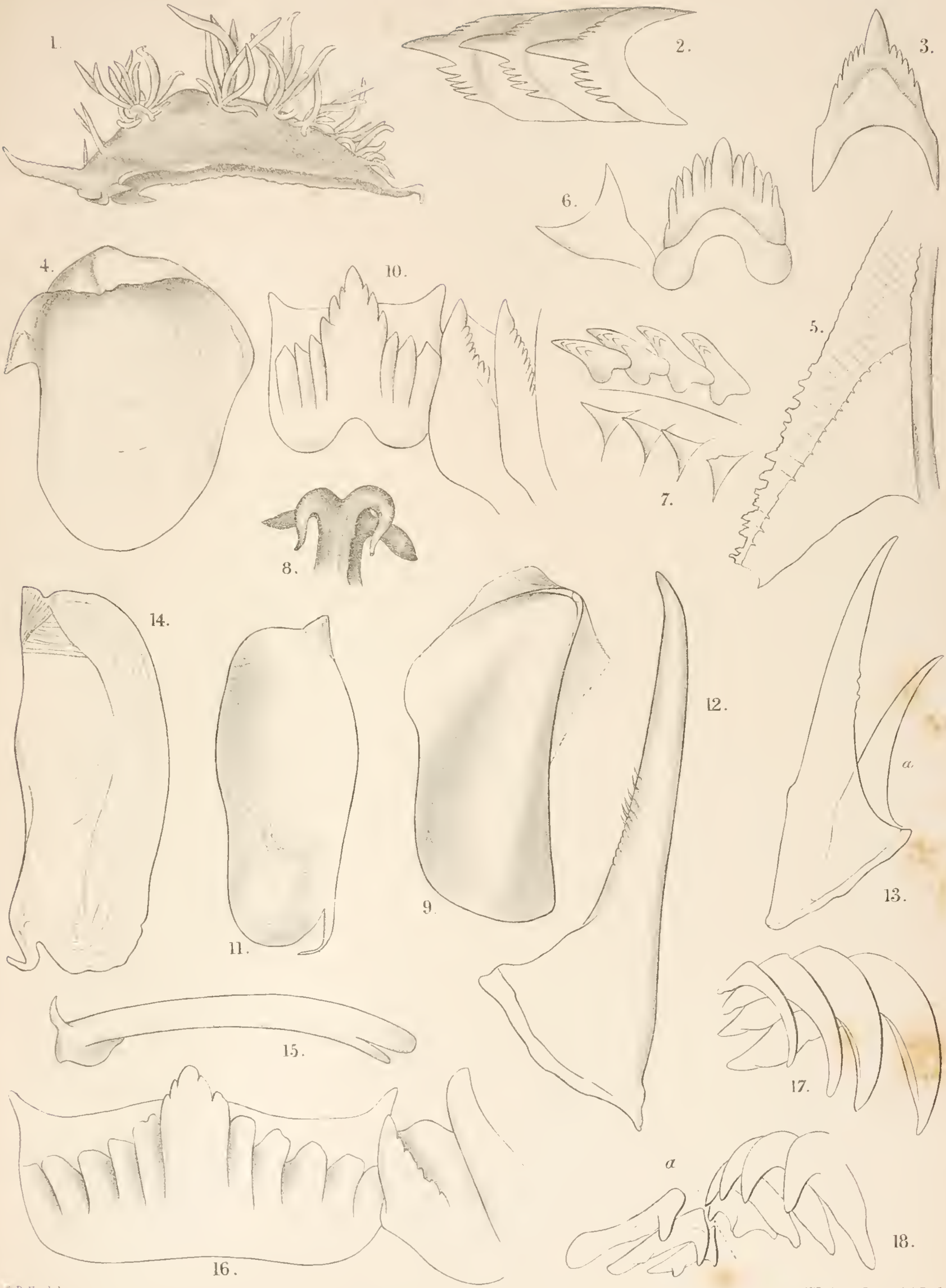
PLATE V.

Fig. 1. *Phyllaplysia pellucida*, n. sp., shell, dorsal view. × 7.
„ 2. *Aplysiella mollis*, n. sp., shell, ventral view. × 7·5.
„ 3. „ „ calcareous layer of shell, dorsal view. × 7·5.
„ 4. *Dolabrifera maillardi*, DESH., animal, dorsal view. × 2.
„ 5. „ „ , seen from right side. × 2.
„ 6. „ „ teeth from radula, middle of lateral row. × 315.
„ 7. „ „ lateral tooth from radula, 19th from centre. × 315.
„ 8. „ „ apex of shell showing spire.
„ 9. „ „ shell, ventral view. × 15.
„ 10. „ „ median and 1st lateral teeth from radula. × 315.
„ 11. *Dolabrifera marginata*, n. sp., animal, dorsal view. × 2.
„ 12. „ „ median and 1st to 3rd lateral teeth from radula. × 310.
„ 13. „ „ lateral tooth from radula, 3rd from margin. × 310.
„ 14. „ „ 22nd and 23rd lateral teeth from radula. × 310.
„ 15. „ „ shell. × 15.
„ 16. *Dolabella scapula*, MART., lateral teeth from radula. × 74.
„ 17. „ „ median and 1st to 3rd lateral teeth from radula. × 74.
„ 18. *Notarchus ceylonicus*, n. sp., animal, dorsal view. × 2.
„ 19. „ „ rods from jaw plates. × 130.
„ 20. „ „ 9th and 10th lateral teeth from radula. × 114.
„ 21. „ „ median and 1st and 2nd lateral teeth from radula. × 114.
„ 22. „ „ 24th and 25th lateral teeth from radula. × 114.
„ 23. „ „ outermost 3 teeth from radula. × 310.
„ 24. *Pleurobranchæa brocki*, BGH., animal, dorsal view. × 2.
„ 25. „ „ „ from left side. × 2.
„ 26. „ „ 5 innermost teeth from radula. a = innermost. × 116
„ 27. „ „ rods from margin of jaw plate. × 320.
„ 28. „ „ 12th and 13th lateral teeth from radula. × 116.

PLATE VI.

Fig. 1. *Pleurobranchus hornelli*, n. sp., shell, membranous margin not shown. × 13.
„ 2. „ „ 9 outermost teeth from radula. × 320.
„ 3. „ „ 7 innermost teeth from radula. × 320.
„ 4. „ „ portion of jaw plate. × 300.
„ 5. „ „ section of mantle.

Fig. 6. *Phyllaplysia albomaculata*, n. sp., dorsal view. × 2.
,, 7. *Pleurobranchus* (*Berthella*) *citrinus* (R. and L.), shell. × 7·5.
,, 8. ,, ,, ,, sculpture of shell.
,, 9. ,, ,, ,, lateral teeth from radula. × 320.
,, 10. ,, ,, ,, portion of jaw plate. × 320.
,, 11. *Aplysiella mollis*, n. sp., dorsal view. × 1·5.
,, 12. *Phyllaplysia pellucida*, n. sp., dorsal view. × 2.
,, 13. *Onchidium verruculatum*, Cuv., dart. × 31.
,, 14. ,, ,, papilla of dart sac.
,, 15. ,, ,, apex of dart. × 78.
,, 16. ,, ,, another view of same. × 78.
,, 17. ,, ,, male gonads. *a*, ampulla of dart sac; *b*, dart sac; *c*, rod of penis; *d*, vas deferens; *e*, retractor penis; *f*, adductors. × 28.
,, 18. ,, ,, hooks from glans of penis. × 116.
,, 19. ,, ,, teeth from radula, 53rd and 54th from centre. × 300.
,, 20. ,, ,, side view of tooth from near margin of radula. × 300.
,, 21. ,, ,, 5 outermost teeth from radula. × 310.
,, 22. ,, ,, median and 2 lateral teeth from radula. × 300.
,, 23. *Marsenia perspicua*, Linn., shell. × 2.
,, 24. ,, ,, 2 rows of teeth from radula.
,, 25. ,, ,, apex of lateral tooth.
,, 26. ,, ,, 2 median teeth.



G. P. F. del. M'Farlane & Erskine Lith Edin^r

1-5. Hervia Ceylonica n. sp. 6-9. Galvina producta, n. sp. 10-13. Linguella cinerea, n. sp.
14-16. Pleurophyllidia formosa, Kel. 17 18. Discodoris labifera, (Abr.)

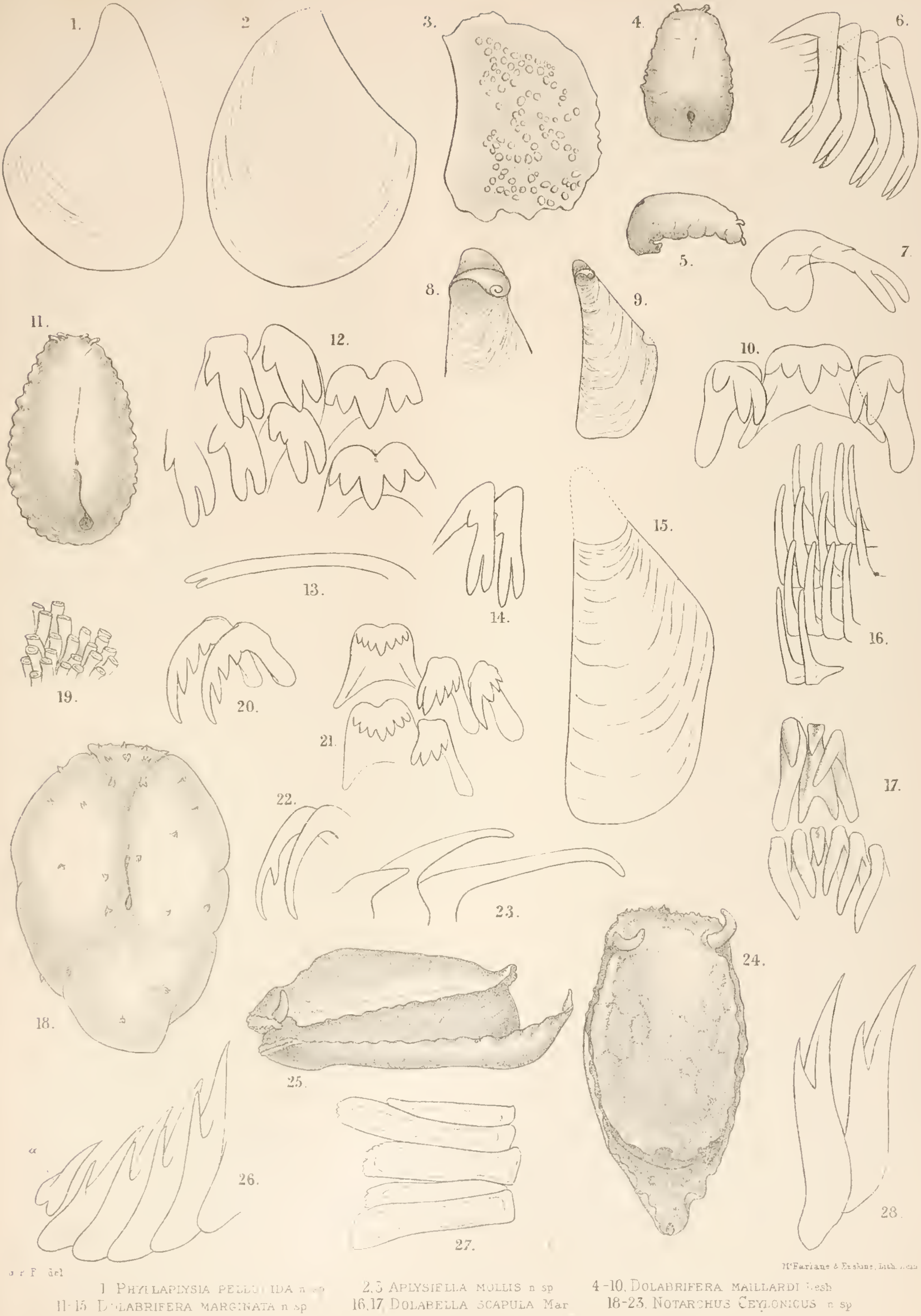
G. P. F. del. M^cFarlane & Erskine Lith. Edin^r

1. PLEUROPHYLLIDIA FORMOSA, Kel. 2-7 PLATYDORIS INFRAMACULATA, (Abr) 8-12, PLATYDORIS SPECIOSA, (Abr)
13-17, PLATYDORIS HERDMANI, n sp 18, 19, THORDISA CAUDATA n sp 20-23, PLATYDORIS SPINULOSA, n sp.

G. P. F. del. M^cFarlane & Erskine Lith Edin^r

1-3 Platydoris spinulosa, n. sp. 4-7, Halgerda punctata, n. sp. 8, 9, Platydoris inframaculata, (Abr.) 10, Platydoris speciosa, (Abr.) 11-15, Chromodoris tenuilinearis, n. sp. 16-17, Phyllidia nobilis, Bgh. 18-22 Aegirus villosus, n. sp. 23, 24, Kalinga ornata, A & H.

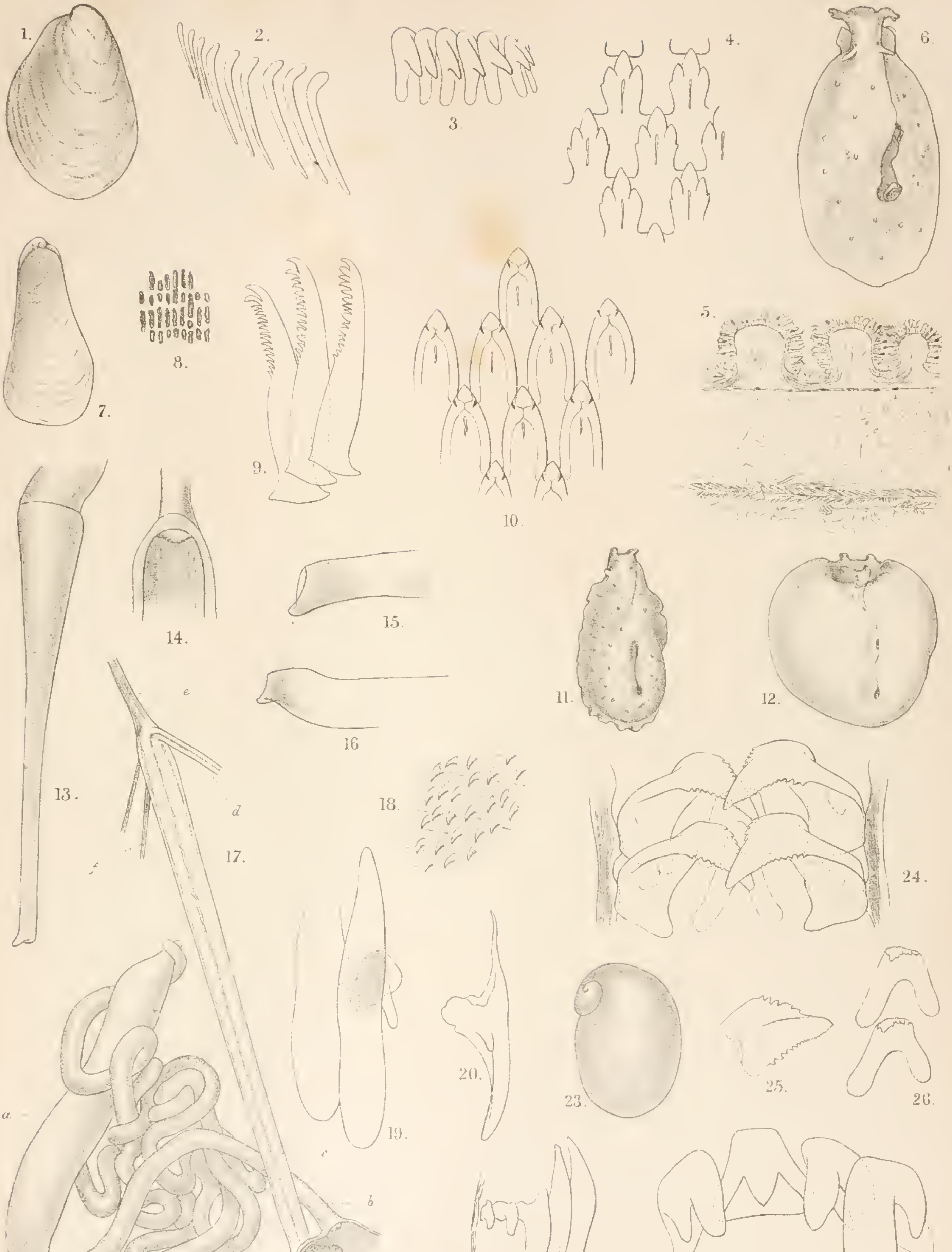
1. [illegible] APLYSIA Linn. 2-7 AP[illegible] 8. APLYSIA INTER[illegible]IA n. sp.
9-12 APLYSIA ELONGATA, P[illegible]e. 15-16 PHYLLAP[illegible] [illegible] n. sp. 17-21 [illegible]
22-26 APL[illegible] MOLLIS n. sp.



J r F del

M'Farlane & Erskine, Lith. Edin

1. Phyllaplysia pellucida n. sp. 2, 3. Aplysiella mollis n. sp. 4-10. Dolabrifera maillardi Lesh.
11-15. Dolabrifera marginata n. sp. 16, 17. Dolabella scapula Mar. 18-23. Notarchus ceylonicus n. sp.
24-28. Pleurobranchæa brocki. Bgh.



I. F. del. M'Farlane & Erskine Lith. Edin.r

1-5 PLEUROBRANCHUS HORNELLI n. sp. 6. PHYLLAPLYSIA ALBOMACULATA n. sp. 7-10. PLEUROBRANCHUS CITRINUS (R&L.)
11 APLYSIELLA MOLLIS n. sp. 12. PHYLLAPLYSIA PELLUCIDA, n. sp. 13-22 ONCHIDIUM VERRUCULATUM Cuv.
23-26. MARSENIA PERSPICUA (Linn.)

REPORT

ON THE

OSTRACODA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

ANDREW SCOTT, A.L.S.,
RESIDENT FISHERIES ASSISTANT IN THE MARINE LABORATORY AT PIEL, BARROW-IN-FURNESS.

[WITH TWO PLATES.]

THE OSTRACODA forming the subject of this report were, with a few exceptions, found amongst the sand and *débris* washed out of the vessels containing other groups of the Ceylon collection. Pelagic species were occasionally taken in the tow-nettings made during the examination of the pearl banks, and also in the series of plankton collections taken during the outward and homeward journeys. Samples of mud and sand from various pearl banks were also examined, but these yielded no members of this group. Some of the material had been preserved in formol, which had apparently a bad effect on the delicate shells of these creatures. In some cases the lime salts had been partly or entirely dissolved out, making the identification a work of much difficulty.

The Ostracoda are represented by 77 species belonging to 22 genera. Thirty-five of the above number appear to be undescribed, and are now added to the Ceylon Fauna, and figured in the plates.

A considerable amount of work has already been done and a good deal of information published relating to the Ostracoda of Ceylon. Professor BRADY has one paper in 'The Journal of the Linnean Society' (vol. xix., No. 114, 1886) which deals entirely with Ceylonese Entomostraca. It contains descriptions of new and other marine species dredged in 2 fathoms off Kalpentyn, in the Gulf of Manaar. Descriptions of other species are given by Professor BRADY in reports published in the 'Transactions of the Zoological Society.' The valuable work on the Ostracoda collected by the "Challenger" is indispensable in dealing with tropical forms. 'The Monographs on the North Atlantic and North-Western European Ostracoda,' by Professor BRADY and Dr. NORMAN, are also of much service. The splendid work of Dr. G. W. MÜLLER, published by the Naples Zoological Station, is a mine of information, as the anatomical details of the animals are fully illustrated, and the positions of many hitherto incompletely described species are thus firmly established. Finally, every paper dealing with marine Ostracoda from foreign localities requires to be consulted, and this has been done as far as possible in the present case; but it is not considered necessary to give references under the species, or to add a list of the literature, as the authors named and the papers made use of are well known to all workers at the group.

I am much indebted to Professor BRADY, F.R.S., for looking over the identifications made and for assistance given with some doubtful species. My father, Dr. T. SCOTT, has also helped me greatly with the work of classifying the undescribed forms. Owing to the absence of the appendages, the exact positions of one or two of the new species, which happened to be only empty shells, are at present uncertain.

It is almost impossible to find good descriptive names in certain genera of Ostracoda which are not pre-occupied, and geographical terms are apt to prove misleading. So I have named the new species of *Cythere* and *Cytherella* in honour of some of the officials and naturalists connected with Ceylon and its pearl fisheries who were mentioned in Professor HERDMAN'S Introduction to these Reports.

SECTION I.: MYODOCOPA.

FAMILY: ASTEROPIDÆ.

Asterope oculata, BRADY.

In washings from young pearl oysters collected from Cheval Paar, February and March, 1902, and from Muttuvaratu Paar, November 19th, 1902; also in general washings from invertebrates from Gulf of Manaar. Ten females and four males were found altogether. Professor BRADY records it from the surface at Trincomalee, and from Cruz Bay.

Asterope quadrata, BRADY.

Three females were present in the washings from invertebrates dredged on the pearl banks. This species was described from specimens collected at Lyttelton Harbour, New Zealand.

Asterope arthuri, STEBBING.

Specimens of this fine species were taken by the tow-net in 6 to 10 fathoms at Karativo Paar on March 10th, 1902, and at 9 fathoms at 9 P.M. on Vankali Paar, March 13th, 1902. On the latter date there was much phosphorescence in the water. STEBBING describes it in Dr. ARTHUR WILLEY'S "Results," Crustacea, Part v.

Cyclasterope similis, BRADY.

Two females in general washings from dredged invertebrates from Gulf of Manaar. Java Sound is the only previous locality given for the species.

FAMILY: CYPRIDINIDÆ.

Cypridina faveolata, BRADY.

One specimen, from the pearl banks in the Gulf of Manaar. It has hitherto been recorded only from the China Sea, where a single example was found.

Pyrocypris chierchiæ, MÜLLER.

This species appeared to be generally distributed throughout the area investigated and has been found in the following places:—Muttuvaratu, West Cheval, South-south-west of Silavaturi, off Kalpentyn Island, at Galle, in washings from young pearl oysters, and from the general washings from dredged invertebrates from the Gulf of Manaar.

According to Professor BRADY, this and other species of *Pyrocypris* occur in immense numbers in tropical seas, and seem to contribute a very large share to the phosphorescence of these regions. MÜLLER states that as many as twenty thousand of the above species have been taken in a single haul, and attributes their light-producing power to the labial papillæ which so far appear to be peculiar to the genus.

Codonocera cruenta, BRADY.—Plate II., figs. 43 to 45.

A single specimen of this peculiar ostracod was taken in the collection made by Professor HERDMAN on the homeward journey when west of Minikoi, in the Indian Ocean. In Professor BRADY'S description of the animal it is stated that the post-abdominal laminæ have only three ungues. In the present specimen there are distinctly four, the fourth, however, being very small (Plate II., fig. 43). The specimen was a male. The peculiar filaments on the antennules ending in bell-shaped disks (fig. 44) and the muscular hand of the antenna (fig. 45) are noteworthy characters; size, 1·73 millims.

Professor BRADY'S single specimen was taken at Pulo Penang.

FAMILY: SARSIELLIDÆ.

Sarsiella ornithoides, BRADY.

One specimen of this distinct form was found in the collection made at Karativo Paar on March 10th, 1902.

The only other locality for the species is Trincomalee.

Sarsiella carinata, n. sp.—Plate I., figs. 1 and 2; Plate II., figs. 40 and 41.

Shell membranous, thin and flexible, seen from the side subrhomboidal, height equal to about two-thirds of the length. Anterior extremity truncate, and provided with a prominent protuberance at the beginning of the dorsal curve; posterior narrower, deeply excavated, bounded above and below by prominent projections; dorsal margin boldly arched, highest behind the middle, whence it slopes rapidly towards the large projection; ventral margin nearly flat, except at the posterior end, where it is deeply sinuated; seen from above elongated, widest in the middle, width considerably less than half the length; anterior extremity narrow, emarginate; posterior wide, terminating in one median and two lateral protuberances. The dorsal and ventral margins are in the form of a continuous ridge with radiating lines, two longitudinal ribs of a similar structure run parallel to, but at a considerable distance within the margins, both terminating posteriorly in protuberances; ventral margin adorned with four protuberances of various sizes; in addition to these, there are two between the ventral margin and the lower ridge and one on the surface of the lower posterior projection. Surface of the shell marked with numerous circular depressions, which have four or five short setæ round the outside; dorsal and ventral margins ciliated; size, 1·1 millims.

Three specimens, all males, were found in washings from deep-water dredgings off Galle. The antennules have the characteristic dense brush of long fine hairs; post-abdomen with five marginal ungues, increasing in length from the first to the last, which is about five times as long as the first; margins spinulose.

Sarsiella gracilis, n. sp.—Plate I., figs. 3 and 4; Plate II., fig. 37.

Shell membranous, thin and flexible; seen from the side subcircular, height equal to fully two-thirds of the length; anterior extremity broadly rounded, crenate, with a distinct notch near the middle; posterior truncate, with a wide triangular process above and below; dorsal and ventral margins rounded, the former sloping rapidly at its posterior end; seen from above, oblong subovate, widest near the posterior end, width slightly less than one-third of the length; anterior extremity obtusely rounded, posterior truncated, with a median process; surface of the shell slightly ciliated, covered with small impressed puncta; anterior and ventral margins ciliated; size, 1·34 millims.

Two specimens were found in a dredging from 100 fathoms, off Galle, and one in the general washings from invertebrates from Gulf of Manaar. All were mature females with ova. The postabdomen has three stout ungues with spinulose margins, and three short plumose setæ.

Sarsiella similis, n. sp.—Plate I., figs. 5 and 6; Plate II., fig. 38.

Shell thin and flexible, subcircular, height fully two-thirds of the length; seen from the side anterior extremity rounded, crenate, with a slight notch in the centre, posterior truncate, with distinct projections above and below; dorsal and ventral margins boldly convex; seen from above subovate, fully twice as long as broad, anterior extremity narrow, posterior widely truncate, with a small median process; for the greater part the sides are nearly parallel, converging rapidly towards the anterior end; surface of the shell slightly ciliated, covered with small impressed puncta, the valves have four or five longitudinal ribs at the posterior and a number of radiating lines at the anterior extremity; anterior and ventral margins ciliated; size, 0·93 millim.

A number of ova-bearing females were found in washings from Muttuvaratu Paar and in the general washings from Gulf of Manaar. The species resembles the last in general shape, but is distinguished by the longitudinal ribs. The postabdomen (Plate II., fig. 38) is much narrower, and the ungues more spinulose.

Sarsiella crispata, n. sp.—Plate I., figs. 7 and 8; Plate II., fig. 39.

Shell thin and flexible; seen from the side subcircular, broadly rounded in front, slightly narrowed and produced into a wide ciliated beak posteriorly; seen from above broadly ovate, widest just behind the middle, twice as long as broad; anterior extremity narrow, posterior truncate, with one median and two lateral projections; surface covered with large impressed puncta, valves with a number of conspicuous ridges, the two near the posterior end of the dorsal margin forming distinct projections, anterior and ventral margins crenate and ciliated, with a corrugated line a little within; size, 0·8 millim.

About a dozen mature females were obtained in the same material as the previous species. Postabdomen (fig. 39) with four stout spinulose ungues of different lengths.

Sarsiella tumida, n. sp.—Plate I., figs. 9 and 10; Plate II., fig. 42.

Shell membranous, thin and flexible. Seen from the side subcircular, slightly longer than wide; anterior extremity broadly rounded, with a small beak in the centre; posterior truncate and produced into a wide beak at the lower angle; dorsal and ventral margins boldly convex, the dorsal forming a distinct hump in the centre; seen from above broadly ovate, widest slightly in front of the middle, width equal to less than two-thirds of the length, narrow in front, rectangularly truncate behind, with a distinct median projection; surface of the shell devoid of sculpture, but having a large fold near the posterior end of the dorsal margin; anterior and ventral margins ciliated; size, 1·26 millims.

Two mature females of this species were found in the general washings from dredged invertebrates. The postabdomen is narrow and furnished with five spinulose ungues, the longest being about five and a half times the length of the shortest.

Future investigation may show this form to be the female of *Sarsiella carinata*, as the comparative lengths of the ungues on the postabdomen of both species are nearly alike, but in the meantime it is thought best to keep them separate.

Family: HALOCYPRIDÆ.

Conchœcia magna, Claus.

Two specimens belonging to this species were taken in the tow-netting collected in the Suez Canal, between Port Saïd and Suez, on the outward journey.

Conchœcia clausii, G. O. Sars (?).

Two specimens apparently belonging to this species occurred in the above collection, but their very poor condition makes their identity uncertain.

Conchœcetta acuminata, Claus.

One specimen in the above collection, one from near Perim Island in the Red Sea, and a third from the middle of the Indian Ocean.

Halocypris concha, Claus.

This species occurred in a number of the collections taken between the Mediterranean and Ceylon on both journeys, and also on the pearl banks in the Gulf of Manaar.

Section II.: PODOCOPA.

Family: CYPRIDÆ.

Macrocypris decora (Brady).

In general washings from invertebrata and in washings from sponges dredged in the Gulf of Manaar.

Macrocypris orientalis, Brady.

In general washings from invertebrata from the Gulf of Manaar.

Macrocypris similis, Brady.

Also in general washings from invertebrata from the Gulf of Manaar.

Macrocypris maculata (Brady).

In the general washings from the Gulf of Manaar and in washings from Cheval pearl oysters.

Pontocypris robusta, n. sp.—Plate I., figs. 17 and 18.

Shell seen from the side subtriangular, the height being equal to slightly more than half the length, anterior extremity moderately broad and obliquely rounded, posterior attenuated and almost acuminate; dorsal margin boldly arched, highest in the middle, sloping with a steep curve backwards, and more gently towards the front; ventral margin deeply sinuated well in front of the middle. Seen from above the outline is ovate, acuminate in front and rounded behind, greatest width in the middle and equal to fully two-fifths of the length; shell white, polished, with minute setæ and impressed puncta; the valves are marked with five lucid spots arranged in a semicircular manner; size, 0·82 millim.

A few specimens from the general washings from Gulf of Manaar; from Cheval pearl oyster washings; and from Gulf of Manaar sponges.

At first it was thought this might be a form of *Pontocypris trigonella*, G. O. Sars, but a comparison with the figures given in the '"Challenger" Report,' in the report 'On the Entomostraca from the Gulf of Guinea,' by my father, and in the 'Monograph on the North Atlantic and North-western European Ostracoda,' by Brady and Norman, shows that it is distinct.

Pontocypris elegans, n. sp.—Plate I., figs. 19 and 20.

Shell seen from the side oblong, compressed, subreniform, the height being equal to rather less than one-third of the length; anterior extremity obliquely rounded, posterior produced and subacute at the ventral angle; dorsal margin moderately arched, greatest height slightly in front of the middle, and sloping gently towards each extremity; ventral margin deeply sinuated in the middle; seen from above compressed, ovate, widest in the middle, width about one-fourth of the length, acuminate in front and slightly rounded behind; shell white, polished, with a few minute impressed puncta; the valves are marked with a circular patch of lucid spots and three smaller detached ones; size, 0·6 millim.

A few specimens were found in the same washings as the previous species.

Pontocypris rostrata, n. sp.—Plate I., figs. 21 and 22.

Shell seen from the side subtriangular, greatest height nearly equal to half the length; anterior extremity broadly rounded, almost truncate, posterior produced, subacute in the centre; dorsal margin boldly arched, highest slightly in front of the middle, sloping very gently towards the front, but rapidly to the posterior; ventral margin sinuated in front of the middle, becoming convex near the posterior end where it turns up to join the extremity; seen from above ovate, greatest width in the middle and about equal to one-third of the length, acuminate in front and behind, sides distinctly compressed in front, forming a beak-like process; shell white and polished, valves unequal, the right being slightly smaller than the left; size, 0·64 millim.

In washings from sponges dredged in the Gulf of Manaar.

Pontocypris tumida, n. sp.—Plate I., figs. 30 and 31.

Shell seen from the side subovate, the height being rather more than half the length; anterior extremity rounded, somewhat depressed, posterior subacute; dorsal margin boldly arched, highest in the middle, ventral slightly sinuated in front of the middle; seen from above ovate, widest behind the middle, length equal to two and a half times the width, right valve smaller than the left; shell white, smooth, and polished; size, 0·97 millim.

In general washings and in washings from Gulf of Manaar sponges.

Erythrocypris herdmani, n. sp.—Plate I., figs. 15 and 16.

Shell seen from the side subtriangular, the height being about equal to half of the length; anterior extremity broadly rounded, posterior attenuated and subacuminate; dorsal margin strongly arched, almost angular at its highest point, forming a distinct hump, greatest height considerably in front of the middle, and sloping with a steep curve to both extremities, ventral margin slightly sinuated; seen from above ovate, width fully two-fifths of the length, greatest width about one-third from the anterior extremity, extremities obtusely pointed, rather more acute in front than behind; valves yellowish, smooth, and shining, covered with numerous short rigid hairs, the left valve has a distinct tooth at its posterior end; size, 0·85 millim.

Specimens were found in general washings from Gulf of Manaar, in washings from Cheval pearl oysters, and Manaar sponges, and on Karativo Paar. This species, which is easily distinguished from any of those already described, is named in compliment to Professor Herdman, whose labours on the Ceylon pearl banks have added an extensive chapter to our knowledge of the tropical marine fauna.

Bairdia villosa, Brady.

In general washings from invertebrates from the Gulf of Manaar.

Bairdia attenuata, Brady.

In general washings from invertebrates from the Gulf of Manaar.

Bairdia woodwardiana, Brady.

In general washings from invertebrates from the Gulf of Manaar.

Bairdia amygdaloides, Brady.

In general washings from invertebrates from the Gulf of Manaar.

Bairdia faveolata, Brady.

In the general washings and in washings from Cheval pearl oysters.

Bairdia hirsuta, Brady.

In general washings, in washings from Cheval pearl oysters, and from Karativo Paar.

All these species of *Bairdia* are new to the fauna of Ceylon.

Bairdia inornata, n. sp.—Plate I., figs. 11 and 12.

Shell seen from the side subreniform, height equal to more than half the length;

anterior extremity obliquely rounded, posterior produced in the middle into an obtusely angular beak; dorsal margin boldly arched, highest in the middle and sloping steeply towards the extremities, slightly sinuated at the anterior and posterior ends, ventral margin deeply sinuated in the middle; seen from above compressed, ovate, widest in front of the middle and nearly three times longer than wide, extremities obtuse, subtruncate; colour almost black, with one or two lighter bands; surface of the valves covered with closely set, short, stiff setæ; posterior end of the ventral margin finely serrate; right valve smaller than the left; size, 0·74 millim.

A few specimens in general washings from invertebrates from Gulf of Manaar.

Bairdia robusta, n. sp.—Plate I., figs. 13 and 14.

Shell seen from the side subtriangular, height equal to fully two-thirds of the length; anterior extremity obliquely rounded, posterior produced in the middle into an obtusely angular beak; dorsal margin greatly arched, highest slightly in front of the middle, ventral nearly straight; seen from above broadly ovate, length fully one and a half times the width, extremities subacute, posterior more so than the anterior; shell white, polished, closely beset with black setæ; anterior and posterior extremities with a dense fringe of setæ; size, 0·87 millim.

In general washings from invertebrates from Gulf of Manaar. This species resembles *Bairdia villosa*, Brady, but is much more tumid and obtuse.

Anchistrocheles bradyi, n. sp.—Plate I., figs. 34 and 35.

Shell seen from the side reniform, height slightly less than half the length; anterior extremity wide, obliquely subtruncate, posterior broadly rounded, slightly produced in the middle; dorsal margin gently and evenly curved, highest behind the middle, ventral sinuated in front of the middle: seen from above the outline is elongated, with parallel sides, nearly four times longer than wide; both extremities acute, anterior more so than the posterior; shell smooth, thin and fragile; size, 0·9 millim.

In dredged material from 6 fathoms to 10 fathoms, Karativo Paar.

The species resembles *Anchistrocheles fumata*, Brady, in general appearance, but is easily recognised by the more acute extremities, as seen from the dorsal aspect. I have great pleasure in naming it after Professor Brady, to whom we remain indebted for much help both in this group and in the Copepoda.

Pseudocythere minuta, n. sp.—Plate I., figs. 28 and 29.

Shell seen from the side oblong, subquadrate, slightly higher in front than behind, height slightly less than half the length; anterior extremity rounded, with one or two tooth-like projections near the middle; posterior oblique, subtruncate, much compressed, produced at the upper angle into a broad, blunt beak, lower angle also produced, but the beak is much smaller: dorsal margin almost flat, highest near the anterior end, sloping very slightly towards the posterior, ventral margin slightly sinuated in front of the middle; seen from above ovate, widest in the middle, tapering to the extremities, both of which are acuminate, the posterior much attenuated; width equal to less than half the length; shell marked with numerous puncta arranged in fairly regular, slightly curved, longitudinal rows. Size, 0·35 millim.

A single specimen in general washings from dredged invertebrates from Gulf of Manaar.

Paradoxostoma cingalense, BRADY.

One or two specimens in general washings from dredged invertebrates from Gulf of Manaar. Off Kalpentyn is the only previous locality given for the species.

Paradoxostoma attenuatum, n. sp.—Plate I., figs. 32 and 33.

Seen from the side pear-shaped, about two and a half times longer than broad; anterior extremity very narrow, rounded, posterior broad and truncate, sloping inwards, forming a distinct tooth at the junction with the lower margin; dorsal margin boldly arched, highest considerably behind the middle, ventral margin sloping outwards from the anterior extremity; very slightly sinuated, convex at the widest part; seen from above much compressed, with acute extremities, greatest width in the middle, length four and a half times the width; shell amber coloured, smooth and transparent; size, 0·6 millim.

In washings from Gulf of Manaar sponges.

Paradoxostoma stebbingi, n. sp.—Plate II., figs. 1 and 2.

Shell seen from the side pear-shaped, two and a half times longer than broad; anterior extremity narrow, obliquely rounded, posterior subacute in the centre; dorsal margin boldly and evenly arched, highest slightly behind the middle; ventral margin sinuated near the anterior extremity; seen from above compressed, ovate, widest in the middle, and nearly four times longer than broad, extremities acute; shell smooth, white and semi-transparent; size, 0·6 millim.

In general washings from dredged invertebrates.

I name this species after the Rev. T. R. R. STEBBING.

Xestolebris margaritea, BRADY.

In the general washings, in washings from Cheval pearl oysters and Gulf of Manaar sponges, and in a dredging from Karativo Paar.

Xestolebris tumefacta, BRADY.

In the general washings from Gulf of Manaar.

Xestolebris aurantia, BAIRD.

Also in the general washings. The specimens were first identified as *Xestolebris* *margaritea*, but Professor Brady says he cannot distinguish them from our native *Xestolebris aurantia.*

Xestolebris variegata, Brady.

In the general washings, and in washings from Cheval pearl oysters.

Xestolebris faveolata, Brady.

In a dredging from Karativo Paar, 6 to 10 fathoms.

Xestolebris squamigera, n. sp.—Plate I., figs. 23 to 25; Plate II., figs. 28 and 29.

Shell seen from the side somewhat siliquose, two and a half times longer than broad. Anterior extremity very narrow, rounded, posterior subacute; dorsal margin boldly arched, highest a little behind the middle, sloping rapidly and evenly to the anterior end; posteriorly the slope is more abrupt and almost truncate; ventral margin nearly straight, slightly sinuated in front of the middle; seen from above the outline is broadly ovate; width about three-fifths of the length, and widest behind the middle; anterior extremity subacute, distinctly sinuated, and expanding rapidly; posterior extremity broadly rounded; seen from the posterior end the valves are deeply concave; valves slightly unequal; shell smooth, white and polished, with numerous whitish spots scattered over the surface; size, 0·52 millim.

In the general washings and in washings from Gulf of Manaar sponges. The drawings on Plate I. represent an ova-bearing female; the antennule and antenna are shown on Plate II., figs. 48 and 49.

Xestolebris irrasa, n. sp.—Plate II., figs. 5, 6 and 46, 47.

Shell seen from the side ovate, height fully two-thirds of the length; anterior extremity narrow, posterior broad, both well rounded; dorsal margin boldly arched, highest in the middle, ventral very slightly convex, with slight sinuations at the extremities; seen from above ovate, widest behind the middle, width fully two-thirds of the length, extremities obtusely pointed in front, wider and more rounded behind; surface of the shell marked with numerous concentric spinulose ridges, and clothed with short stiff setæ; colour yellowish; size, 0·53 millim.

In the general washings and in washings from Gulf of Manaar sponges. The figures represent a female shell, the antennule and antenna being shown by figs. 46 and 47.

Xestolebris tumida, n. sp.—Plate II., figs. 3 and 4.

Shell seen from the side broadly pear-shaped, scarcely one and a half times longer than broad, extremities well rounded, anterior much narrower than the posterior; dorsal margin greatly arched, highest behind the middle; ventral slightly sinuated in front and convex behind; seen from above broadly ovate, rather longer than broad, compressed and pointed in front, broadly rounded behind; greatest width behind the middle; shell smooth, white, with numerous whiter spots on its surface; size, 0·6 millim.

In general washings from the Gulf of Manaar.

The species resembles *Xestoleberis variegata*, but is much more tumid.

Paracytheridea perplexa, n. sp.—Plate I., figs. 26 and 27.

Shell seen from the side subrhomboidal, two and a half times longer than broad; anterior extremity obliquely rounded, with three median teeth; posterior produced into a median triangular beak; dorsal margin highest in front, sloping downwards towards the posterior in an irregularly sinuous line; ventral margin slightly convex in front, rising with a gentle slope posteriorly, deeply notched at the hinder end, and then suddenly produced into a curved triangular tooth-like process; seen from above the outline is much like that of a Trilobite, very wide and rounded in front; narrowing slightly posteriorly, then rapidly converging to form a wide triangular end; greatest width much in front of the middle, and equal to three-fourths of the length; surface of the shell marked with large puncta, and in side view with obliquely transverse ridges; size, 0·65 millim.

A few specimens in the general washings from dredged invertebrates from Gulf of Manaar.

The species resembles *Paracytheridea depressa*, G. W. Müller, but differs in the termination of the lateral margins as seen from above. In *P. depressa* the margins end in a distinct tooth projecting at nearly right angles to the sides.

Cytherura concinna, n. sp.—Plate II., figs. 7 and 8.

Shell seen from the side subrhomboidal, with a well-marked dorsal ridge, height equal to half the length; anterior extremity obliquely rounded, posterior broadly beaked above the middle; dorsal margin rugged, broken by a few small blunt projections, sloping gently upwards towards the posterior, ventral convex in the middle; seen from above broadly triangular, greatest width much behind the middle and equal to two-thirds of the length; anterior extremity rounded and produced into a blunt median beak; posterior very wide, subtruncate, and produced into a large median process, its margin forming a distinct flexuous ridge coursing between the outer and inner margins of each valve; surface of the shell marked with numerous puncta, and with a distinct depression in the centre of each valve; size, 0·53 millim.

One or two specimens in general washings from dredged invertebrates from Gulf of Manaar.

Loxoconcha anomala, Brady.

In general washings, in washings from Cheval pearl oysters, and in a dredging from Karativo Paar.

Loxoconcha alata, Brady.

From the same material as the previous species.

Loxoconcha papillosa, Brady.

In general washings from Gulf of Manaar.

Loxoconcha sculpta, Brady.

In washings from Gulf of Manaar sponges.

Loxoconcha australis, Brady.

In the general washings and in washings from Gulf of Manaar sponges.

Cythere bimammillata, Brady.

In washings from Gulf of Manaar sponges.

Cythere darwini, Brady.

In the general washings, in washings from Gulf of Manaar sponges, and in a dredging from Karativo Paar.

Cythere inconspicua, Brady.

In washings from Cheval pearl oysters.

Cythere ovalis, Brady.

In the general washings, in washings from Cheval pearl oysters, and in a dredging from Karativo Paar.

Cythere polytrema, Brady.

In general washings from Gulf of Manaar.

Cythere rectangularis, Brady.

In general washings from Gulf of Manaar.

Cythere ruperti, Brady.

In the general washings and in washings from Gulf of Manaar sponges.

Cythere stimpsoni, Brady.

In a dredging from Karativo Paar.

Cythere subcuneata, Brady.

In general washings from Gulf of Manaar.

Cythere knoxi, n. sp.—Plate II., figs. 9 and 10.

Shell seen from the side elongated, subsigmoid, height equal to half the length, extremities toothed; anterior extremity broad and obliquely rounded, posterior narrower, rounded off below, and obscurely angulated above; dorsal margin sinuated in the centre, highest in front and sloping towards the posterior, ventral sinuated in the middle; seen from above pear-shaped, greatest width near the posterior end, and equal to more than half the length, the outline between the widest point and the anterior end shows two distinct constrictions; shell surface marked with coarse impressed puncta; each valve seen from the side shows two distinct grooves; size, 0·56 millim.

In the general washings and in washings from Cheval pearl oysters.

Named after Captain Robert Knox, 20 years a captive in Ceylon in the seventeenth century.

Cythere chalmersi, n. sp.—Plate II., figs. 11 and 12.

Shell seen from the side subsigmoid, height equal to half the length, extremities corrugated but not toothed; anterior extremity very obliquely rounded, posterior narrower, and broadly rounded; dorsal margin highest at the anterior end, nearly flat, with a gentle slope towards the posterior; ventral sinuated in the middle; seen from above pear-shaped, outline irregular, and marked by three constrictions, widest near the posterior end, greatest width equal to about half the length; anterior and posterior ends with strong thickened lips, the posterior forming a distinct protuberance; surface of the shell marked with moderately coarse impressed puncta, and near the extremities with a row of circular depressions; seen from the side, the valves show three distinct grooves; size, 0·7 millim.

In the general washings and in washings from Gulf of Manaar sponges.

Named after Dr. A. J. Chalmers, Professor in the Medical College, Colombo.

Cythere imthurni, n. sp.—Plate II., figs. 13 and 14.

Shell seen from the side oblong, subquadrangular, height slightly less than halt the length; extremities smooth, anterior extremely broad and obliquely rounded, with an internal row of subcircular markings; posterior narrower, rounded above and truncate below; dorsal margin highest at the anterior end, nearly flat, with a gentle slope towards the posterior, ventral deeply sinuated near the middle; seen from above rather wedge shaped, with nearly parallel sides, deeply constricted near the posterior end, length about two and a half times the width; anterior margin acuminate with projecting thickened lips, posterior almost truncated, projecting slightly in the centre; surface of the shell marked with large irregular impressed puncta, and, when viewed from the side, with a deep hollow near the posterior; size, 0·5 millim.

In the general washings, in washings from Cheval pearl oysters, and from Gulf of Manaar sponges.

Named after the Honourable E. F. im Thurn, Lieutenant-Governor of Ceylon during the pearl oyster investigation in 1902.

Cythere thompsoni, n. sp.—Plate II., figs. 15 and 16.

Shell seen from the side oblong, subquadrangular, height rather more than half the length; anterior extremity wide and obliquely rounded, with about a dozen short thick teeth, posterior slightly narrower, almost truncate, with five or six short stout teeth; dorsal margin deeply sinuated in the middle, highest at the anterior end, ventral margin slightly sinuated near the anterior end; seen from above broadly ovate, with irregular outline, width rather more than half the length, widest near the posterior end; anterior extremity obtuse, with two mucronate processes, posterior wide, truncated, with broad, tooth-like median projections; surface of the shell marked with large regular ridges and deep depressions, which become very conspicuous in dead shells; size, 0·73 millim.

In the general washings and in washings from Gulf of Manaar sponges.

This well-marked species is named in memory of my friend and fellow-worker, the late Mr. Isaac C. Thompson, F.L.S., who was jointly responsible with me in the preparation of the "Report on the Copepoda," published in the first volume of this work.

Cythere donnani, n. sp.—Plate II., figs. 17 and 18.

Shell seen from the side subsigmoid, height equal to half the length; anterior extremity wide and very obliquely rounded, with about fourteen small teeth on the lower margin, posterior narrow, slightly produced in the centre, with four small teeth below the middle; dorsal margin sinuated in the middle, highest at the anterior and rounded off towards the posterior, ventral sinuated, convex in front and behind; seen from above broadly ovate, width slightly less than half the length, with rounded extremities, slightly produced into thickened lips, widest near the posterior, and slightly sinuated in the middle; surface of the shell marked with a number of fairly regular longitudinal ridges and rows of impressed puncta; size, 0·98 millim.

In washings from Cheval pearl oysters, and from Gulf of Manaar sponges.

Named after Captain Donnan, Inspector of the Pearl Banks in 1902.

Cythere willeyi, n. sp.—Plate II., figs. 19 and 20.

Shell seen from the side oblong, subquadrangular, height equal to rather more than half the length; anterior extremity wide and very obliquely rounded, with about seventeen short stout teeth, posterior much narrower, bluntly rounded, with four short teeth on the lower margin; dorsal margin very slightly sinuated in the middle, highest in front, and rounding off posteriorly, ventral sinuated slightly in front of the middle; seen from above broadly ovate, with irregular outline, width rather more than half the length, widest in front of the middle; anterior extremity obtuse, with two mucronate processes, posterior widely triangular; surface of the shell marked with large irregular puncta, and a distinct dorsal ridge; size, 0·8 millim.

In general washings from Gulf of Manaar.

Named after Dr. Arthur Willey, Director of the Museum at Colombo.

Cythere hornelli, n. sp.—Plate II., figs. 21 and 22.

Shell seen from the side siliquose, height rather less than half the length; anterior extremities narrowed and rounded, smooth; dorsal margin boldly arched, highest in the centre, ventral sinuated in the middle; seen from above wedge-shaped, width less than half the length, widest near the posterior; anterior extremity produced, with two mucronate processes, posterior margins truncate, and produced into a broad triangular projection; surface of the shell marked with a number of curved ridges and rows of impressed puncta; size, 0·53 millim.

In general washings from invertebrata from Gulf of Manaar. Named after Mr. James Hornell, now Inspector of the Pearl Banks.

Cythere halyi, n. sp.—Plate II., figs. 23 and 24.

Shell seen from the side oblong, quadrangular, height slightly less than half the length, widest in the middle; anterior extremity broadly rounded, with one tooth below the centre; posterior produced into a wide triangular beak; dorsal margin flat, with a corrugated margin, highest at the extremities, ventral slightly convex and irregular; seen from above narrowly ovate, with produced and thickened extremities, widest behind the middle, width considerably less than half the length; surface of the shell marked with numerous impressed puncta and studded with bluntly pointed spines; size, 0·55 millim.

In general washings from invertebrata from Gulf ot Manaar. Named after Mr. Haly, a former Director of the Colombo Museum.

Cythere kelaarti, n. sp.—Plate II., figs. 25 and 26.

Shell seen from the side oblong, subquadrangular, height scarcely equal to half the length; anterior extremity broadly and obliquely rounded, with about 21 short, stout teeth; posterior narrow and subtruncate, with seven short, thick spines; dorsal margin slightly sinuated, highest in front and sloping gently backwards, ventral nearly straight, much contracted at the posterior; seen from above doubly triangular, widest much behind the middle, where the outline is produced into a blunt tooth; width slightly more than half the length; anterior extremity with two, and the posterior with four, spines; surface of the shell marked with numerous impressed puncta, very rough and studded with short, aculeate spines, one triangular tooth near the posterior; size, 0·65 millim.

In general washings from dredged invertebrates from Gulf of Manaar. Named after Dr. Kelaart, who investigated the pearl banks in 1857.

Cythere willisi, n. sp.—Plate II., figs. 27 and 28.

Shell seen from the side subquadrangular, with compressed margins, height slightly less than two-thirds of the length; anterior extremity broad and very obliquely rounded, with seven short, stout teeth on the lower portion; posterior almost rectangularly truncated, produced below the middle, where it bears two teeth and one or two crenulations; dorsal margin highest in front, sloping with a sinuous curve gently backwards; ventral sinuated in front and convex behind; seen from above ovate, with produced emarginate extremities, sharply constricted in the middle and near the posterior end, width equal to half the length; surface of the shell covered with large irregularly angulated fossæ, marked with a strong marginal ridge and an obliquely transverse one, coursing from the posterior towards the anterior extremity; highest at the posterior end; size, 0·73 millim.

In the general washings, in washings from Gulf of Manaar sponges, and in a dredging from Karativo Paar. Named after Dr. J. C. Willis, Director of the celebrated Botanic Gardens at Peradeniya, Ceylon.

Cythere colletti, n. sp.—Plate II., figs. 29 and 30.

Shell seen from above subquadrangular with compressed margins, height equal to slightly less than two-thirds of the length; anterior extremity broad and obliquely rounded, with 10 short, stout teeth on the lower portion; posterior narrowed, truncated, produced near the middle into a quadri-crenulate projection; dorsal margin highest in front, sloping rather steeply to the posterior; ventral slightly sinuated in front, convex behind the middle, rising quickly near the posterior, where there is a strong, stout incurved tooth; seen from above doubly triangular, widest slightly behind the middle, width rather more than half the length, the margins near the posterior end are produced into strong teeth; anterior extremity blunt and produced into the mucronate processes, posterior truncate; surface of the shell marked with curved ridges and rows of impressed puncta; each valve has a strong tooth near the lower margin of the posterior end; size, 0·5 millim.

In washings from Gulf of Manaar sponges.

Named after the late Mr. Oliver Collett, a well-known naturalist in Ceylon.

Cythere holdsworthi, n. sp.—Plate II., figs. 31 and 32.

Shell seen from the side subrhomboidal, height equal to fully two-thirds of the length; anterior extremity broad and obliquely rounded, posterior truncated, with a small projection in the centre; dorsal margin boldly arched, highest in the middle; ventral convex in the middle; seen from above broadly ovate, widest near the middle, width equal to two-thirds of the length; anterior extremity narrowed and bluntly rounded; posterior broadly rounded, almost truncate; surface of the shell marked with concentric rows of impressed puncta; size, 0·5 millim.

In general washings from dredged invertebrata from Gulf of Manaar.

Named after Mr. Holdsworth, the naturalist who investigated the pearl banks in 1868.

Section III.: PLATYCOPA.

Family: CYTHERELLIDÆ.

Cytherella ondaatjei, n. sp.—Plate II., figs. 33 and 34.

Shell seen from the side subquadrangular, height rather less than two-thirds of the length; anterior extremity broadly rounded, posterior obliquely rounded, sloping steeply inwards; dorsal margin slightly arched, highest behind the middle, ventral deeply sinuated in the middle; seen from above elongate narrow, widest behind the middle, width equal to one-third of the length; anterior extremity bluntly rounded, posterior almost truncated, margins much hollowed above the middle; surface of the shell marked with numerous shining spots, and a conspicuous triangular groove; covered with fine spinules, anterior extremity and ventral margin finely spinulate; size, 0·6 millim.

In a dredging from Karativo Paar.

Named after Dr. Ondaatje, a former naturalist and collector in Ceylon.

Cytherella vraspillaii, n. sp.—Plate II., figs. 35 and 36.

Shell seen from the side subelliptical, height less than two-thirds of the length; valves unequal, left valve larger than the right; anterior extremity rounded, posterior rounded and slightly produced in the centre; dorsal margin slightly arched, highest in the centre; ventral flattened, slightly sinuated; seen from above pear shaped, widest behind the middle, width slightly less than two-thirds of the length, obtusely pointed in front, broadly rounded behind, lateral margins boldly convex; surface of the shell smooth and polished; size, 0·55 millim.

In general washings from dredged material from Gulf of Manaar.

This species is named in honour of Mr. V. Vraspillai, the well-known Adigar of Musali, who has rendered able service in connection with the pearl banks for many years.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. *Sarsiella carinata*, n. sp., from right side.
,, 2. ,, ,, ,, above. × 45.
,, 3. *Sarsiella gracilis*, n. sp., from right side.
,, 4. ,, ,, ,, above. × 36.
,, 5. *Sarsiella similis*, n. sp., from right side.
,, 6. ,, ,, ,, above. × 45.
,, 7. *Sarsiella crispata*, n. sp., from right side.
,, 8. ,, ,, ,, above. × 57.
,, 9. *Sarsiella tumida*, n. sp., from right size.
,, 10. ,, ,, ,, above. × 37.
,, 11. *Bairdia inornata*, n. sp., from right side.
,, 12. ,, ,, ,, above. × 62.
,, 13. *Bairdia robusta*, n. sp., from right side.
,, 14. ,, ,, ,, above. × 44.
,, 15. *Erythrocypris herdmani*, n. sp., from right side.
,, 16. ,, ,, ,, above. × 50·8.
,, 17. *Pontocypris robusta*, n. sp., from right side.
,, 18. ,, ,, ,, above. × 55·5.
,, 19. *Pontocypris elegans*, n. sp., from right side.
,, 20. ,, ,, ,, above. × 74.
,, 21. *Pontocypris rostrata*, n. sp., from right side.
,, 22. ,, ,, ,, above. × 71.
,, 23. *Xestolebris squamigera*, n. sp., from right side.
,, 24. ,, ,, ,, above. × 90.
,, 25. ,, ,, ,, posterior end.
,, 26. *Paracytheridaea perplexa*, n. sp., from above.
,, 27. ,, ,, ,, right side. × 71.
,, 28. *Pseudocythere minuta*, n. sp., from right side.
,, 29. ,, ,, ,, above. × 134.
,, 30. *Pontocypris tumida*, n. sp., from right side.
,, 31. ,, ,, ,, above. × 45.
,, 32. *Paradoxostoma attenuatum*, n. sp., from right side.
,, 33. ,, ,, ,, above. × 74.
,, 34. *Anchistrocheles bradyi*, n. sp., from right side.
,, 35. ,, ,, ,, above. × 45.

PLATE II.

Fig. 1. *Paradoxostoma stebbingi*, n. sp., from right side.
,, 2. ,, ,, ,, above. × 74.
,, 3. *Xestolebris tumida*, n. sp., from right side.
,, 4. ,, ,, ,, above. × 72.
,, 5. *Xestolebris irrasa*, n. sp., from right side.
,, 6. ,, ,, ,, above. × 72.

Fig. 7. *Cytherura concinna*, n. sp., from above.
,, 8. ,, ,, ,, right side. ×72.
,, 9. *Cythere knoxi*, n. sp., from right side.
,, 10. ,, ,, ,, above. ×72.
,, 11. *Cythere chalmersi*, n. sp., from right side.
,, 12. ,, ,, ,, above. ×61.
,, 13. *Cythere imthurni*, n. sp., from right side.
,, 14. ,, ,, ,, above. ×76.
,, 15. *Cythere thompsoni*, n. sp., from right side.
,, 16. ,, ,, ,, above. ×60.
,, 17. *Cythere donnani*, n. sp., from right side.
,, 18. ,, ,, ,, above. ×37·5.
,, 19. *Cythere willeyi*, n. sp., from right side.
,, 20. ,, ,, ,, above. ×46.
,, 21. *Cythere hornelli*, n. sp., from right side.
,, 22. ,, ,, ,, above. ×72.
,, 23. *Cythere halyi*, n. sp., from right side.
,, 24. ,, ,, ,, above. ×60.
,, 25. *Cythere kelaarti*, n. sp., from right side.
,, 26. ,, ,, ,, above. ×60.
,, 27. *Cythere willisi*, n. sp., from right side.
,, 28. ,, ,, ,, above. ×47.
,, 29. *Cythere colletti*, n. sp., from right side.
,, 30. ,, ,, ,, above. ×72.
,, 31. *Cythere holdsworthi*, n. sp., from right side.
,, 32. ,, ,, ,, above. ×70.
,, 33. *Cytherella ondaatjei*, n. sp., from right side.
,, 34. ,, ,, ,, above. ×60.
,, 35. *Cytherella vraspillaii*, n. sp., from right side.
,, 36. ,, ,, ,, above. ×60.
,, 37. *Sarsiella gracilis*, postabdomen. ×70.
,, 38. *Sarsiella similis*, ,, ×120.
,, 39. *Sarsiella crispata*, ,, ×70.
,, 40. *Sarsiella carinata*, ,, ×70.
,, 41. ,, ,, antennule. ×70.
,, 42. *Sarsiella tumida*, postabdomen. ×70.
,, 43. *Codonocera cruenta*, postabdomen. ×70.
,, 44. ,, modified seta of antennule. ×110.
,, 45. ,, prehensile branch of antenna. ×70.
,, 46. *Xestolebris irrasa*, antennule. ×260.
,, 47. ,, antenna. ×156.
,, 48. *Xestolebris squamigera*, antennule. ×260.
,, 49. ,, antenna. ×156.

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1078

REPORT

TO THE GOVERNMENT OF CEYLON

ON THE

PEARL OYSTER FISHERIES

OF THE

GULF OF MANAAR,

BY

W. A. HERDMAN, D.Sc., F.R.S., P.L.S.,

Professor of Natural History in the University of Liverpool.

WITH SUPPLEMENTARY REPORTS

UPON THE

MARINE BIOLOGY OF CEYLON,

BY OTHER NATURALISTS.

PART IV.

PUBLISHED AT THE REQUEST OF THE

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1079

CONTENTS OF PART IV.

PEARL OYSTER REPORT.

SUPPLEMENTARY REPORTS.

PREFACE.

When the last Part of this Report was issued, early in the present year, I still hoped that it would be possible to compress the remaining Supplementary Reports, along with the conclusion of the Pearl Oyster Report proper, within the limits of Part IV., and an intimation to that effect was made in the Preface. During the summer, however, when the Authors of the Supplementary Reports began to send in their manuscripts, it became plain that I had been too sanguine, and that a fifth and concluding Part would be necessary to finish the series. Under these circumstances I have decided to issue all the Supplementary Reports that are ready in the present Part—making it up to a volume of about the usual size of 300 pages and 30 plates—and to publish the few remaining Reports along with the several concluding sections of the Pearl-oyster work in Part V., early in 1906.

The Reports (all well advanced) which I still expect are:—On the Brachyura, by Mr. Douglas Laurie; on the Schizopoda and Stomatopoda, by Mr. Walter Tattersall; on the Anomura, and on the Actiniaria; on the Marine Insects, by Professor G. Carpenter; on the Tunicata, by myself; a list of the Molluscan Shells, by Mr. R. Standen and Mr. A. Leicester; and a list of the Foraminifera, by Mr. W. J. Dakin. There will be a further, and final, instalment on the Parasites of the Pearl Oyster, by Mr. Shipley and Mr. Hornell, and I propose to add a general discussion of the faunistic results. These sections, with the remainder of the Pearl-oyster work, and the Summary of Results and Recommendations as to the Conservation of the Banks, should then complete the Report.

The valuable memoirs in the present volume will speak for themselves, but I desire to express here my very cordial thanks to my friends the various contributors for their kindness in undertaking the work, and for their skill in carrying it out. The only case that calls for any further remark is the last in the volume. In order to prevent delay, I arranged with Dr. Willey that the proofs of the Report on the Polychæta should not be sent out to Ceylon. As the "copy" was supplied to me in the form of a corrected print marked "for press," and as Mr. Arnold Watson and Mr. Cyril Crossland—both familiar with the group—have kindly helped me to read the proofs, I hope that the chance of errors having escaped notice has been minimised. I have added at the last moment an interesting note by Mr. Arnold Watson on the Polychæte worm which is commensal with the sponge *Aulospongus* *tubulatus*—a familiar object on the pearl banks. This worm, when first found, was supposed to be an Oligochæte, but now proves, as Mr. Watson has shown, to be a Polychæte allied to the *Leucodore* that burrows in the pearl oyster shells.

During the present year, since the issue of Part III., important changes have taken place in Ceylon, both on the pearl banks and in the arrangements proposed for future fisheries. The recommendations made, on biological grounds, in the article on 'The Present Condition of the Pearl Banks' (Part III., p. 44) were not fully adopted by the Government of Ceylon.

The South Cheval Paar, which it was hoped would be left for another year, to supply a fishery in 1906, was stripped along with the Modragam Paars and some other sections of the Cheval—the result being that the great fishery in the Spring of 1905 now holds the record both for the total number of oysters fished and also for the amount of revenue brought in to the Government. The prices obtained were very high, and it is, of course, under such circumstances, a great temptation to a Government to fish and sell as many oysters as it is possible to obtain in the limited time permitted by the weather. It must always be a difficult matter to decide whether oysters present in abundance but admittedly immature should be secured at once or left to have an additional year of growth and probable pearl-formation. We can only hope that on the present occasion the decision has been a wise one, and that the clearing of the South Cheval Paar has not imperilled the success of next year's fishery.

Another factor which may have an important bearing upon the future history of the Ceylon Pearl Fisheries is the proposal that the pearl banks should be leased for a period of years to a Syndicate, which will be bound by the terms of the lease to expend a considerable sum annually in the cultivation and exploitation of the fishing grounds. It seems probable at the time of issuing this volume that the next Ceylon Pearl Fishery will be held under the auspices of the Syndicate.

W. A. HERDMAN.

The University, Liverpool.
November, 1905.

REPORT ON THE PEARL OYSTER FISHERIES OF THE GULF OF MANAAR.—PART IV.

THE GREAT PEARL FISHERY OF 1905.

(Drawn up from the Government Official Reports and Mr. Hornell's Letters, with Additions and Remarks.)

The Pearl Fishery which was held at Ceylon in the spring of 1905 may well be called "the great fishery." The temporary "fishery-town" erected at Marichchukaddi was larger than it is known to have ever been before, the inhabitants congregated there were at least 10,000 more than in the previous "record" fishery of 1904, the numbers of divers (4991) and their attendant manducks (4894) and the fleet of boats (318) were much greater, and the totals of oysters fished and of rupees obtained for the Government were far beyond all previous records. There were forty-seven fishing days as against thirty-three in 1904. The number of oysters collected (upwards of eighty-one and a half millions) is nearly double that obtained at any previous fishery, and the revenue derived from the Government share alone was nearly two and a half million rupees, which beats all other known fisheries with nearly 15 lacs of rupees to spare.

This is the last of a series of three highly successful fisheries in consecutive years, and it does not seem likely to be rivalled by any prospective fishery of the oysters now in sight upon the grounds. The fishery of 1903 yielded 41,180,137 oysters and the Government share of the revenue was about £55,303; in 1904 the oysters totalled 41,039,085 and the Government revenue £71,050; in 1905 the number of oysters was 81,580,716 and the revenue over £167,381. From these fisheries, taken together, the Government of Ceylon has derived fully £293,735, without taking into account the revenue derived from postal returns (which at these three fisheries were considerable), and other receipts indirectly connected with, but consequent upon, the industry.

These figures look magnificent, and they show what a valuable possession the

Ceylon Government has in the pearl banks, but it must be remembered that this series of three very profitable fisheries followed on an interval of eleven years during which there were no returns, and that the average yield for the last three years is far above that of the last hundred or so—the period for which we have any accurate record.

It may be of interest to quote here the results of the chief fisheries of that century:—

(1.)	1905	yielded	81,580,716	oysters.	Revenue =	2,510,727 Rs.
(2.)	1904	,,	41,039,085	,,	,, =	1,065,751 ,,
(3.)	1814		*		,, =	1,051,876 ,,
(4.)	1891	,,	44,311,441	,,	,, =	963,748 ,,
(5.)	1808		*		,, =	842,577 ,,
(6.)	1903	,,	41,180,137	,,	,, =	829,548 ,,
(7.)	1888	,,	22,052,769	,,	,, =	804,247 ,,

* Particulars as to number of oysters fished not available previous to 1835.

After that the revenue rapidly drops to seven, five, four, three, and two hundred-thousand rupees, and there are a number of fisheries on the list with between one and two hundred-thousand. As an example of a very poor fishery, we may take the one held in 1884 off Chilaw, yielding only 636,000 oysters and a revenue of 17,153 rupees. Many single days in the recent fishery far exceed the entire proceeds of certain previous fisheries.

The Report of Mr. G. P. Lewis, Government Agent, writing as Superintendent of the fishery, puts in this way "the extraordinary achievements of this fishery by comparison with the chief fisheries of former years, the fisheries of 1808 and 1903 were beaten in ten days, that of 1891 in eleven, and those of 1904 and 1814, which had hitherto occupied the first and second places respectively, in twelve." The fishery lasted for 35 days after that. Mr. Hornell, in his Report, puts it another way, and says that the total number fished "all but equals the combined totals of the two great fisheries of 1903 and 1904, and is not far from double the highest number taken in any other fishery concerning which we have authentic information, namely, 44,311,441 in 1891" ('Ceylon Sessional Papers,' 1905, p. 36).

Enough has been said to show the exceptional nature of the recent fishery, but it is quite a pertinent question whether this phenomenal success has not been attained, to some extent at least, at the expense of the next few years. It will be remembered that in the section of this Report entitled 'Present Condition of the Pearl Banks' (Part III., p. 37), written a year ago as the result of Mr. Hornell's inspection in November, 1904, certain reasons were given for fishing in 1905 the two Modragams and the sections of the Cheval defined as south-west, mid-east, and south-central (see fig. 1), leaving for 1906 the sixty-odd million oysters upon the South and South-

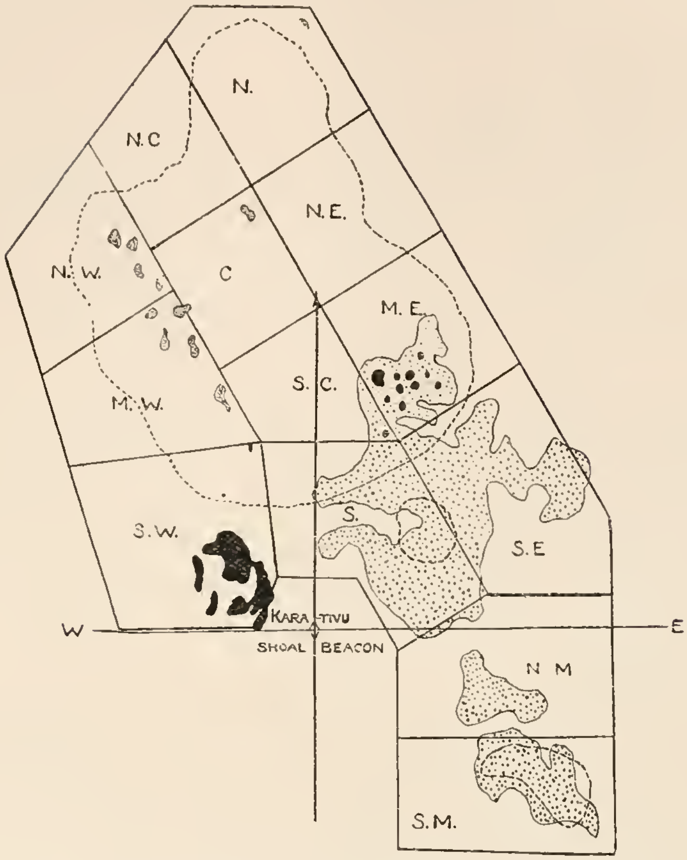


Fig. 1. Sketch-plan of the Cheval and Modragam paars, showing the distribution of pearl oysters in November, 1904. Scale: Half an inch to one nautical mile. The broken line surrounds the areas covered with spat a few months old, the dotted areas are those with oysters about 3 years old, the solid black indicates those beds of oysters over 5 years old.

east Cheval. The oysters on the banks in question were then estimated to be as follows :—

Paar.	Number of oysters.	Age in March, 1905.
South Modragam	21,000,000	Over 3 years.
North Modragam	4,700,000	„ 3 „
South-west Cheval	3,500,000	„ 5 „
Mid-east and South-central Cheval	13,750,000	3 to 6 „
South Cheval	40,220,000	Over 3 „
South-east Cheval	23,600,000	„ 3 „

Of these, the oysters on the two Modragam paars were thought to be unhealthy and liable to die off; those on the South-west Cheval were very old and clearly had to be secured at once or not at all; and those on the Mid-east and South-central Cheval were apparently being smothered by young oysters. Consequently the recommendation was that these forty-three million oysters should be fished first, leaving the rest which seemed healthy, vigorous, and safe for a further year of growth and pearl-production.

On the other hand, the November valuation of the pearls from the samples collected gave 24.65 Rs. per thousand to the South Cheval, as against 17.86 Rs. for the South Modragam which stood next. That fact was sure to cause pressure to be brought by the pearl merchants upon the Government in favour of fishing the South Cheval; and it is, of course, impossible to avoid sympathising with the view that 40 million oysters in the hand may be worth a good deal more than the chance of getting them next year at an enhanced value. Our recommendation of last year accordingly ended with these words:—"On the other hand, there is, of course, always a certain risk in leaving a fishable bed of oysters unfished, and, once the biological facts given above have been stated, it lies with the Government to decide what risk can be run and what course should be taken. If the 40,000,000 oysters on the South Cheval Paar, or a considerable number of them, can be fished in addition to the 43,000,000 which certainly ought to be secured first, there will, no doubt, be a large additional profit now—a present certainty in place of the prospect of a possibly much greater result next year" (Part III., p. 46).

The 'Gazette' of 16th December, 1904, gave notice, however, that the fishery, to begin on 20th February, 1905, would include the South Cheval, the South-west Cheval, the Mid-east Cheval, and the North and South Modragams. We can now only hope that the decision of Government to fish the South Cheval in 1905, in addition to the beds we had recommended, was a wise one, and that it has not too seriously affected the fishery prospects of the next few years. It is to be feared that the oysters fished from the South Cheval will scarcely maintain in pearl-yield the reputation of their bank, and it can scarcely be doubted that, had they been left, and had they survived, their value next year would have been much greater.

The inspection in February, immediately before the fishery, showed fortunately that no catastrophic change had taken place. The numbers for the South Cheval and North Modragam were increased, those for the Mid-east Cheval and South Modragam were reduced somewhat, while the very old oysters on the South-west Cheval, as was to be expected, had continued to dwindle and were now so few and so scattered as to be scarcely fishable.

The most noteworthy observation in this inspection was, as Mr. Hornell states, that on the south-east side of the South Modragam "the bed extended beyond the limit of the ground inspected, and there was therefore a probability that the actual numbers would prove considerably in excess of the estimate." I discuss this particular bed of oysters further on (see below, p. xi.).

The following statement of the numbers* estimated at the November and February inspections, and the actual numbers fished from the beds, may be worth recording:—

* The numbers recorded by Mr. Lewis and by Mr. Hornell respectively in their reports differ somewhat in detail on account of the methods adopted in assigning the oysters to their banks.

Paar.	November.	February.	Fished.
South Cheval	40,220,000	47,500,000	29,383,444
Adjacent part of South-east	—		1,503,590
Mid-east and South-central Cheval . .	13,750,000	9,000,000	2,975,849
North Modragam	4,700,000	10,000,000	7,280,817
South Modragam	21,000,000	19,700,000	Say, 10,000,000
Kutiramalai	Not estimated.	Not estimated.	„ 30,732,820
			81,876,520

Mr. Hornell estimates that about forty-one and a half millions of adult oysters are left on the banks. It is to be feared that a considerable number of these will die off during the year, but a solid bed of 10,000,000 remains on the South-east Cheval, and will probably be available for fishing next spring. There may be other patches on other parts of the Cheval still remaining in sufficient numbers to be worth fishing, and there ought to be a good many left on the South Modragam and the Kutiramalai paars, but these are said to be largely overgrown with a younger generation, and it is quite doubtful whether a sufficient number of the old will survive to yield a fishery in 1906 on these banks.

I now come to a question connected with the large number of oysters recorded in Mr. Lewis's report as fished from the South Modragam Paar, upon which I wish to make some observations. I shall quote first a couple of passages I find in Mr. Hornell's report (p. 38) in regard to the finding and fishing of these oysters :—

"34. On 22nd February a considerable number of boats fished on the ground to the south of that portion of the South Modragam inspected earlier in the month. The whole of this area is composed of purely sandy bottom, whereon lay oysters free from commingling with any of a younger generation ; all were a little over three years old. In some places they lay in loose bunches ranging from five to twelve individuals in each ; elsewhere the oysters clung to the projecting edges of large wedge-shaped shells of *Pinna bicolor*, rooted upright in the sand by the narrow end. The former condition delighted the hearts of the divers ; the latter gave those unprovided with protecting finger-stalls considerable trouble, the sharp edges of the Pinna shells inflicting frequent cuts and scratches on the hands tearing them from their sandy foothold. In both cases the divers filled their bags with remarkable celerity, 40 seconds in many cases sufficing to fill the diver's bag with 60, 70, or even 100 oysters. As a result, the day's catch, aggregating the enormous total of 4,574,460 oysters, broke every known record."

* * * * * *

"35. Work, on this sandy area, continued with feverish activity for the remainder of the week. The daily catches never fell below 4,000,000 per day, while on 24th February high-water mark was reached with the enormous take of 5,005,685 oysters.

Such a large total for one day's fishing establishes a record that is likely to remain unsurpassed for many years to come."

It is exceedingly interesting to find thus, from the official reports, that a considerable number of the oysters (from twenty-seven to thirty millions) credited (in the report of the Superintendent, p. 2) to the South Modragam Paar were really fished from an area extending to the south-east far beyond the usual limit of that paar. We must either conclude that the oysters have extended over the sandy ground lying between the South Modragam Paar and Kutiramalai point or that a new bed of oysters in this position has been fished. The difference may be considered to be unimportant, as being little more than a point in nomenclature. I notice that Mr. LEWIS in his report prefers to regard the whole of the large irregular-shaped area as being the South Modragam Paar; while Mr. HORNELL gives to this new southern part a new and quite appropriate name, "Kutiramalai Paar," on the analogy of Aripu Paar, Vankali Paar, Karativo Paar, Chilaw Paar, and others—all named after the land off which they lie. I think the latter course is the better simply because it does less violence to our existing ideas, charts and definitions. I reproduce here (fig. 2) a tracing from Captain DONNAN's chart with which I worked when on the pearl banks in 1902. It shows the North and South Modragams as two little areas of approximately equal size, and the South is certainly nothing like, either in shape or position, the area from which, judging from Mr. HORNELL's sketch-plan given as "Annexure I" on p. 49 of his report (Colombo, 1905), the oysters in question were obtained. In the definitions of these paars which I gave in the first volume of this Report I find that the North Modragam is described (Part I., 1903, p. 105) as lying "south-east of the central part of the Cheval Paar, at from $\frac{1}{2}$ mile to 1 mile distant, and is nearly 1 mile in diameter. It is about $8\frac{1}{2}$ miles west of Kallar tower. The depth is from $5\frac{3}{4}$ to $6\frac{3}{4}$ fathoms," &c. The description of the South Modragam runs (*loc. cit.*, p. 106): "This lies 1 mile south-south-east of the North Modragam, and is about $\frac{1}{2}$ to $\frac{3}{4}$ mile in diameter. It is about 7 miles north-north-west of Kodramallai Point, and has a depth of $5\frac{1}{2}$ to 6 fathoms. The bottom is rocky," &c. All this agrees with Captain DONNAN's chart and, I think, with previous records of these paars, but not with the area from which the thirty million oysters were fished this year, as shown in Mr. HORNELL's sketch-plan which I here reproduce (fig. 3) for comparison with fig. 2. Consequently I would favour the application of the new name "Kutiramalai Paar" to this very considerable southerly extension of the area hitherto known as the South Modragam Paar. It has this year proved itself to be of very much greater importance than many paars which have for long enjoyed distinctive names.

Now to turn to a more interesting point than mere nomenclature. Have these oysters on the Kutiramalai Paar, which had apparently not been inspected and estimated last year, but which have been fished this year along with those of the South Modragam, ever been seen before? *I believe they have*, and that I found them myself in March, 1902, when dredging along with Sir WILLIAM TWYNAM, Captain Donnan, and Mr. Hornell, in the "Lady Havelock." When I read of these oysters in the Reports of Mr. Lewis and Mr. Hornell, I at once recollected

Fig. 2. Captain Donnan's outlines and positions of the Modragams (N.M. and S.M.) and Cheval Paar (Ch.) in relation to Kutiramalai Point (K.P.), the Shoal Buoy (S.B.). The positions of the dredgings made from the "Lady Havelock" on March 17th, 1902, are shown by the four crosses lying to the south-east of the South Modragam. Scale one-fourth of an inch to the nautical mile.

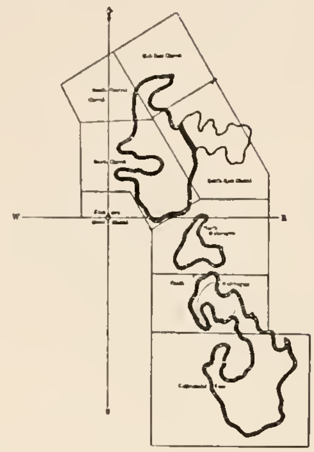


Fig. 3. Mr. Hornell's sketch-plan of the fishing ground of 1905, reduced to the same scale as fig. 2, one-fourth of an inch to the nautical mile. The thick lines show the areas fished, the thin line in the South-east Cheval the area with oysters over three years old left unfished, and the dotted line in the South Modragam the ground occupied by oysters six months old. Below that is the large area which Mr. Hornell has called the "Kutiramalai Paar."

the occasion, and on turning to my notes I find (see this Report, Part I., 'Narrative,' p. 84, published in 1903) :—

"After rejoining Captain Donnan and the inspection boats in the South Cheval district, we took four hauls of the dredge between the South Modragam Paar and Kodramallai Point. These may be united as Station LXIV. From between South Modragam and Jaggerboom Paars, along a line south-east towards Kodramallai Point; depth $4\frac{1}{2}$ to $5\frac{1}{2}$ fathoms; bottom coarse sand, with much fine green weed and small pearl oysters."

* * * * * *

"The fine green weed from the bottom had very young spat of pearl oysters on it. The small oysters dredged were 8 or 9 months old, and were in quantity at about $3\frac{1}{2}$ miles off Kodramallai Point." I had brought Sir W. Twynam from Jaffna that same morning (March 17th, 1902) and wished to show him how the dredge could bring up oysters or whatever else lay on the bottom, and I believe that these first dredged young oysters that we showed him "between South Modragam Paar and Kodramallai Point" were a sample of the oysters which have been fished this year from the "Kutiramalai Paar," and have contributed much to the success of the present fishery. The age of the oysters agrees, and the position on the chart is about right. The four little crosses on fig. 2 show the four dredgings united in the 'Narrative' as Station LXIV.

Finally, I would make a general remark upon paar-ground in the Gulf of Manaar. It is, that we need never be surprised to find that boundaries of banks alter, and that oysters appear on occasions in new spots. I have already pointed out in a previous part of this Report that the whole of the shallow shelf within, say, the 12-fathom line is potential paar-ground. The bottoms shift to some extent and may change their character, sand may be washed over a paar, or again may be swept away, leaving a hard bottom. One of my first observations when dredging on the "Lady Havelock" was that we found oysters in the Cheval district where they had no right to be, according to Captain DONNAN's outline of the paar. This statement may seem to cut at the root of my own charts and definitions; but it is not really so. The outlines of the paars are justifiable and, in fact, necessary as representing the normal, departures from which may be expected, but are exceptional.

It is evident that there is some difference of opinion amongst the authorities in Ceylon as to whether or not "dredging is economically a more sound method of fishing than is diving." I am inclined to think that the operation has not yet had a fair trial; but even though it may not, under the conditions in vogue in the East, be able to compete economically with native diving, I must emphasise what I have said elsewhere in this report, that the utility of dredging is by no means confined to obtaining a supply of adult oysters for the market, but is really fourfold, consisting as it does :—

(*a*) In fishing oysters;
(*b*) In cleaning the ground and removing enemies;
(*c*) In thinning out overcrowded beds; and
(*d*) In spat transplantation.

Its value is not properly assessed if account be taken of the first of these alone, or even of the first and the last. Finally, it must be remembered that several of these important operations can usually be carried on in the same series of dredgings.

Mr. HORNELL is acting in accordance with these views, and at the recent fishery it is evident that a good deal of transplanting, cleaning, and thinning out went on simultaneously with the fishing for oysters. I shall quote a few sentences in regard to this work in Mr. HORNELL's own words :—

"90. On 15th March enough of mature oysters had been removed by the divers from the central portion of the South Cheval to permit of the commencement of operations for the establishment there by transplantation of a bed of young ones. Accordingly, I instructed Captain Jelstrup to dredge for young oysters aged about six to seven months, which I knew to be in profusion in the South Modragam Paar, to convey them to the South Cheval and there to throw them overboard within the limits which I defined by a series of mark buoys.

"91. The method adopted was to bag all the young oysters taken, to keep them in a cool place covered with wet sacks, and to steam twice a day, noon and evening, to the South Cheval, throwing them out as the vessel manœuvred between the flags. The young oysters stood the treatment well; there was practically no mortality, as I ascertained by sending divers down from time to time to ascertain the condition of these young, and to bring me samples.

"92. The total quantity transplanted was upward of ten millions. I propose to concentrate attention upon this bed during the next season, in order to give the experiment fair treatment. I hope to transplant thereto in November next an additional 10 to 15 millions; after that we may hope that enough work shall have been accomplished to ensure a small fishery two years later—a result that would be due entirely to cultural methods, and not to the fortuitous interaction of currents and other natural influences.

"93. During the course of the dredging, a great amount of good was done by the capture and destruction of large numbers of starfishes and carnivorous gastropod molluscs, noted enemies of the pearl oyster. Frequently between 200 and 300 starfishes were taken and destroyed in one day. By my instructions these were retained on board for twenty-four hours in order to insure that life should of a certainty be extinct, when they were returned to the sea."

In regard to the bed of young transplanted oysters, Mr. Hornell adds:—

"109. Prior to leaving the banks, I directed the Government divers to examine the area in question. They reported young oysters apparently numerous, the individuals they brought up were in good health, exhibiting no ill-effects consequent on the transplanting operation. Some had attached to fragments of cultch rubble laid out during the course of the fishery.

"110. (*b*) *Thinning out.*—This operation went on concurrently with transplantation, the abundance of young oysters on the South Modragam being so inordinate as to constitute, through overcrowding, a grave danger to their own continued prosperity. Transplantation, by entailing a reduction in the numbers upon the South Modragam, should re-act favourably, and if the density of population be found still too great when next the bed is inspected, further transplantation should be resorted to. So great is the present profusion, that the numbers taken in the dredges upon the last day appeared as great as on the day transplantation was begun, and indicated no appreciable diminution in the fertility of the bed.

"111. (*c*) *Cultching.*—During the fishery a quantity of rubble obtained from the indurated limestone strata of Kayts, near Jaffna, was laid down, principally upon the sandy portion of the South-central Cheval, a region which has never yet yielded a pearl fishery. The quantity contracted for was 180 cubes; unfortunately the contractor experienced such difficulties in obtaining vessels to convey the stone to its destination that he was able to deliver less than half the specified quantity, although I helped him materially by extending the time limit by a week.

"112. The stone, on the whole, was satisfactory in quality, and likely to prove a durable cultch material. In size the blocks approximated $3\frac{1}{2}$ in. by $3\frac{1}{2}$ in. by $2\frac{1}{2}$ in., but several consignments contained a proportion of blocks of excessive dimensions, and these I rejected.

"113. The total amount laid down was just under 300 tons. Some 40 tons of the friable semi-calcareous sandstone of Kalpitiya was also used. The greater part was deposited on the South-central Cheval, some 20 tons on a sandy patch near the centre of the South Cheval, and about the same quantity on the north-east quarter of the South Modragam Paar, a locality where there is no outcropping rock on the bottom. Several times towards the end of the fishery I received fragments of this cultch from the divers with young oysters attached to the surface."

This fishery was phenomenal not only in the number of oysters obtained, but also in the prices that they fetched. While the valuation of the samples taken at the November and February inspections showed a range of from 8 to 24·65 rupees per 1000, the oysters at the fishery sold at very much higher prices—the lowest being 24 and the highest 124 rupees per 1000. The average price over the whole fishery was 48·89 rupees. Of these oysters sold by the Government, Mr. Lewis states that "India took a hundred times the quantity taken by Ceylon." It is to be hoped that India will not be sorry that it took them. Judging from the probable pearl-yield of these oysters, it is difficult to see how the business can be made to pay at such inflated prices. However, the Bombay pearl merchants, Kilakarai Moormen and Paumben Chetties probably know best what they are about, and the mysteries of the Indian pearl market may justify even more remarkable proceedings than the paying of 124 rupees for oysters valued by the experts at 12·70, 27·41, and 31·10 rupees per 1000.

REPORT

ON THE

ISOPODA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

THE REV. THOMAS R. R. STEBBING, M.A., F.R.S., SEC. L.S., F.Z.S.,
FELLOW OF KING'S COLLEGE, LONDON.

[WITH TWELVE PLATES.]

THE interest of the present collection is not to be measured by the number of species or the number of specimens, still less by the size of the animals. The species are not numerous, the examples in many cases are few, and of some the dimensions have proved to be afflictingly small. On the other hand, there is no want of variety, since the thirty-four species more or less definitely discriminated are spread over five very distinct tribes and divided among sixteen families. There is no want of novelty, since two of the families, three of the genera, and fourteen of the species are now added to science on what appear to be satisfactory grounds. Certainly the family AMESOPODIDÆ, founded on some small creatures allied to *Idotea*, must be thought well worthy of notice.

The only family illustrated by a rather large supply of specimens is that of the Sphæromidæ. But the supply has not thrown much convincing illumination on the difficulties of this group, which have of late years arrested the attention of several writers. Any person of impatient temper who has ever attempted, when pressed for time, to disentangle with unskilful fingers a knotted skein of string, may understand the plight of a busy naturalist who has Sphæromidæ to classify. There is always the chance in regard to this family that, after struggling with the complexities of the situation, one may have done more harm than good, by adding to the confusion instead of lessening it. It is, indeed, a general disadvantage attending the description of a local fauna, or of a special collection, that it may involve the fragmentary treatment of problems which can only properly be solved by a monographic survey.

The tribal division of the Isopoda is here accepted from the invaluable 'Crustacea of Norway,' by Professor G. O. SARS.

DESCRIPTION OF THE SPECIES.

ISOPODA ANOMALA.

Tribe: CHELIFERA.

Family: TANAIDÆ.

Tanais, Audouin and Milne-Edwards.

1828, **Tanais**, Audouin and Milne-Edwards, 'Résumé d'Entomologie,' p. 182, pl. 29, fig. 1, and 'Précis d'Entomologie,' vol. 1, p. 46, pl. 29, fig. 1.

The genus was named *Anisocheirus* by Westwood in 1832 ('Ann. Sci. Nat.,' vol. 27), *Zeuxo* by Templeton in 1836 ('Trans. Entom. Soc.;' vol. 2, p. 201), and *Crossurus* by Rathke in 1843 ('Fauna Norwegens,' p. 35). Sars, when defining it in 1896 ('Crustacea of Norway,' vol. 2, part i., p. 11), remarked that it was well distinguished from all the other genera of the family, especially by the circumstance that the pleon was composed of only five segments and carried only three pairs of pleopods. He assigned to it only four species: *T. tomentosus*, Kröyer; *T. cavolinii*, Milne-Edwards; *T. dulongii* (Audouin); and *T. novæ-zealandiæ*, Thomson. According to Dollfus ('Bull. Soc. Zool. France,' vol. 21, p. 207, 1897) the first of them is a synonym of the second. But several other species are on record, *T. macrocheles*, Nicolet, 1849; *T. brasiliensis*, Dana, 1849; *T. loricatus*, Bate, 1864; *T. gracilis*, Heller, 1866; *T. willemoesii*, Studer, 1884; *T. hirsutus*, Beddard, 1886; and since Sars wrote, several additions have been made to the list, namely, *T. robustus*, Moore, 1894; *T. grimaldii*, Dollfus, 1897; *T. chevreuxi*, Dollfus, 1897; *T. testudinicola*, Dollfus, 1897; *T. alascensis*, H. Richardson, 1899; *T. stamfordi*, H. Richardson, 1901; *T. philetærus*, Stebbing, 1904; *T. normani*, H. Richardson, 1905. In this group it must be noticed that *brasiliensis*, *gracilis*, *willemoesii*, *hirsutus*, *robustus*, *testudinicola*, *normani*, are all excluded from the genus, not as defined by Dana, but as restricted by Sars, since they all have six segments in the pleon instead of five. It is not improbable that other more or less correlated differences will be found to exist, but the material here at disposal would not justify interference in the matter. It may, however, be observed that *T. testudinicola*, Dollfus, is evidently the same species as *T. robustus*, Moore. *T. loricatus*, Bate, described from an imperfect specimen, still awaits fuller description. *T. novæ-zealandiæ*, G. M. Thomson ('Trans. N. Zealand Institute,' vol. 13, p. 207, plate 7, fig. 3), according to the figure, has the pleon distinctly six-jointed, but no notice of this is taken in the text, which includes in the generic definition the character "pleon five-jointed."

Tanais gracilis, Heller—Plate I. (D).

1866, **Tanais gracilis**, Heller, 'Novara Exp., Zool.,' vol. 2, pt. 3 (Crustacea), p. 133, pl. 12, fig. 3.

Heller's description is as follows:—"The head very short, the roundish black eyes placed forward on the somewhat projecting lateral angles, the front bluntly triangular. The lower antennæ five-jointed, thinner than, but almost as long as, the upper, which are three-jointed. The first [coalesced] peræon segment is the largest of all, narrowed forward, the second [first free] segment the shortest, the fifth, sixth and seventh sub-equal one to the other. The pleon narrows gradually backwards. The first three pleon segments shorter than those of the peræon, but longer than the fourth and fifth pleon segment, the last (sixth) again larger and apically rounded. The uropods (Schwanzanhänge) five-jointed, their basal joint thick, triangular, the first joint of the appendage (des Anhanges) tolerably long, towards the end somewhat thickened, the four following somewhat shorter than the first, among themselves subequal, cylindrical, the last blunt-ended, all the joints beset with long setæ. The first chelipeds large and strong. The legs little setose. The colour of the body on the surface yellowish or brownish, with dark points and markings. Locality:—St. Paul." Length, 3 millims.

In Heller's account there are one or two ambiguities, for, while he speaks of and figures six segments in the pleon, he uses the expression "fourth and fifth pleon segment" as if intending to mention a composite segment, and, while he distinctly says that the uropods are five-jointed, he appears to distinguish a peduncular joint from a five-jointed ramus. His figure shows only five joints in all, as in our specimen, which was not otherwise separable from Heller's. The mouth organs agree with those in the genus *Tanais*. The upper antennæ have a fourth joint in the shape of a tubercle, representing the flagellum. The finger in the hinder group of peræopods is strongly uncinate. The pleopods are delicate in structure. Whether there were more than three pairs I did not succeed in ascertaining.

Length of specimen, 2 millims.

Locality:—Gulf of Manaar.

In *T. brasiliensis* and *T. normani* the uropods are six-jointed, in *T. willemoesii* nine-jointed, in *T. hirsutus* about twelve-jointed, in *T. robustus* four-jointed.

Heterotanais, G. O. Sars.

1880, **Heterotanais**, Sars, 'Arch. Naturv. Kristian.,' vol. 7 (1881), separat., p. 28.

1886, **Heterotanais**, Sars, 'Arch. Naturv. Kristian.,' vol. 11, p. 333.

1886, **Heterotanais**, Norman and Stebbing, 'Trans. Zool. Soc. London,' vol. 12, pt. 4, p. 108.

1896, **Heterotanais**, Sars, 'Crustacea of Norway,' vol. 2, pt. 1, p. 13.

1897, **Heterotanais**, Dollfus, 'Mém. Soc. Zool. France,' vol. 11, p. 38.

1901, **Heterotanais**, H. Richardson, 'Proc. U.S. Mus.,' vol. 23, p. 501.

The leading feature in this genus is the sexual difference in the first gnathopods, which are small and normally chelate in the female, but large and complexly subchelate or not normally chelate in the male. It is, however, probable that up to a certain stage the males may not exhibit this distinction. The species referred to the genus by SARS are *H. örstedi* (KRÖYER), *H. limicola* (HARGER), *H. tenuis* (G. M. THOMSON), *H. anomalus*, SARS. To these DOLLFUS, in 1897, adds *H. algiricus* and *H. provincialis*, but, upon a comparison of the descriptions and figures of *H. algiricus* and *H. anomalus*, there is no character given by which they can be distinguished. H. V. HODGSON ('Nat. Hist. of the "Southern Cross,"' p. 240, 1902) remarks that but for the structure of the uropods he would have placed his own *Paratanais antarctica* and BEDDARD'S *P. dimorphus* in SARS' genus *Heterotanais*.

The species now offered as an additional member of the genus labours under the considerable disadvantage of not being represented by any adult male specimen, apart from which it is not easy to say whether junior or female specimens should be allotted to *Heterotanais* or *Leptochelia*. As will be seen by the description, if the minute character of the maxillary palp can be trusted, the species belongs to *Heterotanais*. As the first gnathopods are remarkably stout, one may be glad to rescue it from a genus like *Leptochelia* that derives its name from the slenderness of those appendages.

Heterotanais crassicornis, n. sp.—Plate I. (A).

In the cephalothorax the line of junction between the head and the first peræon segment is slightly indicated. The antepenultimate and penultimate segments of the peræon are the longest. The first five segments of the pleon are subequal, the telsonic segment not elongate.

The eyes are socketed, at apex in dorsal view apparently, but not really, acute, lenses about 12 in number.

First antennæ: first joint unusually stout, not twice as long as broad, more than twice as long as the second; third not longer than the second, very narrow, tapering, with three setæ, one of which is, perhaps, attached to a scarcely perceptible flagellar joint.

Second antennæ shorter and much narrower than the first, second joint the widest, fourth the longest, but not very long; a minute flagellar joint is tipped with a very long seta.

Mandibles nearly as figured by SARS (' Crustacea of Norway,' pl. 6) for *H. örstedi*, but on the left mandible the cutting edge and accessory plate are far less distinctly denticulate, and on the right the cutting edge shows a little tooth, the serration of the upper border being barely perceptible. There is no accessory plate on the right, and on both mandibles the molar is very prominent, as in the species described by SARS.

The first maxilla has the palp terminated by one seta, in accordance with the generic character given by SARS, whereas in the female of *Leptochelia* this organ is tipped with two setæ.

The first gnathopods are remarkably stout, the fifth joint being a little longer than broad, but almost quadrate, the sixth subequal to it in length but less broad, with the trunk a little longer than its rather broad thumb. The thumb has a slightly serrate inner margin, ends in a small tooth, and is furnished with a row of three setæ on the surface and one seta on the outer margin. The finger is more slender, with undulating inner margin.

The second gnathopods are very slender, with second joint scarcely longer than the fifth or sixth, which are subequal; the fourth joint is much shorter than these, but a little longer than the third; the slender curved finger is about as long as the sixth joint.

The peræopods are small, with the second joint decidedly longer and, especially in the last three pairs, broader than any of the other joints; the fourth and fifth joints differ little in length, each being shorter than the sixth, which is also considerably longer than the finger.

The pleopods resemble those of *Leptochelia*, having the inner margin of each oval ramus fringed with setæ, and the outer margin of the outer ramus carrying one seta placed high up.

The uropods have a six-jointed inner ramus, of which the first joint is the stoutest and the last the longest, carrying at its apex one seta as long as the ramus and one or two shorter setæ. The outer ramus, which is also tipped with a long and a short seta, is composed of two joints, the first very short, the second more than twice as long, the two together rather longer than the first joint of the inner ramus.

Length :—Of four specimens the largest measured a little over 2 millims., and the smallest a little over 1 millim. in length.

Locality :—Gulf of Manaar.

The specific name refers to the remarkable stoutness of the first antennæ, which appears to distinguish the species from any hitherto described in this genus or *Leptochelia*.

Leptochelia, Dana.

1849, **Leptochelia**, Dana, 'Amer. J. Sci.,' ser. 2, vol. 8, p. 425.
1900, **Leptochelia**, Stebbing, in Willey's 'Zoological Results,' pt. 5, p. 614.
1900, **Leptochelia**, Borradaile, 'Proc. Zool. Soc.,' London, p. 797.
1902, **Leptochelia**, H. F. Moore, 'Bull. U.S. Fish Comm.,' vol. 20 (for 1900), p. 165.
1902, **Leptochelia**, H. Richardson, 'Trans. Connecticut Ac. Sci.,' vol. 11, p. 279.

For a fuller synonymy of this genus down to 1900, Willey's 'Zoological Results' may be consulted. Mr. H. F. Moore's recently established Porto Rican species, *L. incerta*, is hesitatingly referred by Miss H. Richardson to *L. dubia* (Kröyer). The undesigned coincidence of dubiety and uncertainty in the specific names with the note of interrogation in the reference very appropriately marks the position of the systematist in dealing with this genus. When the generic name is justified by the presence of the extraordinarily elongated first gnathopods of the mature male, the standing ground is tolerably firm. This applies to four species, but in those leaves the determination of female and immature specimens in obscurity. In regard to the uropods the outer branch seems to vary not only in different species but even in the same species, being sometimes two-jointed and sometimes one-jointed. The inner branch has always more than three joints.

Leptochelia mirabilis, n. sp.—Plate I. (B).

While in many of its features resembling *L. minuta*, Dana, and *L. forresti* (Stebbing), the present species is easily distinguishable from them both and from *L. rapax*, Harger, by characters of the first and second antennæ, of the first gnathopods and the uropods, as well as by its much greater size.

The cephalothorax has the front rather broadly angled, not reaching beyond the eyes, the sides at first slightly concave, then considerably bulging. In the dorsal line the free segments of the peræon are successively longer to the antepenultimate, with a slight successive decrease in the remaining two. The first five segments of the pleon are subequally short, the telsonic segment equal to two of them combined, apically angular. The pleon at the centre is slightly wider than the peræon.

The eyes are movably socketed, dark, composed of a few large lenses.

The first antennæ are once and two-thirds as long as the body, the first joint a little swollen and bent at the base, about nine times as long as the third joint, the more slender second being about eight times the third; the flagellum of thirteen joints, carrying sensory filaments, is between two and three times as long as the third joint.

The second antennæ are about one-fourth as long as the first, the fourth joint of the peduncle longer than the three preceding joints combined and more than twice as long as the fifth joint, which is a little shorter than the two-jointed needle-like flagellum, not including its two or three long apical setæ attached to the minute second joint.

The first gnathopods are of very surprising length, being much more than twice as long as the whole body of the animal, and while, considered in themselves, they are very slender, on the other hand, when compared with the frame that carries them, their stoutness becomes a matter for wonder. The basal joints are short, but the three terminal joints are of enormous length. The pair are not symmetrical and both members are damaged, so that exact measurements cannot be given. In the larger one the slender, apically curved, movable finger is equal in length to the first joint of the first antennæ; it is shorter than the trunk of the hand, which widens to the hinge of the finger, and is produced to a long slender thumb or immovable finger, the apex of which is broken. The existing portion of the antepenultimate joint is longer than the trunk of the hand, and is narrower near the base than in the greater part of its length. In the shorter member the hand widens more abruptly and shows a little gap at the base of the fingers, the movable finger being sinuous, and having three little tubercles on the inner margin near the base.

Second gnathopods of quite insignificant size, agreeing in character with the first and second peræopods, but rather longer, all the joints slender, the third very short, the sixth shorter than the second, but longer than the fourth or fifth, these being subequal, each a little longer than the very slender slightly curved finger.

The third, fourth, and fifth peræopods are shorter and stouter than the preceding pairs, with curved spines round the apex of the fifth, and small setæ round that of the sixth joint; the finger tolerably stout.

The pleopods, as in the other species and in *Heterotanais*, have the two narrowly oval subequal rami fringed on the inner margin with long plumose setæ, the outer ramus having high up on its outer margin a single adpressed seta.

The uropods have the inner ramus seven-jointed, the joints carrying numerous setæ (the apex of the seventh broken); the outer ramus has two joints, longer than the first two of the inner ramus.

Length, 6 millims. to 7 millims. For *L. minuta* and *L. forresti* the recorded length does not exceed 2·5 millims.

Locality:—Gulf of Manaar.

Leptochelia lifuensis, Stebbing—Plate I. (C).

1900, **Leptochelia lifuensis**, Stebbing, in Willey's 'Zool. Results,' pt. 5, p. 616, pl. 64c, d, pl. 65b.

1900, **Leptochelia**, sp., Borradaile, 'Proc. Zool. Soc. London,' p. 797, pl. 51, figs. 2–2c.

This species has recently been described and figured, and the illustrations here given will, I think, show that the Ceylon specimens are in substantial agreement with those from Lifu. They also show the considerable contrast between the antennæ and gnathopods of the male in this species and those in *L. mirabilis*. The question, however, remains open as to a possible dimorphism in the males, which would diminish or destroy the contrast.

Specimens in the collection from eight stations are referred to this species.

Locality, &c.:—On baskets of oysters hung to buoy at Galle: Two specimens, female; one 3·35 millims. long with seven large eggs. From pearl oysters, East Cheval Paar, Gulf of Manaar: A male, 2 millims. long; the two teeth on the thumb of the cheliped rather close together, and on one of the chelipeds not fully formed; outer ramus of uropod one-jointed, inner five-jointed. Female from same station, 2·5 millims. long and agreeing with description in Willey's 'Zoological Results.' From pearl oysters, Gulf of Manaar: Male, 2·5 millims. long; two teeth on thumb of cheliped close together; outer ramus of uropod one-jointed, very short; inner ramus imperfect. Female, 3 millims. long. Off Mutwal Island, March 19, 1902: A female, 4 millims. long; outer ramus of uropod two-jointed, inner six-jointed. Cheval Paar, Gulf of Manaar: A female, 3 millims. long; outer ramus of uropod one-jointed, inner five-jointed, the last two joints rather long; the one-jointed ramus very short. Also a female, 1·75 millims. long; outer ramus one-jointed, inner four-jointed. At each of two other points in the Gulf of Manaar a female specimen was taken. By "female" should be understood specimens without any distinctively male characters.

ISOPODA GENUINA.

Tribe : FLABELLIFERA.

Family : ANTHURIDÆ.

Calathura, Norman and Stebbing.

1886, **Calathura,** Norman and Stebbing, 'Trans. Zool. Soc.,' London, vol. 12, pt. 4, p. 122.
1897, **Calathura,** Sars, 'Crustacea of Norway,' vol. 2, p. 44.
1901, **Calathura,** Whitelegge, 'Mem. Australian Mus.,' vol. 4, pt. 2, p. 225.
1901, **Calathura,** H. Richardson, 'Proc. U.S. Mus.,' vol. 23, p. 509.

To the species *Calathura brachiata* (Stimpson) Sars has added his *C. norvegica*, Whitelegge his *C. gigas*, and Miss Richardson her *C. crenulata*. Bonnier's *C. affinis* (1896) seems rather to belong to *Paranthura*.

Calathura, sp.

Two specimens occur in the collection, one from weed-bearing oysters off south-east of Modragam Paar, the other from north end of Chilaw Paar, February 2, 1902, 9 to 11 fathoms. Both have dark eyes. The former is about 14 millims. in length, the latter about 9 millims. They may be the species which Haswell has described in 'Proc. Linn. Soc. N. S. Wales,' vol. 5, p. 478, plate 10, fig. 5, 1881, as *Paranthura* (?) *crassicornis*, sp. nov. The Australian Anthuridæ will no doubt before long be more fully described, and I have therefore left over these specimens till a more favourable opportunity offers for their specific identification.

Family : GNATHIIDÆ.

Gnathia, Leach.

1814, **Gnathia,** Leach, 'Edinb. Encycl.,' vol. 7, p. 402.
1835, **Gnathia,** Westwood, Loudon's 'Mag. Nat. Hist.,' vol. 8, p. 273.
1885, **Anceus,** Haswell, 'Proc. Linn. Soc. N. S. Wales,' vol. 9, pt. 4, p. 1005.
1887, **Anceus,** H. J. Hansen, 'Dijmphna-Togtets Krebsdyr,' p. 205.
1896, **Gnathia,** Bonnier, 'Ann. Univ. Lyon,' vol. 26, p. 571.
1900, **Gnathia,** Stebbing, in Willey's 'Zoological Results,' pt. 5, p. 625.
1901, **Gnathia,** Ohlin, 'Bihang K. Svenska Vet.-Akad. Handlingar,' vol. 26, No. 12, p. 20.
1902, **Gnathia,** Hodgson, 'Nat. Hist. of the "Southern Cross,"' p. 241.

The references here given are supplementary to the much longer list supplied in Willey's 'Zoological Results.' As the material in the present collection is limited to a single small specimen, it would not be a suitable opportunity for an extended review of the genus. Especial attention, however, should be directed to *Gnathia ferox* (Haswell), since it is evidently a near ally of the species about to be described. The details of the mandibles are similar in the two, but by the relative size and position of these features the appendages in question are strongly distinguished. The maxillipeds and first gnathopods of *G. ferox* are as yet undescribed. It is not improbable that a separate genus will be thought desirable for these species, when they are more fully known.

Gnathia insolita, n. sp.—Plate XII. (B).

The head is very broad, markedly emarginate between the mandibles, the minute rostral point in the emargination only becoming visible after mounting, which involved some flattening of the frontal border. The telson is acutely triangular. Eyes small, dark, oval, slightly oblique in position, facets numerous.

Upper antennæ: Second joint shorter than first, first shorter than third, flagellum with very short first joint, long second, which is subequal to remaining three joints combined.

Lower antennæ: These are longer than the upper, with second joint of the four-jointed peduncle much the shortest; of the six-jointed flagellum the first joint is the longest.

The mandibles implanted wide apart are of uncommon pattern. There is no tooth on the outer margin; about midway on the inner is a quadrate process that might represent the molar; the apical part presents two strongly divergent teeth, with a small convex lamina at the bottom of the cavity between them.

The maxillipeds are of very delicate structure, except for the strong muscles in the second joint. This joint is broader than long, not showing any distinct apical lobe. In the four-jointed palp each joint is successively narrower than its predecessor. They have the outer margin fringed with setæ, 3 on the first, 5 on the second, 8 or 9 on the third, and 7 on the rounded incurved fourth joint.

The first gnathopods are very distinctive of the species, not having the ordinary tapering character, but the principal joint being as broad as it is long. Within are seen the chitinized areas, probably indicative of original joints now in coalescence. The middle area is the most extensive, the lowest has a feebly indicated companion. The upper half of the rounded margin is furnished with 21 graduated setæ. This margin is the upper and inner when these valve-like limbs are closed together, but it is not to be inferred that that is the proper description according to homology. There is a very small apical joint, with no trace of a division into two joints.

The second gnathopods are rather longer than the four pairs of peræopods, of which the second pair are slightly the shortest. In general character all five pairs of trunk-limbs agree.

The first pleopods have the rami rather longer than those of the other four pairs. All five agree with the uropods in carrying rather long setæ, which is contrary to custom in the adult male of this genus.

Length barely 2 millims., breadth a little less than half the length.

Locality:—Gulf of Manaar, off Karativo, from a sponge.

The specific name refers to the unusual characters of the mandibles and first gnathopods.

Family: EURYDICIDÆ.

(Cirolanidæ of Harger, Hansen, Bonnier, Stebbing, Norman, and others.)

Among the genera that have been assigned to this family, *Eurydice*, Leach, 1815, is beyond dispute the earliest, so that the name Cirolanidæ, notwithstanding the distinction conferred upon it as the title of Hansen's notable work in 1890, is bound to give way to Eurydicidæ. Another generic name has "page precedence" over *Cirolana*, since in 1818 Leach established *Nelocira* as his tenth genus of Cymothoadæ, and *Cirolana* as the eleventh, assigning a single species to each respectively, *Nelocira swainsoni* and *Cirolana cranchii*. These are now considered to be one and the same species. The only distinction between them which Leach supplied was that the pleon of *Nelocira* had five segments and that of *Cirolana* six. As, therefore, the generic character of *Nelocira* is erroneous, it is just that the preference should be given to the correctly described *Cirolana*, and this has been done by general consent. It is, moreover, convenient, because *Nelocira* is apt to be confused with the very similarly named but quite distinct genus which Leach at the same date called *Nerocila*.

The family at present includes seven closely connected genera, distinguished in the following synoptic table :—

1	Pleon forming only two distinct segments.	1. *Colopisthus*, H. Richardson, 1902.
	Pleon forming more than two distinct segments—2.	
2	Eyes absent; peduncle of uropods with inner apex not produced.	2. *Cirolanides*, Benedict, 1896.
	Eyes present; peduncle of uropods with inner apex produced—3.	
3	Peduncle of second antennæ four-jointed; maxillipeds without hooks on second joint.	3. *Eurydice*, Leach, 1815.
	Peduncle of second antennæ five-jointed;* maxillipeds with hooks on second joint—4.	
4	First pleopods with inner branch broad.	4. *Cirolana*, Leach, 1818.
	First pleopods with inner branch narrow—5.	
5	Head and trunk broad.	5. *Hansenolana*, Stebbing, 1900.
	Head and trunk narrow—6.	

* With regard to a sixth joint in this peduncle in *Cirolana*, *Conilera* and *Bathynomus*, see Hansen, 'Journ. Linn. Soc.,' vol. 29, p. 339.

6. First pleopods indurated; second with male appendix attached at base of inner ramus. — 6. *Conilera*, LEACH, 1818.
First pleopods not indurated; second with male appendix attached far from base of inner ramus. — 7. *Conilorpheus*, n. gen., 1905.

In addition to these some authors include in this family the huge-eyed *Bathynomus*, A. MILNE-EDWARDS, 1879, which has the two abnormal characters of an accessory branch on the first antennæ and supplementary branchiæ on the pleopods, the blind *Anuropus*, BEDDARD, 1886, in which the uropods resemble the pleopods in character, and the maxillipeds have a one-jointed palp, and *Branchuropus*, H. F. MOORE, 1902, which agrees with *Anuropus* in the characters just mentioned, but differs from it by possessing eyes and in the general habit of body. I am disposed to allot *Bathynomus* to a separate family Bathynomidæ, and the other two genera to a family Anuropidæ, as already suggested for the former of them in 1893.

A. DOLLFUS ('Ann. Sci. Nat.,' Zool., Ser. 8, vol. 20, p. 271) now transfers his genus *Sphæromides*, 1898, to the family Cirolanidæ, and institutes in that family a new genus *Faucheria* for *Cæcosphæroma faucheri*, DOLLFUS and VIRÉ, 1900, to which he believes that *Spelæosphæroma julium*, FERUGLIO, 1904, is nearly allied.

Cirolana, LEACH.

1818, **Cirolana**, LEACH, 'Dict. Sci. Nat.,' vol. 12, p. 347.
1881, **Cirolana**, MIERS, 'Ann. Nat. Hist.,' ser. 5, vol. 8, p. 369.
1896, **Cirolana**, BONNIER, "Edriophthalmes du 'Caudan,'" 'Ann. Univ. Lyon,' vol. 26, p. 574.
1900, **Cirolana**, STEBBING, in WILLEY'S 'Zoological Results,' part 5, p. 629.
1902, **Cirolana**, F. MOORE, 'Bull. U.S. Fish Commission,' vol. 20 (for 1900), pt. 2, p. 166.
1902, **Cirolana**, STEBBING, 'South African Crustacea,' part 2, p. 49.
1903, **Cirolana**, DOLLFUS, 'Bull. Soc. Zool. France,' vol. 28, p. 5.
1904, **Cirolana**, STEBBING, in WILLEY'S 'Spolia Zeylanica,' vol. 2, pt. 5, p. 11.
1904, **Cirolana**, STEBBING, in GARDINER'S 'Fauna, Maldive and Laccadive Archip.,' vol. 2, pt. 3, p. 701.
1904, **Cirolana**, H. RICHARDSON, 'Proc. U.S. Mus.,' vol. 27, p. 35.
1904, **Cirolana**, NORMAN, 'Ann. Nat. Hist.,' ser. 7, vol. 14, p. 437.
1905, **Cirolana**, HANSEN, 'Journ. Linn. Soc. London,' Zool., vol. 29, p. 339.

The species assigned to this genus are now very numerous, and it must be considered a fortunate circumstance that there is no necessity for transferring them to *Nelocira*, which lapses as practically a nomen nudum. The references above given will enable the student to trace a far longer list. The blind *C. cubensis*, W. P. HAY, 1903, needs to be compared with *C. cæca*, DOLLFUS, 1903.

Cirolana sulcaticauda, STEBBING.

1900, **Cirolana sulcaticauda**, STEBBING, in GARDINER'S 'Fauna, Maldive and Laccadive Archip.,' vol. 2, pt. 3, p. 701, pl. 49B.

Of this species a specimen measuring about 6 millims. in length was taken at

Cheval Paar, and five specimens occurred in a tow-net gathering off Marichchukaddi. With the five there were four young specimens, two of which did not certainly belong to the same species. In this latter gathering there were also two specimens of a young *Idotea*.

Cirolana parva, H. J. Hansen.

1890, **Cirolana parva**, Hansen, 'Vid. Selsk. Skr.,' ser. 6, vol. 3, pp. 321, 340, pl. 2, fig. 6–6*b*; pl. 3, fig. 1–1*d*.

1901, **Cirolana parva**, H. Richardson, 'Proc. U.S. Mus.,' vol. 23, p. 514 (Localities).

1902, **Cirolana parva**, H. F. Moore, 'Bull. U.S. Fish. Com.,' vol. 20 (for 1900), pt. 2, pp. 166, 167, pl. 8, figs. 6–8.

This species is known from both the East and West Indies, and is probably to some extent variable, since Hansen and Moore agree in saying that the broad, sub-triangular telsonic segment has the rounded apical margin furnished with about eight spines, while in our specimens the number appears to be uniformly six.

Moore describes the uropods as "short, reaching hardly to end of telson: rami subequal, narrow at ends, bifid, their margins furnished with spines and a few short setæ." But our specimens agree with Hansen's account, according to which the inner ramus reaches beyond the outer and is broader, and with his figure which shows it to be very much broader, so as to make the term subequal quite inapplicable.

The first antennæ have the third joint of the peduncle about as long as the composite first and second joint, the flagellum little shorter than the peduncle, nine-jointed in both adult male and female. Hansen gives it as eleven-jointed, much shorter than the peduncle, Moore as eleven- to twelve-jointed. The second antennæ have the first three joints of the peduncle very short, fourth a little shorter than the fifth, flagellum in male twenty-six-jointed, in female twenty- to twenty-two-jointed. A specimen not fully adult, having the fifth peræopods unarmed and much shorter than the fourth, had the flagellum of the first antennæ seven-jointed, that of the second fifteen-jointed.

In the maxillipeds the antepenultimate joint is furnished with only four or five setæ on the outer margin.

The first gnathopods have five blunt spines on the hind margin, the bluntness probably due to wear. At the apex of the inner margin the sixth joint in all the limbs has a rather strong spine.

The male appendix of the second pleopods is slender, the acute apex slightly incurved, reaching beyond the rami.

Length, male about 6·5 millims., breadth 2 millims.; female about the same size; specimen not adult, 3 millims. long, 1·25 millims. broad.

Localities:—Male, Chilaw Paar, Station LXIX., 8 to 11 fathoms; female with young, Muttuvaratu Paar, 10 fathoms. Specimen not adult, Talaivillu Paar.

Cirolana, sp.

The telsonic segment is smooth, triangular, with the apex almost acute, but not quite, since a high magnification shows it narrowly truncate, carrying two spines. Each side also carries two spines just above the apex.

The eyes are rather small, lateral. The first antennæ have the third joint about as long as the composite first and second, and the flagellum of seven joints, most of which carry sensory filaments. In the second antennæ the ultimate joint of the peduncle is slightly longer than the penultimate; the flagellum is rather long, fifteen-jointed. The mouth organs are of the pattern characteristic of *Cirolana*. The limbs are rather slender, not very strongly setose or spinose, the first gnathopods being, as usual, discriminated from the succeeding legs by the position of the fifth joint. The uropods, like the telson, have a fringing of fine spines and feathered setæ; the inner apex of the peduncle is rather sharply produced about to the middle of the broad inner ramus, which narrows apically and extends beyond the telsonic segment and the narrower inner ramus. The integument is covered with scale-like markings.

The length is 5 millims., with a breadth of about 2 millims. The specimen carried several young ones, still enclosed in membranous capsules, but with the eyes already visible. I hesitate about applying a specific name, whether new or old, to this small ovigerous specimen.

Locality:—Deep water, south of Galle, depth up to 100 fathoms.

Conilorpheus, n. gen.

Only the male known. Both first and second antennæ short. First maxillæ carrying four strong plumose setæ on the inner plate. The maxillipeds having the plate of the second joint furnished with hooked spines. The male appendix of the second pleopods is attached far down on the inner ramus. The uropods have the process of the peduncle very elongate and the outer ramus much smaller than the inner.

The body is almost cylindrical, with the basal segment of the short pleon covered by the laciniated seventh segment of the peræon. In the first pleopods the peduncle is not longer than broad, and neither ramus is hard.

The generic name refers to the combination of characters, here presented, partly pointing to the genus *Conilera* and partly to the genus *Eurydice*, which takes its name from the wife of Orpheus. The first maxillæ, like those of *Bathynomus*, show an unusual feature in carrying four setæ instead of three on the inner plate, and the laciniate border of the last peræon segment is also uncommon in this family.

Conilorpheus herdmani, n. sp.—Plate II. (A).

The head is produced into a narrow distally widened process between the first antennæ; its breadth is not much greater than its length. The second and third segments of the parallel-sided peræon are the shortest; the first segment even at the forward produced sides is not longer than the seventh, of which the postero-dorsal margin is cut into four acute lappets; between these the pleon segments, second to fifth, are partially seen. The telsonic segment narrows near the base, forming a broad oval, of which the serrate apical margin is beset with setæ and small spines.

The eyes are not large, wide apart, round.

The short stout first antennæ have the second joint of the peduncle as it were embedded in the broader first joint; the tapering flagellum is composed of seven short joints, most of them carrying sensory filaments. The second antennæ are about twice the length of the first. The third joint of the peduncle is the longest, and not much longer than broad, the fourth joint is of equal length and breadth, shorter but much broader than the fifth joint and on its obliquely truncate distal margin carrying some elongate setæ; one such seta is similarly situate on the fifth joint. The flagellum is shorter than the peduncle, nine-jointed.

The mouth-parts are as in *Cirolana*, except that the first maxillæ have four stout plumose setæ on the inner plate. The spines on the outer plate are slender. The maxillipeds are well furnished with setæ and spines, and the antepenultimate joint is large.

The first gnathopods have the second joint distally widened and the third still more so, the latter having the front apex and hind margin fringed with setæ. The fourth joint has four blunt spines on the hind margin and a long spine on the front apex; it entirely overlaps the small fifth joint which carries two blunt spines, one of them minute. The sixth joint has a stout spine between two thin ones, and some long setæ. The finger is slightly curved, nearly as long as the sixth joint, and, like the other limbs, has on the inner margin a small tooth or spine at the base of the short curved nail.

The fourth and fifth peræopods are nearly alike and about equal in length, but the second and fourth joints are longer and the fifth and sixth joints are shorter in the fifth pair than in the fourth. The side-plates are distally subquadrate in the sixth peræon segment, but are more produced and distally triangular in the seventh.

The first pleopods have the peduncle of equal length and breadth, with four delicate coupling spines. The inner ramus is rather shorter than the outer and less than half as broad. Both have the rounded distal margin fringed with plumose setæ. In the second pair the peduncle is broader than long; the inner ramus is almost as long as the outer and much more than half as broad. The male appendix is slender, apically acute, attached just above the middle of the inner margin of the inner ramus and extending considerably beyond both rami, which are armed as in the preceding pair. In all five pairs the outer ramus is broad, more or less vaulted and distally fringed with setæ. The inner ramus has some distal setæ in all but the last pair.

The uropods have the short base of the peduncle produced on the inner side into a very long process. The inner ramus is large, oval, reaching nearly to the end of the telsonic segment, and having all its free margin similarly serrate and armed with short spines and long plumose setæ. It has two or three dark markings. The outer ramus is only half as broad and half as long as the inner, with similar armature on the distal half.

Length 6 millims., breadth 1·5 millims.

Locality:—Station V., north end of Chilaw Paar, February 2, 1902, 9 to 11 fathoms.

The specific name is chosen out of respect to the president of the Linnean Society, to whose ever watchful activity in the interests of science the collection of species here described is due.

Hansenolana, STEBBING.

1900, **Hansenolana**, STEBBING, in WILLEY'S 'Zoological Results,' pt. 5, p. 634.

The species *H. anisopous*, for which this genus was originally established, shows, as I observed at the time, various points of resemblance to *Cirolana sphæromiformis*, HANSEN. While retaining the latter in the genus *Cirolana*, HANSEN himself forcibly calls attention to the singularity of its appearance. He had at command only one specimen, a female, not ovigerous, 4·25 millims. long, from St. Thomas, in the West Indies. The examination of a male specimen in Professor HERDMAN'S collection induces me now to transfer the species to *Hansenolana*, the definition of which will in consequence require to be modified as follows:—

Head transverse, produced into a process between the two pairs of antennæ; first five segments of pleon very short. Eyes small and wide apart. Mouth organs nearly as in *Cirolana*, but on the inner plate of the first maxillæ the three setæ are spine-like and not coarsely plumose. In the second maxillæ the outer pair of plates carry very few spines. First gnathopods with the sixth joint broad. First pleopods with narrow rami. Male appendix of the second pleopods attached at some distance from the base of the ramus.

The two species which at present fall under this definition are easily distinguished:—

Apex of telsonic segment broad. 1. *H. anisopous*, STEBBING.
Apex of telsonic segment narrow. 2. *H. sphæromiformis* (HANSEN).

Between these two may, perhaps, be placed *Cirolana hanseni*, BONNIER ('Ann. Univ. Lyon,' vol. 26, p. 574, 1896), originally described from an obviously juvenile specimen, and now (1905) re-described by HANSEN from specimens probably still immature. In this species the telsonic segment has an apex much less broad than that of *H. anisopous*, but considerably broader than that of *H. sphæromiformis*.

Hansenolana sphæromiformis (HANSEN)—Plate II. (B).

1890, **Cirolana sphæromiformis**, H. J. HANSEN, 'Vid. Selsk. Skr.,' ser. 6, vol. 5, pp. 319, 351, pl. 4, fig. 3–3*g*.
1900, **Cirolana sphæromiformis**, STEBBING, in WILLEY'S 'Zoological Results,' pt. 5, p. 634.
1901, **Cirolana sphæromiformis**, H. RICHARDSON, 'Proc. U.S. Mus.,' vol. 23, p. 512.

HANSEN'S full description, together with his figures of the female, and those here given of the male, leaves only a few points needing to be submitted or explained. The flagellum of the second antennæ has in our specimen ten joints instead of twelve. The epistome and upper lip I did not clearly make out. HANSEN does not call attention to the almost complete smoothness of the three setæ on the inner plate of the first maxillæ. The second maxillæ have three spines on the outermost plate and four on its companion. In the second pleopods the inner ramus is narrow and has the male appendix attached about one-third of its length from the base, reaching beyond both rami, and having apparently a bifid apex. The first four pairs of pleopods have setæ on both rami; the fifth pair escaped observation. In the telsonic segment, which is covered with squamose markings rather more conspicuously than the rest of the body, the three dorsal carinæ are clearly developed. But here the lateral pair appear to run without divergence and none of the three quite reach the margin of the segment, in these respects differing from the female represented by HANSEN. According to HANSEN the apex is not spinose, and he says the same of the uropods. In our specimen both the segment and its appendages carry several minute spines, which are only visible under high magnification. This is also the case in a specimen sent me from Antigua by W. R. FORREST, Esq.

In the first gnathopods the spines on the inner margin of the broad hand show a variety of minute denticulations. In this and the other limbs the point of junction between nail and finger is marked on the convex margin by a group of microscopic setules. The first gnathopods cannot claim to be subchelate, though otherwise by breadth and compactness they make some approach to the corresponding limbs in *H. anisopous*. But, whereas in that species the two following pairs are very differently and more slenderly constructed, here they show a very near agreement, in all three pairs the fifth joint underriding the sixth.

Length scarcely 3 millims., breadth 1·5 millims., the proportion being 27 : 14. HANSEN's specimen was 4·25 millims. long.

Locality :—Among compound Ascidians and with other Isopods at Reef, Galle.

The small size and deceptive appearance of this species, rather than any actual rarity or any marvel of distribution, may account for the fact that the East Indies have now revealed a solitary specimen of the male fourteen years after the West Indies had disclosed a solitary specimen of the female.

FAMILY: ARGATHONIDÆ, nov.

Mandibles, with cutting edge bidentate or simple; molar represented by a feeble blade, not serrate. First maxillæ with inner plate broadly truncate, outer strongly produced, ending in an unguis with a small curved spine at its base. Second maxillæ very short, ending in a broadly rounded single lobe. Maxillipeds six-jointed, second joint not elongate, fourth and fifth joints fused together, seventh well-developed, blunt. Male appendix of second pleopods affixed at the base of the ramus.

By the character of the mandibles this family offers a connecting link between the

Eurydicidæ and other neighbouring families, such as the Corallanidæ, but in every one of the mouth parts it presents some distinctive feature. It is at present represented only by a single specimen of a single species, so that it is not possible to say what amount of sexual dimorphism may occur.

Argathona, n. gen.

The characters of the family will at present suffice for those of the single genus. *Argathona* is a nymph or half-goddess, so recently sprung from the brain of Mr. Justin Huntly McCarthy, that her name is not likely to have been hitherto borrowed for scientific purposes.

Argathona normani, n. sp.—Plate III. (A).

The first peræon segment is rather the longest, and the last rather the shortest. The side-plates are diagonally furrowed, those of the second and third segments less deep than the rest, and not produced beyond their segments; the last four pairs are rhomboidal. The fourth pleon segment overlaps the fifth at the sides. The telsonic segment, with sinuous sides, becomes rather narrowly triangular as it approaches the rounded apex. The dorsal surface of the animal from one end to the other is beset with spines large or small, the only segment free from them being the first of the pleon, but also a basal area is left free where one segment slides under another, and a sinuous free area marks what is probably the boundary between the sixth pleon segment and the true telson. The sixth and seventh segments of the peræon have each six pale tubercles among the fringing spines of the hind margin; the fourth pleon segment has the same number, but less regularly spaced; the fifth has two that are submedian and much larger than those already mentioned, and the sixth segment has a pair which are quite near to the sides. The telson carries numerous spines in the serrate border besides those that belong to the dorsal cover, and is likewise fringed with long plumose setæ.

The eyes are dark, rather large, set wide apart.

The short first antennæ have the first and second joints apparently fused into one thick joint, not much longer than the following more slender joint; the flagellum, rather longer than the peduncle, is twelve-jointed.

The second antennæ have the fourth joint rather longer than the three preceding joints combined, and the fifth rather longer than the fourth; the twenty-nine-jointed flagellum is once and two-thirds the length of the peduncle.

The frontal lamina is pentagonal, not very large. The epistome forms two arms widely divergent, reaching beyond the membranaceous upper lip, in which a transverse area is perceptible of normal form, probably more highly chitinized than the remainder of the appendage.

The lower lip is longer than broad, the lobes elongate piriform, flattened on the confronting margins, the rounded apices not as usual fringed with setules, but carrying a short tooth or spine at the inner angle, and a longer one inserted a little behind and outside the other.

The mandibles are elongate, that on the left bidentate, that on the right with the cutting edge undivided; each has a narrow, transparent, apparently very feeble blade representing the molar, but devoid of the saw-teeth which are conspicuous in *Eurydice* and *Cirolana*. The palp is implanted near the base of the trunk, its second joint much longer either than the first or falciform third.

The maxillipeds are narrow, the three terminal joints setose, none very widely expanded.

The first gnathopods are moderately robust, with four short stout spines conspicuous on the stout fourth joint; the fifth joint short, not produced along the inner side of the sixth joint, which is very slightly armed; the finger curved, simple. The second gnathopods and first peræopods agree with the preceding limb. The four following pairs have a different character, with less tendency to geniculation, except between the second and third joints. There is little difference in length between the joints from the second to the sixth, the first three of these having the expanded distal margin beset with spines of varying length, and some of the spines, especially on the hinder apex of the fifth joint, are serrate. The finger shows a little projection at the base of the nail.

The pleopods have large rami. In the second pair the male appendix, affixed close to the base of the ramus, reaches a little beyond it, and is abruptly narrowed to a short linear apex; near the base its margin is fringed with minute setules.

The uropods have the peduncle considerably produced, spinose on its outer part, but dorsally almost clear, the long process having lateral and apical armature. The rami are strongly fringed like the telson, and the broad inner ramus, which reaches a little beyond the telson, is dorsally sprinkled with short spines, but the much narrower outer ramus has much of its dorsal surface smooth, evidently to suit its habit of folding underneath its companion.

The smooth ventral surface is orange-coloured, the spiny coating of the back dark brown, the limbs quite pale.

Length of the specimen in slightly bent position, 10 millims., which is about two and a-third times the breadth. A second specimen measured 12 millims. in length by 6 millims. in breadth.

Locality:—The smaller specimen was from coral reefs, Gulf of Manaar, the larger from Station XXXIX., south of Galle, up to 30 fathoms.

The clothing of this species gives it, when under the microscope, a very striking appearance; especially its caudal fan, by the grouping and variety of the spines and the addition of the long feathered setæ in more or less symmetrical arrangement, produces a particularly agreeable effect on the eye. I have named it in honour of my friend the Rev. A. M. Norman, D.C.L., F.R.S., whose services to the zoology of invertebrates are justly celebrated.

FAMILY: CORALLANIDÆ.

It is only necessary here to recall that the family embraces the genera *Corallana*, DANA, *Tachæa*, SCHIÖDTE and MEINERT, *Alcirona*, HANSEN, and *Lanocira*, HANSEN, with HANSEN'S definition of the family Alcironidæ transferred to the modified family Corallanidæ.

Lanocira, HANSEN.

1890, **Lanocira**, HANSEN, 'Vid. Selsk. Skr.,' ser. 6, vol. 5, pt. 3, pp. 287, 313, 391, 395.
1904, **Lanocira**, STEBBING, in GARDINER'S 'Fauna, Maldive and Laccadive Archip.,' vol. 2, pt. 3, p. 706.

The species may be distinguished as follows :—

1	The hinder part of the body not setigerous.	1. *L. kröyeri*, HANSEN.
	The hinder part of the body setigerous—2.	
2	Head (of male) with frontal horn.	2. *L. gardineri*, STEBBING.
	Head without frontal horn—3.	
3	Telsonic segment with broadly rounded apex.	3. *L. rotundicauda*, STEBBING.
	Telsonic segment with narrowly rounded apex.	4. *L. zeylanica*, n. sp.

Lanocira gardineri, STEBBING.

1904, **Lanocira gardineri**, STEBBING, in GARDINER'S 'Fauna, Maldive and Laccadive Archip.,' vol. 2, pt. 3, p. 706, pl. 51 A.

For the features which may apparently be relied on for distinguishing this species from *L. zeylanica*, see the next following account of the latter form.

Locality :—One specimen of *L. gardineri* was taken at the Galle reef, with compound Ascidians and some other Isopods. A second was taken along with some small sphæromids at Cheval Paar, and a third was labelled "Gulf of Manaar."

Lanocira zeylanica, n. sp.—Plate V. (B).

The general resemblance of this species to *L. gardineri*, which I have recently described from the Maldive-Laccadive Archipelagoes, is extremely close. The distinguishing features are that the present form has the body from the fifth peræon segment to the extremity of the pleon far more strongly setigerous ; that it has the front of the head with a well-marked margin and a faintly indicated longitudinal depression behind it, but no upturned frontal horn and no pair of dorsal tubercles between the eyes ; that the first maxillæ are stronger ; and that the fifth peræopods are armed on the third and fourth joints with far longer spines. As in the other species the second maxillæ are tipped with two setæ, but the difference in length between the two is greater here. The apical spine of the fourth joint in the first gnathopods is here stronger.

The eyes are dark. The first antennæ have a flagellum of five joints carrying sensory filaments. The mandibles with broad base and slender trunk exhibit an apical tooth, and alongside of the plate which carries this a thin membrane, which appears to be prolonged backward into a slightly curved lingual representative of the molar, the whole apparatus being somewhat obscured by entanglement with the lower lip. The upper lip is slightly emarginate.

The curved finger of the first gnathopod shows two minute prominences on the inner margin, and one such prominence is visible on the other limbs, faintly marking the base of the nail, but the feature is not peculiar to this species. The telsonic segment has six spines at the apex.

Length 6 millims., breadth 2·75 millims.

Locality:—The dissected specimen was a male from Jokkenpiddi Paar. Two other specimens, apparently of the same species, were obtained at the south end of Cheval Paar.

Family: ÆGIDÆ.

The accepted genera may be distinguished as follows:—

1	Pleon abruptly narrower than peræon.	1. *Syscenus*, Harger, 1880.
	Pleon not abruptly narrower than peræon—2.	
2	First antennæ with flagellum of not more than six joints; maxillipeds of not more than four joints.	2. *Rocinela*, Leach, 1818.
	First antennæ with flagellum of more than six joints; maxillipeds of not less than six joints.	3. *Æga*, Leach, 1815.

Syscenus agrees with *Rocinela* in respect to the maxillipeds. It is now recognised that the *Rocinela lilljeborgii* described by Bovallius in 1885 is identical with *Syscenus infelix*, Harger, 1880, but it seems to have been overlooked that Bovallius himself was the first to acknowledge the generic identity, and to point out the probability that *Harponyx pranizoides*, Sars, would prove to be a young *Syscenus* ('Bihang till k. Svenska Vet. Akad. Handl.,' vol. 11, No. 17, p. 17, 1887). *Ægiochus*, Bovallius, is not accepted as distinct from *Æga*. *Acherusia*, Lucas, 1849, and *Alitropus*, Milne-Edwards, 1840, are regarded as synonyms of *Rocinela*; *Pterelas*, Guérin, 1836, and *Ægacylla*, Dana, 1856, as synonyms of *Æga*.

Æga, Leach.

1815, **Æga**, Leach, 'Trans. Linn. Soc. London,' vol. 11, p. 369.
1879, **Æga**, Schiödte and Meinert, 'Naturhist. Tidsskr.,' ser. 3, vol. 12, p. 334.
1882, **Æga**, Haswell, 'Proc. Linn. Soc. N.S. Wales,' vol. 6, p. 11.
1890, **Æga**, H. J. Hansen, 'Vid.-Selsk. Skr.,' ser. 6, vol. 5, p. 316.
1897, **Æga**, Sars, 'Crustacea of Norway,' vol. 2, p. 58.

In recent years species have been added to this genus by Hansen, Whitelegge, H. Richardson and Norman. Many other references to it may be traced under those given above and in company with those given below for the genus *Rocinela*.

In defining the genus Leach laid stress on the ample development of the first two joints of the peduncle of the first antennæ. The dilatation of these joints is used as a character also by Schiödte and Meinert. Sars, however, employs the qualified statement, "the first two peduncular joints more or less expanded," and, in fact, describes the antennæ as very slender both in *Æga arctica*, Lütken, and *Æga ventrosa*, M. Sars. The absence of any expansion from the two peduncular joints in question is conspicuous in the figures given by Schiödte and Meinert of their species *Æga nodosa*. They further speak of the frontal lamina, that is, the plate above the upper lip between the bases of the second antennæ, as large or very large in *Æga*, but minute or evanescent in *Rocinela*. But, taking all the species of the two genera together, this distinction does not seem to be stable.

In the species about to be described the peduncular joints of the first antennæ are not specially dilated and the frontal lamina is not very large. But while in these respects it makes an approach to *Rocinela*, it is clearly separated from that genus by the flagellum of the first antennæ and by the maxillipeds. Its peculiarities tempted me to make it the type of a new genus, but I am content to leave it for the present as a very distinct unit among the many species of the genus *Æga*.

Æga ommatophylax, n. sp.—Plates IV., V. (A).

The very marked and at present seemingly unique feature of this species pertains to the first peræon segment of the male. The anterior border of this segment projects a sub-median pair of cylindrical processes over the large contiguous eyes. The specific name has been chosen to suggest that their function is protective to the organs of vision. In *Rocinela cornuta*, Richardson, the antero-lateral angles of the first peræon segment are extended straight forwards, probably with the same object. The defence obtained is presumably worth the interference with sight that must result from it.

Male. The head projects a distally widened round-ended frontal process slightly upturned, with the exception of this process having its dorsal surface almost completely and its ventral surface partially covered by the dark eyes. The first peræon segment, without including its slightly convergent antero-dorsal processes, is longer than any of the other segments, these varying little among themselves in length or breadth. The first five segments of the pleon are but little narrower than the peræon and are subequal one to the other, somewhat wider than the telsonic segment, which is broader than long, with its broadly rounded apical margin serrate, carrying spines and setæ and having the central point a little produced.

The eyes meet in the middle line of the head, leaving a little triangular interval above, but occupying all the hind margin.

The frontal lamina is not large. The bases of the first antennæ are concealed from above by the front of the head, and have a slender peduncle with flagellum thirteen- to fourteen-jointed. In the second pair the joints of the slender peduncle increase in length from the second to the fifth, and the flagellum is thirty-two-jointed.

The upper lip appears to be rounded, membranaceous. The mandibles have the palp planted near the base of the trunk, with the first joint nearly as long as the second, the third not very short. The first maxillæ are long and slender, the small apex carrying three hooked spines and four spinules. The second maxillæ are much broader than the first, having the inner margin of the apex armed with three little hooks, in addition to which a small, narrowly oval, movable inner plate is tipped with two hooks. The maxillipeds have an irregularly rounded epipod, as wide as the second joint, which is itself wide, elongate, and produced into a narrowly tapering process tipped with two setules. The third joint is short, distinct, the fourth and fifth have distinct outlines, but are, perhaps, only apically separate, the fifth carrying outward curved spines at its apex, its outer margin forming a continuous curve with the faintly separable sixth and seventh joints, which together have a free inner margin tipped with two outward curving spines. As will be seen from the figures, this account of the mouth organs in the male has been a little supplemented from the mouth organs of another specimen possibly of a different sex.

The first gnathopods have a few short finely plumose setæ along the front margin of the rather narrow second joint, and the same garniture seems to occur on the corresponding margin in the other limbs. The third joint is rather longer than the fourth and carries a single spine at its front apex. The fourth joint has two stout spines on the hind margin, the fifth is small, underriding the sixth, but not overlapped in front by the fourth; its spines like those of the hand are slight. The finger is nearly as long as the hand, with setules marking the base of the nail.

The second gnathopods are very similar to the first, but stronger and more spinose. The third joint has a stout spine on the hind margin, and the fourth has four or five such spines; the fifth joint does not underride the sixth. The first peræopod is of nearly the same appearance. On the left side of the specimen each of these limbs has, on the inner apex of the short fifth joint, an articulated obtuse process about twice as long as it is broad, giving the limb a subchelate character. On the right side of the specimen these processes are not present. Whether they are abnormal growths on the left side or are accidentally missing from the right I cannot determine.* The side-plates of the second gnathopods are round-ended. In the following limbs they tend to become less and less obtuse and those of the fifth peræopods are subacute, produced over the first segment of the pleon, of which, however, the angles are free.

In the last four pairs of peræopods the third joint attains a considerable length, this and the three following joints being armed with numerous well developed spines, of which a group on the hind apex of the fifth joint, though not very long, are

* It is worth noting for comparison that SARS ('Crustacea of Norway,' vol. 2, p. 61) describes the three anterior pairs of legs in *Æga crenulata*, LÜTKEN, as "distinguished by a very conspicuous cultriform spine, issuing from the end of the propodos, inside the base of the dactylus," and WHITELEGGE ('Mem. Australian Museum,' iv., pt. 2, p. 233) describes a similar process on first peræopods of his *Æga angustata*.

distinguished by their pectinate character. The genital papillæ on the ventral side of the last peræon segment are short and broad.

In the first pleopods the sinuous inner margin of the peduncle carries seven coupling spines and as many plumose setæ. The outer branch, as in the following pairs, is fringed round most of its margin with plumose setæ. The inner branch in this and the next pair has a fringe of setæ on the lower half of the inner margin and on the apical border. The second pair are distinguished by the extraordinary length of the slender male appendix, which is twice as long as the trunk of the supporting branch.

The uropods have the inner apex of the peduncle greatly produced into an acute process, of which the inner margin is setose. The broad inner ramus is mostly fringed with plumose setæ and carries eleven spines in the serrate part of its margin. The shorter and much narrower outer ramus is fringed also with plumose setæ and carries nine spines.

Length 14 millims., breadth about 6 millims.

Locality :—The single specimen, a male, was taken in "deep water off Galle."

A specimen which I deem to be the female or a younger form of the foregoing was "dredged off Mutwal Island," and measured 12 millims. in length, with a width of about 4·5 millims. It is devoid of the frontal process of the head, and the first peræon segment is without the two submedian dorsal processes. The last three segments of the peræon more decidedly surpass in length the preceding three segments than in the form already described; the first antennæ have twelve and the second antennæ have twenty-six joints to the flagellum. The peculiar process of the wrist in the second gnathopod and first peræopod is wanting. No male appendix could be discerned in the (undissected) pleon. Otherwise the agreement of the two specimens is extremely close. The remarkable eyes are alike in both, and though they agree with those of *Rocinela vigilans*, Haswell, that much larger species, if the figure of the maxillipeds can be trusted, must be generically distinct. The tenacity with which some of the mouth parts in this and kindred species cling together makes satisfactory dissection difficult. But there is little reason to doubt that the frontal lamina, epistome, and rounded membranaceous upper lip figured from the second specimen would equally well represent those parts in the first, had they there been in a condition for figuring. *Æga cyclops*, Haswell, is described as having the eyes confluent, the telsonic segment sub-triangular.

Rocinela, Leach.

1818, **Rocinela**, Leach, 'Dict. Sci. Nat.,' vol. 12, p. 349 ("*Rocinèle*," p. 348).
1825, **Rocinela**, Desmarest, 'Consid. gén. Crust.,' p. 304.
1849, **Acherusia**, Lucas, 'Explor. Algérie, Crust.,' p. 78.
1867, **Rocinela**, Bate and Westwood, 'Brit. Sessile-eyed Crust.,' part 18, vol. 2, p. 289.
1879, **Rocinela**, Schiödte and Meinert, 'Naturhist. Tidsskr.,' ser. 3, vol. 12, p. 380.
1880, **Rocinela**, Haswell, 'Proc. Linn. Soc. N. S. Wales,' vol. 5, p. 472.
1883, **Rocinela**, Harger, 'Bull. Mus. Comp. Zoöl.,' vol. 9, art. 23, p. 97.

1890, **Rocinela**, H. J. Hansen, 'Vid. Selsk. Skr.,' ser. 6, vol. 5, pp. 298, 316, 406.

1893, **Rocinela**, Stebbing, 'History of Crustacea,' p. 348.

1896, **Rocinela**, Bonnier, "Édriophthalmes du 'Caudan,'" 'Ann. Univ. Lyon,' vol. 26, p. 578.

1897, **Rocinela**, H. J. Hansen, 'Bull. Mus. Comp. Zoöl.,' vol. 31, p. 108.

1898, **Rocinela**, H. Richardson, 'Proc. Amer. Philos. Soc.,' vol. 37, No. 157, p. 8.

1899, **Rocinela**, Sars, 'Crustacea of Norway,' vol. 2, p. 65.

1899, **Rocinela**, H. Richardson, 'Proc. U.S. Mus.,' vol. 21, p. 827.

1900, **Rocinela**, H. Richardson, 'American Naturalist,' vol. 34, No. 399, p. 218.

1901, **Rocinela**, H. Richardson, 'Proc. U.S. Mus.,' vol. 23, pp. 520, 523.

1902, **Rocinela**, H. F. Moore, 'Bull. U.S. Fish Commission,' vol. 20 (for 1900), pt. 2, p. 171.

1903, **Rocinela**, H. Richardson, 'Bull. U.S. Fish Comm. for 1903,' p. 49.

1904, **Rocinela**, H. Richardson, 'Proc. U.S. Mus.,' vol. 27, p. 33.

In 1898 Miss Harriet Richardson reckoned the then known species of this genus at nineteen, of which she provided a useful analytic key. Bonnier's blind species, *R. typhlops*, 1896, had probably at that time not come under her notice, as it is not included in the list. On the other hand, one of the accepted nineteen is the Tasmanian species which G. M. Thomson named *R. spongicola* in 1892 (1893). Since this has about fourteen joints to the flagellum of the first antennæ and a distinct third joint to the maxillipeds, it should be transferred to the genus *Æga*. In 1899 Miss Richardson made *R. alaskensis* (Lockington) a synonym of *R. belliceps*, which Stimpson had assigned to the genus *Æga*. In 1903 she described *R. hawaiiensis* as a new species, near to *R. orientalis*, and in 1904 established a new species, *R. affinis*, near to Harger's *R. oculata*, and gave the name *R. angustata* to a form which she had previously supposed identical with Hansen's *R. laticauda*. In 1902 Lanchester instituted *R. mundana* ('Proc. Zool. Soc. London,' p. 378, pl. 35, figs. 9–9*a*).

Rocinela orientalis, Schiödte and Meinert.—Plate VI. (C).

1879, **Rocinela orientalis**, Schiödte and Meinert, 'Naturhist. Tidsskr.,' ser. 3, vol. 12, pp. 383, 395, pl. 13, figs. 1, 2.

1898, **Rocinela orientalis**, H. Richardson, 'Proc. Amer. Philos. Soc.,' vol. 37, No. 157, pp. 9, 11.

This species belongs to a group distinguished by the Danish authors as having the eyes clearly separated, the flagellum of the second antennæ composed of fourteen to sixteen joints, and the sixth joint in the first three pairs of trunk-limbs armed with three or four spines. To distinguish it from its neighbours in this group, Miss Richardson notes that the frontal margin is not produced as it is in *R. dumerilii* (Lucas), and that, whereas Schiödte and Meinert's *R. maculata* and *R. americana* have the telsonic segment "linguate," and both branches of the uropods crenulate on their exterior margins, in the present species the telsonic segment is subtriangular and the branches of the uropods are not crenulate on their exterior margins. The Danish authors mention the crenulation in the two former species, but neither deny nor affirm it in regard to *R. orientalis*, the telsonic segment of which they describe as subtriangular, with rounded sides, a phraseology quite as applicable to their figures of that segment in *R. americana* and *R. maculata*. A more tangible distinction appears to lie in the proportions of the uropods, which in both the species last mentioned are said to have the inner branch a little longer and broader than the outer, while in the present species it is described as much longer and a little broader. Probably it was not the absolute length of each branch that was taken into comparison, but the inner branch was reckoned the longer by all that part of it which extended beyond the outer branch. It will be seen by the figures here given, that, if the specific determination is correct, the telsonic segment is subject to some variation, the apical margin passing from the subtriangular to a rather broadly rounded contour. In either case the margin is minutely serrate and fringed with minute spines and short plumose setæ. The uropods have the margins a little more strongly serrate and the armature rather stronger. Their peduncle is greatly produced at the inner apex, and the long process is rather strongly fringed with setæ.

In the first antennæ the flagellum is six-jointed, but in the smaller and perhaps not fully adult specimen five-jointed. The second antennæ have a long spine on the apex of the fourth joint of the peduncle, the flagellum in the male specimen with fourteen joints on one antenna and fifteen on the other, many of the joints fringed with setules. In the smaller specimen the flagella were twelve- and thirteen-jointed.

In the mandibles the first joint of the palp is the longest. The terminal joint of the maxillipeds has two outward curving apical spines, and a similar spine below the apex (this, however, not being clearly discerned in the male specimen).

The fingers of the prehensile legs are strongly hooked. The ambulatory legs have the third joint very elongate, especially in the last pair.

The first pleopods have both branches narrow, fringed with setæ, except on much of the outer border of the inner branch. The second pleopods have the outer branch longer and much broader than the inner. In both the margin is somewhat irregular and much of it fringed. The male appendix does not reach the end of the inner branch.

Length of largest specimen, male, 13 millims., with a breadth of 7 millims. The smaller specimen figured was 11·3 millims. long by 5 millims. broad. A specimen laden with eggs was 12 millims. long, 5·75 millims. broad.

Localities:—Station I., off Negombo, 20 fathoms; Station II., off Uluwitti, 8 fathoms; Station V., Chilaw Paar, 10 fathoms; on weed bearing oyster spat, S.E. of Modragam Paar.

Family: CYMOTHOIDÆ.

Anilocra, Leach.

1818, **Anilocra**, Leach, 'Dict. Sci. Nat.,' vol. 12, pp. 348, 350.

1900, **Anilocra**, Stebbing, in Willey's 'Zoological Results,' pt. 5, p. 639.

1901, **Anilocra**, H. Richardson, 'Proc. U.S. Mus.,' vol. 23, p. 528.

1902, **Anilocra**, H. F. Moore, 'Bull. U.S. Fish Comm.,' vol. 20 (for 1900), pt. 2, p. 172.

Anilocra dimidiata, Bleeker.

1857, **Anilocra dimidiata**, Bleeker, 'Acta Soc. Sci. Indo-Neerl.,' vol. 2, art. 5, pp. 30, 31.

1881, **Anilocra dimidiata**, Schiödte and Meinert, 'Nat. Tidsskr.,' ser. 3, vol. 13, p. 103, 111, pl. 8 (15), figs. 5, 6.

1900, **Anilocra dimidiata**, Stebbing, in Willey's 'Zoological Results,' pt. 5, p. 639.

The two specimens obtained agree closely with the description given by Schiödte and Meinert, having, in accordance with their conspectus of the species in this genus, the first antennæ geniculate, the coxæ not carinate but simple, and the fingers in the first four pairs of trunk-legs inflated in the middle, the inflation here forming a single nodule, not two or three nodules as in *A. leptosoma*, Bleeker. The colouring also agrees, not merely in being yellow, bespattered with minute dark specks, which is common to so many preserved species, but in the much more peculiar character of being very much darker on the right side of the animal than on the other, in accordance with Bleeker's description. Schiödte and Meinert write as though either side might be the darker.

The Danish authors speak of their specimens being more or less twisted to the right, whereas ours are quite straight as in Bleeker's figure. They attribute only nine joints to the second antennæ, while ours have these appendages ten-jointed. Both first and second antennæ, and the latter especially, are much compressed. In one specimen both members of the second pair, and in the other one member, have the antepenultimate joint shorter than either of its neighbours.

The fifth pleon segment has the postero-lateral angle produced a little over the telsonic segment, which is broader than represented by Schiödte and Meinert, but is, as they describe, obscurely carinate, with raised lateral margins. The peduncle of the uropods is only shortly produced on the inner apex; the long narrow rami are perfectly smooth, approximately equal in length, the outer a little the narrower.

One specimen, carrying elongate eggs, measured 24 millims. in length, the other being 22 millims. long. In each case the greatest breadth was 8 millims.

Locality :—Palk Bay, 6 fathoms.

Rhiothra, Schiödte and Meinert.

1884, **Rhiothra**, Schiödte and Meinert, 'Nat. Tidsskr.,' ser. 3, vol. 14, p. 223, 318.

This genus is placed by the Danish authors in the Cymothoinæ, the second tribe of their family Cymothoidæ. In the somewhat conjectural reference to it of a single specimen, a male not fully grown, it would be out of place to indulge in any long discussion of the characters, for which the original work should be consulted. It may be remarked that the generic definition refers to the female, not to the adolescent male, in which the second antennæ have a larger number of joints.

Rhiothra callipia, Schiödte and Meinert.—Plate VI. (A).

1884, **Rhiothra callipia**, Schiödte and Meinert, 'Nat. Tidsskr.,' ser. 3, vol. 14, p. 319, pl. 12, figs. 8–13.

The single specimen here available agrees with the account of the "mas adolescens" given by the Danish authors as well as could be expected considering its smaller size. The slender second antennæ, however, consist of thirteen joints instead of twelve. The eight-jointed first antennæ have the five joints of the flagellum each apically furnished with a spray of sensory filaments. The male appendix of the second pleopods, which the above-named authorities describe as very thin, hooked, scarcely reaching the end of the rami, is, in our example, only a third as long as the rami, not especially thin, and not showing any perceptible hook. The coupling spines of the peduncle are numerous. The delicately laminar rami of the uropods have fringes of finely plumose setæ and are scarcely, or not at all, shorter than the telsonic segment, the broadly rounded hind margin of which is fringed with very short but finely plumose setæ. Its base carries dorsally numerous setules, of which there are a few on the preceding segments. The pleopods are without setæ, according to the custom of the family Cymothoidæ.

A feature of our specimen, to which SCHIÖDTE and MEINERT make no allusion, is, that in all the limbs the fifth joint has the inner apex protruding, acutely in the first gnathopod, broadly in the fifth peræopod, where it is armed with three spines. The third joint is remarkably short in the former, but tolerably long in the latter pair of limbs. In all the limbs the finger is strongly uncinate.

Colour orange yellow, lightly sprinkled with small dark flecks, especially on the sides, the limbs pale.

Length about 6·75 millims., breadth about 2·75 millims.

Locality:—Station LVIII., off Karativo Paar, 9 to 26 fathoms.

Irona, SCHIÖDTE and MEINERT.

1884, **Irona**, SCHIÖDTE and MEINERT, 'Nat. Tidsskr.,' ser. 3, vol. 14, pp. 327, 381.
1897, **Irona**, H. J. HANSEN, 'Bull. Mus Comp. Zoöl. Harvard,' vol. 31, p. 110.
1901, **Irona**, H. RICHARDSON, 'Proc. U.S. Mus.,' vol. 23, pp. 525, 531.

This genus was placed by its authors in the Livonecinæ, the third tribe of their family Cymothoidæ. From the seven other genera which they assign to the same tribe it is distinguished by one or more of the following characters:—Segments of the pleon clearly separate, fifth peræopods subequal in length to the preceding legs, or a little longer, with uncinate fingers, the body all moderately convex, the front broadly or shortly rounded, the pleon deeply immersed in the peræon.

In the definition of the genus nothing is said as to the mouth organs or the character of the pleopods. Four species were placed in the genus, to which HANSEN has since added a fifth, *I. foveolata*. This last agrees with the species about to be described in a rather striking feature, of which HANSEN gives the following account:— The side-plates of the sixth, and especially of the seventh, segment are much broader and posteriorly much more produced than the others, besides on each side rising considerably above the more lateral part of the dorsal surface of the thorax [peræon], which is brought about by the curious fact that these epimera are turned outwards and somewhat upwards." In *Cterissa pterygota* (Koelbel) there is a similar expansion of the side plates, but it applies to all six of them on one side of the animal and to none on the other side.

Irona nanoides, n. sp.—Plate VI. (B).

The specimen, a female, having its pouch enormously distended with young ones, was slightly distorted so as to make the outline of the left side very convex. The middle of the back is raised considerably above the lateral parts of the segments. The head has a short, very broad front. The peræon is very broad, the side-plates of the fifth segment approaching the character of the two following pairs. The first two segments of the pleon are overlapped by the last segment of the peræon, the next three are very short but wider than the almost semicircular telsonic segment.

The eyes are wide apart, not very large, black. The first antennæ are rather stout, especially as to the first three of the eight joints. The ten-jointed second pair are slighter, subequal in length. The upper lip has a four-lobed margin as in *Anilocra curieri*, Leach, and in *Renocila periophthalmi*, Stebbing. The mandibles have a stout first joint to the palp, the second much thinner and a little shorter, the third shorter and thinner than the second, and armed with a few spines. The trunk thins out in advance of the palp, apparently carrying a quasi-molar not very remote from the pointed cutting-plate. The slender first maxilla is tipped with five spinules. The second maxilla appears to have a membranous apical margin accompanied by a process carrying small hooked spines. The maxillipeds have the composite second and third joints long and broad, followed by a joint which is about equal in length and breadth, narrowed at the rounded apex, to which is attached the narrow terminal bearing two outward bent hooks at its summit and one such hook on its side.

The gnathopods and peræopods are all very similar in appearance and structure, the hinder pairs having some superiority of size. The second joint is substantial, but not conspicuously expanded; the third in the gnathopods is as long as the hand, but in the hinder peræopod is longer than any one of the joints that follow it; the fourth joint is short but wide, being especially bulging in the fifth peræopod; the fifth joint is of insignificant size, tending slightly to underride the short curved hand, which does not exceed in length the simple but strongly hooked finger.

The pleopods are all of remarkable breadth, both branches similar in structure and devoid of setæ. The coupling spines of the short peduncles are small. The uropods are short, with two subequal oval branches, little longer than the stout peduncle, of which the inner apex is not produced. There are some tiny spinules on the branches, of which the inner is decidedly not longer than the outer. Colour in spirit yellow, with the upturned side-plates whitish.

Length 10 millims., greatest breadth 5·5 millims.

Locality:—Station XXXIX., Gallehogalle Bank, 16 to 20 fathoms.

The young ones taken from the mother's pouch have the broad front to the head as in the adults and the eight-jointed first antennæ. In the limbs the nail is rather more distinct from the trunk of the finger than it is in the full-grown animal. The seventh segment of the peræon is, as usual, without limbs, and resembling the segments of the pleon which at this stage are much narrower than the peræon. The telsonic segment shows a broadly rounded or very obtusely-angled apical margin, which like those of the uropods, and possibly also those of the pleopods, is feebly and microscopically fringed with setules. There is no subapical constriction of the telsonic segment as in the "pullus stadii primi" of *Irona foveolata*, and the inner branch of the uropod is broader than in the young of that species.

In *Irona nana*, Schiödte and Meinert, the adult female has the outer branch of the uropod much longer than the inner; in Hansen's species the inner is considerably longer than the outer, so that both species may be easily distinguished from the one here described.

Family: SPHÆROMIDÆ.

The genera that with more or less acceptance have maintained places in this family are *Sphæroma*, Bosc, 1802; *Campecopea*, Leach, 1813; *Cymodoce*, Leach, 1814; *Dynamene*, Leach, 1814; *Næsa*, Leach, 1815 (for *Nesæa*, Leach, 1813, preoccupied); *Cilicæa*, Leach, 1818; *Zuzara*, Leach, 1818; *Cerceis*, *Amphoroidea*, *Cassidina*, *Ancinus*, all four instituted by Milne-Edwards in 1840; *Monolistra*, Gerstaecker, 1856; *Isocladus*, Miers, 1876; *Ceratocephalus*, Woodward, 1877 (not preoccupied by *Ceratocephala*, Warder, 1838, and therefore taking precedence of *Bregmocerella*, Haswell, 1885); *Cycloidura*, Stebbing, 1878 (for *Cyclura*, Stebbing, 1874, preoccupied); *Scutuloidea*, Chilton, 1882; *Plakarthrium*, Chilton, 1883 (of which *Chelonidium*, Pfeffer, 1887, is a synonym, so that the family Chelonidiidæ if maintained must be named Plakarthriidæ); *Haswellia*, Miers, 1884 (for *Calyptura*, Haswell, 1881, preoccupied); *Cymodocella*, Pfeffer, 1887; *Næsicopea*, Stebbing, 1893; *Cæcosphæroma*, Dollfus, 1896 (part); *Tecticeps*, H. Richardson, 1897; *Exosphæroma*, Stebbing, 1900; *Cassidinella*, Whitelegge, 1901; *Chitonopsis*, Whitelegge, 1902; *Parasphæroma*, Stebbing, 1902; *Vireia*, Dollfus, 1905.

This rather unwieldy group suffers at present under various difficulties, towards the solution of which only a few suggestions can here be volunteered. Eugène Hesse in 1872 undertook to prove, with a reserve which he evidently scarcely entertained, that *Sphæroma* represented the female of *Cymodoce* and *Dynamene* the female of *Næsa*. The discovery of undoubted males in several species of *Sphæroma* has shown that the first part of his hypothesis is untenable, but for the second part there is much to be said. It is exceedingly probable that *Dynamene montagui*, Leach, is the young male, and that *Dynamene rubra* and *viridis*, Leach, are young forms, female or male, of *Næsa bidentata* (Adams), which is the adult male. The colouring, the general structure, and very frequent occurrence under similar conditions of these four forms give warrant to this belief (see 'Journ. Linn. Soc.,' London, vol. 12, p. 148, 1874). From acceptance of this view will follow the necessity of cancelling one of the generic names. *Nesæa*, LEACH, has priority, but is preoccupied. *Næsa* was substituted for it. But *Dynamene* has priority over *Næsa*, although its title is a little peculiar. It was indeed defined in advance of the substituted naming of *Næsa*, but the species for which it was defined were not specified by name until 1818. The simplest issue out of the complication seems to be by reducing the two genera and their four representative species to a single genus and species under the name *Dynamene bidentata* (ADAMS). Thus *Næsa* disappears, and *Dynamene* in its place acquires an intelligible status.

The relief, however, is not very great, because there are several other species that have been assigned to this dimorphic genus before its dimorphism was understood, and of these the true generic position remains uncertain.

Although sexual dimorphism is not conspicuous in *Sphæroma*, *Exosphæroma*, or *Parasphæroma*, in many other genera of the family it has been more or less clearly established, and there exists at least a possibility that the females of different genera may be much less divergent in appearance than the males. The latter sex is distinguished in *Dynamene* and *Campecopea* by having the sixth segment of the peræon dorsally produced, in *Zuzara*, *Cycloidura*, *Isocladus*, and *Haswellia* by having the peræon's seventh segment so produced. In *Dynamene*, *Campecopea*, *Cilicæa*, and *Næsicopea* the males have the inner ramus of the uropods degraded (with an exception subsequently mentioned). In *Ancinus* that ramus is wanting, but the sexes have not as yet been discriminated either in that genus or in *Tecticeps*, which shows a near relationship to it. The uropods in *Tecticeps* are biramose, with the inner branch much the shorter.

In regard to some isolated members of the family, it may be suggested that *Sphæroma algoense*, STEBBING, 1875, *Cymodocella tubicauda*, PFEFFER, 1887, and *Sphæroma* (?) *egregia*, CHILTON, 1891, must all belong to the same genus, and may possibly deserve to be united under the name *Cymodocella algoensis*. *Cymodocea antarctica*, HODGSON, 1902, also appears to approach *Cymodocella* more nearly than *Cymodoce*. *Exosphæroma amplifrons*, STEBBING, would, according to my present view, stand better in the genus *Cymodoce*, and, in any case, I agree with my friend Dr. H. J. HANSEN that it cannot properly be retained under *Exosphæroma*.

Since the above was written, Mr. HOLMES has kindly sent me his interesting essay on the sexes of Sphæromids ('Proc. California Ac. Sci.,' ser. 3, Zool., vol. 3, p. 295). He takes the view that the name *Dynamene* should be accepted in place of *Næsa*, but further extends it to supersede *Cilicæa*, a procedure which can scarcely be accepted without more consideration and argument. As regards the male sex, *Cymodoce* seems fairly distinguishable by superficial characters from *Dynamene* and both sections of *Cilicæa*, but whether there are stable and sufficient marks for separating either the female or the juvenile forms of *Cymodoce* and *Cilicæa* in all cases is less clear. The addition of new species without tolerably full description and figures is rather to be deprecated than welcomed.

Sphæroma, Bosc.

1802, **Sphæroma**, Bosc, 'Hist. Nat. des Crustacés,' vol. 2, p. 182.
1873, **Sphæroma**, Harger, 'Amer. Journ. Sci.,' ser. 3, vol. 5, p. 314.
1880, **Sphæroma**, Harger, 'Rep. U.S. Fish. Comm. for 1878,' p. 368.
1900, **Sphæroma** (*sensu restricto*), Stebbing, 'Proc. Zool. Soc. London,' p. 552.
1904, **Sphæroma**, Stebbing, in 'Spolia Zeylanica,' vol. 2, pt. 5, p. 15.
1904, **Sphæroma**, Stebbing, in Gardiner's 'Fauna, Maldive and Laccadive Archip.,' vol. 2, pt. 3, p. 710.

The definition of the restricted genus may be formulated as follows:—Sexual dimorphism not conspicuous. Telsonic segment without apical sinus. Maxillipeds having the fourth and fifth joints fringed on the inner margin with long setæ, but neither these two joints nor the sixth produced into lobes. First and second gnathopods having the third and fourth joints fringed on the front margin with long setæ. Uropods with subequal rami.

Conforming to these characters are the type species, *S. serratum* (Fabricius), *S. terebrans*, Bate, *S. quadridentatum*, Say, and *S. walkeri*, n. sp. In the multitude of species which from early dates down to the last two or three years have been assigned to *Sphæroma*, there are many which are obviously excluded from that genus as above defined. But there are several of which not enough is known to enable us to say whether they belong to it or not. There is a presumption in favour of *S. quoianum*, Milne-Edwards, since Heller in re-describing that species says that the first three pairs of feet have the middle joints fringed on the outer side with long hairs, and there is a similar presumption in regard to *S. sieboldii*, Dollfus, 1889, and *S. pentodon*, H. Richardson, 1904. On the other hand, Whitelegge, describing *S. australe*, *S. latifrons*, and *S. plumosum* in 1902, speaks of the lobes in the palp of the maxillipeds as well developed. At least the first of these three may be referred with some certainty to *Exosphæroma*.

Sphæroma walkeri, n. sp.—Plate VII.

Head not very broad or long. Peræon convex, its segments not greatly differing in length, although a contrary impression may be produced by the telescoping or extension of a particular segment. The unsutured side-plates of the first segment are as usual much the longest, being subacutely outdrawn backwards and forwards. The next two pairs are apically narrowed, the following three somewhat squared, and the seventh pair with a rather deep trituberculate hind margin. The transverse tuberculation of the segments, which is scarcely perceptible on the first segment, gradually increases in prominence, and fringes the seventh segment in a very pronounced manner. In the front division of the pleon, representing five faintly distinguishable segments consolidated into one, there is a curved transverse row of tubercles, belonging chiefly to the fourth segment. The telsonic segment is only moderately convex, and becomes slightly concave near the broadly rounded, slightly crenulate apical margin. This shield is ornamented by four longitudinal rows of tubercles, two submedian, of about eight tubercles apiece, and two sublateral of four, which lead to an encircling apical ridge, the sloping sides of the shield carrying at the upper part short divergent lines of tubercles, and usually a little tubercle outside each sublateral line.

The eyes are dark, deeply inserted in the front margin of the peræon.

The first antennæ have a broad basal joint, probably representing two joints consolidated. The following joint is small, scarcely as long as broad. The flagellum in the specimen examined consisted of fourteen joints, the first much the longest, as long as the basal and twice as long as the terminal joint of the peduncle.

The slender second antennæ are rather longer than the first; the fourth and fifth joints of the peduncle are equal in length; the flagellum is fourteen-jointed, rather longer than the peduncle.

The epistome is somewhat longer than broad; the upper lip has a feebly trilobed margin.

The gastric spines on the folds of the stomach at its entrance display a variety of shapes, which, however, may be customary.

The mandibles have the molar strong and prominent, the palp less slight than usual. In both pairs of maxillæ the plates appear to be somewhat broader than is usually the case.

The maxillipeds have the plate of the second joint broad, strongly setose round the convex distal margin and down the surface at some distance from the inner margin. The latter is armed with an exceptionally long and slender upward-bent coupling spine. The third joint is exceedingly small, the fourth as broad as long, with inner margin narrower than the outer, the fifth about square, like the preceding joint having its inner margin densely fringed with long setæ; the sixth and seventh joints are subequal, apically setose, considerably longer and narrower than the fifth joint.

The first gnathopods have the hind margin of the second joint setose in its upper part, the third joint nearly as long, with the plumose setæ of the front margin very long; the much shorter fourth joint has long plumose setæ on the convex front margin; the triangular fifth joint is quite small; the sixth joint is about as long as the fourth, with short plumose setæ distally on the front margin and a serrate spine at apex of hind margin; the finger has minute setules along the concave hind margin.

The second gnathopod differs from the first chiefly by the cylindrical fifth joint, which is nearly as long as the sixth, the former carrying plumose setæ at its front apex, and both being setose along the hind margin.

The peræopods are fringed with setæ on the front margin of the second, third, and fourth joints, and on the hind margin of all joints from the second or third to the sixth in the first two pairs, and on the corresponding but inverted margins of the other three pairs. The second and third joints are more robust than in the gnathopods.

The fifth joint is uniformly shorter than the sixth, which in the fifth pair is considerably elongated, being as long, though not as broad, as the third joint.

The fixed inner branch of the uropods has two or three tubercles on its upper surface; the outer branch is fringed with setæ along the inner margin and has the outer divided into six or seven teeth.

The colouring (as preserved) is a symmetrical dark-grey mottling on a pale ground.

The specimen figured was 9 millims. long and 5 millims. broad. The second pleopods showed no trace of a male appendix.

Numerous examples were obtained at Jokkenpiddi Paar, one in tow-net gathering at Marichchukaddi, two at Cheval Paar, one in Galle Harbour, and one elsewhere.

The tuberculation of the dorsal surface is not incapable of being regarded as forming a series of transverse lines, but the general effect produced is that of a striking contrast between longitudinal lines on the telsonic segment and transverse lines on the rest of the body. I name this prettily sculptured species in honour of A. O. Walker, Esq., F.L.S., a carcinological colleague whose cheering friendship I have for many years enjoyed.

Cilicæa, Leach.

1818, **Cilicæa**, Leach, 'Dictionnaire des Sciences Naturelles,' vol. 12, p. 342 ("*Cilicée*," p. 341).
1818, **Næsa** (part), Say, 'Journ. Acad. Sci. Philad.,' vol. 1, p. 482.
1825, **Cilicæa**, Desmarest, 'Consid. gén. Crust.,' p. 295 ("*Cicilæa*," p. 442).
1829, **Cilicæa**, Latreille, 'Le Règne Animal,' vol. 4, p. 138.
1836, **Cilicæa**, Guérin, 'Iconogr. Règne Animal, Crust.,' pl. 30.
1840, **Nœsea** (part), Milne-Edwards, 'Hist. Nat. Crust.,' vol. 3, p. 216 ("*Nesea*," p. 628).
1853, **Nesæa** (part), Dana, 'U.S. Expl. Exp.,' vol. 13, p. 749.
1879, **Nesea**, G. M. Thomson, 'Trans. New Zealand Inst.,' vol. 11, p. 234.
1881, **Cilicæa**, Haswell, 'Proc. Linn. Soc. N.S. Wales,' vol. 5, p. 475.
1882, **Cilicæa**, Haswell, 'Proc. Linn. Soc. N.S. Wales,' vol. 6, p. 1.
1882, **Cilicœa**, Haswell, 'Catal. Australian Crust.,' p. 295.
1884, **Cilicæa**, Miers, 'Zool. of the "Alert,"' p. 308.
1886, **Cymodocea**, Beddard, '"Challenger" (Isopoda) Reports,' vol. 17, p. 145.
1891, **Cymodocea**, Ives, 'Proc. Acad. Sci. Philad.,' pp. 188, 194.
1899, **Cilicæa**, H. Richardson, 'Proc. U.S. Nat. Mus.,' vol. 21, pp. 831, 838.
1900, **Cilicæa**, H. Richardson, 'The American Naturalist,' vol. 34, No. 399, p. 222.
1900, **Cilicæa**, Stebbing, Willey's 'Zoological Results,' pt. 5, p. 643.
1901, **Cilicæa**, H. Richardson, 'Proc. U.S. Nat. Mus.,' vol. 23, pp. 532, 535.
1902, **Cilicea**, H. F. Moore, 'Bull. U.S. Fish Comm.,' vol. 20 (for 1900), p. 172.
1902, **Cilicæa**, H. Richardson, 'Trans. Connect. Acad.,' vol. 11, p. 291.
1902, **Cilicœa**, Whitelegge, 'Mem. Australian Mus.,' Mem. 4, p. 265.

To include the numerous species now assigned to this genus, the following definition is offered :—

Sexual dimorphism conspicuous. Segments of peræon devoid of dorsal processes. Telsonic segment with an apical sinus. Maxillipeds with fourth, fifth, and sixth joints produced into apically setose lobes. Gnathopods without fringes of long plumose setæ. Uropods of male (except in *C. spinulosa*) having only the outer ramus strongly developed.

LEACH having only *C. latreillii* on which to found his genus, availed himself of characters which would exclude many of the forms now grouped under this generic name. The four marks which he used for distinguishing *Cilicæa* among the Sphæromidæ were: first, the approximate equality of the sixth and seventh segments of the peræon; second, the prolonged medio-dorsal process on the anterior division of the pleon; third, the apical sinus with central lobe in the hinder division of the pleon; and fourth, the rudimentary character of the inner ramus of the uropods. The second of these characters is conspicuous in fewer than half the species at present assigned to the genus.

The lobe within the apical sinus of the pleon is found in only four of the species, and the fourth character is subject to one curious exception, since in *C. spinulosa* the inner ramus of the uropods is rather longer than the outer. LEACH himself evidently suspected that the long process of the pleon might be peculiar to the male, and this has proved to be the case. But the females, so far as is known, besides being without the dorsal process, have the apical sinus, at least usually, simple, and the rami of the uropods subequal. WHITELEGGE, however, says that "the sexual differences in *C. hystrix* are very slight," and that in *C. stylifera* "the female does not differ materially from the male." He thinks it highly probable that the form figured by HASWELL as the female of *C. hystrix* may really be the female of *C. spinulosa*, HASWELL in his text leaving the point ambiguous. MIERS regards *Sphæroma pubescens*, MILNE-EDWARDS, the *Cymodocea pubescens* of HASWELL, as with scarcely any doubt the female of *C. latreillii*. H. F. MOORE explains *Cymodocea bermudensis*, IVES, as female of *C. caudata* (SAY), and suggests that *Dynamene nodulosa*, RICHARDSON, is the female of *C. caudata-gilliana*, RICHARDSON, *nodulosa* being apparently named by a slip of the pen instead of *tuberculosa*. But S. J. HOLMES makes it fairly certain that *Dynamene tuberculosa* is the female of *Cilicæa cordata*, RICHARDSON. As *tuberculosa* has page precedence, it will supersede *cordata*, and not without advantage to the genus, since to many ears *cordata* and *caudata* are indistinguishable. The confusion caused by the sexual dimorphism in this genus will not, perhaps, be very easily disentangled.

The following synoptic view of the species rather suggests that, for practical convenience, those which are devoid of the great dorsal process might be grouped under a separate generic name:—

1	Anterior division of pleon in male with long medio-dorsal process—2.
	Anterior division of pleon in male without such process—11.

2	Apical sinus in male with prominent central lobe—3.	
	Apical sinus in male with central lobe very small or absent—5.	
3	The medio-dorsal process with apex simple.	1. *C. latreillii*, Leach, 1818.
	The medio-dorsal process with apex bifid—4.	
4	Outer ramus of uropods sub-apically notched.	2. *C. crassa*, Haswell, 1882.
	Outer ramus of uropods not notched.	3. *C. longispina*, Miers, 1884.
5	Apical sinus of pleon in male with very small central lobe.	4. *C. antennalis*, Miers, 1884.
	Apical sinus of pleon in male without central lobe—6.	
6	Surface of peræon conspicuously spinulose—7.	
	Surface of peræon smooth or moderately granular—8.	
7	Inner ramus of the uropods in male not shorter than the outer.	5. *C. spinulosa*, Haswell, 1882.
	Inner ramus of the uropods in male shorter than the outer.	6. *C. hystrix*, Haswell, 1882.
8	Apex of medio-dorsal process not distinctly bifid—9.	
	Apex of medio-dorsal process distinctly bifid—10.	
9	Apex of medio-dorsal process truncate, slightly indented.	7. *C. caniculata* (Thomson), 1879.
	Apex of medio-dorsal process truncate, slightly trifid.	8. *C. granulata*, Whitelegge, 1902.
10	Outer ramus of uropods in male with bifurcate apex.	9. *C. tenuicaudata*, Haswell, 1881.
	Outer ramus of uropods in male with simple apex.	10. *C. whiteleggei*, n. sp., 1905.
11	Apical sinus of pleon in male with minute central lobe.	11. *C. sculpta* (Holmes), 1904.
	Apical sinus of pleon in male with large central lobe—12.	
	Apical sinus of pleon in male without central lobe—13.	

12	Central lobe with the flanking apices bifid.	12. *C. granulosa*, H. Richardson, 1899.
	Central lobe with the flanking apices simple.	13. *C. linguicauda*, H. Richardson, 1901.
13	Apical sinus in male simple—14.	
	Apical sinus in male sculptured—17.	
14	Apical sinus visible from above—15.	
	Apical sinus dorsally concealed—16.	
15	Movable ramus of uropods in male stiliform.	14. *C. stylifera*, Whitelegge, 1902.
	Movable ramus of uropods in male uncinate.	15. *C. carinata*, H. Richardson, 1900.
16	Apical sinus concealed by a trilobed process.	16. *C. curtispina*, Haswell, 1882.
	Apical sinus concealed by a simple acute process.	17. *C. ornata*, Whitelegge, 1902.
17	Apical sinus with two teeth in the border.	18. *C. beddardi*, n. sp., 1905.
	Apical sinus with four teeth in the border.	19. *C. caudata* (Say), 1818.
	Apical sinus with six teeth in the border—18.	
18	Teeth in the sinus boldly cut.	20. *C. tuberculosa* (H. Richardson), 1899.
	Teeth in the sinus minute.	21. *C. gilliana*, H. Richardson, 1899.

In regard to this list it should be mentioned that Miers treats Haswell's *C. crassicaudata* and his own *C. longispina* as two varieties of *C. latreillii.* The specific name of *C. antennalis* he adopts from White, who published it in 1847 without a description. The species described by G. M. Thomson, in 1879, as *Nesea caniculata* was recorded by Thomson and Chilton, in 1886, as *Næsa canaliculata*, with a notice that Miers supposed it to belong to *Cilicæa*, and that the type specimen had apparently been lost. Miss Richardson's *C. gilliana* was described by her under the name *C. caudata gilliana*, as a new sub-species of *C. caudata* (Say). Species that may belong to the genus, but which have as yet only been described in the female form, are not included in the list.

Cilicæa latreillii, Leach—Plates III. (B), VIII.

1818, **Cilicæa latreillii**, Leach, 'Dict. Sci. Nat.,' vol. 12, p. 342.
1825, **Cilicæa latreillii**, Desmarest, 'Consid. gén. Crust.,' p. 296, pl. 48, fig. 3.
1836, **Cilicæa latreillii**, Guérin, 'Iconogr. Règne Animal,' pl. 30, fig, 4 (by error marked 2 on plate; see explanation of plates, p. 32, second edition).
1840, **Nœsea latreillii**, Milne-Edwards, 'Hist. Nat. Crust.,' vol. 3, p. 218.

1881, **Cilicæa crassicaudata**, Haswell, 'Proc. Linn. Soc., N.S. Wales,' vol. 5, p. 475, pl. 17, fig. 3.
1884, **Cilicæa latreillei**, Miers, 'Zool. of the "Alert,"' p. 308, var. *crassicaudata*, p. 309.
1902, **Cilicœa crassicaudata**, Whitelegge, 'Mem. Austral. Mus.,' Mem. 4, p. 273, fig. 35.

Male.—Miers says, "the segments of the body are covered with a very short stiff pubescence." In the Ceylon specimen the integument is clothed with plumose setules accompanied by thin pellucid undulating fringes, the precise character of which is not easy to determine. Their function may be to retain a concealing coverlet of mud on the animal's coat, as suggested by Doflein ('Brachyura of the "Valdivia,"' p. 203), for the "leaf-hairs" of the Dromiacea and Oxyrrhyncha. The hind region of the last three peræon segments is ornamented with transverse rows of small granules. The long unsutured side-plates of the first segment have the narrowly-squared front apex commonly found in this and some other genera. In contrast to these, the side-plates of the next three segments are extremely short, those of the third segment ending acutely, with the points less produced than those of their neighbours on either side. The anterior division of the pleon projects a thick, apically obtuse, medio-dorsal process over and beyond the telsonic segment, leaving exposed to view the pair of sub-lateral bosses on that segment, but covering both the central lobe and the sides of its apical notch.

The first antennæ in the specimen figured have a flagellum of twenty-one joints. The second antennæ in the same specimen show a want of symmetry, in one member of the pair the fourth and fifth joints of the peduncle being considerably longer than any of the preceding joints, the flagellum ten-jointed, shorter than the peduncle, while in the other member the fourth and fifth joints of the peduncle are each shorter than the second, and the flagellum is twelve-jointed, longer than the peduncle. Normally, as shown by another specimen, and in Desmarest's figure, the first antennæ are not, as in this instance, longer, but shorter than the second.

Mandibles with dark horn-coloured cutting edge with dentation obscure, accessory plate bidentate on one mandible, simple on the other, a tuft of spines between this and the prominent molar, palp slender.

Maxillipeds: The second joint has a sinuous outer margin to the stem, its plate is of moderate breadth, and the ultimate joint of the palp reaches well beyond the lobe of the penultimate joint.

First gnathopods: Third joint elongate, hind margin carrying many little groups of spinules, front distally channeled and above the groove produced into an obtuse spine-tipped process, fourth joint broader than long, its spine-tipped front apex overlapping the fifth joint, with seven spines along the hind margin; small fifth joint with five, and sixth joint with six spines along the hind margin, of the last set the sixth being shorter than the one before it, but with this exception, the three successive sets of slightly serrate spines beginning with smaller and ending with larger forms. The finger is strong, as long as the stout sixth joint, ending in two horny nails, of which the short inner one is serrate on its inner margin.

The second gnathopods are less robust, the spines of the front margin more developed, those of the hind margin more numerous, but for the most part not so strong, the fifth joint not differing greatly in size and character from the fourth, the finger not quite so long as the sixth joint, and its inner nail showing no serration.

The fifth peræopod is the longest of the limbs, the process of the third joint by successive reduction in prominence here almost disappearing, the fourth, fifth, and sixth joints attaining their greatest elongation, and the finger being decidedly shorter than the preceding joint.

The first pleopods exhibit an interesting feature of the inner branch in that its inner margin, instead of joining the outer either by a continuous straight line or a convex curve, here makes a slightly concave sweep from the point where the fringe of long, feathered setæ begins. The second pleopods, as already described and figured by Mr. WHITELEGGE, are remarkable for the great length and corrugated appearance of the male stilet. This in our specimen, as in that described by Mr. WHITELEGGE, was stiffened into a strongly bent position. The three following pairs have the covering branch sutured and lying very close to the branchial plate. In the fifth pair the short, but broad, portion beyond the suture is bilobed, and from the junction of the lobes rises a forward-pointing lappet, this, with the border of the inner lobe, and two tubercles just in advance of the suture, being also closely beset with little teeth or prickles in regular arrangement.

The uropods have the short stout peduncle produced on the inner side to a short thick process representing the inner ramus, of which the appearance varies considerably with the point of view. The stout, blunt outer ramus has a tooth on the outer margin at some distance from the apex, often obscure, and, according to MIERS, occasionally obsolete.

Length, 11 millims. to 13 millims. From the tendency of the specimens to fold up, the exact length is not very easily measured.

Localities :—South of Manaar ; Coral reef, Gulf of Manaar ; Pearl banks, Palk Bay. One specimen was obtained at each station.

Cilicæa latreillii, LEACH, juv.—Plate III. (B).

This small specimen is remarkable for its coat. This may be described as thickly beset with short, stiff, irregularly blunt setæ covering all the dorsal surface, except such parts as are adapted for sliding under neighbouring parts. In the 'Zoology of H.M.S. "Alert,"' pp. 308–310, 1884, Mr. E. J. MIERS makes *Sphæroma pubescens*, MILNE-EDWARDS, 1840, doubtfully, a synonym of *Cilicæa latreillii*, and HASWELL'S *Cymodocea pubescens*, 1881, with conviction, another synonym. His remarks on the variations of this species according to age, sex, and individuality, should be carefully studied by anyone interested in the subject. HASWELL gives the length of his longest specimen of *Cymodocea pubescens* as 1 inch. That the setose covering should be worn down in large specimens might be easily explained, but it is less easy to understand in an evidently young specimen, such as that in the present collection. Probably, therefore, the peculiar setæ are not stumps due to attrition, but an inchoate stage of the undulating fringes noticed above. It will be observed that the spines of the first gnathopod are not blunted, and the finger clearly shows a delicate serration of the inner margin and small setules on the outer. In the adult male the serration is less easy to observe, the finger having become thicker and coarser.

Length 6 millims., breadth 3 millims.

Locality :—Coast of Ceylon, under 100 fathoms.

Cilicæa whiteleggei, n. sp.—Plate IX. (A), (B).

Male.—This species is easily distinguished from *C. latreillii* by its much slighter general structure, as well as by the character of the very elongate dorsal process in the front division of the pleon, the terminal part of which is not conical but almost parallel-sided and sharply bifid at the apex. Also, the apical notch of the telsonic segment is simply semicircular without median lobe. The three species which make a nearer approach are *C. tenuicaudata*, HASWELL, distinguished by the bifid apices of the uropods ; *C. caniculata* (G. M. THOMSON), with practically truncate apex to the dorsal process and the free ramus of the uropods short and thick ; and lastly *C. granulata*, WHITELEGGE, which also has the dorsal process truncate, "with three small terminal subspiniform granules." This last species attains a length of 13 millims., therefore greatly exceeding in size that which I am here naming after Mr. WHITELEGGE out of respect for his useful researches in this group.

The surface is very inconspicuously granular and hairy, only on the pleon and uropods showing these characters at all distinctly. The side-plates are similar to those of the preceding species, but having in addition a subcarinate appearance along the upper portion. The pleon, which is as long as head and peræon combined, has a rounded tooth or projection on either side of the dorsal process at its base, which must be regarded as an additional distinction between this species and *C. granulata*. It has "a submedian pair of tubercles transversely disposed behind the middle of the terminal segment," such as WHITELEGGE considers distinctive of the female in his species.

The first antennæ have the flagellum consisting of ten or eleven unequal joints, with sensory filaments on the last five. The longer second antennæ have the last joint of the peduncle decidedly longer than the penultimate, the flagellum longer than the peduncle, fifteen-jointed.

In the mouth organs it was probably a casual abnormality that the first maxilla had only three setæ instead of the usual four on the inner plate.

The maxillipeds differ from those of *C. latreillii* by the stronger stem of the second joint, which has a straight outer margin and carries a much wider plate ; also the lobes of the fifth and sixth joints are longer than in the older species.

First gnathopods : The third joint projects and carries a spine at the middle of the front margin, but has no process. The fourth joint has a spine at the front apex and three on the hind margin, the small triangular fifth has two spines, and the sixth three on the hind margin ; the finger has a horny principal nail, but the accessory nail is only represented by a small pellucid spine.

The second gnathopods have similar fingers, but the four preceding joints more elongate, the fifth joint being of the same character as in the peræopods. Most of these limbs show a fur-like clothing of the inner margin of the fourth and two following joints ; the spines are quite small and not very numerous ; the proportions of the joints are variable, in the long fifth peræopods the fourth joint being as long as the third or the sixth and a little longer than the fifth.

The first pleopods have the inner branch triangular with no distal emargination of the inner border. Both branches are covered with scale-like markings. The male appendix of the second pair is produced only a little way beyond the branches and is subapically widened but apically narrowed to a short obtuse point, thus differing from the longer, not subapically widened, stilet in *C. granulata*. The third pleopods differ from those of *C. latreillii* by having the inner branch considerably shorter than the outer, and the part of the outer branch below the suture with a breadth much less in excess of its length.

The uropods have a dorsal tubercle on the peduncle ; the peduncle is widened above on the inner side, and is still more widened below into the short unjointed inner ramus. The outer ramus is very long and nearly straight, the tolerably acute tip tending to bend outwards.

Length at full stretch from front of head to end of dorsal process of pleon, 8·5 millims. The uropods reach little beyond the dorsal process.

Localities :—Cheval Paar, Gulf of Manaar ; deep water off Galle ; off Foul Point, Trincomalee, Station XXIV.

Female.—The form which I regard as the female of this species is devoid of the long dorsal process and has the rami of the uropods subequal. It is also considerably smaller than the male. But in other respects the agreement between the two forms is so close as to leave little room for doubt that they are the same species. The maxillipeds are especially characteristic. The antennæ, first gnathopods, and fifth peræopods, as will be seen by the illustrative figures, are in close agreement. The pleopods, in addition to agreement in shape, show the same scale-like markings.

The uropods have the fixed branch squarely truncate, the outer narrowly ovate, with its apex acute, turned slightly outward. The front division of the pleon has a faintly marked medio-dorsal projection of its hind margin. The telsonic segment has two prominent submedian bosses and a semicircular apical notch.

Localities :—Trincomalee, Station XXIV., off Foul Point ; deep water off Galle.

Cilicæa beddardi, n. sp.—Plate X. (A), (B).

Male.—This species is nearly related to *C. caudata* (Say), but, according to the more recent descriptions and figures of the latter by Ives ('Proc. Ac. Sci., Philad.,' 1891, pp. 188, 194, pl. 6, figs. 11–16), and by H. F. Moore ('Bull. U.S. Fish. Comm.,' vol. 20 for 1900, p. 172, pl. 10, figs. 5–8, 1902), the present form must be considered distinct. Say, in his original account, speaks of the telsonic segment as "marked by a deep sinus, within which are two or four small teeth." Ives, who had six male specimens from Bermudas, takes no notice of the alternative two teeth, but says, "there appears to be a tendency in the four spines within the sinus of the posterior abdominal segment to become double." Moore says, "the apical notch is furnished with four teeth, two small ones at the base, and two larger ones outside of them and at a slightly lower level. The two limbs forming the borders of the notch are notched at their tips and furnished with a tuft of setæ." These notches at the tips are also very clearly shown in the figure given by Ives. In the Ceylon species there are decidedly only two teeth within the sinus, and the tips of the sinus are not notched, but carry dorsally an upright tuft of setules seemingly seated on a tubercle.

A few setules rise from the dorsal surface throughout the length of the animal. There is little difference in length between the segments of the peræon, except in regard to the seventh, which is the shortest, and has its side-plates rounded, less produced than the rest. The anterior division of the pleon has a transverse row of five small setulose tubercles. To these succeed on the telsonic segment three longitudinal ridges divided into tubercles, some of which carry setules. Behind the ridges the segment is depressed and has a group of setules in advance of the sinus which has been above described.

The first antennæ have an eight-jointed flagellum. In the second antennæ one member had the flagellum ten-jointed, while in the other it was seven-jointed.

The epistome is conspicuously tri-lobed above. The distal margin of the upper lip is evenly convex.

One of the mandibles has both cutting edge and accessory plate tri-dentate. On the other the dentation of these parts is obscure. They are succeeded by a bunch of spines. The molar is well developed; the palp slender, with its first joint not much longer than the second or third.

The first maxillæ have the usual four feathered setæ on the inner plate, the apical spines of the outer plate slender.

The maxillipeds are slightly constructed, with the last four joints apically setiferous, the three preceding the terminal joint being produced into narrow lobes.

The limbs are very similar to those of *Cilicæa whiteleggei*, but rather less robust. The second peræopod on the right side of the specimen figured has the sixth joint reduced to an oval stump, carrying no finger.

The first pleopods are remarkable for having the inner ramus twice as broad as it is long, agreeing with the same appendage as described by Whitelegge for *Zuzara emarginata*, Haswell. The second pleopods also have the inner ramus much broader than long, with the male appendix a little longer than the breadth of the ramus, transparent, smooth, of uniform width, with the apex turned a little away from the ramus. The outer ramus has the serration of its distal outer margin produced into prominent teeth. The third pleopods have the portion of the outer ramus beyond the suture nearly as long as it is broad. The fourth and fifth pairs have branchial folds on both rami.

The uropods are very hairy. The short peduncle is produced into a quadrate process representing the inner ramus, which has its lower angle a little acutely produced and beset with short feathered setæ. The movable ramus is long, cylindrical, slightly curved, the outer margin being convex.

Length 5 millims., breadth 2·5 millims.

Locality :—Cheval Paar; Muttuvaratu Paar.

Cilicæa (?), sp. juv.—Plate IX. (C).

The small specimen figured is no doubt immature, as may be judged from the unfurnished condition of the maxillipeds. The pleon differs little from that of the female or young *C. whiteleggei*, except that the outer ramus of the uropods shows no outward curving. The first antennæ have a massive peduncle and a flagellum of eight joints or, perhaps, more. The flagellum of the second antennæ is twelve-jointed. In the finger of the gnathopods the little spine or tooth at the base of the nail is comparatively strong.

Length, in a somewhat bent position, about 5·5 millims.

Locality :—Palk Bay.

Cymodoce, Leach.

1814, **Cymodoce**, Leach, 'Edinburgh Encycl.,' vol. 7, p. 433.
1902, **Cymodoce**, Stebbing, 'South African Crustacea,' part 2, p. 73.
1904, **Cymodoce**, Stebbing, in Gardiner's 'Fauna, Maldive and Laccadive Archip.,' vol. 2, pt. 3, p. 712.

Cymodoce bicarinata, Stebbing—Plate X. (C).

1904, **Cymodoce bicarinata**, Stebbing, in Gardiner's 'Fauna, Maldive and Laccadive Archip.,' vol. 2, pt. 3, p. 712, pl. 52B.

The specimen here figured differed from the type by its greater proportionate breadth, being 4 millims. broad by 6 millims. long, while the flagellum of the first antennæ was only eleven-jointed, and that of the second fourteen-jointed. But the long genital papillæ* of the seventh peræon segment and the greatly produced inward curving male appendix of the second pleopods and various other features showed close agreement. To judge by other specimens, the breadth is variable.

Milne-Edwards, 'Hist. Nat. Crust.,' vol. 3, p. 213, 1840, describes *C. pilosa* as

* This term is introduced by Dr. H. C. Williamson in the 'Twenty-second Annual Report of the Fishery Board for Scotland,' part iii., p. 101, 1904. For an earlier vague use of it by v. Willemoes Suhm, see '"Challenger" Amphipoda,' p. 438.

follows:—"Body very flexible and almost smooth in front, but granular and setose in the hinder half. Front obtuse as in *Sphæroma*; hind margin of the first pleon segment furnished with two rounded tubercles; two tubercles similar but much larger, more salient and above all more elongated, situated on the last pleon segment and separated by a longitudinal furrow, at the extremity of which is found a boss furnished with a pencil of long setæ. Terminal incision of the pleon very wide; the elongate median process almost cylindrical, rounded at the end, and terminating at the level of the extremity of the two teeth formed by the sides of the incision. Terminal plates of the uropods reaching much beyond the extremity of the pleon; the inner large and obtuse; the outer much broader, thin on the inner side, but very thick towards the outer margin and armed with a conical tooth at its extremity. Length about 6 lines. Habitat, the Mediterranean." A length of 12·5 millims., compared with 6 millims., makes the difference in size very considerable, but in other respects there is a close resemblance between the Pacific species and that described from the Mediterranean.

Localities:—East of Shoal buoy; off Chilavaturai; on trap sunk to bottom, Shoal buoy.

Cymodoce inornata, Whitelegge.

1902, **Cymodoce inornata**, Whitelegge, 'Mem. Australian Mus.,' iv., pt. 4, p. 263, fig. in text.

The specimen referred to this species agrees well with Mr. Whitelegge's account and figure. It has the body minutely hairy, the pigmented area of the eyes with the narrow end directed backwards, the process in the apical sinus of the telsonic segment small and rounded, the outer ramus of the uropods bidentate, with the outer tooth smaller and higher up than the inner.

On the other hand, it should be stated that the apical sinus is much more marked than that which Mr. Whitelegge represents, and the tip of the median process scarcely reaches the level of the apices of the sinus. The outer ramus of the uropods is not so forcibly bidentate as in Mr. Whitelegge's figure, and above the semicircular depression, which that author mentions as extending from one uropod to the other, the telsonic segment is here bilobed. In the Australian memoir it is spoken of simply as convex.

Length about 12 millims., equal to twice the breadth. The specimen was crowded with young ones, in which the eyes were already visible.

Locality:—Coral reefs, Gulf of Manaar. A second specimen was taken south of Adam's Bridge.

Tribe: VALVIFERA.

To the tribe, in 1897, Sars assigned the three families Idotheidæ (synonymous with Idoteidæ), Arcturidæ (with suggestion of Astacillidæ as the proper substitute), and Chætiliidæ. The late Axel Ohlin in 1901 added a new family, Pseudidotheidæ, to receive the three species, *Idothea miersii*, Studer, *Pseudidothea bonnieri*, Ohlin, and *Arcturides cornutus*, Studer. He was, however, almost convinced that the first two were identical, and suspected that in any case both would have to be transferred to *Arcturides*, the genus of the third. He recognised that in the latter event the family name would have to be changed. It would rather inconveniently become Arcturididæ. Another family, likewise intermediate between the Idoteidæ and Astacillidæ, is now required. This is remarkable for the negative character in which it agrees with the Amphipoda Caprellidea, a common result being no doubt referable not to any close tie of consanguinity, but to the simple fact that in each instance nature has enabled a species to get rid of limbs for which it had no further use. For the genera *Antarcturus* and *Pseudoprion*, zur Strassen, see 'Zool. Anzeiger,' vol. 25, p. 686; vol. 26, p. 31; 1902–03.

Family: AMESOPODIDÆ, nov.

Body not geniculate, but antennæ, mouth organs, first gnathopods, and appendages of pleon nearly as in the Astacillidæ. Second gnathopods ambulatory, not setose, not fully jointed. First and second pairs of peræopods unrepresented, except by the marsupial plates in the female.

Amesopous, n. gen.

To the characters of the family none can be added for generic distinction, so long as the family contains but a single genus. It may be noticed that the first segment of the peræon is coalesced with the head, that all the segments of the pleon are fused into one, and that the wrist and hand of the first gnathopods are fringed with conspicuously trifid setæ.

The name is framed to express the default of the median pairs of legs. In *Cleantis*, Dana, a genus of the Idoteidæ, which in general facies makes some approach to the present, the second peræopods are the smallest of the limbs. In *Arcturides* the head is only incompletely separated from the first peræon segment, but Ohlin finds this fusion complete in his *Astacilla falclandica*, and nearly so in *A. magellanica*.

Amesopous richardsonæ, n. sp.—Plate XI. (A).

Head united to first peræon segment without apparent suture, rostral point minute, lateral lobes produced about to the end of the first joint of the upper antennæ. Body in male narrowly cylindrical, the limbless segments of the peræon the smallest, but in the ovigerous female the cephalothorax widens distally, and the second, third, and fourth peræon segments which carry large marsupial plates are much wider, the third and fourth being also considerably longer than any of the three following segments. The pleon is narrowly ovoid, narrowly rounded at the apex. In lateral view the dorsal outline is corrugated, and the female has a pair of dorso-lateral tubercles on each of the second, third, and fourth peræon segments.

The eyes are dark, laterally protuberant just below the frontal lobes of the head. The facets are small and numerous.

The first antennæ reach some way along the third joint of the second pair which they overlie. The first joint is stout, a little longer than broad, the second and third shorter and much narrower, together as long as the one-jointed flagellum, which carries three apical sensory filaments.

The second antennæ have a very short first joint, the second not long, the fifth rather longer than the third and rather shorter than the fourth, the three-jointed flagellum being as long as the peduncle's third joint. The very short apical joint is tipped with a curved spine.

The upper lip appears to be rounded. The lower lip forms two broadly rounded lobes.

The mandibles are without palp, with small tridentate cutting plate and narrow accessory plate, close to which is a strong but not elongate molar with finely denticulate crown.

The first maxillæ show only two plumose setæ on the apex of the inner plate, and nine not very elongate spines on that of the outer plate.

The second maxillæ are remarkably short, with short comparatively broad plates, the outermost tipped with two long setæ, the middle one with four that are not so long, and the innermost with five that are shorter and more spine-like.

The maxillipeds have the lobe of the second joint produced about to the end of the fifth joint and armed on the inner margin with setæ and with three or sometimes only two hooks. The third joint is small, the fifth broadly oval, the sixth much shorter, nearly as broad as long, the seventh almost tubercular; the fifth and sixth are well fringed with setæ on the inner margin. The epipod is quadrately oval in the female, but in the male balloon-like, being very narrow at the base.

The first gnathopods are closely applied to the mouth. They have the fourth joint somewhat cup-like, much broader than the third, the fifth joint longer but not so wide, the sixth narrower than the fifth but subequal to it in length, and both of these notable for the trifid setæ along the inner margin. The middle branch of the setæ is the longest. The narrowed apical part of the sixth joint has curved setæ on the outer margin. The finger is short and conical, and tipped with a spine.

The second gnathopods display only five joints. The finger has its inner margin denticulate and ends in a very small curved unguis, agreeing with the finger in the third, fourth, and fifth peræopods. The two preceding joints have the inner margin denticulate or serrate. Of the four joints preceding the finger the second is not longer than broad, the third is shorter than the first, and the first than the fourth. Whether the first represents a coalescence of the first and second or of the second and third joints, or whether the fourth may be a fusion of the true fifth and sixth joints it is, perhaps, vain to speculate.

The three hinder peræopods are almost exactly alike, the second joint in the female decidedly longer than the sixth, but scarcely so in the male. The third joint is longer than the fourth and the fourth than the fifth.

The first and second pleopods have two slender branches with long apical setæ.

The others appear to be simply branchial, narrowly oval, without setæ. A male pleopod figured shows one of the branches apically divided for a short distance. The smooth inner division is probably the male stilet in preparation.

The uropods are elongate, the narrowly triangular terminal division being about a quarter as long as the peduncle. Within it is a plate about two-thirds as long and half as broad, with a long seta on its rounded apex.

The female is brown, with numerous conspicuous white spots, and three dorsal longitudinal dark bands. The males did not exhibit any white spots, and had two dorso-lateral dark bands.

The length of the female was 6 millims., not including the second antennæ which were 2·75 millims. long. The longest male was 4 millims. From this the detail figures of the male are taken. The male figured measured 2·5 millims. in length. The sex of the female specimen was beyond question, as it was provided with fourteen large eggs. As to the other much smaller specimens one must speak with more reserve, as they might be young ones of either sex.

Locality :—From pearl oysters, East Cheval Paar.

The specific name is given out of respect to the assiduous work which Miss Harriet Richardson has devoted to this tribe of the Isopoda.

Family: IDOTEIDÆ.

Idotea, Fabricius.

1798, **Idotea**, Fabricius, 'Supplementum Ent. Syst.,' p. 302.

Idotea sp.

In a tow-net gathering off Marichchukaddi there were two specimens of a young *Idotea*, 2 millims. long, in which the last pair of peræopods were not yet visible.

Family: ASTACILLIDÆ.

Astacilla, Cordiner.

1795, **Astacilla**, Cordiner, 'Remarkable Ruins . . . and Singular Subjects of Natural History.' Section, "Astacillæ," etc.

1893, **Astacilla**, Stebbing, 'History of Crustacea,' p. 370.

1897, **Astacilla**, Sars, 'Crustacea of Norway,' vol. 2, p. 87.

1904, **Astacilla**, Norman, 'Ann. Nat. Hist.,' ser. 7, vol. 14, p. 447.

Astacilla amblyura, n. sp.—Plate XI. (B).

The head has a minute rostral point and the usual broad lateral lobes in advance of the dark protuberant eyes; it is rather gibbous between the eyes and apparently has a pair of tubercles wide apart in advance of the hump. The specimen was rather foul with adhesive extraneous matter, by which the excrescences were in part obscured, in part exaggerated, and there was some risk, in clearing away what was adventitious, of removing what really belonged to the animal. A strong groove (but not necessarily an articulation) separates the first segment of the peræon from the head. The long fourth segment has a dorsal hump in advance of the middle and a small medio-dorsal tubercle closely flanked by two others a little to the rear of it on the hind margin. The sixth peræon segment appears to have two lateral tubercles, the fifth and seventh segments each one such tubercle on either side. No transverse dorsal divisions of the pleon could be discerned, but on each lateral margin there are three projections; to the last and most prominent of these a short obtusely ending apical triangle succeeds, very different from the acute ending of the pleon in the four Norwegian species figured by Professor G. O. Sars, but agreeing with the apex in *A. granulata*, Sars, and *A. marionensis*, Beddard.

The first antennæ are normal, with stout first joint, the second and third successively narrower, the one-jointed flagellum fringed with thirteen or fourteen sensory filaments.

The second antennæ are very little shorter than the body, the third joint much stouter distally than at its base, the fourth joint the longest of all, but much narrower than the third and curving to a little conspicuous tooth not far from the base; the fifth joint is narrower, intermediate in length between the third and fourth, about twice as long as the three-jointed flagellum.

In the mouth parts and limbs there is scarcely any tangible difference from the corresponding structures figured by Sars for *A. longicornis* (Sowerby).

On one of the mandibles, between the accessory plate and the strong molar, in this species two or three short spines are to be seen crowded into a very narrow space. The cutting edge has three or four close-set teeth. The first maxillæ have three setæ on the inner plate, nine very short spines on the outer. The second maxillæ have the inner plate much broader and more setose than the other two plates. In the maxillipeds the broad plate of the second joint is armed with a remarkably large coupling hook; the seventh joint is well developed, not unguiform.

The first gnathopods, of which the last four joints are by no means unlike the corresponding four of the maxillipeds, have serrate spines on the broad fifth joint. The seventh joint has one conspicuous spine among many that are smaller. The second gnathopods and the first and second peræopods are, as usual, alike, very slender, with the seventh joint minute, this and the three preceding joints being furnished with very long setæ. The fourth, fifth and sixth joints are subequal in length. The third peræopods are a little longer than the fourth or fifth, all three pairs being stoutly built, with the second and sixth joints longest, but none very elongate or conspicuously armed, except the finger which has a stout apical tooth on the inner margin in addition to the short curved nail. The finger is also tuberculate on the inner margin, and this is perhaps the case with some of the preceding joints.

The pleopods agree very nearly with those which have been figured by Sars for the male of *A. longicornis* and *A. granulata*, the first two pairs having slender rami, with the setæ of the apical border elongate, and the masculine appendix of the second pair forming a narrow stilet which reaches to the end of the ramus and carries two long apical setæ.

The uropods are rounded above, widest below the middle, then rather rapidly narrowed to the rami, of which the external is very small, acutely triangular, and reaching to the apex of the pleon. The internal ramus is still smaller. Colour in spirit a dull yellowish.

Length 9 millims., apart from the antennæ, the lower of which are nearly as long as the body, about 8·5 millims.

Locality :—Periya Paar, Gulf of Manaar.

A specimen, 4 millims. long, delicately pink in colour, from East Cheval Paar, is no doubt the young of this species. It has the first peræon segment not marked off from the head, the fourth segment very elongate and smooth. The flagellum of the first antennæ is armed about the apex with only three or four sensory filaments. The fifth peræopods are still imperfectly articulated, very small, ending obtusely without a nail.

Another specimen, from East Cheval Paar, is only 3 millims. long, with the fifth peræopods in a still more inchoate condition. Here, however, the fourth segment of the peræon is not especially elongate and shows traces of median and terminal tuberculation. The colour is a delicate pink. Neither in this nor the other juvenile specimen is there a tooth on the fourth joint of the lower antennæ.

The specific name is from the Greek ἀμβλύς, blunt, and οὐρά, tail. Apart from size and arrangement of tubercles, the distinguishing characters of this species depend on the antennal tooth just mentioned, the decided groove between head and peræon, the solidarity of the pleon, and the extension of the uropods further back than appears to be the case in any of the species hitherto described.

Tribe: ASELLOTA.

Family: JANIRIDÆ.

Sars, when separating this family in 1897 from the Asellidæ, incidentally mentioned *Stenetrium* as belonging to the latter. Miss Richardson, in 1902, without comment transferred the genus to the newer division within the Asellota. It certainly seems to conform in many important respects to the following definition which Sars himself gives of the Janiridæ :—

"General habitus that of the Asellidæ, but the lateral parts of the cephalon always lamellarly expanded. Eyes, when present, subdorsal. Superior antennæ sometimes well developed, with the flagellum multiarticulate, sometimes very small, with rudimentary flagellum. Inferior antennæ always longer than the superior, with the peduncle six-articulate, and generally carrying a small accessory appendage (scale) outside the third joint. Oral parts normal. Legs subequal in length, with the dactylus generally bi- or tri-unguiculate ; first pair sometimes differing from the others in being prehensile. First pair of uropoda [pleopoda] in female transformed into a single, large, opercular plate; in male, constituting the median piece of the compound operculum, the lateral pieces of which are formed by the copulative appendages. The three succeeding pairs very delicate, the last pair forming simple, smooth lamellæ, the two preceding ones with the outer ramus narrow and confluent with the basal part. Uropoda biramous, more or less developed."

From this characterization Miss Richardson's account varies in one or two respects, assigning to the Asellidæ and Janiridæ in common a feature which Sars only attributes to the former, namely, that the first antennæ issue close together, which cannot be predicated of all the Janiridæ, and omitting a feature on which Sars lays stress, namely, that the peduncle of the second antenna is six-jointed. In two species of *Stenetrium* the small fourth joint of this peduncle has been clearly observed, but in three of the species, including the one first assigned to the genus, it is either not present or has been overlooked.

Sars speaks of nine or ten genera as being included in the family, and since he wrote, the genus *Carpias*, Richardson, 1902, has been added. In 1901, Dr. Ortmann ('Proc. Ac. Philad.,' p. 157) introduced the new generic name *Tole* to take the place of "*Janthe*, Bovallius," on the ground of preoccupation. In this he is followed by Miss Richardson in 1905. But the genus which Bovallius instituted in 1881 is *Ianthe*, not *Janthe*, so that no change is required. Moreover, in his key to the species of *Tole*, the first species which Dr. Ortmann mentions is "*J. bovallii* (Studer)," which was named *Ianthopsis bovallii* by Beddard in 1886 ('"Challenger" Isopoda,' vol. 17, pt. 48, p. 15, pl. 5, fig. 5). Seeing that Dr. Ortmann expressly adopts the type species of *Ianthe* as the type of *Tole*, that name must lapse as a synonym, and could not properly be revived in case either *Tole libbeyi*, Ortmann, or *Tole holmesi*, Richardson, should in future be transferred from *Ianthe* to a distinct genus.

Janira, Leach.

1814, **Janira**, Leach, 'Edinburgh Encycl.,' vol. 7, p. 434.
1886, **Janira**, Beddard, '"Challenger," Isopoda, Reports,' vol. 17, part 48, p. 5.
1897, **Janira**, Sars, 'Crustacea of Norway,' vol. 2, p. 98.
1898, **Janira**, A. O. Walker, 'Trans. Biol. Soc. Liverpool,' vol. 12, p. 280.

The species about to be described agrees in many respects with this genus as defined by Sars, but the fifth joint or wrist of the first gnathopods is not subfusiform; it is distally expanded, so as to form a kind of bidentate palm. The single specimen in the collection appears to be an adult male. It was, however, so exceedingly small and defective, having lost most parts of the second antennæ, all the last three pairs of peræopods, and the uropods, that it was not well suited for initiating a new genus. The parallel-sided peræon agrees with what is found in *Jæropsis*, *Stenetrium*, and *Iais*. Haswell's *Stenetrium inerme* may be congeneric, but the great difference in size makes specific agreement very unlikely.

Janira (?) nana, n. sp.—Plate III. (C).

The general appearance agrees with that of *Jæropsis curvicornis*, in company with which the specimen was taken, but the segments of the peræon are not so markedly separated. The pleon is nearly circular, not serrate, with a small apical convexity, on either side of which the uropods probably protrude.

The eyes are pale orange coloured, differing from those of *Iais pubescens* by having not two but thirty-eight components.

The first antennæ have a stout basal joint, the second much smaller, and the third almost like a flagellar joint; the flagellum is longer than the peduncle, its seven joints unequal in length, all slender, the last tipped with a couple of long setæ or filaments.

The upper lip is rounded, and seemed to be projected forward with the lower lip. The mandibles have a prominent cutting-plate divided into five teeth, the accessory plate on the left similarly divided, but bidentate on the right. The spine-row has five or six spines. The molar is prominent, denticulate. The three joints of the palp are subequal in length. The first maxillæ have a slender inner plate, and nine, mostly denticulate, spines on the outer. The outer and middle plates of the second maxillæ carry each three setæ. In the maxillipeds the plate of the second joint is rather large, with several plumose setæ on the distal margin, and one hook on the inner margin; the third, fourth, and fifth joints are broad, the fifth having its outer margin longer than the inner; the sixth and seventh joints are narrow.

The first gnathopods have the fifth joint much broader but not longer than the sixth, which in closing down would reach much beyond the palmar margin. The finger is much the same in all the known limbs of the peræon, having a short trunk with two distinct nails. The second gnathopods agree with the first and second peræopods in structure, but are longer, especially in the second, fifth, and sixth joints; the sixth joint is narrower than the preceding joint.

The male operculum is composed of the first two pairs of pleopods. The first pair are narrow and more or less tapering, but with a constriction below the middle. They end in two pairs of overlapping shortly lanceolate lobes. The second pair are semicircular, with a long sinuous almost filiform masculine appendix.

Length 1·5 millims. HASWELL'S *Stenetrium inerme* is described as $\frac{5}{16}$ths of an inch in length.

Locality :—Gulf of Manaar.

Jæropsis, KOEHLER.

1885, **Jæropsis**, KOEHLER, 'Ann. Sci. Nat.,' sér. 6, Zool., vol. 19, Art. 1, p. 2.
1886, **Jæropsis**, BEDDARD, '"Challenger," Isopoda, Reports,' vol. 17, p. 20.
1891, **Jæropsis**, CHILTON, 'Trans. New Zealand Inst.,' vol. 24, p. 267.
1893, **Jæropsis**, STEBBING, 'History of Crustacea,' p. 379.
1899, **Jæropsis**, H. RICHARDSON, 'Proc. U.S. Mus.,' vol. 21, p. 857.

1899, **Jæropsis**, NORMAN, 'Ann. Nat. Hist.,' ser. 7, vol. 4, p. 291.
1900, **Jæropsis**, H. RICHARDSON, 'Amer. Naturalist,' vol. 34, No. 400, p. 298.
1902, **Jæropsis**, H. RICHARDSON, 'Trans. Connect. Acad. Sci.,' vol. 11, p. 298.

By the addition, which is well justified, of *Jæra curvicornis*, NICOLET, Miss RICHARDSON is able to say in 1902 that "six species of this genus have been heretofore described." They are *J. curvicornis* (NICOLET); *J. brevicornis*, KOEHLER; *J. marionis*, BEDDARD; *J. neo-zelanica*, CHILTON; *J. lobata*, RICHARDSON; *J. dollfusi*, NORMAN; to which on the same occasion Miss RICHARDSON adds *J. rathbunæ*. *Jæra antarctica*, PFEFFER, may perhaps belong to the group, but the description and figures leave its generic location quite uncertain. All the species have many features in common. They range in size from 2 millims. to a little over 4 millims. The sides of the middle body or peræon are nearly or quite parallel, with the segments very distinctly separated. Both pairs of antennæ are short. The appendages of the peræon are truly isopodous, without any real distinction between gnathopods and peræopods. The uropods are small, carrying two minute dissimilar rami, and occupying emarginations in the distal border of the caudal shield. In the second antennæ the joint numbered second by KOEHLER, third by CHILTON, BEDDARD, and RICHARDSON, fourth by Canon NORMAN, is broadly expanded, unless *J. marionis* be an exception, for in that species the joint is figured as cylindrical rather than laminar.

It may perhaps be objected that there is a want of authority for the statement that the uropods occupy emarginations in the telsonic segment. Miss RICHARDSON indeed says that her species, *J. lobata*, differs from KOEHLER'S "in the shape of the terminal segment, which is perfectly rounded in *J. brevicornis*," while in *J. lobata* "there are two posterior incisions for the reception of the uropods." But one may easily press too far the differences shown in the habitus figures of very minute animals. When the highly magnified figure of the uropod of *J. brevicornis* is considered, it will be noticed that the outer margin is serrate, and this makes it probable that here as in other species it has its share in completing the curve of the tail-piece.

Jæropsis curvicornis (NICOLET)—Plate XI. (C).

1849, **Jæra curvicornis**, NICOLET, in GAY'S 'Hist. fis. y pol. de Chile,' Zool., vol. 3, p. 263, pl. 3, fig. 10.
1891, **Jæropsis neo-zelanica**, CHILTON, 'Trans. New Zealand Instit.,' p. 267.
1902, **Jæropsis curvicornis**, H. RICHARDSON, 'Trans. Connect. Acad. Sci.,' vol. 11, p. 298.

The body, as described by NICOLET, forms a rounded longitudinal medio-dorsal elevation. This is not particularly easy to see, but, when the specimen is placed back downwards, its rolling from side to side is evidence of the shape in question. The head corresponds with CHILTON'S description as being "produced slightly into a rostrum between the bases of the antennæ; end of rostrum emarginate, and with a rounded lobe fitting into the emargination." NORMAN says of the head in *J. dollfusi* "the anterior margin is emarginate, and in front of this the buccal organs are conspicuously projected," but his figure also shows the rounded lobe in the emargination. The figure of *J. dollfusi* shows the pleon more sharply contracted towards the apex and the sides more deeply serrate than is the case with the present species.

The eyes are not large, not dark, placed near the front angles of the head. The first antennæ have a broad basal joint, seemingly denticulate at the front corners. The second joint is much shorter and much narrower, the third smaller than the second, and the two remaining joints very insignificant, but tipped with two long filaments.

The second antennæ are of the typical form, seemingly with three short basal joints, followed by the characteristic large dilated joint with thin outer margin slightly crenulate, not strongly as in *J. dollfusi*; to this succeeds a much smaller, apically expanded joint, helping to form a double geniculation. The five remaining joints, perhaps, constitute the flagellum, but the first, which is very far the largest of them, has usually been accounted the terminal joint of the peduncle. It is, however, not very usual for the penultimate joint of the peduncle to be shorter than the joint preceding as well as the joint following it.

The upper lip has a rounded distal margin. The mandibles have the cutting edge cut into five teeth, eight spines in the spine-row, the three-jointed palp very small. The first maxillæ have three short spine-like setæ on the inner plate, and nine to eleven spines, mostly denticulate, on the outer plate. The second maxillæ are notable for the shortness of the inner plate; each of the three plates carries four apical setæ. The maxillipeds have a very large second joint with extremely broad plate, the distal margin slightly and irregularly crenulate with a gentle curvature or sinuosity, distinct from the quadrate character displayed in *J. dollfusi*. The coupling hooks are two. The fourth joint is distally produced on the inner margin, the sixth joint is very narrow and the seventh minute.

The limbs of the peræon differ but little, the fourth joint being shorter than the third, fifth, or sixth. The finger has two conspicuous nails and one that is inconspicuous.

The operculum of the pleopods in the female is broadly rounded for nearly two-thirds of its length, and then contracts to a narrowly truncate apex carrying four setules. It does not show marks of a longitudinal or a transverse suture, such as are said by Dr. CHILTON to be indistinctly visible in his specimen.

The uropods fill the emarginations of the pleon. The peduncle is more strongly serrate on the inner than on the outer margin. The inner ramus is hook-like; the outer, which is even smaller than the inner, carries a bunch of setæ.

Length 2 millims. NICOLET gives 2 lines for the length of his specimen; CHILTON about 2·5 millims. for his.

Locality :—Gulf of Manaar.

Family: STENETRIIDÆ*

Stenetrium, Haswell.

1881, **Stenetrium**, Haswell, 'Pr. Linn. Soc. N.S. Wales,' vol. 5, p. 478.
1882, **Stenetrium**, Haswell, 'Cat. of Australian (Malacostracan) Crustacea,' p. 308.
1884, **Stenetrium**, Chilton, 'Trans. N. Zealand Instit.,' vol. 16, p. 251.
1885, **Stenetrium**, Haswell, 'Pr. Linn. Soc. N.S. Wales,' vol. 9, p. 1009.
1886, **Stenetrium**, Beddard, '"Challenger" Isopoda, Reports,' vol. 17, pt. 48, p. 8.
1895, **Stenetrium**, Hansen, 'Isopoden der Plankton-Exp.,' p. 6.
1902, **Stenetrium**, H. Richardson, 'Trans. Connect. Ac. Sci.,' vol. 11, p. 295.
1905, **Stenetrium**, Hansen, 'Proc. Zool. Soc. London,' pp. 303, 316.

Five species have been assigned to this genus, *S. armatum*, Haswell, *S. inerme*, Haswell, *S. fractum*, Chilton, *S. haswelli*, Beddard, and *S. stebbingi*, Richardson. But Haswell's *S. inerme* differs from his other species in having rounded lateral eyes, the antepenultimate joint of the maxillipeds distally narrowed, and perhaps, also by having the rostrum subacute. It appears to belong to the genus *Notasellus*, Pfeffer, 1887. The union of the other four species in a single genus is probably justifiable, though in each case some important evidence is wanting. For *S. armatum* Haswell has twice figured the mandible, and on each occasion gives no indication of its possessing a molar. In *S. haswelli*, and in the species about to be described from Ceylon, this part of the mandible is strongly developed and too conspicuous to be overlooked. In the descriptions of *S. fractum* and *S. stebbingi* the presence or absence of this structure is not discussed. For the last-mentioned species no account is given of the pleopods, and for the other species the accounts of these organs are variable or uncertain. Including the new species, which is nearly allied to what is known of *S. fractum*, the genus may be defined as follows:—

Body depressed, parallel-sided. Pleon consolidated. Head bluntly rostrate. Eyes obliquely dorsal. First antennæ short, inserted close to the rostrum on either side of it. Second antennæ elongate, with exopod on the third joint. Mandible with palp. Maxillipeds with third to fifth joints broad, sixth and seventh narrow. First gnathopods simply or complexly subchelate. Second gnathopods and all the peræopods slender, ambulatory, biunguiculate. Pleopods not in every case biramose. Uropods biramose, not adjacent, inserted apically on the telsonic segment.

The uncertainty attending the characters in some of the species makes it difficult to

* After the manuscript of this paper had passed out of my hands, I received the luminous essay, "On the Morphology and Classification of the *Asellota*-group of Crustaceans, with Descriptions of the Genus *Stenetrium*, Hasw., and its Species," by Dr. H. J. Hansen ('Proc. Zool. Soc. London,' p. 302, April 18, 1905). In this the new family Stenetriidæ is defined (*loc. cit.*, p. 315), and nine species of *Stenetrium* are described, with illustrative figures of several and a conspectus of them all. Five are new, *S. mediterraneum*, *S. serratum*, *S. occidentale*, *S. antillense*, *S. siamense*. For a more accurate account of the pleopods than I had myself arrived at I am now indebted to Hansen's instructive treatise.

produce a useful synoptic table. The following is offered, therefore, with all necessary reserves :—

	Telsonic segment without lateral notch.	1. *S. haswelli*, BEDDARD.
	Telsonic segment with lateral notch—2.	
2	First gnathopod with hind margin of wrist produced.	2. *S. stebbingi*, RICHARDSON.
	First gnathopod with hind margin of wrist not produced—3.	
3	First antenna, second joint as long as first.	3. *S. fractum*, CHILTON.
	First antenna, second joint shorter than first—4.	
4	Margin of head convex between rostrum and antero-lateral angles.	4. *S. armatum*, HASWELL.
	Margin of head angular between rostrum and antero-lateral angles.	5. *S. chiltoni*, n. sp.

In the adult male the first gnathopods strikingly distinguish *S. haswelli*, *S. stebbingi*, *S. armatum*. But in the female of the last-named species these gnathopods do not appear to differ from those of *S. fractum*, and from those of *S. chiltoni* only by the greater robustness of the hands.

Stenetrium chiltoni, n. sp.—Plate XII. (A).

The whole body, dorsally and at the sides, is beset with rather long stiff setæ. The head has a rather broad, blunt rostrum not reaching so far forward as the broad epistome. The antero-lateral angles of the head are acutely incurved, and between each of these and the rostrum the margin is produced to a point, thus forming sockets for the first antennæ. The segments of the peræon differ but little in length or breadth ; the sides are nearly straight, with the anterior angles of the first four pointing acutely forwards. The telsonic segment has the lateral margins regularly but quite microscopically serrate, and, as in all the species except *S. haswelli*, each of these margins far down is produced into a tooth. The indentation or pocket thus formed is followed lower down by a small setiferous indent, to which succeed the rounded corners of the broad apical margin, with its shallow convex projection between the uropods.

The eyes are narrowly bean-shaped, placed obliquely near the middle of the convex lateral ridges that run below the anterior lobes of the head.

The first antennæ agree closely with those of *S. armatum*, the second joint being much shorter than the first and not so long as the third ; the flagellum is obscurely six-jointed. The second antennæ have the first joint acutely produced on the outer side, but the short second joint and the longer third are not produced on either side. The exopod is conical, having its truncate point tipped with a pencil of setæ. HASWELL has apparently overlooked the second joint and described the third as produced like the first externally and distally into a slender acute process, the process ending in a hair-like appendage. He does not mention the articulated scale or exopod. For *S. fractum* CHILTON describes and figures the third joint as "produced acutely at its antero-distal angle, bearing on the outer edge an articulated appendage, which has the end rounded and supplied with a few long setæ." The small fourth joint, which is seen in the present species and in *S. haswelli*, is not noticed or figured in connexion with the other three species, as noted in the discussion of the family. The fifth and sixth joints of the peduncle are elongate, the sixth slightly longer than the fifth, the flagellum three times as long as the sixth joint, rather longer than the whole peduncle, composed of very many little scarcely separated joints, setose.

The upper lip is apically rounded. The two broad lobes of the lower lip have the usual armature of minute spines.

Left mandible with dentate accessory plate like the cutting edge but smaller, spine-row of five serrate spines; right mandible without accessory plate, unless it be represented by the first of the five spines in the spine-row; cutting edge with four or five crowded teeth, but within the mandible the new teeth in preparation for the moult are spread out in one plane; molar long and prominent; palp of three long joints, the second carrying five short spines between two long ones, the third falciform, with long spines at apex, short ones fringing the margin.

First maxilla with three spines, a little tooth and some setules on apex of inner plate, and nine more or less denticulate spines on apex of outer plate.

Second maxilla with about four slender spines on apex of outer plate, and also on that of the middle one, the rather broader and more oval inner plate carrying several spines along the inner margin.

Maxillipeds with large distally narrowed epipods reaching nearly to the apical border of the broad lobes which surmount the second joint and considerably overtop the fourth joint; the third joint is short but broad, the fourth larger than the fifth, both of them broad and widened distally, the sixth and seventh being abruptly much narrower.

The first gnathopods have the second joint moderately long, the three following joints short, the fourth subacutely produced on the front margin; the fifth joint is setose on the hind margin; the sixth joint is less than twice as long as its greatest breadth; the front margin is curved and carries a few setules, the hind margin straight, furnished with many setæ; the palm, defined by a long spine, carries several smaller pectinate spines sloping towards this palmar spine; the finger, which curves over the palm and ends in a small simple nail (broken in the specimen), has a few setules on the convex margin and several microscopical spines on the concave border. CHILTON speaks of the palm of his species as "armed with strong serrated setæ," and the finger as having the "inner edge thickly fringed with strong denticulated setæ," but these expressions may refer to the armature as it appears when very highly magnified.

The second gnathopods appear to have a round-lobed first joint; the second joint is about as long as the third and fourth combined, the third being much longer than the fourth, nearly as long as the sixth, which is slightly shorter than the fifth. The finger is less than half as long as the sixth joint; it curves to a sharp apical point, which is overhung by an unguis-like spine, while on the concave margin of the finger there is a small spine. The peræopods differ little in character from the second gnathopods, except that the second joint is less elongated and the third joint is more nearly subequal in length to the sixth. To the first and second gnathopods and first and second peræopods in one of the specimens four pairs of marsupial plates were attached, the third pair being the largest, but the fourth also of considerable size. In dissection of the pleon there came away a linear ring, which, perhaps, represents a degraded first pleon segment. Dorsally two such segments are indicated.* A small unpaired plate, square above and triangular below, without any trace of longitudinal or other suture, must be regarded as representing the first pair of pleopods.† The second pleopods are wanting, as in other females of this tribe. The third pleopods form a very large pair of biramose appendages, the peduncle small, the inner ramus branchial, with three or four setæ on the narrow apex, the outer ramus of great size, with slightly oblique transverse suture below the middle, but starting just above the apex of the inner ramus. The fourth pair are biramose, and have the oval inner branchial ramus much broader and not shorter than the outer ramus, which shows a transverse suture above the middle and has the tapering lower division fringed with several long setæ. In the fifth pair each pleopod consists of a single branchial ramus, possibly representing a coalescence of two rami, the outer margin raised and distally fringed with setæ.‡

The uropods are inserted a little within the distal margin of the telsonic segment, separated by the convexity which may be considered an equivalent of the actual telson. The peduncle is rather stout, shorter than the rami, of which the inner is the larger, both being well furnished with tufts of long setæ on sides and apex.

Description of the uropods and the complete second antennæ is based on a specimen of the same dimensions as the one figured, but which did not come to light till after the less complete example had been figured. This second specimen was straight, but a third, rather smaller specimen with it had a distortion similar to that shown in the plate.

Length 4·5 millims., breadth 1·5 millims.

Locality :—Reef, Galle, with Ascidians; and Coral banks, Gulf of Manaar.

* For the genus at large HANSEN says, "two rudimentary segments are observed in front of the large abdominal shield" (*loc. cit.*, p. 304).

† HASWELL (*loc. cit.*, p. 1010) says: "The bases of the first pair of abdominal appendages are covered in both cases by a broad plate, with a bifid apex attached to the posterior border of the last thoracic segment." By "both cases" no doubt the two sexes are intended, and "the first pair of abdominal appendages" are really the third pair of pleopods.

‡ HANSEN in his character of the family says in regard to the pleopods, "fifth pair with only one ramus, in all probability the exopod" (*loc. cit.*, p. 315).

The specific name is given out of respect to my friend Dr. Charles Chilton, whose *Stenetrium fractum* has a name only too suggestive of the mishaps to which these delicate isopods are liable. Haswell's species is described as half-an-inch long, Chilton's as about a sixth of an inch. Though it remains a little doubtful whether the species here described belongs to Haswell's genus, the possibility is also open that *S. armatum*, *S. fractum*, and *S. chiltoni* may all be the same species.

Family: MUNNIDÆ.

Pleurocope, A. O. Walker.

1901, **Pleurocope**, Walker, 'Journ. Linn. Soc.,' London, vol. 28, p. 297.

Mr. Walker remarks that "this genus differs from *Pleurogonium*, its nearest ally, in the large size and peculiar appendages of the head, the different relative proportion and structure of the antennæ, in the form of the caudal segment, and in the position and size of the uropods, which are unusually large for the family." It may, however, be observed that in the genus *Dendrotion*, Sars, the uropods are larger and more conspicuous than in the present genus.

Pleurocope dasyura, Walker.

1901, **Pleurocope dasyura**, Walker, 'Journ. Linn. Soc.,' vol. 28, p. 297, pl. 27, figs. 12 to 18.

The description by Mr. A. O. Walker, and the excellent figures by Mr. Andrew Scott which accompany it, place the identification of this species beyond doubt. Beyond verification I have nothing to add, except that the peræon displayed four stiff upstanding dorsal setæ. A point of interest would have been to ascertain the character of the mandibles. But at the very moment when I was arranging the specimen for dissection, it disappeared like a dream, and defied all the efforts made for its re-discovery.

The length was a little over 1 millim., therefore approximately the same as Mr. Walker's type specimen from the Mediterranean. It came into my hands already named by Mr. A. Scott.

Locality:—Gulf of Manaar.

Tribe: ONISCIDEA.

Family: LIGIIDÆ.

Ligia, Fabricius.

1798, **Ligia**, Fabricius, 'Supplementum Ent. Syst.,' p. 301.
1885, **Ligia**, Budde Lund, 'Isopoda Terrestria,' p. 258.

Ligia exotica, Roux.

1828, **Ligia exotica**, Roux, 'Crust. Médit.,' livr. 3, pl. 18, f. 9.
1885, **Ligia exotica**, Budde Lund, 'Isopoda Terrestria,' p. 267.

A mutilated specimen occurs in the collection, which appears with little doubt to belong to this widely distributed species.

Locality:—Station XXXIX., Gallehogalle Bank, 16 to 30 fathoms

INDEX.

EXPLANATION OF PLATES.

PLATE I.

A. *Heterotanais crassicornis*, n. sp.—*n.s.*, natural size of specimen figured in lateral and in dorsal view; *a.s.*, *a.i.*, upper and lower antennæ more highly magnified; *gn.* 1, *gn.* 2, first and second gnathopods; *prp.* 1, *prp.* 3, first and third peræopods; *urp.*, uropod.

All the details are to the same scale, except the separate thumb and finger of *gn.* 1, and the separate outer branch of the uropod, which are more magnified than the other parts.

B. *Leptochelia mirabilis*, n. sp.—*A.n.s.*, natural size of specimen figured in dorso-lateral view, with first gnathopod of the right side supplied from fragments; *gn.* 1, part of first gnathopod of the left side, probably belonging to the above specimen and drawn to the same scale; *a.s.*, *a.i.*, third joint of peduncle and the flagellum of upper antenna, and the lower antenna—these and the following details on a higher scale of magnification; *gn.* 2, *prp.* 5, second gnathopod and part of fifth peræopod; *plp.*, *urp.*, one of the pleopods and a uropod; *B.n.s.*, natural size of specimen figured in dorsal view, showing lower antennæ and base of right upper antenna; uropods broken.

C. *Leptochelia lifuensis*.—*a.s.* ♀, *a.i.* ♀, upper and lower antennæ of female; *gn.* 1, ♀, *gn.* 2, ♀, first and second gnathopods of female; *urp.* ♀, uropod of female; *a.s.* ♂, *a.i.* ♂, upper and lower antennæ of male; *gn.* 1, ♂, first gnathopod of male; *urp.*, uropod of male.

All the above are magnified to the same scale as the general details in Plate I., A, except the separate ramus of the male uropod, which is magnified on the same scale as the corresponding ramus in Plate I., A.

D. *Tanais gracilis*, Heller.—*n.s.*, natural size of specimen figured in lateral and dorsal views; *a.s.*, *a.i.*, upper and lower antennæ very highly magnified; *gn.* 1, *gn.* 2, *prp.* 4, first and second gnathopods and fourth peræopod; *Pl.*, *urp.*, dorsal view of pleon and uropods, to the same scale as the preceding details; *m.*, *mxp.*, mandible and maxillipeds, exopod of the latter detached and incomplete. These and the separate portions of the second gnathopod and fourth peræopod are more magnified than the other details.

PLATE II.

A. *Conilorpheus herdmani*, n. gen. et sp.—*n.s.*, lines indicating natural size of specimen figured below in dorsal and lateral view; *C.*, dorsal view of the head; *Per.s.* 7, seventh segment of peræon in dorsal view, and in lateral view with the fifth peræopod and pleopods showing below; *Pl.*, pleon in dorsal view; *a.s.*, *a.i.*, first and second antennæ; *m.*, *m.*, *mx.* 1, *mx.* 2, *mxp.*, the two mandibles, first and second maxillæ, and maxillipeds, the mandible on the right figured from the inner side; *gn.* 1, *prp.* 4, *prp.* 5, *plp.* 1, *plp.* 2, *urp.*, first gnathopod, fourth and fifth peræopods, first and second pleopods, and uropods, the last in ventral view.

The mouth organs are magnified on a higher scale than the other appendages.

B. *Hansenolana sphæromiformis* (Hansen).—*n.s.*, lines indicating natural size of specimen figured in dorsal view; *Pl.*, pleon in dorsal view; *a.s.*, *a.i.*, first and second antennæ; *m.*, *mx.* 1, *mx.* 2, *mxp.*, mandible, first and second maxillæ, maxillipeds; *gn.* 1, *gn.* 2, *prp.* 5, *plp.* 1, *plp.* 2, *plp.* 4, *urp.*, first and second gnathopods, part of fifth peræopod, first, second, and fourth pleopods, and uropods. Below the full figure of *gn.* 1 from the outside is given a more enlarged figure of the other member of the pair from the inner side. The portion of this *gn.* 1 and the portion of *prp.* 5 are enlarged on the same scale as the mouth organs.

PLATE III.

A. *Argathona normani*, n. gen. et sp.—*n.s.*, lines indicating natural size of the specimen represented by the adjoining figures in dorsal and lateral views; *Pl.*, pleon in dorsal view, more highly magnified; *a.s.*, *a.i.*, the first and second antennæ; *l.s.*, the upper lip, with the epistome surmounted by the frontal lamina; *l.i.*, the lower lip; *m.*, *m.*, the left mandible entire, and part of the right mandible; *mx.* 1, *mx.* 2, *mxp.*, the first and second maxillæ and the maxillipeds; *gn.* 1, *gn.* 2, *prp.* 5, the first gnathopod without side-plate, the second gnathopod and fifth peræopod each with its side-plate; *plp.* 2, the second pleopod.

The mouth parts are magnified on a higher scale than the other appendages, but the uropods figured in attachment to the pleon are enlarged on a lower scale than the rest.

B. *Cilicæa latreillii*, Leach, juv.—*n.s.*, lines indicating natural size of specimen figured below in dorsal and dorso-lateral aspects; *Pl.*, pleon in dorsal view; *a.s.*, *a.i.*, first and second antennæ; *l.s.*, upper lip with epistome; *mxp.*, maxillipeds; *gn.* 1, first gnathopod.

The mouth parts are more highly magnified than the other appendages.

C. *Janira* (?) *nana*, n. sp.—*n.s.*, line indicating natural size of the specimen; *Pl.*, pleon, without appendages; *a.s.*, *a.i.*, first antenna and four basal joints of second; *l.s.*, *l.i.*, upper and lower lips; *m.*, *m.*, *mx.* 1, *mx.* 2, *mxp.*, the mandibles, first and second maxillæ, and a maxilliped; *gn.* 1, *gn.* 2, *prp.* 1, first and second gnathopods and first peræopod, the finger of the first gnathopod and that of the first peræopod more enlarged; *plp.* 1, *plp.* 2, the first and (one of the) second pleopods, the two pairs together forming the male operculum.

The mouth parts are more highly magnified than the other appendages, being on the same scale as the more enlarged finger of the first gnathopod.

PLATE IV.

Æga ommatophylax, n. sp., ♂.—*n.s.*, lines indicating natural size of the specimen figured in dorsal aspect; *C.*, the head in dorsal aspect; *C.L.*, lateral view of the head in conjunction with the first two segments of the peræon; *Per.s.* 1., anterior part of first segment of peræon in dorsal view; *g.p.*, ventral plate of the seventh peræon segment, with the genital papillæ also more highly magnified; *Pl.*, Pleon in ventral view, after removal of the pleopods; *a.s.*, *a.i.*, first and second antennæ; *m.*, *mx.* 1, *mx.* 2, *mx.* 2, *mxp.*, mandible, first maxilla, second maxilla in two positions, maxillipeds in ventral aspect. These organs are magnified on a higher scale than the other details in general, and the distal parts of mandible, first maxilla, and maxillipeds are again more highly magnified. In the mandible the third joint of the palp is missing. The further enlargement of the maxillipeds is from the dorsal aspect. *gn.* 1, *gn.* 2, *gn.* 2, *prp.* 3, *prp.* 5, *plp.* 1, 2, 5, *urp.*, the first and second gnathopods, third and fifth peræopods, first, second and fifth pleopods, and the uropod. The portions of these appendages which required further enlargement are on the same scale as the principal figures of the mouth organs. Both members of the second pair of gnathopods are figured, to show the difference mentioned in the text.

PLATE V.

A. *Æga ommatophylax*, n. sp., ♀ (?).—*n.s.*, lines indicating natural size of specimen figured above in dorsal view; *C.*, ventral view of the head; *l.s.*, upper lip surmounted by the epistome and frontal lamina; *m.*, *m.*, the two mandibles, with higher magnification of a seta from second joint of palp, and of apical portion of the trunk. In both mandibles a rounded lobe is shown below the apical margin, but this lobe was only indefinitely made out. *mx.* 1, *mx.* 2, *mxp.*, first and second maxillæ, with the apices more highly magnified, and the maxillipeds.

B. *Lanocira zeylanica*, n. sp.—*n.s.*, lines indicating natural size of specimen figured above in dorsal view; *Pl.*, dorsal view of pleon more highly magnified; *a.s.*, *a.i.*, first and second antennæ; *l.s.*, upper lip; *m.*, *m.*, *mx.* 1, *mx.* 1, *mx.* 2, *mxp.* the mandibles, first maxillæ, one of the second maxillæ, and the maxillipeds; *gn.* 1, *prp.* 5, first gnathopod and fifth peræopod; *plp.* 1, *plp.* 2, first and second pleopods.

The mouth organs are more highly magnified than the other appendages.

PLATE VI.

A. *Rhiothra callipia*, Schiödte and Meinert.—*n.s.*, lines indicating natural size of male specimen figured above in dorsal view; *C.*, the head, stripped of its appendages, in dorsal view; *a.s.*, *a.i.*, the first and second antennæ, with the terminal portion of each more highly magnified; *m.*, a mandible in connexion with the epistome; *mx.* 1, *mx.* 2, *mxp.*, the first and second maxillæ and the maxillipeds; *gn.* 1, *prp.* 5, the first gnathopod and the fifth peræopod; *plp.* 2, the second pleopod, a more highly magnified portion showing the numerous coupling-spines of the peduncle and the male appendix of the inner branch. *urp.*, one of the uropods.

The mouth organs are more highly magnified than the full figures of the other appendages.

B. *Irona nanoides*, n. sp.—*n.s.*, lines indicating natural size of the female specimen figured at the centre in dorsal view; *C.*, the head, stripped of its appendages, in dorsal view; *a.s.*, *a.i.*, the first and second antennæ; *m.*, the mandible in connexion with the upper lip; *mx.* 1, *mxp.*, the first maxilla and a maxilliped; *gn.* 1, *prp.* 5, first gnathopod and fifth peræopod; *plp.*, *urp.*, a pleopod and one of the uropods.

The mouth organs are more highly magnified than the other parts.

C. *Rocinela orientalis*, Schiödte and Meinert.—*n.s.*, lines indicating natural size of specimen figured at the centre in dorsal view; *n.s.* ♂, lines indicating natural size of a full-grown male specimen, from which the figures marked ♂ are taken; *a.s.*, *a.s.* ♂, first antenna of each specimen; *mxp.*, *mxp.* ♂, one maxilliped of the smaller specimen and both maxillipeds of the larger; *gn.* 1, *gn.* 2, *prp.* 5, first and second gnathopods and fifth peræopod from the smaller specimen; *plp.* 2, second pleopod of the full-grown male; *Pl. urp.*, dorsal view of the pleon of the smaller specimen, much of the right side omitted for want of space; *Pl.* ♂, *urp.*, telsonic segment and left uropod of the full-grown male in dorsal view. The unsymmetrical right margin of the segment is seen through the figure of the transparent pleopod placed above it for convenience.

The maxillipeds are more highly magnified than the other parts.

PLATE VII.

Sphæroma walkeri, n. sp.—*n.s.*, *n.s.*, curved line indicating natural size of partially rolled specimen figured above in lateral view, crossed lines showing length and breadth of the same specimen unrolled and figured below in dorsal view; *a.s.*, *a.i.*, first and second antennæ; *l.s.*, epistome and upper lip; *m.*, *m.*, the mandibles, the palp of one separately figured on the right to display relative length of the first joint; *mx.* 1, *mx.* 2, *mxp.*, *mxp.*, first and second maxillæ, and one of the maxillipeds figured from the outer and the inner surface; *gn.* 1, *gn.* 2, the first and second gnathopods, with a more enlarged figure of the terminal part of the first; *prp.* 1, 4, 5, first, fourth and fifth peræopods; *g.sp.*, gastric spines, more highly magnified than the other details, among which the mouth organs are on a higher scale than the antennæ and limbs.

PLATE VIII.

Cilicæa latreillii, Leach.—*n.s.*, outline indicating natural size of specimen figured below in partially bent position and in lateral view; *Pl.V.*, ventral view of the pleon, omitting the pleopods; *Pl.D.*, dorsal view of the pleon with seventh segment of the peræon; *a.s.*, upper antenna; *a.i.*, *a.i.*, both members of the lower pair of antennæ, to show the casual want of symmetry; *l.s.*, upper lip and epistome from the upper (inner) side; *l.i.*, lower lip; *m.*, *m.*, the two mandibles; *mx.* 1, *mx.* 2, *mxp.*, the first and second maxillæ and the maxillipeds; *gn.* 1, *prp.* 5, the first gnathopod and the fifth peræopod; *plp.* 1, 2, 4, 5, the first, second and fifth pleopods, and part of the fourth; *int.*, a small piece of the integument from side-plate of seventh peræon segment.

The antennæ, mouth organs, and limbs in detail are drawn to a uniform scale. The fragment of the integument is more highly magnified.

PLATE IX.

A. *Cilicæa whiteleggei*, n. sp., ♂.—*n.s.*, line indicating natural size of specimen figured above in partially bent position and in lateral view; *C.D.*, dorsal view of head with first two segments of peræon not flattened out; *Pl.D.*, *Pl.V.*, dorsal and ventral views of pleon to the same scale as preceding figure; *mx.* 1, *mxp.*, first maxilla and maxillipeds more highly magnified than the other figures, with one exception; *a.s.*, *a.i.*, *l.s.*, first and second antennæ with epistome and upper lip; *gn.* 1, *prp.* 5, first gnathopod and fifth peræopod; *plp.* 1, 2, 3, *plp.* 2, *m.s.*, first, second and third pleopods, to the same scale as the antennæ and trunk limbs, but the separate male stilet of *plp.* 2 to the same scale as the maxillipeds.

B. *Cilicæa whiteleggei*, n. sp., ♀.—*n.s.*, line indicating natural size of specimen figured above, much bent and in lateral view; *Pl.*, pleon in dorsal view, with last segment of peræon and parts of the two preceding segments; *a.s.*, *a.i.*, first and second antennæ; *mx.* 1, *mxp.*, first maxilla and maxillipeds. These are more highly magnified than the other details, and more highly than the corresponding parts of the male; *gn.* 1, *prp.* 5, *plp.* 1, first gnathopod, fifth peræopod, and first pleopod.

C. *Cilicæa* sp., juv.—*n.s.*, line indicating natural size of specimen figured above, slightly bent, and in lateral view; *mxp.*, maxillipeds magnified to the same scale as those in Plate IX., B; *gn.* 1, *urp.*, first gnathopod and uropod.

PLATE X.

A. *Cilicæa beddardi*, n. sp. ♂.—*n.s.*, line indicating natural size of male specimen figured above in dorsal view; *a.s.*, *a.i.*, first and second antennæ; *l.s.*, upper lip with epistome; *l.i.*, lower lip; *m.*, *m.*, complete mandible on the right of the plate, and on the left the cutting edges and spine row of its companion; *mx.* 1, *mxp.*, first maxilla and maxillipeds; *gn.* 1, 2, *prp.* 1, 2, 3, 4, 5, the first and second gnathopods and the five peræopods in lateral view, connected together; *plp.* 1, 2, 5, the first, second, and fifth pleopods; *urp.*, uropod.

Of the details, the mouth parts are magnified on a higher scale than the other appendages.

B. *Cilicæa beddardi*, n. sp. ♀.—*n.s.*, line indicating natural size of female specimen figured above in dorsal view and not quite flat. Some of the details are from another female specimen; *juv.*, dorsal view of a young one taken out of the specimen of which the mouth organs and pleon are figured; *a.s.*, *a.i.*, first and second antennæ; *m.*, *l.i.*, *mx.* 1, 2, *mxp.*, mandible, lower lip, first and second maxillæ, and maxilliped, rather more highly magnified than the antennæ and limbs; *gn.* 1, *prp.* 1, first gnathopod and first peræopod; *Pl.*, telsonic segment and uropods.

C. *Cymodoce bicarinata*, STEBBING.—*n.s.*, lines indicating natural size of specimen figured above in dorsal view; *Pl.*, ventral view of pleon, the pleopods removed; *g.*, part of the gastric apparatus; *a.s.*, *a.i.*, first and second antennæ; *l.s.*, *l.i.*, *mxp.*, upper and lower lips and maxillipeds; *gn.* 1, *prp.* 5, first gnathopod and fifth peræopod; *g.p.*, genital papillæ from seventh peræon segment; *plp.* 2, second pleopod, with apical part of male appendix more highly magnified.

PLATE XI.

A. *Amesopous richardsonæ*, n. gen. et sp.—*n.s.* ♀, line indicating length of body and second antennæ of the female specimen figured above in lateral and below in dorsal view; *n.s.* ♂, line indicating length of body of a young, probably male, specimen figured in dorsal view. *C.T.*, *a.s.*, *a.i.*, cephalothorax (head and first peræon segment), with a first antenna and part of the second as far as base of fourth joint; the flagellum shown separately; *l.i.*, *m.*, *mx.* 1, *mx.* 2, *mxp.*, lower lip, a mandible (with part more enlarged), first and second maxillæ, and maxillipeds; *gn.* 1, *gn.* 2, first and second gnathopods. All these details are from the female specimen, the mouth organs more highly magnified than the other appendages. *prp.* 4 ♂, *plp.* ♂, *urp.* ♂, fourth peræopod, second pleopod, and uropod from a male specimen 4 millims. long. The figures drawn to the same scale as that used for the limbs of the female.

B. *Astacilla amblyura*, n. sp.—*n.s.*, line indicating length of body and second antennæ of the specimen figured in lateral view; *C.*, part of head; *Pl.*, dorsal view of pleon, showing one of the valvular uropods thrown open; *a.s.*, *a.i.*, first and second antennæ; *m.*, *mx.* 1, *mx.* 2, *mxp.*, mandible (with part more enlarged), first and second maxillæ, maxillipeds; *gn.* 1, *gn.* 2, *prp.* 5, first and second gnathopods and fifth peræopod, with the finger of each more enlarged; *plp.* 2, *urp.*, second pleopod and uropod.

C. *Jæropsis curvicornis* (NICOLET).—*n.s.*, line indicating length of specimen figured above in dorsal view; *C.*, dorsal view of head, with upper lip and one of the mandibles projecting in front; *Pl.*, ventral view of pleon, without the pleopods; one uropod more highly magnified; *operc.*, opercular plate formed by the first pleopods; *a.s.*, *a.i.*, upper and lower antennæ, with most of the lower antenna more enlarged; *m.*, *m.*, *mx.* 1, *mx.* 2, *mxp.*, the mandibles, first and second maxillæ, and maxillipeds, with the cutting plates of the mandibles and one palp of the maxillipeds more highly magnified; *gn.* 1, *gn.* 2, *prp.* 5, first and second gnathopods and fifth peræopod, with the fingers of first gnathopod and fifth peræopod more enlarged.

All the detail figures are enlarged to the same scale, but are accompanied in some instances by parts more highly magnified.

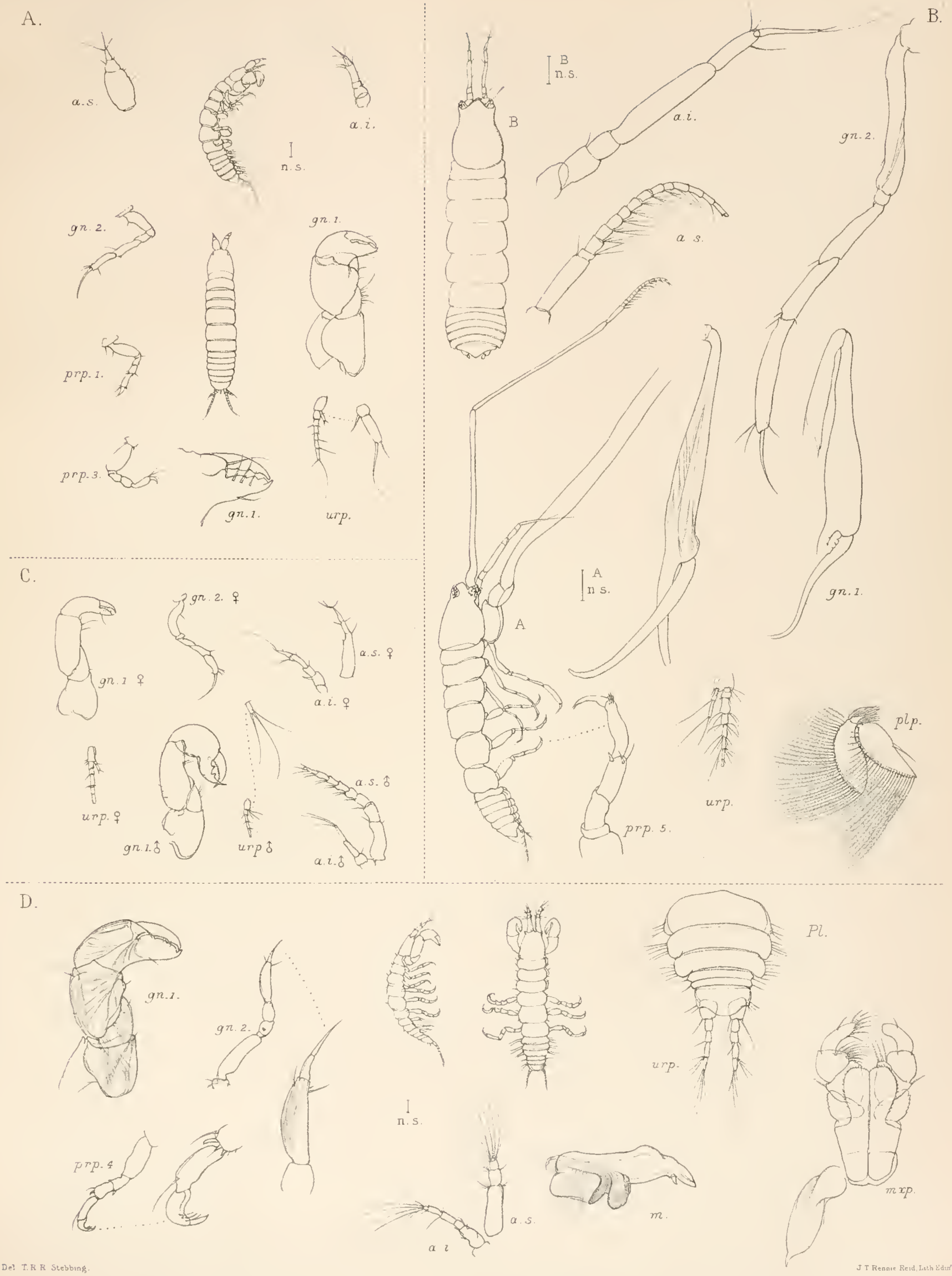
PLATE XII.

A. *Stenetrium chiltoni*, n. sp.—*n.s.*, lines indicating natural size of specimen figured below in dorsal view; *C.*, *a.s.*, *a.i.*, dorsal view of head more enlarged, with the eyes, the first antenna of the left side, part of that on the right, and parts of the second antennæ, ending with the third joint on the left, with the fourth on the right. *Pl.*, terminal part of pleon; this, with the legs and pleopods, is enlarged to the same scale as the preceding figure, while the mouth organs are more highly magnified, and the spines of the first gnathopod still more highly. *l.s.*, *l.i.*, upper and lower lips; *m.*, *m.*, *mx.* 1, *mx.* 2, *mxp.*, *ep.*, mandibles, first and second maxillæ, maxillipeds, with one epipod detached; *gn.* 1, *gn.* 2, *prp.* 1, first gnathopod, with some of the spines of the palm and finger very highly magnified; second gnathopod; first peræopod; *plp.* 1, 3, 4, 5, the first, third, fourth and fifth pleopods; *a.i'.*, second antenna from a different specimen, to which the following parts also belong;

gn. 1′, first gnathopod, showing the marsupial plate; *prp.* 5′, terminal part of fifth peræopod; *urp.*′, the uropods.

B. *Gnathia insolita*, n. sp.—*n.s.*, lines indicating natural size of specimen figured in dorsal view; *C.*, cephalic region, showing the muscles belonging to the mandibles; *Pl.*, pleon in dorsal view, with rudimentary seventh segment of peræon; *a.s.*, *a.i.*, first and second antennæ; *m.*, *mxp.*, a mandible and the maxillipeds; *gn.* 1, 2, first and second gnathopods; *plp.* 1, *plp.*, first pleopod, and one of the following pairs.

All the details are magnified to the same scale.



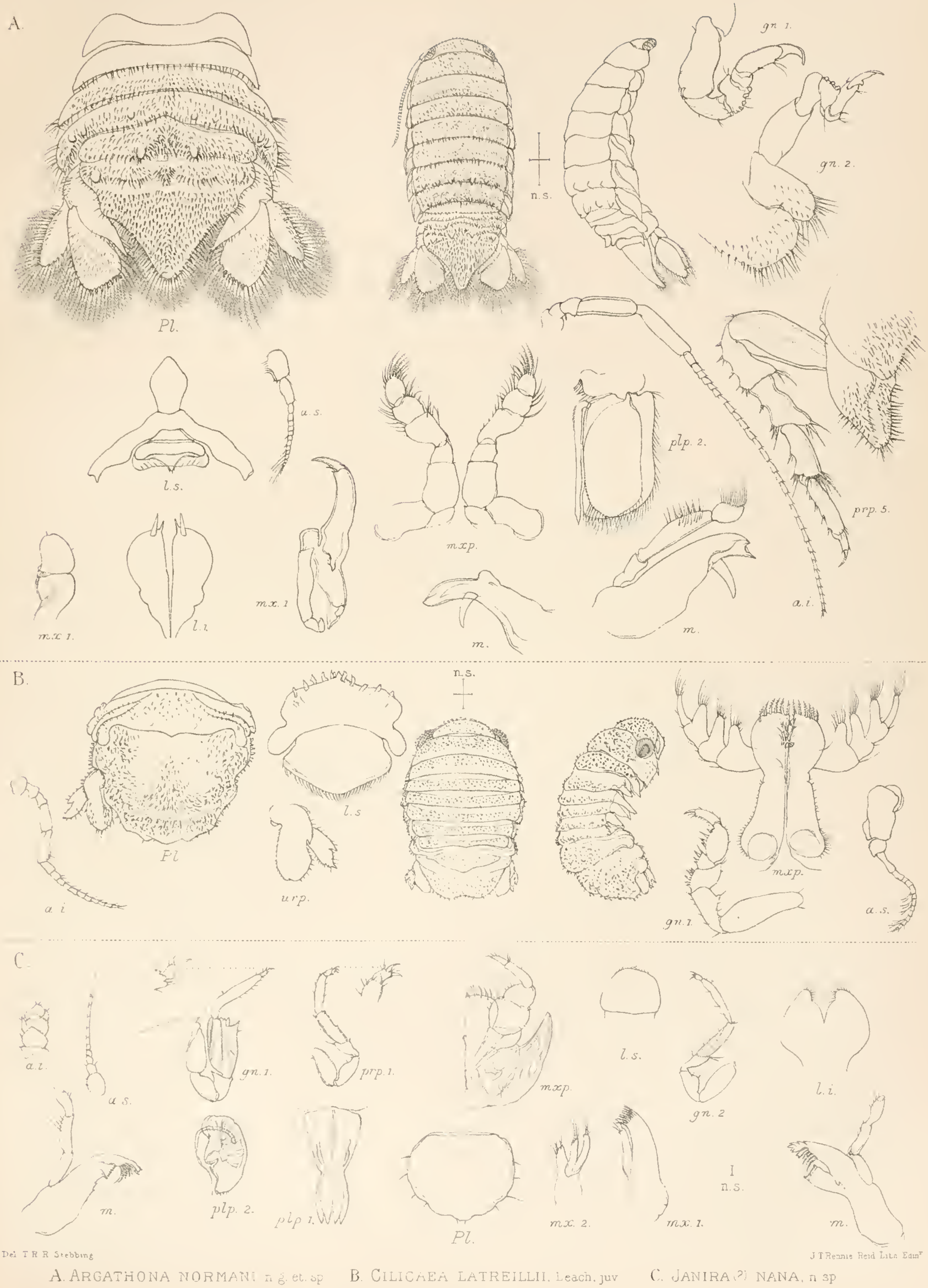
Del. T. R. R. Stebbing. J. T. Rennie Reid, Lith. Edin.

A. HETEROTANAIS CRASSICORNIS, n. sp. B. LEPTOCHELIA MIRABILIS, n. sp. C. L. LIFUENSIS, Stebbing
D. TANAIS GRACILIS, Heller

Del T. R. R. Stebbing

J. T. Rennie Reid Lith. Edin^r

A. CONILORPHEUS HERDMANI, n. g. et. sp. B. HANSENOLANA SPHAEROMIFORMIS (Hansen).

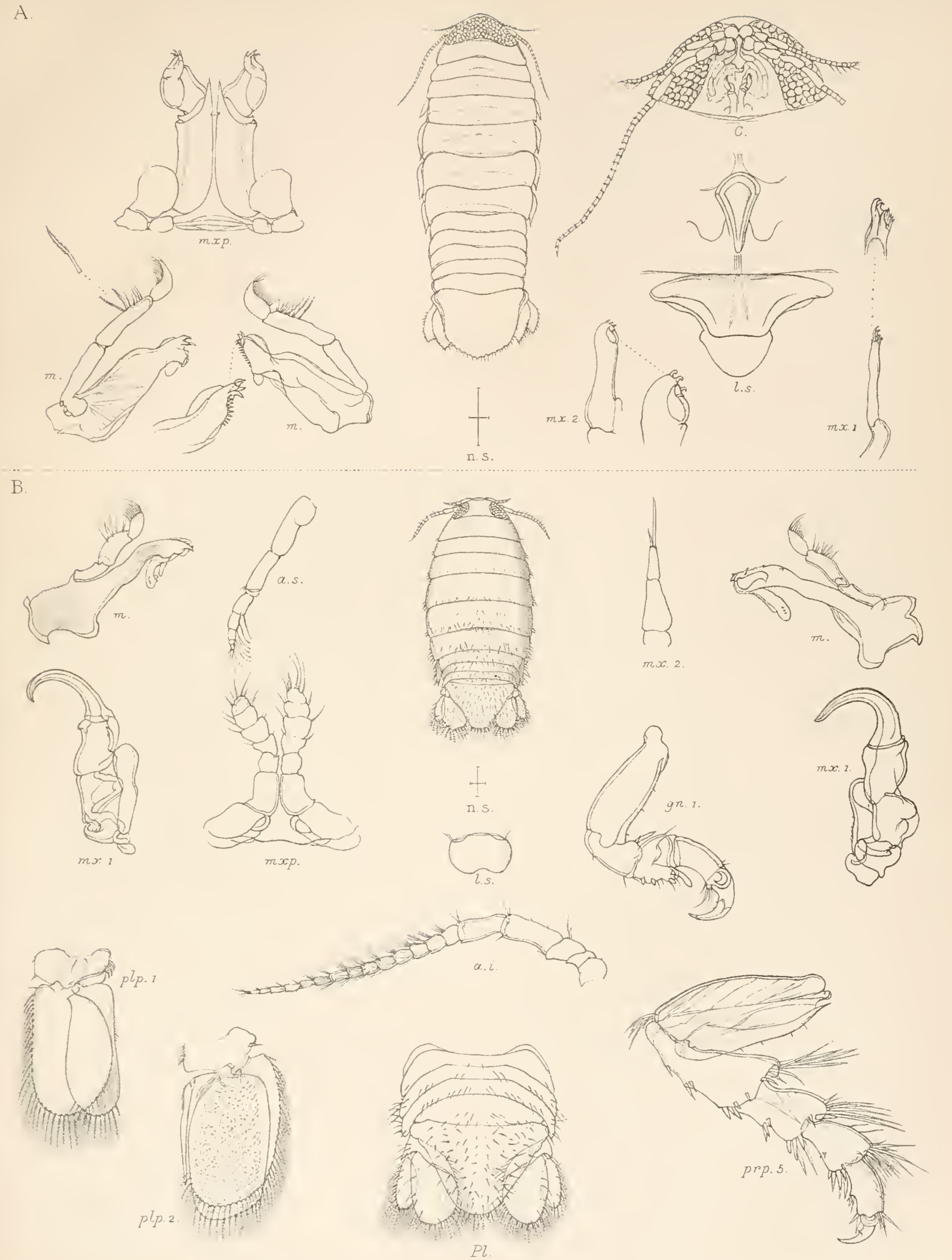


Del. T.R.R. Stebbing J.T. Rennie Reid Lith. Edin^r

A. ARGATHONA NORMANI n.g. et. sp. B. CILICAEA LATREILLII, Leach. juv. C. JANIRA (?) NANA, n. sp.

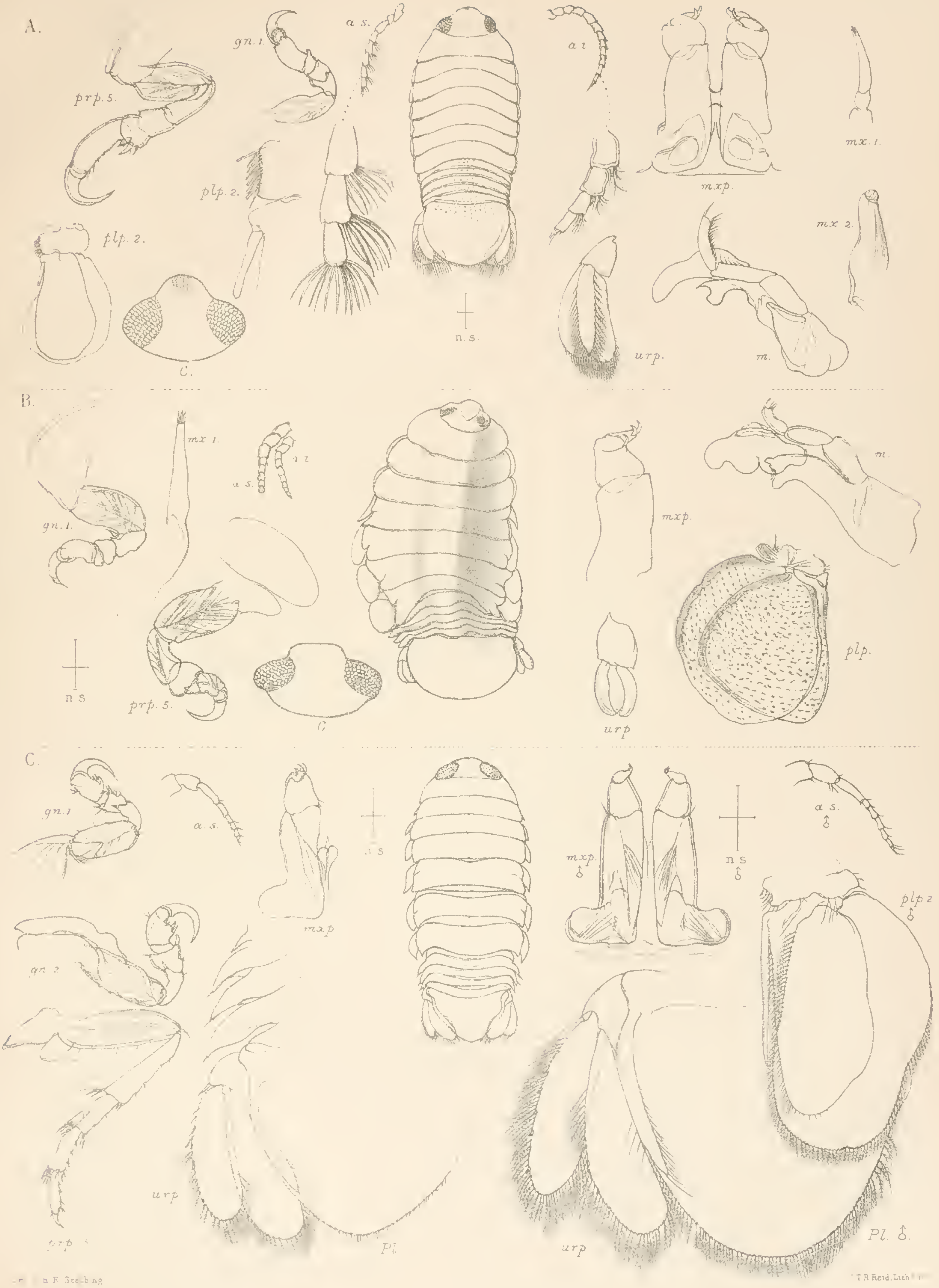
Del. T. R. R. Stebbing. J. T. Rennie Reid, Lith. Edin.

ÆGA OMMATOPHYLAX, n. sp.



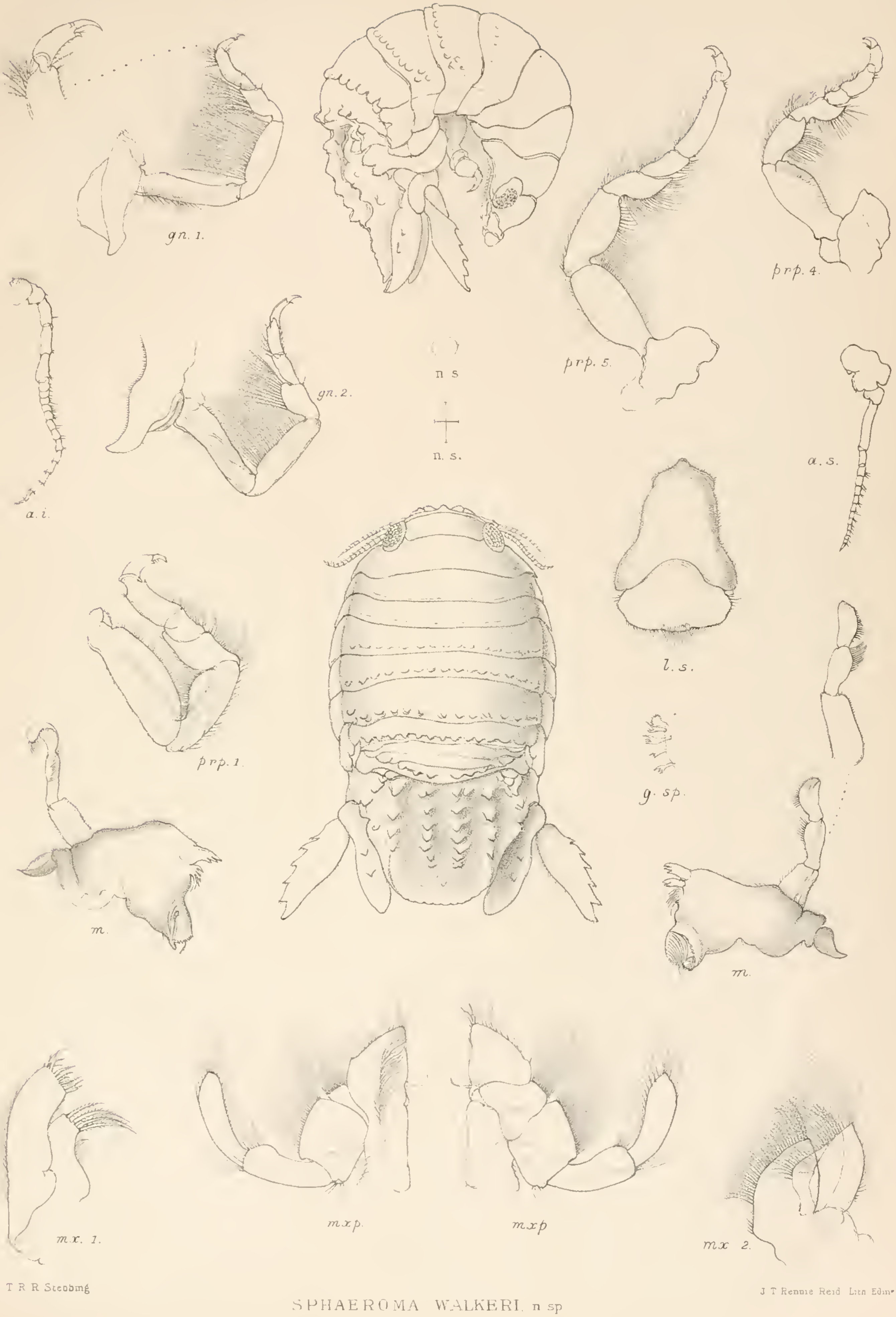
Del. T. R. R. Stebbing J. T. Rennie Reid Lith. Ed.

A. ÆGA OMMATOPHYLAX, n. sp. B. LANOCIRA ZEYLANICA, n. sp.



T R Reid, Lith.

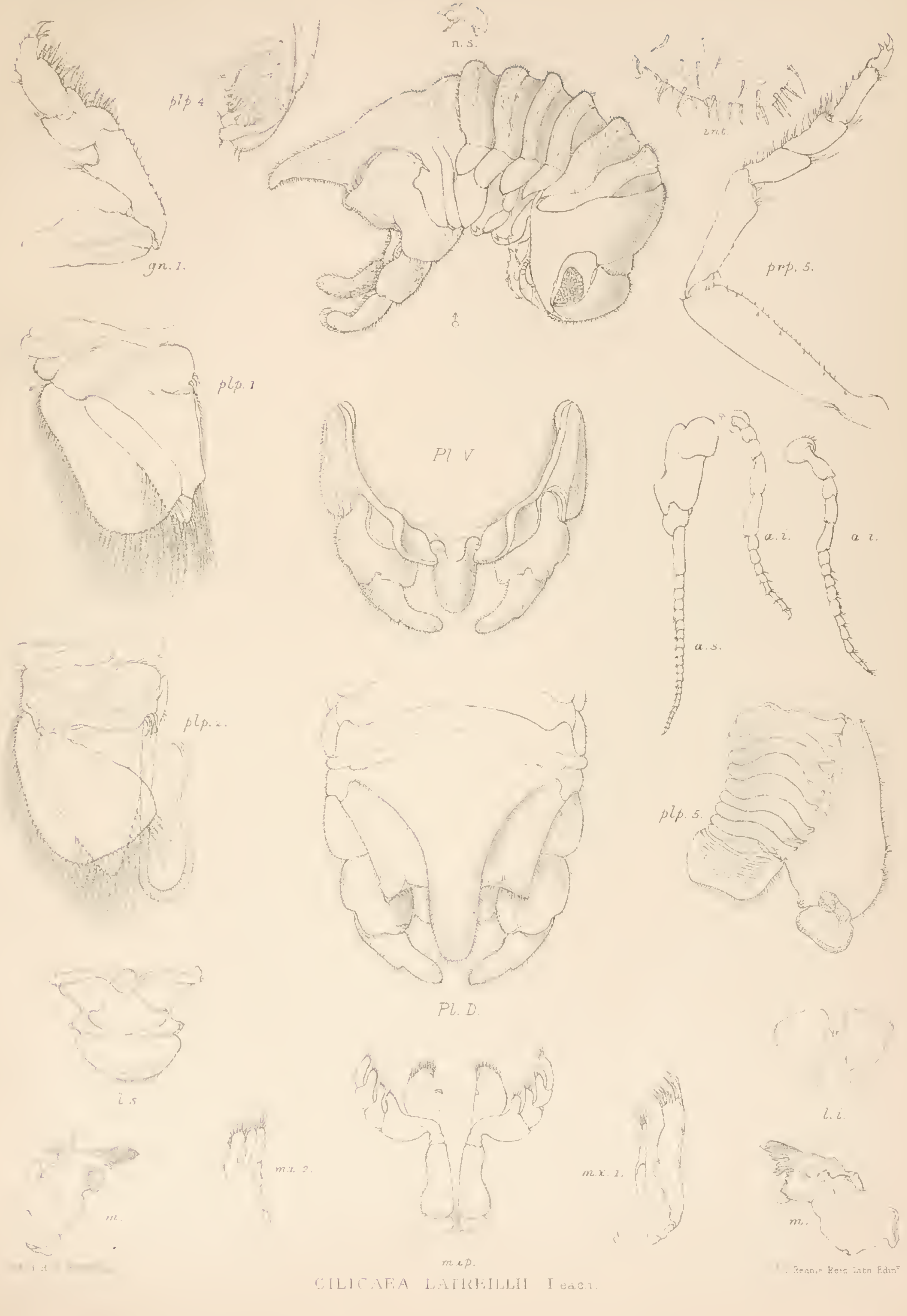
A. RHIOTHRA CALLIPIA, Schiödte & Meinert. B IRONA NANOIDES, n. sp.
C ROCINELA ORIENTALIS, Schiödte & Meinert.



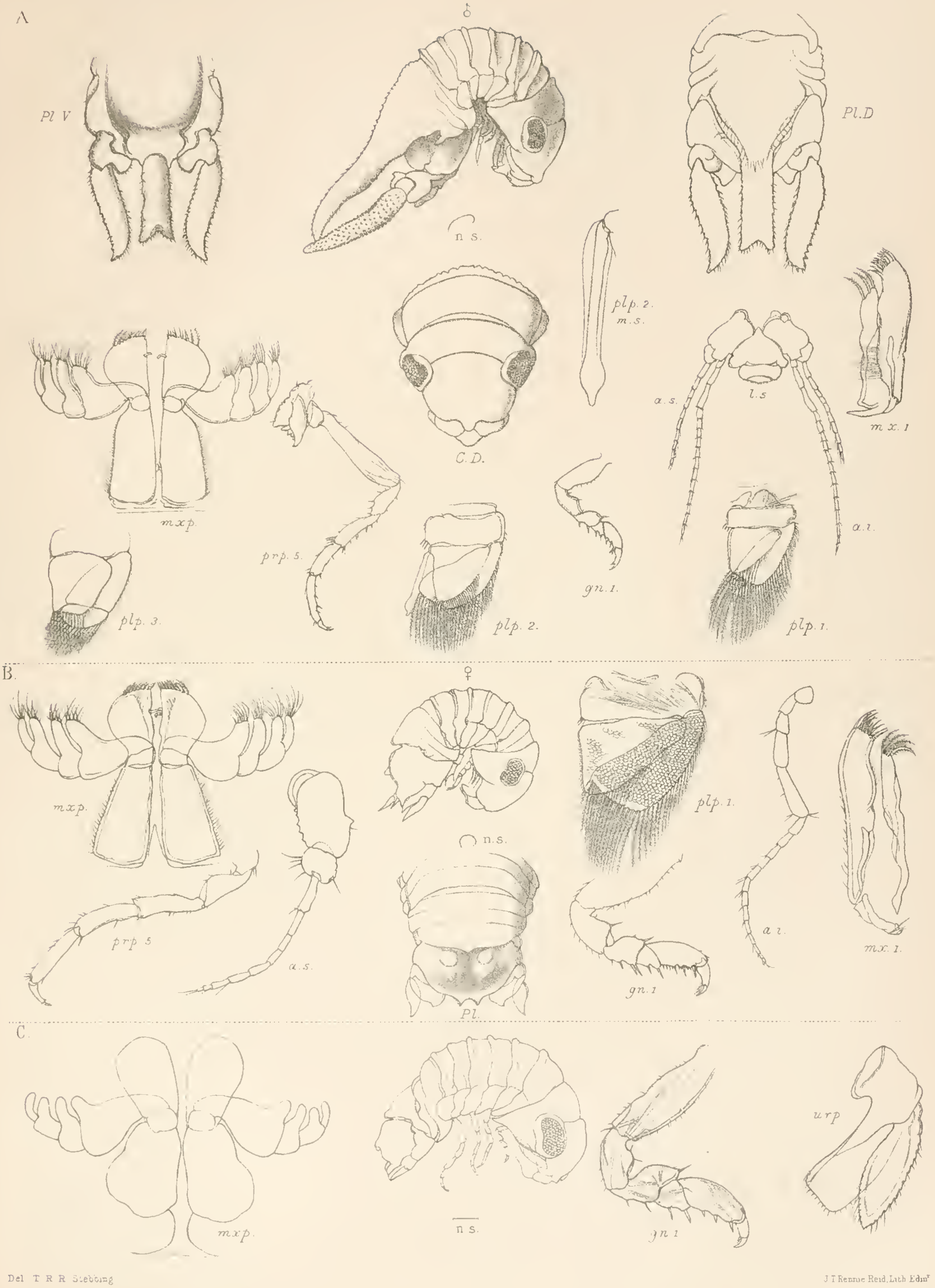
Del T R R Stebbing

J T Rennie Reid Lith Edin

SPHAEROMA WALKERI. n sp

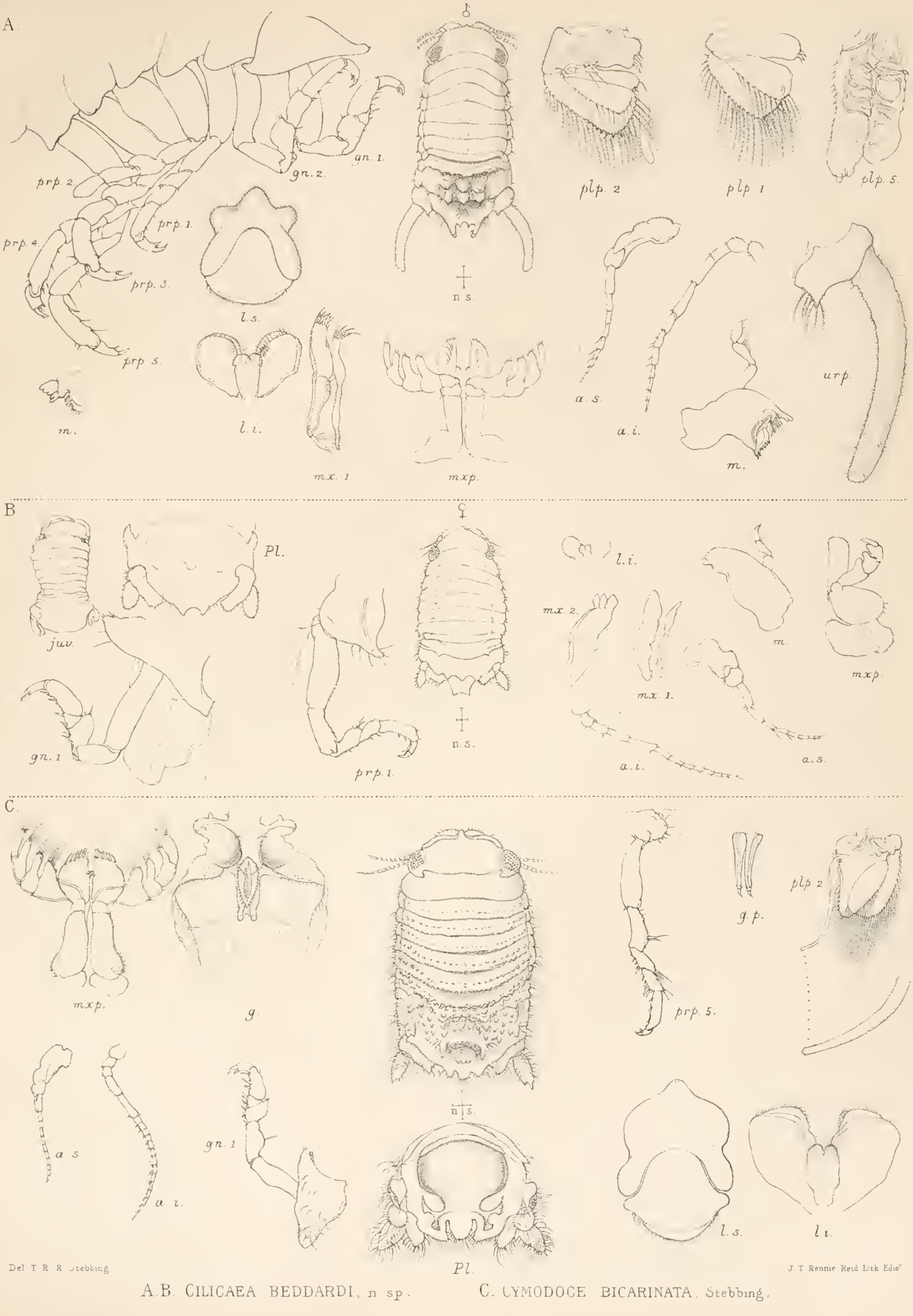


CILICAEA LATREILLII Leach.



Del T R R Stebbing J T Rennie Reid, Lith Edin[r]

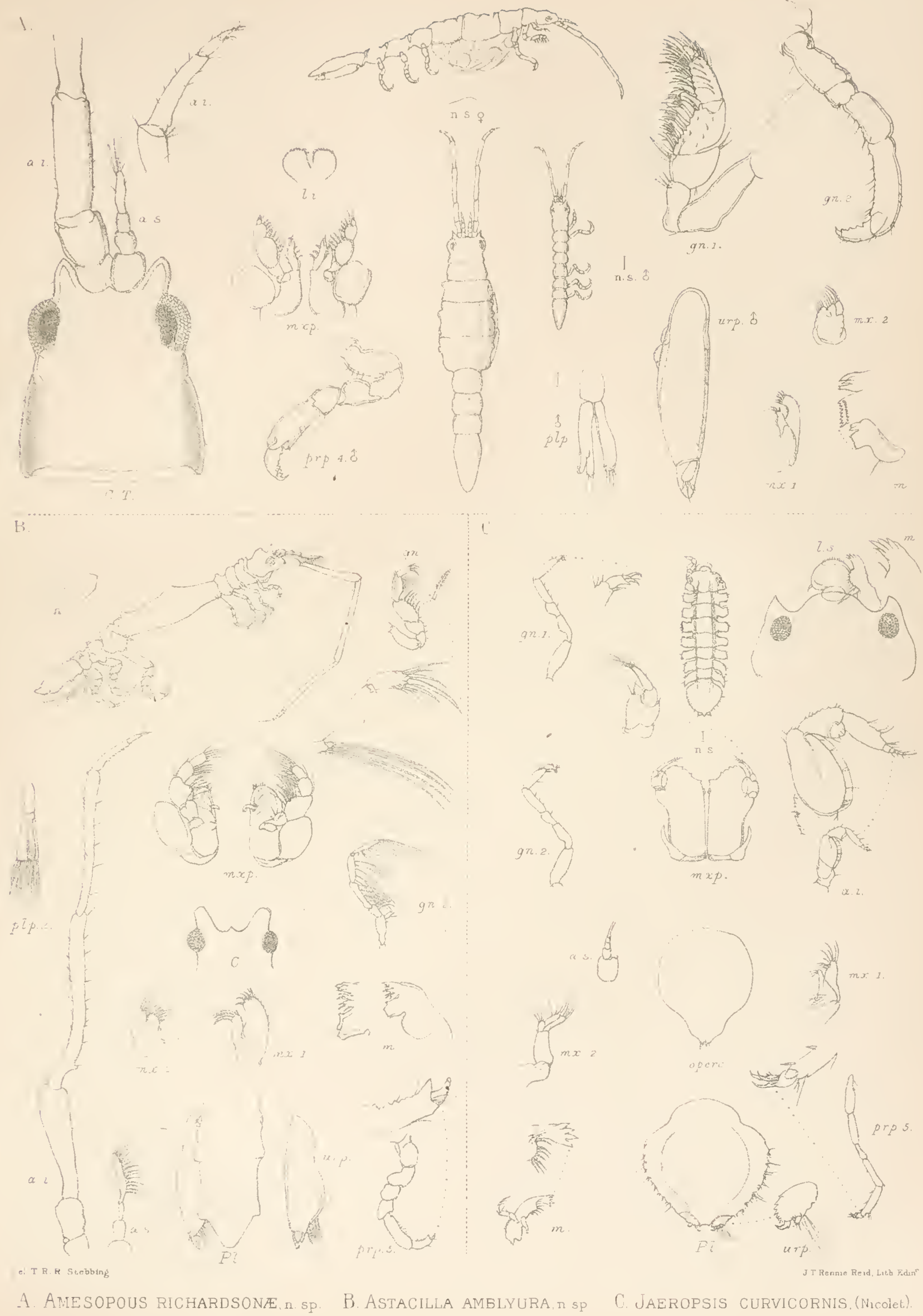
A B CILICAEA WHITELEGGEI n. sp. C. CILICAEA (?) sp. juv.



Del T. R. R. Stebbing

J. T. Rennie Reid Lith Edinr

A. B. CILICAEA BEDDARDI, n. sp. C. CYMODOCE BICARINATA, Stebbing.



del. T.R.R. Stebbing J.T. Rennie Reid, Lith Edin^r.

A. AMESOPOUS RICHARDSONÆ, n. sp. B. ASTACILLA AMBLYURA, n. sp. C. JAEROPSIS CURVICORNIS, (Nicolet).

Del T R R Stebbing

J T Rennie Reid Lith Edin[r]

A, STENETRIUM CHILTONI, n. sp. B. GNATHIA INSOLITA, n. sp.

REPORT

ON THE

MACRURA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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DEMONSTRATOR AND ASSISTANT LECTURER IN ZOOLOGY, UNIVERSITY OF LIVERPOOL.

[WITH TWO PLATES.]

PROFESSOR HERDMAN'S collection of Macrurous Crustaceans from Ceylon consists of 53 species, of which 4 are new to science.

With the probable exception of 3 species the collection is entirely typical of a representative Indo-Pacific shallow-water fauna. *Bithynis savignyi* (SP. BATE), *Athanas nitescens*, LEACH, and *Urocaris longicaudata*, STIMPSON, appear hitherto to have had a known distribution limited to the Atlantic and the Mediterranean.

The following is a list of the species described in this Report :—

TRIBE: PENÆIDEA.

FAMILY: Penæidæ.

Penæus canaliculatus (OLIVIER).
,, *monodon*, FABRICIUS.
,, *indicus*, MILNE-EDW.
Parapenæus anchoralis (SP. BATE).
,, *incisipes* (SP. BATE).
,, *dalei*, RATHBUN.
,, *mogiensis*, RATHBUN.
,, *acclivis*, RATHBUN.
gallensis, n. sp.
Philonicus pectinatus, SP. BATE.
Sicyonia lancifer (OLIVIER).
,, *cristata* (DE HAAN).
,, *sculpta*, MILNE-EDW.

FAMILY: Sergestidæ.

Acetes indicus (MILNE-EDW.).
Leucifer typus (VAUGH. THOMPS.).

TRIBE: CARIDEA.

FAMILY: Atyidæ.

Caradina vitiensis, BORRADAILE.

FAMILY: Pontoniidæ.

Periclimenes vitiensis, BORRADAILE.
,, *danæ* (STIMPSON).
Conchodytes meleagrinæ, PETERS.
Anchistus inermis (MIERS).

FAMILY: Palæmonidæ.

Bithynis savignyi (SP. BATE).
Urocaris longicaudata, STIMPSON.

FAMILY: Latreutidæ.

Nauticaris futilirostris, SP. BATE.
,, *unirecedens*, SP. BATE.
,, *grandirostris*, n. sp.
Latreutes ceylonensis, n. sp.

FAMILY: Alpheidæ.

Alpheus idiocheles, COUTIÈRE.
,, *phrygianus*, COUTIÈRE.
,, *paraculcipes*, COUTIÈRE.
,, *paralcyone*, COUTIÈRE.
,, *miersi*, COUTIÈRE.
,, *pareucheirus*, COUTIÈRE.
,, *bis-incisus*, var. *malensis*, COUTIÈRE.
,, ,, ,, *stylirostris*, COUTIÈRE.
,, *audouini*, COUTIÈRE.
,, *macrodactylus*, ORTMANN.
,, *spongiarum*, COUTIÈRE.
,, *lævis*, RANDALL.
Synalpheus gravieri, COUTIÈRE.
Synalpheus laticeps, COUTIÈRE.
,, *biunguiculatus*, STIMPSON.
,, *comatulorum*, HASWELL.
,, *neomeris*, DE MAN.
,, *carinatus*, DE MAN.
Athanas nitescens, LEACH.
,, *orientalis*, n. sp.

FAMILY: Crangonidæ.

Ægeon cataphractus (OLIVIER).

FAMILY: Processidæ.

Processa canaliculata, LEACH.

TRIBE: SCYLLARIDEA.

FAMILY: Scyllaridæ.

Scyllarus tuberculatus (SP. BATE).
,, *sordidus* (STIMPSON).

TRIBE: THALASSINIDEA.

FAMILY: Callianassidæ.

Callianassa rotundicaudata, STEBBING.
,, *maldivensis*, BORRADAILE.
Upogebia intermedia (DE MAN).

In addition to the above species, two fresh-water forms—*Bithynis lar* and *Bithynis grandimanus*—were obtained from the River Gin Ganga. They are not included in this Report.

LIST OF STATIONS

at which Macrura were obtained, with the species collected in each:—

STATION I.—Five miles west and south-west of Negombo; 12 to 20 fathoms; bottom coarse yellow sand with a few dead shells.

Parapenæus mogiensis.

STATION III.—Two and a-half to four miles off Chilaw; 9 to 14 fathoms; bottom coarse sand and small corals.

Penæus canaliculatus, Parapenæus anchoralis, Parapenæus dalei, Parapenæus mogiensis, Parapenæus acclivis, Philonicus pectinatus, Sicyonia lancifer, Anchistus inermis, Periclimenes danæ, Alpheus miersi, Alpheus phrygianus, Alpheus audouini, Synalpheus gravieri, Synalpheus neomeris, Processa canaliculata, Callianassa maldivensis.

STATION VI.—Across Muttuvaratu Paar; depth 6 to 9 fathoms; bottom sand, with hard patches of "rock" at intervals.

Leucifer typus, Bithynis savignyi, Alpheus idiocheles, Athanas orientalis, Processa canaliculata, Upogebia intermedia.

STATION XVIII.—South-west part of Palk Bay, off Rameswaram Island and Adam's Bridge; 7 to 9 miles off shore; bottom fine soft bluish-grey mud containing casts of various Molluscan shells; depth 7 to 8 fathoms.

Penæus monodon, Parapenæus mogiensis, Leucifer typus.

STATION XX.—North part of Back Bay, Trincomalee; depth 11 to 13 fathoms; bottom hard.

Parapenæus anchoralis, Parapenæus dalei, Parapenæus acclivis, Sicyonia sculpta.

STATION XXXV.—Entrance to Galle Harbour; depth 4½ to 7 fathoms; bottom coarse sand.

Nauticaris unirecedens, Nauticaris grandirostris, Ægeon cataphractus, Scyllarus tuberculatus.

STATION XXXVI.—Galle Harbour, off Gibbet Island; depth 2 to 4¾ fathoms; bottom fine sand and mud.

Parapenæus dalei, Leucifer typus, Acetes indicus, Caradina vitiensis, Nauticaris futilirostris.

STATIONS XXXIX. to XLII.—Deep water off Galle; depth up to 100-fathom line; bottom sand, shells, nullipores.

Parapenæus dalei, Parapenæus mogiensis, Parapenæus acclivis, Parapenæus gallensis, Synalpheus laticeps, Synalpheus biunguiculatus, Synalpheus carinatus, Alpheus lævis.

STATION XLIII.—Six miles west of Kaltura; depth 22 fathoms; bottom hard sand and nullipores.

Parapenæus anchoralis, Philonicus pectinatus.

STATIONS XLVII. to XLIX.—Cheval Paar; depth 6½ to 13 fathoms; bottom sand, nullipores and dead shells.

Penæus indicus, Parapenæus anchoralis, Leucifer typus, Periclimenes vitiensis, Periclimenes danæ, Conchodytes meleagrinæ, Anchistus inermis, Alpheus phrygianus, Alpheus paraculeipes, Alpheus miersi, Alpheus spongiarum, Alpheus bis-incisus, var. *malensis, Synalpheus gravieri, Synalpheus comatulorum, Athanas nitescens, Athanas orientalis, Processa canaliculata, Callianassa rotundicaudata.*

STATION LIII.—Ten to twelve miles north of Cheval Paar, and 12 miles west of Vankali Church; depth 7½ to 9 fathoms; bottom muddy sand with dead shells.

Latreutes ceylonensis.

STATION LIV.—South of Adam's Bridge; depth 4 to 40 fathoms; bottom varied, from sand to living coral.

Conchodytes meleagrinæ, Alpheus pareucheirus, Upogebia intermedia.

STATIONS LV. to LX.—Coral reefs and pearl banks, Gulf of Manaar; depths varying from 9 to 36 fathoms; bottom nullipores and dead coral.

Parapenæus mogiensis, Sicyonia cristata, Conchodytes meleagrinæ, Alpheus miersi, Alpheus bis-incisus, var. *stylirostris, Alpheus audouini, Synalpheus gravieri, Synalpheus comatulorum, Synalpheus laticeps, Synalpheus biunguiculatus, Athanas orientalis, Scyllarus sordidus.*

STATION LXI.—Northern end of Periya Paar; depth 12 to 14 fathoms; bottom sand, nullipores and coral.

Leucifer typus, Sicyonia cristata, Synalpheus gravieri, Athanas orientalis.

STATION LXIV.—From between South Modragam and Jagerboom paars along a line south-west towards Kodramallai Point; depth $4\frac{1}{2}$ to $5\frac{1}{2}$ fathoms; bottom coarse sand, with much fine green weed and small pearl oysters.

Periclimenes vitiensis, Processa canaliculata.

Aripu Reef; depth 5 fathoms.

Parapenæus acclivis, Parapenæus anchoralis, Philonicus pectinatus, Urocaris longicaudata, Scyllarus tuberculatus.

STATION LXVII.—Off south end of Mutwal Island; depth 10 to 14 fathoms; bottom dead coral and nullipore.

Synalpheus gravieri, Alpheus paralcyone, Alpheus miersi, Alpheus macrodactylus.

STATION LXVIII.—From off Coppeluddi southwards to Navakaddua Paar; depth 8 to $18\frac{1}{2}$ fathoms; bottom nullipores, coral and muddy orbitolites sand.

Synalpheus comatulorum.

STATION LXIX.—North end of Chilaw Paar; depth 8 to 11 fathoms; bottom yellow quartz sand with some coral fragments.

Synalpheus biunguiculatus, Synalpheus comatulorum, Nauticaris unirecedens.

MACRURA.

TRIBE: PENÆIDEA.

FAMILY: PENÆIDÆ.

Penæus, FABRICIUS, 1798.

Penæus canaliculatus (OLIVIER).

Palæmon canaliculatus, OLIVIER, 'Ency. Méthod.,' VIII., p. 660, 1811.
Penæus canaliculatus, MILNE-EDWARDS, 'Hist. Nat. Crust.,' II., p. 414, 1837.
Penæus canaliculatus, var. **japonicus,** SP. BATE, '"Challenger" Macrura,' p. 245, 1888.

Locality:—Pearl banks, Gulf of Manaar (Station III.), 1 specimen very much damaged.

General distribution:—Japan, Mauritius, Figi, Australia, Ceylon.

Penæus monodon, Fabricius.

Penæus monodon, Fabricius, 'Suppl. Ent. Syst.,' p. 408, 1798.

Penæus semisulcatus, de Haan, 'Fauna Japonica,' p. 191, 1849.

Penæus carinatus, Dana, 'U.S. Expl. Exp.,' p. 602, 1852.

Locality :—Palk Strait (Station XVIII.), several specimens.

Measurements of two males and two females :—

	Males.		Females.	
From end of telson to tip of rostrum . .	162 millims.,	131 millims.	195 millims.,	135 millims.
Length of carapace and rostrum . .	52 ,,	41 ,,	60 ,,	43 ,,

Both male and female specimens possess a well-marked median groove extending from behind the rostrum to the posterior end of the carapace. Spence Bate found this groove absent in the single male which he examined. There is no doubt that the position of the ventral rostral teeth relative to the upper rostral teeth is subject to variation.

General distribution :—India, Ceylon, Singapore, Japan, Pacific and South Africa.

Penæus indicus, Milne-Edw.—Plate I., fig. 1.

Penæus indicus, Milne-Edw., 'Hist. Nat. Crust.,' II., p. 415, 1837.

(?) **Penæus merguiensis**, de Man, 'Journ. Linn. Soc.' (Zool.), vol. 22, p. 287, 1888.

Locality :—Gulf of Manaar (Station XLIX.), 5 specimens. Lengths varying from 14 millims. to 40 millims. All immature.

The rostrum in these specimens differs from the type species and has a formula $\frac{1+(6 \text{ to } 7)}{6}$. The anterior half of the rostrum bears no teeth dorsally. The rostrum is very slender and extends in front of the antennular peduncle a distance equal to half the length of the peduncle. In spite of these differences from the type species, I have referred these specimens to the above species, because there seems to be little doubt that the rostrum is subject to a great deal of variation in this form. The "Challenger" specimens differed in the form of the rostrum from Milne-Edward's species, and de Man's species, *P. merguiensis*, appears to differ in no important respects from *P. indicus*.

An examination of the various forms grouped together under this species would be valuable and instructive, and would throw some light on the value of the rostrum in classification.

General distribution :—India, Philippines, Mergui (?), Ceylon.

Parapenæus, Smith, 1885.

I have followed Smith* in separating certain species from the genus *Penæus.* The characters of the genus *Parapenæus,* which distinguish it from the genus *Penæus,* are:—(1) Endopodite of 1st maxilla is short and unsegmented; (2) 3rd maxilliped without an epipodite, and (3) the absence of branchiæ from the last thoracic segment.

Parapenæus anchoralis (Sp. Bate).

Penæus anchoralis, Sp. Bate, '"Challenger" Macrura,' p. 258, 1888.

Localities:—Pearl banks, Gulf of Manaar (Station III.), 1 specimen (♀); Trincomalee (Station XX.), 1 specimen (♀); off Kaltura (Station XLIII.), 1 ♂; Galle (Station XXXVII.), 1 ♀; Aripu Reef (Station XLIV.), 1 ♂ and 2 ♀.

Male:—Total length 40 millims., carapace and rostrum 15 millims.

Female:—Total length 64 millims., carapace and rostrum 23 millims.

Rostral formula is $\frac{(8 \text{ to } 9)+1}{0}$.

The rostrum in the females appears to be slightly longer than in the males. The female rostrum reaches to the end of the second antennular segment. In the male it only reaches slightly past the first segment.

The dorsal groove of the telson appears to be deeper in the female than in the male.

General distribution:—Pacific, Japan, Ceylon.

Parapenæus incisipes (Sp. Bate).

Penæus incisipes, Sp. Bate, '"Challenger" Macrura,' p. 257, 1888.
Parapenæus incisipes, Rathbun, 'Proc. U.S. Nat. Mus.,' vol. xxvi., p. 38, 1902.

Locality:—Gulf of Manaar, 1 specimen, ♂.

The rostrum is straight and not so deep as in the preceding species. It extends to the middle of the 3rd joint of the antennular peduncle. Rostral formula is $\frac{9+1}{0}$.

The flagella of the antennule are short and equal in length to the 2nd and 3rd joints of the peduncle.

Two obliquely longitudinal grooves cross each side of the carapace. The anterior groove becomes comparatively deep ventrally. The carapace tends to become much shallower dorso-ventrally at the anterior end.

The meropodite of the 5th pereiopod is notched at its proximal end. There is a tubercle present on the endopodite of the 2nd abdominal appendage. The 6th abdominal segment is $1\frac{1}{2}$ times as long as the 5th. The uropods are slightly notched at their outer proximal margins.

General distribution:—Philippines, Japan, Ceylon.

* Smith, 'Proc. U.S. Nat. Mus.,' VIII., p. 170, 1885.

Parapenæus dalei, RATHBUN.*

Parapenæus dalei, M. RATHBUN, 'Proc. U.S. Nat. Mus.,' vol. xxvi., p. 40, 1902.

Localities:—Pearl banks, Gulf of Manaar (Station III.), 1 ♂; Galle (Station XXXVI.), 2 ♂; south of Galle (Station XXXIX.), 1 ♂; Trincomalee (Station XX.), 1 ♂.

These specimens appear to agree with Miss RATHBUN'S diagnosis of the species. The antennular flagella are thicker than in the other species of the *velutinus* group.

Length of largest specimen (♂):—

Total length from end of rostrum to tip of telson . .	40 millims.
From tip of rostrum to end of carapace	11 ,,
Side length of carapace	9 ,,

Rostral formula $\frac{6+1}{0}$.

General distribution:—Japan, Ceylon.

Parapenæus mogiensis, RATHBUN—Plate I., fig. 2.

Parapenæus mogiensis, M. RATHBUN, 'Proc. U.S. Nat. Mus.,' vol. xxvi., p. 39, 1902.

Localities:—Pearl banks, Gulf of Manaar (Station III.), 31 specimens; west of Negombo, hauls 1 to 4 (Station I.), 15 specimens; Palk Straits (Station XVIII.), 2 specimens; south of Galle (Station XXXIX.), 1 specimen; Coral reef, Gulf of Manaar (Station LIV.), 7 specimens.

The petasma agrees with the type, but the thelycum in all the specimens shows a slight difference (see fig. 2). The appendages are more richly setose than is the case with the other species of this group. The 3rd maxillipeds do not extend as far as the tips of the antennal scales, but are situated behind them a distance equal to the length of the distal joint of the 3rd maxilliped. The antennal scale is slightly longer than the antennular peduncle.

Dimensions of males (3 specimens):—

Total length	56 millims.,	48 millims.,	61 millims.
Length of rostrum and carapace . .	18 ,,	15 ,,	19 ,,
Lateral length of carapace . . .	15 ,,	12 ,,	14 ,,

Dimensions of females (3 specimens):—

Total length	75 millims.,	67 millims.,	61 millims.
Length of rostrum and carapace . .	24 ,,	23 ,,	20 ,,
Lateral length of carapace . . .	19 ,,	18 ,,	16 ,,

Rostral formula $\frac{8+1}{0}$.

General distribution:—Japan, Ceylon.

* This and the three following species belong to the *Parapenæus velutinus* group. This collection of Ceylon Crustaceans has given me an opportunity of examining a large number of specimens belonging to

Parapenæus acclivis, Rathbun.

Parapenæus acclivis, Rathbun, 'Proc. U.S. Nat. Mus.,' vol. xxvi., p. 41, 1902.

Localities:—Pearl banks, Gulf of Manaar (Station III.), 1 specimen; Trincomalee (Station XX.), 1 specimen; south of Galle (Station XXXIX.), 1 specimen; Aripu Reef (Station LXIV.), 1 specimen.

The 3rd maxillipeds do not extend as far as the ends of the antennal scales, but they are longer than those of *Parapenæus mogiensis*. The antennal scale is slightly shorter than the antennular peduncle.

Dimensions of two females:—

Total length	88 millims.,	80 millims.
Length of rostrum and carapace	29 ,,	26 ,,
Lateral length of carapace	25 ,,	21 ,,

Rostral formula $\frac{(7 \text{ to } 8)+1}{0}$.

General distribution:—Japan, Ceylon.

Parapenæus gallensis, n. sp.—Plate I., fig. 3.

Locality:—South of Galle (Station XXXIX.), many specimens.

This species is of the *velutinus* type, and possesses certain characters which distinguish it from Dana's species and also from the species formed by Miss Rathbun.

In the form of the rostrum this species resembles somewhat closely *P. dalei*. The length of the rostrum, however, is slightly shorter than in the latter species. In typical specimens the rostrum reaches to the end of the 1st segment of the antennular peduncle. In *P. dalei* the rostrum reaches to the middle of the 2nd segment. The rostrum in *P. gallensis* is generally less toothed than in *P. dalei*, having a formula of $\frac{(5 \text{ to } 6)+1}{0}$. The anterior tooth is much smaller than the others, and in some cases is hardly perceptible. But in the form of the petasma and thelycum it differs distinctly from *P. dalei*, and approaches nearer to *P. akayebi*, showing, however, distinct differences from the latter species. The rostrum is much shorter than in *P. akayebi* and has fewer teeth. The left branch of the petasma is much more delicate and slightly longer than the right branch, and ends in a few small denticles, which, however, are only observed when the petasma is examined under a microscope. The antennal scale reaches as far forward as the extremity of the antennular peduncle. The 3rd maxillipeds are slightly longer than those of the three previous species, reaching almost to the end of the antennal scale. There is a pair of well-developed

to the *velutinus* group, and I think Miss Rathbun is justified in separating from the old species certain forms possessing various definite and distinctive characters. But it is doubtful whether these characters are of sufficient importance to warrant the formation of new *species*, and I am not sure whether their separation from *Parapenæus velutinus* merely as new varieties would not have been preferable.

spines present between the bases of the feet of the second pair. These only appear to be present in the female. The last four abdominal segments have a dorsal carina which ends in a well-developed tooth at the posterior end of the 6th segment. The sixth abdominal segment is about $1\frac{1}{2}$ times as long as the fifth and slightly shorter than the telson. The telson is slightly shorter than the uropods and has the usual number of spines, which is characteristic of the *velutinus* group. The anterior pair of spines are much smaller than the posterior three pairs, and in some specimens are only observed with difficulty.

The general surface of the body is smooth. The dimensions are :—

	millims.	millims.	millims.	millims.	millims.	millims.
Total length along mid-dorsal line from tip of rostrum to end of telson . .	49	43	50	48	59	40
Length of carapace and rostrum along mid-dorsal line	15	13	15	14	17	10·5
Side length of carapace to tip of antennular tooth	13	10	12	12	15	9
Length of sixth segment of abdomen, mid-dorsal line	7	6	7	6	7·5	5
Sex	♀	♀	♀	♀	♀	♂

It would appear that this species is in an intermediate position between *Parapenæus akayebi* and *P. dalei*.

The characters of the rostrum and of the petasma and thelycum appear to be the most reliable characters on which to base the identification of the various species of this group. Of these characters the former is not altogether trustworthy, as it is subject to some variation, and it is not impossible to obtain a series based upon the length of the rostrum and the number of rostral teeth which will connect all the species of this group. Still, in a broad manner, Miss Rathbun's method of separation holds good.

The form of the genital opercula appears to be much more constant, and each of the species is quite distinct in this respect.

The comparative length of the sixth abdominal segment does not seem to be constant enough to be of value as a basis of identification.

So that, as I have already suggested, it is, perhaps, placing too high a value upon the distinguishing characters of the various forms of the *velutinus* group to give these forms the rank of species. For the present, however, I follow Miss Rathbun.

Philonicus, Spence Bate, 1888.

Philonicus pectinatus, Sp. Bate.

Philonicus pectinatus, Sp. Bate, '"Challenger," Macrura,' p. 279, 1888.

Localities :—Deep water off Galle (Station XL.), 1 specimen ♀, 35 millims.; off

Kaltura (Station XLIII.), 2 ♀, 35 millims. and 48 millims.; Pearl banks, Gulf of Manaar (Station III.), 1 ♀, 48 millims.; Aripu Reef (Station LXIV.), 1 ♂, 35 millims.

All the specimens are much damaged, the exoskeleton apparently being poorly calcified. In all the female specimens the thoracic legs are incomplete.

In the male the petasma is comb-like as described by Sp. Bate. The antennular flagella, which were absent in the "Challenger" specimen, are typical of the genus. There are two long flagella on each antennular peduncle, the upper one being thin and the lower being very broad. The antennal scale is well developed and is longer than the antennular peduncle and twice as long as the antennal peduncle. The antennal flagellum is long and is slightly thicker than the upper antennular flagellum. The form of the rostrum and carapace agrees with Spence Bate's description. In the "Challenger" specimen the 3rd maxillipeds and the thoracic legs were absent.

In the Ceylon specimens the 3rd maxillipeds are very long, reaching well in front of the antennal scale. The distal end of the propodite is about on a level with the end of the antennal scale. All the joints are richly covered with setæ, some of which are so robust as to have the appearance of long slender spines. Of the thoracic legs the first is the shortest and only reaches to the end of the carpos of the 3rd maxilliped. The second leg reaches to the end of the propodite of the 3rd maxilliped. The third pair is missing. The fourth is very long and slender, reaching almost as far forward as the end of the 3rd maxilliped. The last pair of thoracic legs are short, being only slightly longer than the 1st pair and more slender.

Comparative lengths of appendages in male specimen:—

3rd maxilliped	12 millims.
1st thoracic leg	9 ,,
2nd ,, ,, ...	11·5 ,,
3rd (wanting)	—
4th thoracic leg	14 millims.
5th ,, ,, ...	10 ,,

General distribution:—Papua, Ceylon.

Sicyonia, Milne-Edw., 1830.

Sicyonia lancifer (Olivier).

Palæmon lancifer, Olivier, 'Encyclop.,' t. vi., p. 664.
Sicyonia lancifer, de Haan, 'Fauna Japonica,' p. 194, 1849.
Sicyonia lancifer, Sp. Bate, '"Challenger" Macrura,' p. 297, 1888.

Locality:—Pearl banks, Gulf of Manaar (Station III.), 3 ♀ and 1 ♂, average length 40 millims.

There is very little to add to Spence Bate's description and figures.

In the male the petasma is symmetrical, and there is a conspicuous triangular plate between the bases of the last three pairs of thoracic legs, having the apex produced into a long pointed tooth anteriorly like the thelycum in the female. As in the female, there is a pair of spines present at the base of each of the first two pairs of walking legs. The 3rd maxillipeds are similar in both sexes, and are more massive than the thoracic walking legs and extend slightly further forward than the tip of the antennal scale. They are richly setose and have the joints somewhat flattened. The first three pairs of walking legs are chelate and the carpopodite is only slightly longer than the propodite. The fingers are slightly longer than the palm.

General distribution :—New Guinea, Japan, Indian Ocean.

Sicyonia cristata (DE HAAN) (?).

Hippolyte cristatus, DE HAAN, 'Fauna Japonica,' pl. xlv., 1849.
Sicyonia cristata, DE HAAN, 'Fauna Japonica,' p. 194, 1849.

Localities :—West of Periya Paar (Station LXI.), 1 ♂, 25 millims. ; off Dutch Modragam (Station LVII.), 1 ♂, 25 millims. ; Coral reef, Gulf of Manaar (Station LIV.), 1 ♀, 35 millims.

I refer these specimens to the above species, although a little doubtful as to their identity. I have not been able to see figures of DE HAAN'S species, but these specimens agree closely with the description. SP. BATE evidently considered this species to be identical with *Sicyonia lancifer*. The Ceylon specimens resemble the latter species closely, but they possess characters differing from *S. lancifer*. The carapace is more arched than in *S. lancifer*. The rostrum does not turn up at the end and only reaches to the end of the eyes. The abdomen differs only from that of *S. lancifer* in not having pleural spines on each segment. The three distal joints of the 3rd maxillipeds appear to be more flattened than in *S. lancifer*, and the hepatic spine on the carapace is not so well developed as in that species.

General distribution :—Japan, Ceylon.

Sicyonia sculpta, MILNE-EDW.

Sicyonia sculpta, MILNE-EDW., 'Ann. des Sci. Nat.,' sér. 1, t. 19, p. 339, 1830.

Locality :—Trincomalee (Station XX.), 1 ♀, 17 millims.

General distribution :—Atlantic, Mediterranean, Ceylon.

FAMILY: SERGESTIDÆ.

Acetes, MILNE-EDW., 1830.

Acetes indicus, MILNE-EDW.

Acetes indicus, MILNE-EDW., 'Ann. des Sci. Nat.,' t. 19, p. 350, 1830.

Locality :—Galle Harbour (Station XXXVI.), 1 specimen, 14 millims. long, in a damaged condition, but evidently belonging to this species.

This species is generally found either in fresh water or in the brackish water of estuaries.

Distribution :—Mouth of River Ganges, Ceylon.

Leucifer, MILNE-EDW., 1837 (= **Lucifer**, VAUGHAN THOMPSON, 1829).

Leucifer typus (VAUGHAN THOMPSON).

Lucifer typus, VAUGHAN THOMPSON, 'Zool. Researches,' p. 58, 1829.
Leucifer typus, MILNE-EDW., 'Hist. Nat. Crust.,' t. ii., p. 469, 1837.

Localities:—Muttuvaratu Paar (Station VI.); Palk Strait (Station XVIII.); Galle Harbour (Station XXXVI.); south of Cheval (Station XLVII.); Cheval Paar (Station XLIX.); Periya Paar (Station LXI.). A large number of specimens from the various localities. It is probable that most of these specimens were taken in the tow-net, although the labels do not definitely say so, except in one instance.

Altogether there are some hundreds of specimens, and I am satisfied that they all belong to this species. It is worthy of note that in the separate gatherings the specimens are almost entirely of one sex.

The differences from SPENCE BATE'S description are very slight. In the male the eyes do not quite reach to the end of the 1st segment of the antennular peduncle. BATE describes them as reaching nearly to the end of the 2nd segment.

The antennal scale is shorter than the 1st segment of the antennular peduncle and about equal in length to the eye. In the females the eyes are slightly shorter than in the male, and in the females the spines at the base of the abdominal appendages are not so well developed as in SP. BATE'S figures.

General distribution:—North and South Atlantic, Pacific, Australia, Ceylon.

TRIBE: CARIDEA.

FAMILY: ATYIDÆ.

Caradina, MILNE-EDW., 1837.

Caradina vitiensis, BORRADAILE—Plate I., fig. 4.

Caradina vitiensis, BORRADAILE, 'P.Z.S.,' 1898, p. 1003.

Locality:—Galle (Station XXXVI.), 5 specimens, average length 13 millims.

These specimens appear to agree closely with BORRADAILE'S description, but the rostrum is not quite so richly toothed, having a formula $\frac{18-20}{6}$. The ventral rostral teeth are smaller than the dorsal ones. The anterior border of the eyes appears to be slightly concave in all the specimens. The chelæ of the first two pairs of thoracic legs are typical of the genus. The distal joint of the last thoracic legs has a large number of closely packed spines on its posterior border. The sixth abdominal segment is almost twice as long as the fifth, and the telson is equal in length to the sixth segment. The telson bears five pairs of small spines on its dorsal side. Each corner of the posterior border bears a small spine, and there are four pairs of longer spines arranged along the posterior border.

The Ceylon specimens are marine. BORRADAILE's Figi specimens were obtained from fresh water.

General distribution :—Figi and Ceylon.

FAMILY: PONTONIIDÆ.

Conchodytes, PETERS, 1851.

Conchodytes meleagrinæ, PETERS.

Conchodytes meleagrinæ, PETERS, 'Ges. naturf. Freunde, Berlin,' 1851.

Pontonia meleagrinæ, BATE, '"Challenger" Macrura,' p. 707, 1888.

Localities :—Cheval Paar (Station XLVIII.), four ♂; Cheval Paar (Station LIV.), two ♂ and two ♀ within *Pinna*; West Cheval (Station LVIII.) two ♂ and two ♀ from shell of *Pinna*.

The mouth parts agree with SPENCE BATE's description of the thoracic legs, the second pair are very massive and are longer than the body. The ischium, meros and carpos are subequal in length, and the three together are shorter than the palm, which is long and massive and more than twice as long as the fingers. The 1st, 3rd, 4th and 5th pairs are small, decreasing slightly in length from before backwards. The distal joint of the last three pairs is triunguiculate.

Dimensions of male specimen :—

Total length from rostrum to end of telson	24 millims.
Length of carapace and rostrum	10 ,,
1st thoracic leg	12 ,,
2nd ,, ...	27 ,,
3rd ,, ...	11 ,,
4th ,, ...	10 ,,
5th ,, ...	10 ,,

General distribution :—East Africa, Torres Straits, New Guinea, Pacific, Ceylon.

Anchistus, BORRADAILE, 1898.

Anchistus inermis (MIERS).

Harpilus inermis, MIERS, 'Zool. Coll. of "Alert,"' 1884.

Anchistus inermis, BORRADAILE, 'Ann. Mag. Nat. Hist.' (7), ii., 1898.

Localities :—Pearl banks, Gulf of Manaar (Station III.), three ♂ and two ♀; Cheval Paar (Station XLVIII), three ♂ and three ♀.

There is nothing to add to the original description. In most of the specimens the sides of the carapace and abdomen are only very slightly calcified.

General distribution :—West Australia, Ceylon.

Periclimenes, Costa, 1844.

Periclimenes vitiensis, Borradaile.

Periclimenes vitientis, Borradaide, 'Ann. Mag. Nat. Hist.' (7) ii., p. 383, 1898.

Localities:—Cheval Paar (Station XLVIII.), 1 specimen; south-east of Modragam (Station LXIV.), 1 specimen "on weed bearing oyster spat," length 18 millims.

General distribution:—Pacific, Ceylon.

Family: PALÆMONIDÆ.

Bithynis, Philippi, 1860.

Bithynis savignyi (Sp. Bate).

Brachycarpus savignyi, Sp. Bate, '"Challenger" Macrura,' p. 798, 1888.
Bithynis savignyi, Rathbun, 'Bull. U.S. Fish Comm.,' vol. 2, p. 124, 1900.

Locality:—Muttuvaratu Paar (Station VI.), 1 specimen, 12 millims.

Rostrum reaching to the end of the antennular peduncle and having a formula $\frac{7}{3}$. The antennular peduncle has the 1st joint broad and much flattened and equal in length to the sum of the 2nd and 3rd joints, which are cylindrical. The flagella are slightly longer than the peduncle. The scale of the antenna is as long as the rostrum. Thoracic legs are mostly missing, but the specimen agrees closely with Bate's description.

Up to the present this species appears to have only been recorded from the Atlantic.

General distribution:—Bermudas, West Indies, Ceylon.

Urocaris, Stimpson, 1860.

Urocaris longicaudata, Stimpson—Plate I., fig. 5.

Urocaris longicaudata, Stimpson, 'Proc. Ac. Nat. Sci. Phil.,' XII., p. 39, 1860.
Urocaris longicaudata, Rathbun, 'Bull. U.S. Fish Com.,' vol. 2, p. 126, 1900.

Locality:—Aripu Paar (Station LXIV.), 1 specimen. Female bearing eggs.

Dimensions:—

Total length from tip of rostrum to end of telson					32	millims.
Length of carapace and rostrum along mid-dorsal line					8	,,
,, ,, along mid-dorsal line					4·5	,,
,, 1st abdominal segment along mid-dorsal line					2	,,
,, 2nd	,,	,,	,,	,,	2	,,
,, 3rd	,,	,,	,,	,,	5	,,
,, 4th	,,	,,	,,	,,	3	,,
,, 5th	,,	,,	,,	,,	3	,,
,, 6th	,,	,,	,,	,,	4	,,
,, telson	,,	,,	,,	,,	4	,,

The rostrum is straight and slightly arched, semi-transparent except on the ventral side, which is strengthened by a thick ridge. There are nine dorsal teeth, the posterior of which is a little remote from the others and is situated on the carapace. There are two minute teeth at the tip of the rostrum on the ventral side. The rostrum reaches almost to the end of the 2nd segment of the antennular peduncle. The antennular peduncle has the 1st joint broad and flattened and equal to the sum of the 2nd and 3rd. There are two flagella, the outer of which is thicker and shows signs of bifurcation at its distal extremity. The flagella are slightly longer than the peduncle. The antennal peduncle is half as long as the 1st joint of the antennular peduncle. The flagellum is about as long as the body. The antennal scale is slightly longer than the antennular peduncle. The eye stalks are long and the eyes project laterally. The carapace bears on its anterior margin a well-developed spine below the eye and also a smaller spine ventral to this. There is also a large hepatic spine. Running along the carapace are two slight grooves. The dorsal groove starts behind the antennal spine and extends half the length of the carapace. The ventral groove starts at the anterior ventral border and traverses the entire length of the carapace in a sinuous manner. The first two pairs of legs are chelate, the second pair being longer and stouter than the first. The last three pairs are long and slender and have the dactylos biunguiculate. The abdomen is more than three-fourths the length of the body and is suddenly bent at right angles at the 3rd segment, the dorsal part of which is much swollen. The dorsal side of the last three abdominal segments forms a straight line. The 6th segment is long, being about one and a half times as long as the 5th, and equal in length to the telson. The telson is slightly shorter than the uropods and ends in two spines.

General distribution :—Atlantic coasts of North America, Ceylon.

Family: LATREUTIDÆ.

Nauticaris, Sp. Bate, 1888.

Nauticaris grandirostris, n. sp.—Plate I., fig. 6.

Locality :—Galle (Station XXXV.), 2 males.

The carapace has a prominent antennal spine and a spine at the antero-lateral border. as well as a spine on the anterior border half-way between these two spines. The median dorsal surface of the carapace is occupied by well-marked teeth, which are continued on to the rostrum. There is a well-developed rostrum, two-thirds as long as the carapace. The rostrum is deep and is turned upwards at the tip. There are six teeth occupying the whole of the mid-dorsal line of the carapace and the posterior half of the rostrum. Of these teeth the posterior one is very small and not easily made out. The others are well developed, the anterior tooth being slightly smaller than the rest. Only the first two of these teeth are situated on the rostrum. The anterior half of the rostrum bears no dorsal teeth. The extremity is marked by three small teeth. On the ventral side there are six teeth, the posterior four being exceptionally well marked and deep. The antennular peduncle is short, and is only half the length of the rostrum. Its proximal joint is the largest, being equal to the sum of the other two. There are two branches to the flagellum. The inner branch reaches slightly beyond the rostrum, and the outer branch, which is slightly shorter, is much thicker and plumose, and shows signs of bifurcation at the tip. The antennular scale is almost as long as the peduncle. The antennal peduncle is as long as that of the antennule. The flagella are broken in both specimens. The scale is stout and reaches to the end of the rostrum. The mouth parts are similar in all important respects to those of *Nauticaris marionis*.

The 3rd maxillipeds reach past the end of the rostrum and have the distal joint tipped by about five well-marked spines. The proportionate lengths of the joints are similar to those of *N. marionis*. There are only four joints, and the second bears a large spine at its distal end. The 3rd joint is richly setose on its anterior face. The legs are robust, excepting the 2nd pair. The 1st pair are chelate and reach a little past the end of the antennal peduncle. The 2nd pair are long and slender and have a multi-articulate wrist. They reach to the extremity of the rostrum, the 3rd, 4th, and 5th pairs are similar to one another in form, decreasing slightly in length from before backwards. The 5th leg reaches to the base of the antennal scale. The carpos of each of the last three pairs bears a blunt process at the anterior distal border. The dactylos ends in two larger spines, and bears several smaller spines on its posterior border. The abdomen is robust and bent at right angles at the 3rd segment. There are two spines on the ventral side of each of the first four abdominal segments, and on the ventral side of the 5th and 6th segments there is a long median spine pointing backwards. The 6th abdominal segment has a well-marked movable spine at each of its posterior lateral borders, and also bears two well-marked spinous processes on its posterior border overhanging the telson. The uropods are slightly longer than the telson. The 2nd abdominal segment has a small transverse groove in the mid-dorsal line.

The telson tapers somewhat posteriorly and has a slightly grooved dorsal surface carrying two pairs of spines. The posterior border bears two pairs of spines and numerous long hairs.

Dimensions (measured along mid-dorsal line):—

From tip of rostrum to end of telson	50	millims.
Rostrum and carapace	20	,,
Carapace	11	,,
1st abdominal segment	2	,,
2nd ,, ,,	4	,,
3rd ,, ,,	8	,,
4th ,, ,,	$5\frac{1}{2}$	,,
5th ,, ,,	2	,,
6th ,, ,,	$3\frac{1}{2}$	,,
Telson	$5\frac{1}{2}$	,,

Nauticaris unirecedens, Sp. Bate.

Nauticaris unirecedens, Sp. Bate, '"Challenger" Macrura,' p. 608, 1888.

Localities:—Galle (Station XXXV.), 5 specimens; Jokkenpiddi Paar, 1 specimen.

These specimens agree closely with Sp. Bate's description, but the rostral formula is slightly different. The Ceylon specimens are not so richly toothed as the "Challenger" specimens.

Rostral formula $\frac{5+1}{2}$.

Average length 35 millims. (3 males and 3 females).

General distribution:—Hong Kong, Ceylon.

Nauticaris futilirostris, Sp. Bate—Plate II., fig. 8.

Nauticaris futilirostris, Sp. Bate, '"Challenger" Macrura,' p. 606, 1888.

Locality:—Galle Harbour (Station XXXVI.), 4 specimens taken in the tow-net. Average length 11 millims.

These specimens agree with Spence Bate's description; the posterior rostral tooth is slightly more remote from the others than in Bate's figure.

General distribution:—Off Japan, Ceylon.

Latreutes, Stimpson, 1860.

Latreutes ceylonensis, n. sp.—Plate II., fig. 7.

Locality:—Cheval Paar (Station LIII.), 1 specimen, 8 millims. long.

The latero-anterior edge of the carapace is furnished with 4 spines at each side. There is a deep rostrum, almost equal in length to the carapace. The carapace and rostrum together equal half the length of the body. The rostrum dips slightly downwards and bears dorsally two prominent teeth above the eyes and a tooth of equal size slightly behind the pointed anterior extremity. In addition to these there are about a dozen smaller teeth on the dorsal side which are only detected under a microscope. The under side of the rostrum is smooth. Each antennular peduncle is short, the proximal joint being as long as the sum of the other two. Each antennule has two flagella which reach to the end of the rostrum, and are slightly longer than the peduncle. The inner flagellum is slightly thicker and shorter than the outer. The antennal peduncles are slightly longer than those of the antennules. The antennal scale is large and broad, and extends slightly beyond the rostrum. Each scale is furnished with half-a-dozen small spines along its outer border. The antennal flagella are missing.

The first two pairs of thoracic legs are chelate. The 2nd pair are longer than the 1st pair and have the wrist 3-jointed. The remaining three pairs of legs are more strongly made, the meros and carpos being very broad. The dactylos terminates in two very robust spines.

The 3rd, 4th, and 5th abdominal segments each has the posterior part of its dorsal surface raised into a blunt keel. The abdominal segments are all subequal. The telson is long and narrow, and is twice as long as the 6th abdominal segment. It ends posteriorly in a blunt median spine, and is furnished with a lateral spine halfway along each side. The uropods are as long as the telson.

Family: ALPHEIDÆ.

Synalpheus, Sp. Bate, 1888.

Synalpheus gravieri, Coutière.

Synalpheus gravieri, H. Coutière, 'Fauna of Maldives and Laccadives,' p. 870, 1905.

Localities:—Pearl banks, Gulf of Manaar (Station III.), 7 specimens; Cheval Paar (Station XLVIII.), 19 specimens; Coral reef, Gulf of Manaar (Station LIV.), 2 specimens; west of Periya Paar (Station LXI.), 2 specimens, "commensal with dendritic Alcyonarian;" off Mutwal Island (Station LXVII.), 2 specimens.

The rostral and orbital spines are equal in length, the latter sometimes being slightly divergent. The rostrum does not reach the end of the 1st joint of the antennular peduncle. The 1st joint of the antennular peduncle is equal to the sum of the other two, the 2nd joint is twice as long as the 3rd. The antennular scale is a little longer than the 1st joint of the peduncle. The antennal peduncle is one and one-third times as long as the antennular peduncle. The outer spine of the antennal scale is as long as the antennular peduncle.

The 3rd pair of legs has a small spine on the dorsal side of the dactylos. The meros has 4 spines on its ventral posterior border. The propodite has about 8 spines on its posterior border.

General distribution:—Maldives, Ceylon.

Synalpheus laticeps, Coutière.

Synalpheus laticeps, Coutière, 'Fauna of Mald. and Lacc.,' p. 874, 1905.

Localities:—Coral reef, Gulf of Manaar (Station LIV.), 1 specimen; deep water off Galle (Station XL.), 4 specimens.

Orbital spines equal in length to rostrum, but slightly broader. Rostrum shorter than 1st joint of antennular peduncle. First joint of antennal peduncle longest, the 2nd and 3rd joints subequal. Antennular scale a little longer than the 1st joint of the antennular peduncle. The antennal peduncle one and one-fifth times as long as the antennular peduncle. Antennal scale as long as antennal peduncle.

Third legs having the dactylos biunguiculate, posterior border of propodite armed with about a dozen spines.

This species approaches closely to *S. biunguiculatus*.

General distribution:—Maldives, Ceylon.

Synalpheus biunguiculatus, Stimpson.

Synalpheus biunguiculatus, Stimpson, 'Proc. Acad. Phil.,' p. 31, 1860.

Localities :—Deep water off Galle (Station XL.), 2 specimens; Coral reef, Gulf of Manaar (Station LIV.), 14 specimens; Chilaw Paar (Station LXIX.), 1 specimen.

This species differs principally from the preceding species in (1) the rostrum and orbital spines being shorter in comparison with the 1st joint of the antennular peduncle; (2) the antennal scale is shorter, and only reaches to the end of the antennular peduncle; (3) the posterior border of the telson has a deeper curve.

General distribution :—Maldives, Philippines, Pacific, Ceylon.

Synalpheus carinatus, de Man—Plate II., fig. 9.

Synalpheus carinatus, de Man, 'Arch. f. Naturg.,' I., 1887.
Synalpheus carinatus, Coutière, 'Ann. des Sci. Nat.,' (8), t. ix., 1899.

Locality :—Deep water off Galle (Station XLI.), 2 specimens.

The rostral spine is more than twice the length of the orbital spines and reaches nearly to the end of the 1st segment of the antennular peduncle. The rostrum and the orbital spines point slightly upwards. The 1st segment of the antennular peduncle is slightly longer than the 2nd and twice as long as the 3rd. The antennular spine reaches to the end of the 1st peduncular segment. The antennal peduncle is slightly longer than the antennular peduncle. The antennal scale reaches to the end of the antennular peduncle. The large chela is on the left side. The carpopodite has a strong ventral spine. The dorsal side of the palm ends in a fairly prominent spine, immediately in front of the digits. This spine seems more strongly developed than in the type species.

In the 3rd pair of legs there is a spine on the ischiopodite, the meros is almost as long as the carpos and propodite combined, and bears 8 well-developed spines on the posterior border. The carpos bears a single spine at the distal end of its posterior border. The propodite has 8 spines on the posterior border. The dactylos is bifid.

In the male each of the abdominal pleura is produced posteriorly into a spine. In the female the pleura are rounded. The telson is as long as the uropods and tapers slightly. It carries two pairs of spines on the dorsal side and there are 3 spines at each of the posterior corners.

General distribution :—Indian Ocean.

Synalpheus comatulorum, Haswell.

Synalpheus comatulorum, Haswell, 'Cat. Austr. Crust.,' p. 187, 1882.
Synalpheus falcatus, Sp. Bate, '"Challenger" Macrura,' p. 574, 1888.

Localities :—Navakaddua Paar (Station LXVIII.), 4 specimens; Gulf of Manaar (Station LIV.), 3 specimens; Chilaw Paar (Station LXIX.), 1 specimen "on *Antedon*"; south end of Cheval Paar (Station XLVIII.), 1 specimen.

Rostrum twice as long as the orbital spines, and reaching to end of the 2nd segment of antennular peduncle. Antennular scale reaching past the middle of the 2nd peduncular joint. The antennal peduncle is longer than the antennular peduncle. The antennal scale is as long as the antennular peduncle.

General distribution :—Australia, Maldives, Ceylon, Pacific.

Synalpheus neomeris, DE MAN.

Synalpheus neomeris, DE MAN, 'Zool. Jahr.,' 9. Bd., p. 734, 1897.

Locality :—Gulf of Manaar (Station III.), 1 specimen.

I have referred the single specimen to the above species. It appears to differ but slightly from *Synalpheus gravieri*.

General distribution :—Red Sea, Bay of Bengal, Madagascar, Australia, Japan, Maldives, Pacific, Ceylon.

Alpheus, FABRICIUS, 1778.

Alpheus idiocheles, COUTIÈRE.

Alpheus idiocheles, H. COUTIÈRE, 'Fauna of Mald. and Lacc.,' p. 883, 1905.

Locality :—Muttuvaratu Paar (Station VI.), 3 specimens.

Carapace deep. Rostrum short, and separated from the orbits by deep grooves. The orbits are well formed and unarmed. In the antennule the 1st and 3rd segments of the peduncle are subequal, each being half as long as the 2nd segment. The antennular scale reaches to the middle of the 1st peduncular segment. The antenna is short, only reaching three-fourths of the way along the 2nd joint of the antennular peduncle. The antennal scale is nearly as long as the antennal peduncle. The large chela is peculiar, having the dactylos portion of the digit hammer-shaped, and the propodite part short as in *Alpheus malleodigitatus*. The 3rd and 4th legs are robust and have the propodite armed with 5 spines, and end in a simple dactylopodite.

General distribution :—Maldives, Ceylon.

Alpheus phrygianus, COUTIÈRE.

Alpheus phrygianus, COUTIÈRE, 'Fauna of Mald. and Lacc.,' p. 886, 1905.

Localities :—Gulf of Manaar (Station III.), 2 specimens; Cheval Paar (Station XLVIII.), 2 specimens.

Somewhat similar to *A. idiocheles*. The eyes are not so prominent. The antennæ are comparatively longer, reaching to the end of the 2nd segment of the antennular peduncle. The antennal scale reaches to the middle of the 2nd segment of the antennular peduncle. The digits of the large chela are similar in shape to the preceding species, but the palm is broader.

General distribution :—Maldives, Ceylon.

Alpheus paraculeipes, COUTIÈRE.

Alpheus paraculeipes, COUTIÈRE, 'Fauna of Mald. and Lacc.,' p. 894, 1905.

Locality :—Cheval Paar (Station XLVIII.), 1 specimen.

Rostrum poorly developed. Orbits unarmed. 1st and 3rd segment of the antennular peduncle equal. 2nd segment twice as long as each of the others. Antennular scale not reaching to the end of the 1st segment. Antennal peduncle one and one-fourth times as long as the antennular peduncle. Spine of antennal scale as long as antennular peduncle.

The 3rd legs have the ischiopodite unarmed. The posterior border of the meropodite is fringed with about 20 very delicate spines and ends distally in a strong spine. The carpopodite has on its posterior external border 1 spine and about 5 hairs, and on its internal border about 15 long, fine spines. The propodite has 7 pairs of spines on its posterior border and is fringed with hairs anteriorly. The dactylos is slightly biunguiculate.

General distribution :—Maldives, Ceylon.

Alpheus spongiarum, Coutière.

Alpheus spongiarum, Coutière, 'Fauna of Mald. and Lacc.,' p. 895, 1905.

Locality :—Cheval Paar (Station XLVIII.), 1 specimen.

This species is very closely allied to *A. paraculeipes*, but differs in the form of the 3rd pair of legs. The meropodite is not so stout as in the latter species. Along the posterior border of the meropodite there are 7 very long hairs with about 15 short hairs between. The carpopodite has no spine on the posterior border and the dactylos is not bifid.

General distribution :—Maldives and Ceylon.

Alpheus paralcyone, Coutière.

Alpheus paralcyone, Coutière, 'Fauna of Mald. and Lacc.,' p. 895, 1905.

Locality :—Off Mutwal Island (Station LXVII.), 2 specimens.

Rostrum is well defined and slightly carinated behind. The 1st and 3rd segments of the antennular peduncle are subequal, and the 2nd segment is one and a half times as long as each of the others. Antennular scale very small, antennal peduncle one and one-third times as long as the antennular peduncle. The spine of the antennal scale reaches past the end of the antennular peduncle. The palm of the large chela is massive, narrowing distally, and the digits are very short.

In the 3rd pair of legs the ischiopodite is armed with a single spine, the meropodite is large and ends distally at the posterior border in a large spine. The carpopodite has about 4 spines on its posterior border, and the propodite has 8 pairs of spines. The dactylos is bifid.

General distribution :—Maldives, Ceylon.

Alpheus miersi, Coutière.

Alpheus miersi, Coutière, 'Fauna of Mald. and Lacc.,' p. 903, 1905.
Alpheus rapax, var. **miersi**, Coutière, 'Bull. Soc. Entom. de France,' No. 7, p. 166, 1898.

Localities :—Pearl banks, Gulf of Manaar (Station III.), 3 specimens; Cheval Paar

(Station XLVIII.), 3 specimens; Coral reef, Manaar (Station LIV.), 2 specimens; off Mutwal Island (Station LXVII.), 1 specimen.

Rostrum well developed, reaching to the end of the 1st segment of the antennular peduncle. The 2nd segment of the antennular peduncle is slightly longer than the 1st or 3rd, which are subequal. The antennal peduncle and scale are equal in length and slightly longer than the antennular peduncle. In the Ceylon specimens the large chela is massive and the palm is broad. The meropodite is spiny on its inferior border.

The 3rd pair of legs has the ischiopodite with a single spine. The meros is smooth except for a small spine at the posterior distal border. The carpos is smooth. The propodite bears five pairs of spines. The dactylopodite is half the length of the propodite and slightly curved.

General distribution :—Pacific, Japan, Maldives, Ceylon.

Alpheus pareucheirus, Coutière.

Alpheus pareucheirus, Coutière, 'Fauna of Mald. and Lacc.,' p. 906, 1905.

Locality :—Haul 6, south of Adam's Bridge (Station LIV.), 1 specimen.

The antennules and antennæ do not differ greatly from those of the preceding species. Their peduncles are not so stout. The rostrum is only two-thirds as long as the 1st segment of the antennular peduncle. The large chela differs in having the palm grooved on both sides. The meropodite is smooth. In the 3rd legs the ischiopodite does not bear a spine. The meropodite is smooth and not so robust as in the previous species. The carpos is smooth and the propodite bears 8 long spines on the posterior border. The dactylopodite is long and slightly curved.

General distribution :—Maldives and Ceylon.

Alpheus bis-incisus, var. **malensis**, Coutière.

Alpheus bis-incisus, var. **malensis**, Coutière, 'Fauna of Mald. and Lacc.,' p. 910, 1905.

Locality :—Cheval Paar (Station LXIX.), 1 specimen.

The rostrum is triangular, and separated from the orbits by two well-marked grooves. It reaches to the middle of the 1st segment of the antennular peduncle. The 1st and 2nd segments of the antennular peduncle are subequal and slightly longer than the 3rd. The antennular scale almost as long as the 1st peduncular segment. The peduncle and scale of the antennal are equal in length and slightly longer than the antennular peduncle.

I have placed this specimen in Coutière's variety merely on the characters of the rostrum and antennæ. The large chela and most of the legs are missing.

General distribution :—Maldives and Ceylon.

Alpheus bis-incisus, var. **stylisostris**, Coutière.

Alpheus bis-incisus, var. **stylisostris**, Coutière, 'Fauna of Mald. and Lacc.,' p. 911, 1905.

Locality :—Coral reef, Gulf of Manaar (Station LIV.), 1 specimen.

This specimen appears to differ mainly from the variety *malensis* in the form of the rostrum, which is much narrower in proportion to its length.

General distribution :—Maldives and Ceylon.

Alpheus audouini, Coutière.

Alpheus edwardsi, Audouin (see Coutiere, 'Fauna of Mald. and Lacc.,' p. 911).
Alpheus audouini, Coutière, 'Fauna of Mald. and Lacc.,' p. 911, 1905.

Localities :—Off Mutwal Island (Station LXVII.), 2 specimens; Pearl banks, Gulf of Manaar (Station III.), 6 specimens; Coral reef, Manaar (Station LIV.), 3 specimens.

This species, which Coutière has separated from *Alpheus edwardsi*, resembles the latter species in the form of the rostrum and in the appearance of the antennæ. The large chela has the dorsal and ventral projections of the palm rounded, thus differing from those of *A. edwardsi*, which are spiny.

General distribution :—Red Sea, Indian Ocean, Malay Archipelago, New Zealand, Sandwich Islands.

Alpheus macrodactylus, Ortmann.

Alpheus macrodactylus, Ortmann, 'Zool. Jahrb.,' V., p. 473, 1890.

Locality :—Off Mutwal Island (Station LXVII.), 1 specimen. Related to *A. edwardsi* and *A. euphrosyne*.

The rostrum is well pronounced and more than half as long as the 1st segment of the antennular peduncle. Of the joints of the antennular peduncle the 2nd is the longest, being twice as long as the 3rd and nearly twice as long as the 1st. The antennular scale is broad and reaches nearly to the end of the 1st segment of the peduncle. The antennal peduncle and scale are equal in length and extend as far forward as the end of the antennular peduncle. The large chela differs from that of *A. edwardsi* in the absence of a dorsal spine and in the comparatively greater length of the digits.

General distribution :—Australia, Ceylon.

Alpheus lævis, Randall.

Alpheus lævis, Randall, 'Journ. Acad. Nat. Sci. Phil.,' vol. viii., p. 141.

Localities :—Galle (Station XXXV.), 4 specimens; Coral reef near Galle (Station XL.), 5 specimens.

Well-developed rostrum reaching to the end of the 1st segment of the antennular peduncle. Orbits armed with two small spines. Segments of the antennular peduncle subequal. Antennular scale slightly longer than the 1st peduncular segment. Antennal peduncle and scale equal to one another and slightly longer than the antennular peduncle. The large chela has a massive palm, laterally compressed, with no dorsal or ventral notches. The carapace is deep.

General distribution :—Indian Ocean, Pacific, Australia.

Athanas, Leach, 1813.

Athanas nitescens, Leach.

Athanas nitescens, Leach, 'Edin. Encycl.,' vol. vii., p. 432, 1813.

Athanas veloculus, Sp. Bate, '"Challenger" Macrura,' p. 529, 1888.

Locality :—Cheval Paar (Station XLVII.), 1 specimen.

This specimen clearly belongs to the well-known species in which must be included—according to Coutière—Bate's species *Athanas veloculus.*

This record is of interest, inasmuch as the distribution of this species up to the present has been limited, so far as I can ascertain, to the Atlantic and Mediterranean.

General distribution :—Atlantic coasts of America, Cape Verd Islands, north-west Europe, Mediterranean, Ceylon.

Athanas orientalis, n. sp.—Plate II., fig. 10.

Localities :—Cheval Paar (Station XLVIII.), 2 specimens; Muttuvaratu Paar (Station VI.), 1 specimen; Coral reef, Gulf of Manaar (Station LIV.), 2 specimens; west of Periya Paar (Station LXI.), 2 specimens.

This species is in many respects very closely allied to *Athanas dimorphus*, Ortmann, and *A. minikoensis*, Coutière, but there are differences in the form of the extra- and infra-orbital spines, as well as in the form of the 1st pair of legs which lead me to place it in a new species.

The rostrum extends as far as the end of the 2nd joint of the antennular peduncle. The infra-corneal spine reaches slightly beyond the eye, and the extra-corneal spine just reaches to the anterior end of the eye, so that it is difficult to make out in side view. There is no supra-corneal spine.

The antennule has the 3 joints of its peduncle subequal, and its scale reaches as far forward as the end of the 2nd peduncular joint and the tip of the rostrum. The antennal peduncle reaches to the end of the 2nd joint of the antennular peduncle, and its scale, which is very broad, reaches slightly beyond the end of the antennular peduncle. In the small leg of the female the carpopodite and the propodite are about equal in length, but the latter is more robust. The meropodite is one and a half times as long as the carpopodite. The ischiopodite has a long delicate spine at the distal end of its dorsal border, and there are five smaller spines along the same border. This is the only specimen bearing the 1st pair of legs, so that it is not possible to compare these appendages in the male.

This species differs from the two allied species in the length of the rostrum and also in the relative lengths of the extra- and infra-orbital spines, as well as in the length and robustness of the joints of the small leg. The other two species are devoid of spines on the ischiopodite of that limb.

Family: CRANGONIDÆ.

Ægeon, Guérin-Méneville, 1835
(= Egeon, Risso, 1816).

Ægeon cataphractus (Olivier).

> **Cancer cataphractus**, Olivier, 'Zool. Adriatica,' p. 30, 1792.
> **Egeon loricatus**, Risso, 'Crust. de Nice,' p. 100, 1816.
> **Crangon cataphractus**, Milne-Edw., 'Hist. Nat. Crust.,' vol. 2, p. 343, 1837.
> **Ægeon cataphractus**, Ortmann, 'Zool. Jahrb.,' vol. 5, p. 535, 1890.

Locality :—Galle (Station XXXV.), 1 specimen.

This single specimen agrees closely with the type species, and also with Henderson's species, *Ægeon orientalis*,* in most respects. The latter species differs from the above species only slightly with regard to the teeth present on the carapace, and in the absence of the small hepatic groove on the sides of the carapace. Since the Indian species was formed from the characters of a single specimen, it is by no means improbable that this specimen merely represents an extreme variation of the parent species. In all other characters, excepting the two above mentioned, *Ægeon orientalis* agrees with *Ægeon cataphractus.*

General distribution :—Mediterranean, Senegambia, South Africa, Ceylon.

Family: PROCESSIDÆ.

Processa, Leach, 1815
(= Nika, Risso, 1816).

Processa canaliculata, Leach.

> **Processa canaliculata**, Leach, 'Malac. Podoph. Brit.,' p. 641, 1815.
> **Nika edulis**, Risso, 'Crustacés de Nice,' p. 85, 1816.
> **Nika canaliculata**, Desmaret, 'Consid. gén. Crust.,' p. 231, 1825.
> **Nika bermudensis**, Rankin, 'Ann. N.Y. Acad. Sci.,' XII., p. 536, 1900.

Localities :—Pearl banks, Gulf of Manaar (Station III.), 6 specimens; Muttuvaratu Paar (Station VI.), 1 specimen; 10 miles west of Cheval (Station XLVII.), 2 specimens; Cheval Paar (Station XLVIII.), 4 specimens; south-east of Modragam (Station LXIV.), 2 specimens.

None of these specimens appear to differ in any marked degree from the ordinary characters of the species.

General distribution :—Madeira, Japan, West Indies, Gulf of Mexico, South Africa, North-west Europe, Ceylon.

* J. R. Henderson, 'Trans. Linn. Soc.,' 2nd series (Zoology), vol. v., part 10, p. 446, and plate 40, figs. 16 and 17, 1893.

Tribe : SCYLLARIDEA.

Family : SCYLLARIDÆ.

Scyllarus, Fabricius, 1793
(= **Arctus**, Dana, 1852).

Scyllarus tuberculatus (Sp. Bate).

Arctus tuberculatus, Sp. Bate, '"Challenger" Macrura,' p. 70, 1888.

Localities :—Pearl banks, Gulf of Manaar (Station III.), 1 specimen, female ; Galle (Station XXXV.), 3 females and 1 male ; Aripu Reef (Station LXIV.), 1 specimen.

Characterised by large tuberculations on the mid-dorsal line of the carapace and of the first 3 pairs of abdominal segments. Those of the second abdominal segment are very distinctive of the species.

In this genus all the legs of the male end in a simple dactylos, and in the female there is a poor developed chela on each of the 5th legs. The propodite digit is not very well developed.

General distribution :—Australia and Ceylon.

Scyllarus sordidus (Stimpson).

Arctus sordidus, Stimpson, 'Proc. Acad. Nat. Sci., Phil.,' p. 8, 1860.

Locality :—Coral reef, Gulf of Manaar (Station LIV.), 3 females and 1 male.

General distribution :—Pacific and Ceylon.

Tribe : THALASSINIDEA.

Family : CALLIANASSIDÆ.

Callianassa, Leach, 1813.

Callianassa rotundicaudata, Stebbing.

Callianassa rotundicaudata, Stebbing, 'Marine Invest. of S. Africa.' Crust., ii., p. 41, 1903.

Locality :—Cheval Paar (Station XLVIII.), 1 specimen, 18 millims. long.

General distribution :—South Africa, Ceylon.

Callianassa maldivensis, Borradaile.

Callianassa maldivensis, Borradaile, 'Fauna of Mald. and Lacc.,' vol. ii., part 3, p. 753.

Locality :—Gulf of Manaar (Station III.), 1 specimen, 24 millims. long.

This specimen is imperfect, but it agrees closely with the above species.

General distribution :—Maldives and Ceylon.

Upogebia, Leach, 1813.

Upogebia intermedia (de Man).

Gebiopsis intermedia, de Man, 'Journ. Linn. Soc.,' vol. 22 (Zool.), 1888.

Localities :—Haul 6, south of Adam's Bridge (Station LIV.), 2 males and 1 female; Muttuvaratu Paar (Station VI.), 1 male.

This species is characterised by the possession of a large number of denticulations on the cephalic portion of the carapace, and also by the anterior thoracic legs being richly clothed with long and very fine setæ.

The anterior portion of the carapace covers the small eyes and projects almost to the end of the antennular peduncle. The peduncle of the antennule is 3-jointed, the 3rd being slightly longer than the 1st and two and a half times as long as the 2nd. The 3rd joint is more slender than the other two. There are 2 flagella one and a half times as long as the peduncle. The inner flagellum is slightly longer and less robust than the outer. The antennal peduncle is slightly longer than that of the antennule and is also 3-jointed. The 1st and 2nd joints are equal and slightly longer than the 3rd joint, which is also less robust than the other two. The 1st and 2nd joints are richly clothed with long fine setæ. The eyes are small and project nearly to the end of the 2nd antennular peduncle. The middle of the carpos of the 1st legs reaches to the end of the rostrum. The appendages agree with de Man's description. The abdomen is large, being twice as long as the carapace and proportionally broad. The segments are subequal, the 2nd and 6th being slightly longer than the others. The telson is broader than long and equal in length to the uropods.

General distribution :—Mergui, Ceylon.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Penæus indicus*, MILNE-EDW., head, side view. × 4.
„ 2. *Parapenæus mogiensis*, RATHBUN, thelycum in Ceylon specimen. × 8.
„ 3. „ *gallensis*, n. sp., head, side view. × 5.
„ 3A. „ „ „ thelycum. × 4.
„ 3B. „ „ „ petasma. × 10.
„ 4. *Caradina vitiensis*, BORRADAILE, rostrum, side view. × 12.
„ 5. *Urocaris longicaudata*, STIMPSON, head, from above. × 7.
„ 5A. „ „ rostrum and carapace, side view. × 7.
„ 6. *Nauticaris grandirostris*, n. sp., side view. × 3.
„ 6A. „ „ rostrum, side view. × 3.
„ 6B. „ „ head, from above. × 5.
„ 6C. „ „ telson, from above. × 3.

PLATE II.

Fig. 7. *Latreutes ceylonensis*, n. sp., rostrum and anterior edge of carapace. × 65.
„ 7A. „ „ head, from above. × 65.
„ 7B. „ „ 3rd maxilliped. × 36.
„ 7C. „ „ 2nd thoracic leg. × 36.
„ 7D. „ „ 3rd thoracic leg. × 36.
„ 7E. „ „ telson, dorsal view. × 28.
„ 8. *Nauticaris futilirostris*, SP. BATE, 4th thoracic leg. × 30.
„ 9. *Synalpheus carinatus*, DE MAN, head, from above. × 12.
„ 9A. „ „ 3rd thoracic leg. × 54.
„ 9B. „ „ telson and right uropod. × 20.
„ 10. *Athanas orientalis*, n. sp., head, from above. × 30.
„ 10A. „ „ side of head. × 30.
„ 10B. „ „ 1st thoracic legs; small chela. × 25.

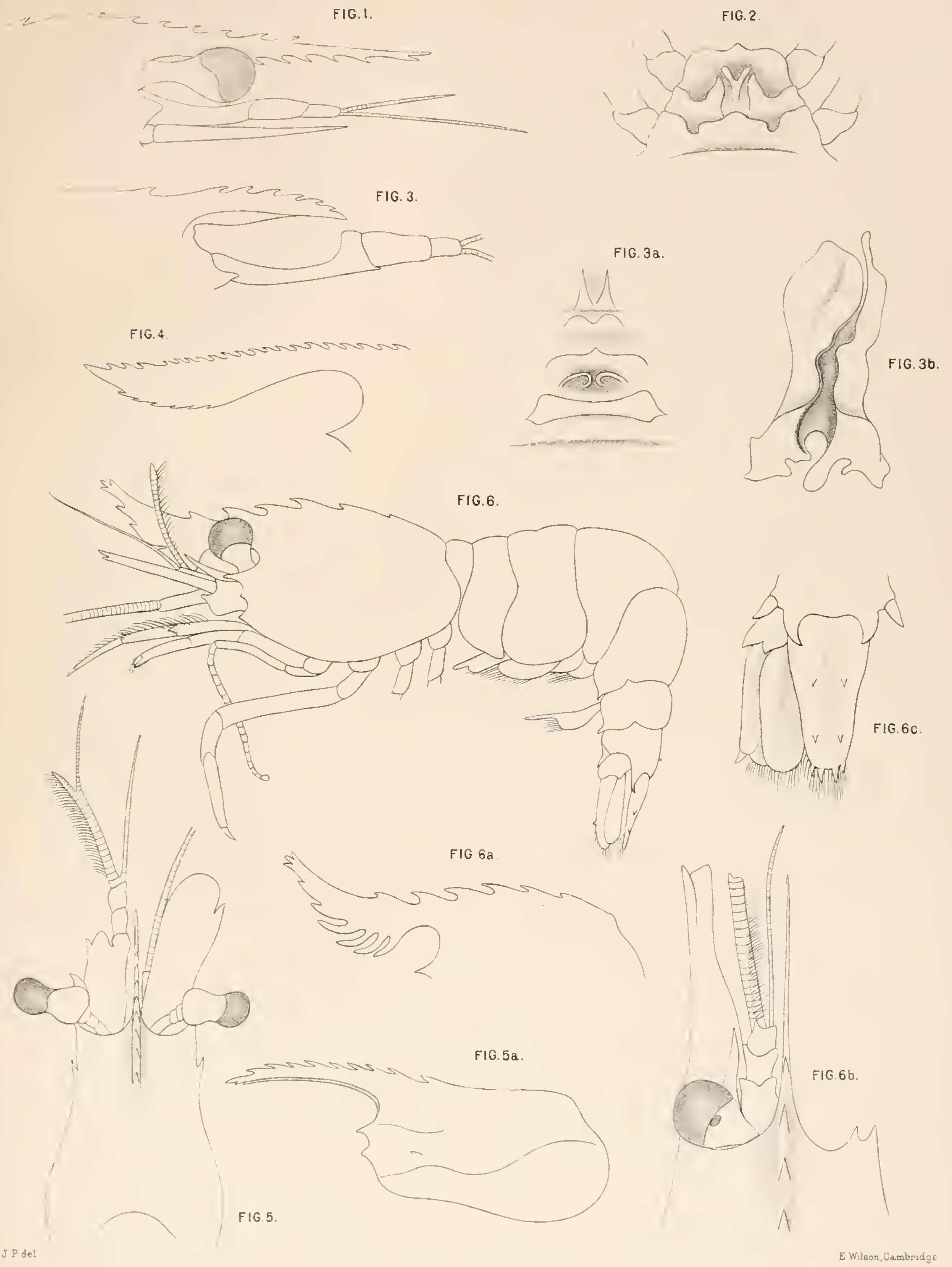

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Fig. 1, Penæus indicus, M. Edw.; Fig. 2, Parapenæus mogiensis, Rathbun; Fig. 3, Parapenæus gallensis, n. sp.; Fig. 4, Caradina vitiensis, Borradaile; Fig. 5, Urocaris longicaudata, Stimpson; Fig. 6, Nauticaris grandirostris, n. sp.;

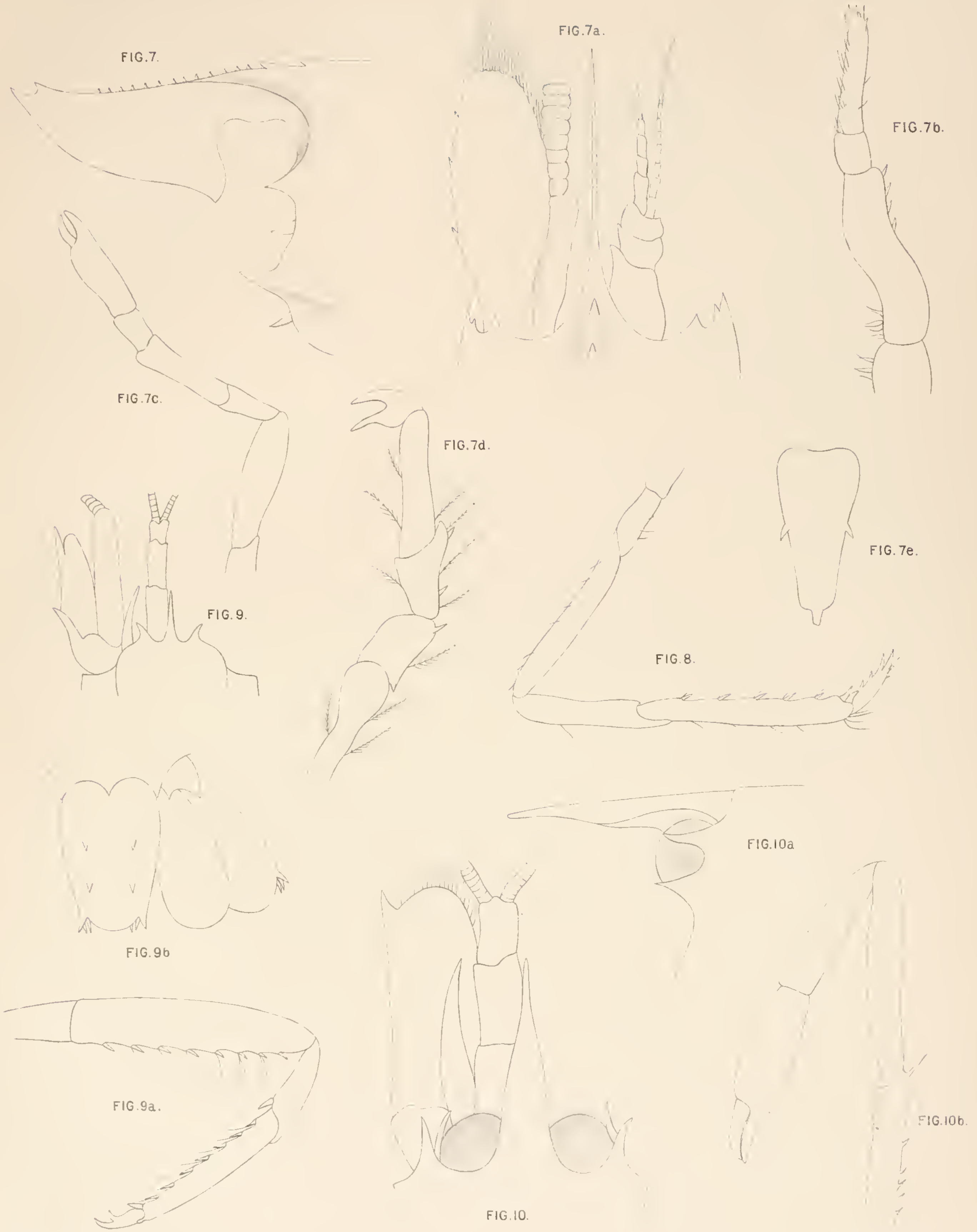

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FIG. 7, LATREUTES CEYLONENSIS, n. sp.; FIG. 8, NAUTICARIS FUTILIROSTRIS, Sp. Bate; FIG. 9, SYNALPHEUS CARINATUS, de Man; FIG. 10, ATHANAS ORIENTALIS, n. sp.

REPORT

ON THE

ANTIPATHARIA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

PROFESSOR J. ARTHUR THOMSON, M.A., UNIVERSITY OF ABERDEEN,

AND

JAMES J. SIMPSON, M.A., UNIVERSITY OF ABERDEEN.

[WITH ONE PLATE.]

THE collection of Ceylonese Antipatharians here reported on was made in 1902 from the Pearl Oyster Banks in the Gulf of Manaar, by dredging within the 100-fathom line off Trincomalee and off Galle. The localities are more precisely referred to in Professor HERDMAN'S "Narrative" in Part I. of the General Report (1903).

The collection is a small one, including thirteen species, but nine at least of these seem to be new. The list is as follows:—

FAMILY: ANTIPATHIDÆ.

SUB-FAMILY: CIRRIPATHINÆ.

**Cirripathes* (?), n. sp.

SUB-FAMILY: ANTIPATHINÆ.

**Antipathes gallensis*, n. sp.
**Antipathes gracilis*, n. sp.†
Antipathes abies, GRAY.
**Stichopathes ceylonensis*, n. sp.
**Stichopathes contorta*, n. sp.
**Stichopathes papillosa*, n. sp.
Stichopathes gracilis, GRAY, var. *spiralis*, nov.
Stichopathes echinulata, BROOK.
**Antipathella rugosa*, n. sp.
**Antipathella elegans*, n. sp.
**Antipathella irregularis*, n. sp.
**Antipathella ceylonensis*, n. sp.

* Those marked with an asterisk are reported as new.

† NON *Antipathes gracilis*, GRAY (1860) = *Antipathella gracilis*, GRAY;
NON *Antipathes gracilis*, KOCH (1889) = *Antipathes mediterranea*, BROOK (1889).

Before proceeding to the systematic report, we would make a few general observations:—

(*a*) In the detailed classification of Antipatharia much importance has been attached to the form and distribution of the spines on the axis. But it does not seem to have been sufficiently emphasised that there is considerable variation in both of these characters in the different parts of the colony. Thus in the branched forms the nature of the spines, the number seen from one aspect, and the arrangement of these in spirals or longitudinal rows in no way correspond on the larger branches and on the pinnules (Plate, fig. 2). In the simple colonies this is even more emphasised, *e.g.*, in *Cirripathes* (?) (Plate, fig. 8) those at the base are arranged irregularly (*a*), those about the middle of the colony have a distinct linear arrangement (*b*), while those near the tip are disposed in whorls around the stem (*c*). This distinction has been illustrated relative to the species described, in the figures on the Plate, where two views, and in one case three, have been given. This is of great importance where species are determined from fragmentary specimens.

(*b*) This difference between stem, branches, and pinnules is also borne out with regard to the size and shape of the polyps. In many of the specimens, on the stem and larger branches, the polyps are almost circular and disposed irregularly, their diameter being less than that of the axis, while on the pinnules they are elongated and rectangular, exceeding in breadth the diameter of the axis. Their distribution also varies in the different portions of the colony; they are often separated by considerable intervals on the older parts, while on the pinnules they may be closely apposed. The length and degree of transparency of the tentacles does not seem to be a safe criterion, varying as it does with the degree of contraction and the mode of preservation.

(*c*) Of some general interest and deserving further investigation is the extraordinary modification shown in the spines of several species. The general Antipatharian spine is simple or papillose, but in some species they pass from an elongated sinuous form through a series of gradations to an antler-like growth and eventually simulate a tree-like structure (Plate, fig. 1, *a–f*). This has been previously noted, *e.g.*, by Carter for *Antipathes spinosa* (Carter), but no interpretation has been suggested. It may be due to a pathological condition, and in some cases where branched spines were observed it was noted that a sponge-like growth surrounded the axis, or it may be the result of irregular regeneration of broken spines. It is particularly well seen at the base of *Antipathes gracilis*, n. sp., and on *Antipathella rugosa*, n. sp. In *Antipathes abies*, Gray, a forking of the spines was occasionally observed.

(*d*) The polyps of *Antipathes abies*, Gray, which were unknown when Mr. George Brook described the "Challenger" Antipatharia, are very well preserved in some of Herdman's specimens, and we have therefore given a full description and figures of their external features (Plate, fig. 4).

(*e*) A fact which may yet prove to be of some importance is that in *Stichopathes papillosa*, n. sp., belonging to a genus typically simple, a knob-like projection, about 6 centims. from the base, indicates, without doubt, the remains of a branch.

(*f*) The various specimens show a considerable number of epizoic animals:—*e.g.*, Sponges, Polyzoa, Serpula-tubes, Spirorbis-tubes, Cirripede-galls, stalked Barnacles, Corals, and in one case a young pearl oyster.

Cirripathes (?) n. sp.—Plate, fig. 8.

A very large simple colony, 135 centims. long, with a diameter varying from 3·75 millims. at the base to 0·75 millim. at the top. The basal portion, which is attached to a stone, is expanded into a circular disc 16 millims. in diameter. The stem is sinuous for the first 35 centims., but after that it is coiled into three distinct spirals, with diameters of 10 centims., 9 centims., and 8 centims. respectively—the corresponding heights being 10 centims., 8 centims., and 7 centims. The total height of the colony is 65 centims. The colour of the axis at the base is jet black, changing gradually to a golden brown. It is hollow, at least in the upper region, and is covered with distinctly papillose spines, which are 0·1 millim. in height near the top of the colony, but shorter and thicker further down. They are arranged irregularly near the base, where twenty can be counted from one aspect, but further up a linear arrangement seems to predominate. Near the top they are disposed in verticils round the stem, about one and a half to two lengths apart, and the number from one aspect diminishes to nine. They are of a paler colour than the stem.

As there are no polyps on the specimen, it is impossible to decide its position with security, beyond saying that it is either a *Stichopathes* or a *Cirripathes*, but the arrangement of the spines and the general nature of the colony would point towards its being a new species of *Cirripathes*, which we would refrain from naming. The specimen was trawled at Station XXIV., off Foul Point, outside Trincomalee, 46 fathoms.

Antipathes gallensis, n. sp.—Plate, fig. 15.

A fragmentary portion of a colony, 8 centims. high and 4·5 centims. broad. The branching is irregular, giving the whole a shrub-like appearance, suggestive of the broom. The main stem is short and sinuous, but a large branch arises about midway up and constitutes the greater part of the colony. The general colour is black towards the base, but rusty brown in the smaller branches, which are long and slightly flexed. The diameter of the axis is 1 millim. at the base and tapers very gradually.

The spines on the main branch are low and conical, standing perpendicularly and arranged irregularly, so that no definite number could be counted from any one aspect. Those on the smaller branches are compressed and thorn-like—the upper margin being sub-horizontal, while the lower is convex. They are comparatively short, about one-third the diameter of the branch, and are disposed in fairly steep sinistrorse spirals and longitudinal rows, those in a row being about two lengths apart. The rows do not consistently alternate, but a quincuncial arrangement is infrequent. Five can be clearly seen from one aspect, while the tip of another is visible, seven making a complete revolution.

The polyps on the stem are large and circular, with a low truncated oral cone and prominent mouth opening, which is also circular. The tentacles are arranged radially and slightly distant on the branches, the polyps are arranged in a single longitudinal row and are elongated in the direction of the axis—this being specially marked on the smaller branchlets. They are very large and prominent, measuring 1·5 millims. in length. The projection bearing the circular oral opening is large and cylindrical. The tentacles when fully expanded are very long, but in most of the polyps they are contracted—being then thick set and conical. They are disposed in three pairs, the sagittal pair being inserted low down in the polyp. On the larger branches the distance between the polyps is equal to about one-half their length, but this diminishes considerably on the branchlets, where the polyps are more elongated though still of the same general character.

This species differs from any known form both in its mode of branching and in the arrangement of the spines.

Locality :—Station XLI., deep water off Galle.

Antipathes gracilis, n. sp.—Plate, figs. 7 and 14.

A small, complete, delicate whin-like colony, 6 centims. high and 1 centim. in diameter, attached by a small expansion. It consists of a main axis, 1 millim. in diameter at the base, tapering gradually to a fine point. The lower 13 millims. of the stem are devoid of branches. On the next 2 centims. small branches bearing pinnules arise sub-horizontally from three sides. These are almost straight and taper to a point, the longest being 8 millims. The remainder of the stem bears branches arising on all sides, but apparently in no definite order. The branches gradually diminish in length towards the apex of the colony. The colour of the axis is golden yellow when seen with transmitted light.

The spines on the bare part of the axis are slightly elongated, compressed, and triangular, the upper margin being sub-horizontal, the lower convex. They are arranged irregularly, about nine being visible from one aspect, at intervals of about one length. Many of the basal spines show an antler-like or dendriform mode of branching. On the upper part of the stem they are disposed in more regular longitudinal lines, five being now visible from one aspect. On the pinnules they are still of the same type, but more elongated, and with a greater slope towards the axis. They seem to be arranged irregularly, but a closer examination reveals a hint of a steep dextrorse spiral. They are about one and a half lengths apart, and seven is a typical number from one aspect.

The polyps are all arranged so as to face in one direction, and it is worthy of note that this is away from the bare portion of the axis mentioned before. On the stem they are disposed irregularly and are somewhat circular, the tentacles being inserted almost equidistant from the mouth opening. The oral projection is very prominent and cylindrical, and the mouth opening is circular. On the branches and pinnules they are very much elongated, and the tentacles are disposed in three pairs, the sagittal pair being inserted slightly below the level of the others; but apart from this the structure is much the same as in those on the stem. On the branches they are separated by intervals about equal to their breadth, but on the pinnules this distinct demarcation disappears.

This species approaches most closely to *Antipathes spinosa* (Carter) (*Hydradendrium spinosum*, Carter), but differs from it both in the mode of branching and in the character of the spines. In *A. spinosa* (Carter) the polyps had not been observed when Mr. Brook described the "Challenger" Antipatharia.

Locality :—Deep water off Galle.

Antipathes abies, Gray—Plate, fig. 4.

Several very fine specimens of this species are included in the Ceylon collection. All are of the bottle-brush, or, more correctly, fir-tree type.

One magnificent colony (A) is 65 centims. in height, the breadth varying at the different parts. At 20 centims. from the base the diameter is 15 centims., but this gradually diminishes to 10 centims. at 40 centims. from the base, and tapers almost to a point at the top of the colony. It is attached to a stone, and for the first 11 centims. the axis is bare. Above this there are about a hundred principal branches of varying sizes. The colour of the axis is black, but owing to the thin cœnenchyma it presents a greyish surface. The branches have a superficial rusty or reddish-brown tint, getting paler towards the top of the colony. The diameter of the axis at the base is 5 millims.; it gradually tapers upwards.

A smaller colony (B) is also very perfect and compact. It is 30 centims. high and 15 centims. in diameter about half way up. From that point it ascends in a symmetrical cone. From the first 9 centims. of the stem the branches have been broken off, but the knob-like ends have been quite overgrown by the cœnenchyma.

The axis is 7 millims. in diameter at the base and tapers to a point. The colour is identical with that of (A).

The main stem is slightly curved and the branches are longest on the concave surface, so that in contour the colony is symmetrical.

The mode of branching is by no means regular. At some places there are signs of a spiral arrangement, but this is often interrupted by extra offshoots. The branches arise very close together, often only 2 millims. apart. They are mostly in planes at right angles to the main stem, but some are turned upwards and others downwards, interlocking, so that no two overlap. At their point of origin they are about 2 millims. in diameter and present the crescentic shape characteristic of the species. A typical branch from the concave side of the stem has a chord of 10 centims., a perpendicular height of 2 centims., and a breadth of 5 centims. The branches bear branchlets, and even secondary and tertiary branchlets, extending in a plane at right angles to the long axis of the branch. The secondary branches arise in a distinctly alternate manner, the planes bearing them enclosing an angle of 60°. The branches do not all curve in one direction, but for the most part they diverge in pairs, so that the tips of two approximate, enclosing an ellipse. The secondary branches arise in a similar manner, so that the maximum of surface is exposed on the contour of the colony.

The spines vary greatly in the different parts of the colony. On the black main stem they are disposed very irregularly, and are very small and abundant. This is also the case on the paler branches, and owing to the conical form the whole gives the impression of a moss-rose stem. They are horny in colour and have a black broadened part where they arise from the stem. The smaller branchlets are transparent and hollow, being of a golden-brown colour with a faint reddish tinge. Here the spines are much longer, being bluntly conical and pointing slightly upwards. They are arranged in distinct longitudinal lines, which in reality are the result of steep sinistrorse spirals, five or six being seen from one aspect. They are almost equal to the radius of the pinnule and are about one length apart.

The polyps, which were unknown when Mr. Brook described the "Challenger" Antipatharia, are of two kinds, according to the position in the colony. On the main stem and larger branches they are scattered irregularly on the concave surface, being thus within the general network of the circumference. They are visible to the naked eye and appear as six-rayed stars. They are almost circular, the tentacles being disposed on six radii. The tentacles vary considerably in size, according to the state of retraction. On the pinnules the polyps are arranged on the convex surface and thus all face outwards. They are more rectangular in shape than on the stem, being elongated in the direction of the long axis of the pinnule. The tentacles are disposed in three pairs, those in the sagittal axis being inserted very far down and standing mostly perpendicular to the polyp. The distance between the polyps is approximately the same as the length of a polyp, viz., 0·9 millim. In all cases the mouth is situated on a prominent cylindrical projection, the oral cavity being elongated in the direction of the sagittal axis.

Cirripede galls are of frequent occurrence, and these are overgrown with the mud-coloured cœnenchyma, also bearing spines. Numerous barnacles are attached to the larger branches.

Another almost complete colony (C), without the basal attachment, is 22 centims. in height and 9 centims. in diameter at the widest portion. The main stem is bent so as to form two arcs. The length of the branches on the concave surface of the stem greatly exceeds that on the convex, so that the contour is symmetrical.

The spines are typical both as to size and arrangement. A few are bifurcated, but as this is only of local occurrence it does not justify the dignity of a new species. The polyps are also typical, but in some, owing to contraction, the tentacles are very inconspicuous.

A beautiful complete colony (D), closely resembling a young larch tree, was attached to a stone by a disc-like expansion. It is 30 centims. in height, the greatest width being 10 centims. The first 10 centims. are bare, owing to the branches having been broken off, and the next 6 centims. bear branches only on one side. The diameter of the axis at the base is 2 millims. The spines and polyps are typical. A great number of barnacles are attached to the branches.

Another complete colony (E) was more of the bottle-brush type. It is 13·5 centims. high, with branches down to the very base—breadth 6·5 centims. The diameter of the axis at the base is 1·5 millims., tapering to 0·5 millim. The branching is not so regular as in the others, but in no case do the branches overlap. The spines and polyps agree closely with the typical forms, but the colour of the branches is slightly darker.

Localities:—Station LXIII., west of Periya Paar, in the Gulf of Manaar, 40 fathoms; and Station XXIV., off Foul Point, outside Trincomalee, 46 fathoms.

Stichopathes ceylonensis, n. sp.—Plate, fig. 9.

A small, complete, simple colony attached to a piece of stone by an almost spherical expansion. It is 8·5 centims. long, but only reaches a height of 6 centims. owing to its spiral course.

The diameter at the base is 1 millim., and this diminishes to 0·75 millim. at the tip of the colony, so that the tapering is very slight. The stem is translucent, golden brown near the base, becoming paler upwards; it is hollow throughout its entire length. The first 4 centims. are straight, followed by two open sinistrorse spirals 1·3 centims. in diameter.

The spines near the base are short, triangular, and compressed, standing at right angles to the stem, disposed irregularly, but mostly one to two lengths apart. Four may be seen from one aspect. On the upper half of the colony the spines are of the same type, but considerably longer in proportion to the thickness of the stem, being equal to about one-third of the diameter. They are arranged in steep sinistrorse spirals and longitudinal rows about two to three lengths apart. Four can be distinctly seen from one aspect, while the tips of two others are visible, so that there are eight altogether in a spiral.

The polyps are typical and prominent. The tentacles are very long and transparent, and the sagittal pair are inserted almost diametrically opposite. They are separated by a distance of about one-half the length of a polyp. Towards the top of the colony they are alternately large and small—the smaller forms being probably younger. They are also separated by greater intervals.

This specimen comes nearest to *S. pourtalesi*, Brook, but cannot be identified with it. It differs, for instance, in not having "crowded" polyps, and the arrangement of the spines is also different.

Locality :—Station LV., outside the pearl banks, Gulf of Manaar.

Stichopathes contorta, n. sp.—Plate, fig. 3.

A simple slender colony, 40 centims. long, attached to a piece of rock. It is very sinuous, growing first upwards, then coiling and turning downwards, again twisting and starting on an upward course. Thus the total height is only 7 centims., and the growing point is but 3 centims. above the base. The diameter of the axis is 1 millim. and is uniform throughout. The colour is blackish with a brown tinge, the axis is hollow down to the disc of attachment.

The spines are of a pale horny colour, and are slightly but distinctly papillose. They are arranged in longitudinal rows in the lower portion about two to two and a half lengths apart, seven being seen from one aspect. Further up, a distinct steep spiral arrangement may be seen—seven being required to form one revolution. Those in one longitudinal row are about two lengths apart.

The polyps are arranged on one side of the axis at intervals of about 1 millim., which is also the length of a polyp.

The oral cone is prominent and the mouth opening circular. The tentacles are about 0·5 millim. in length even in a contracted state. Young polyps are frequent between the larger older forms.

This species is nearest *S. lutkeni* (Brook), but differs from it both in the number and arrangement of the spines.

Locality :—From off Galle and onwards up West Coast of Ceylon.

Stichopathes papillosa, n. sp.—Plate, figs. 6 and 13.

A complete, simple, robust colony attached to a piece of rock. It is 38 centims. long and attains a height of 18 centims.

The first 4 centims. are almost straight, the remainder coiled into ten distinct dextrorse spirals, 13 millims. in diameter and averaging 14 millims. high. The axis is 1·25 millims. in diameter at the base and tapers gradually to 0·5 millim. at the top. At a distance of 6 centims. from the base there is a projection which indicates the remains of a branch. The colour is black at the lower part, becoming lighter towards the apex.

The spines are slightly but distinctly papillose, and vary in number in the different parts of the colony; thus at the base fourteen can be counted from one aspect, whereas at the top only ten and points of two are visible. Those near the base are conical and covered throughout their whole length with small papillæ, but on the upper part of the colony the papillæ are confined to the apex of the spines, which in this region are more flattened and triangular. They are arranged in distinct dextrorse spirals, and are about one length apart.

The cœnenchyma is very thick on the side devoid of polyps.

The polyps are about 1 millim. in diameter and almost form a square—the directive tentacles being inserted at the corners and the sagittal pair at a slightly lower level. The tentacles are very long when expanded, but on contraction form low, broad cones. The oral cavity is large and elliptical, being elongated transversely. The oral cone is large and prominent. The polyps in the upper part of the colony are close together, but lower down they are separated by a distinct groove. Smaller polyps, probably young forms, are of not infrequent occurrence.

The lower part of the stem is covered with Polyzoa.

The distinctive features of this new species are: the thickness of the cœnenchyma, the papillose character of the spines, together with the dextrorse spiral arrangement, and the distance between the spines as compared with their length.

Locality:—Deep water off Galle and onwards up West Coast of Ceylon.

Stichopathes gracilis, Gray, var. **spiralis**, nov.

A very slender, simple colony, 58 centims. in length. Owing to its sinuous and spiral course, it only attains a height of 20 centims. It is attached by a broadened basal expansion. The first 5 centims. are straight; succeeding this there is a sinuous portion 17 centims. long, followed by two distinct spirals 6 centims. in diameter and about 6 centims. high. The diameter at the base of the stem is 1 millim. and this measurement scarcely diminishes even at the tip. The colour appears black, but when viewed with transmitted light has a decided reddish-brown tinge. The stem is hollow to the very base.

The spines near the base are very much damaged, but appear to be short, somewhat flattened cones, irregularly arranged, a comparatively small number (about 5) being visible from one aspect. About the middle portion of the colony they are short and triangular, standing perpendicularly to the axis, and disposed in irregular longitudinal rows and dextrorse spirals. The spines in a longitudinal row are separated by about two lengths. Six can be counted from one aspect.

Near the top of the colony the spines are much smaller and inclined to the axis, the upper margin being concave and the lower convex. They are arranged in very steep dextrorse spirals, nine in one spiral being seen from one aspect.

The distance between any two varies greatly—from two to four lengths. The polyps are arranged in a single longitudinal row, and are very large and prominent, measuring about 2 millims. in length. They are slightly elongated, the oral cone being low but distinct. The tentacles are disposed in three pairs, the sagittal pair being inserted at a considerably lower level than the others. They are very long when fully expanded, but when contracted are low, broad and conical; others are like large spheres with a small filiform projection. They arise from somewhat spherical bases. The polyps are separated by a very small interval, but an annular constriction between each pair seems to pass round the stem.

This specimen agrees on the whole with *Stichopathes gracilis*, but as it differs in some details regarding the spines, and conspicuously in having a spiral course, it has seemed convenient to name a new variety.

Locality :—Deep water off Galle.

Stichopathes echinulata, Brook.

This species is represented by a simple colony, incomplete at the base, 26 centims. long, very irregular and sinuous, so that the total height is only 8 centims. The growing point is turned downwards and is only 5 centims. above the lowest portion. The colony tapers very markedly from 1·5 millims. to 0·5 millim. The colour of the axis is almost black.

The spines are very short, compressed and directed upwards. They are arranged in very steep spirals, the distance between two rows being almost the same as that between any two on a spiral, so that they show a quincunx grouping. The distance between any two is equal to about four lengths of a spine.

The polyps are typical, but the sagittal tentacles are relatively distant from the oral cone. They are separated by a distance about two-thirds of the length of the polyp.

This species has been previously recorded from Mauritius.

Locality :—Station LX., outside the pearl banks, Gulf of Manaar.

Antipathella rugosa, n. sp.—Plate, figs. 5 and 11.

There are two specimens of this new species in the collection, both slightly damaged. The larger of these is 19 centims. high and 13 centims. broad. It is branched mostly in one plane, and consists of two main branches which arise dichotomously from a short main stem 1 centim. long. One branch arises at 60°, while the second after a short distance at right angles to the stem bends upwards and runs closely parallel to it. The first is broken off about 7·5 centims. from its origin, and the second at a slightly lower level. At the point of fracture large secondary branches are given off, and it is noteworthy that the angles of inclination are the same as for the first two, viz., 60° and 90°. The primary and secondary branches give off pinnæ in a strictly alternate manner, and these again bear pinnules. The pinnæ converge slightly. The whole plane of branching is slightly curved and the polyps arise on the convex surface.

Near the base the axis is opaque and black in colour, but this passes gradually into a transparent horny yellow in the upper parts of the colony. The smaller branches and pinnules are hollow.

The spines on the large branches are short and slender, tapering in a marked degree. They are slightly inclined to the axis, and are arranged irregularly, about fifteen being visible from one aspect. Those on the pinnules are very thin and delicate, fairly long, conical in shape, and inclined to the axis at an acute angle. They are arranged in distinct longitudinal lines which are the expression of steep dextrorse spirals. Five can be seen from one aspect. The distance between two in a longitudinal line is equal to about two lengths.

On the main branches the polyps are arranged irregularly, and are almost circular, the tentacles, which are moderately long, being equidistant from the oral cavity. On the pinnules the polyps are arranged on the convex surface and are elongated in the direction of the axis. The distance between the polyps varies. In some places they are crowded together, while in others they are separated by a distance equal to their breadth. In all cases the body of the polyp is large. The oral cavity is circular and borne on a very prominent cylindrical projection. The tentacles are large and inclined outwards, being very rugose in appearance, due probably to the state of retraction. They are arranged in three rows of two each—the sagittal tentacles being inserted far down.

The colony bears numerous epizoic animals :—Cirriped galls and stalked barnacles, tubes of *Spirorbis*, several Polyzoa, a Sponge, and a young pearl oyster shell. It is worthy of note that the majority of these are overgrown by the cœnenchyma and bear both polyps and spines.

A second specimen of this species—also slightly damaged—is 14·5 centims. in height and 8 centims. in breadth. It consists of a main stem with a basal attachment from which three branches arise on one side at about 60°. These are slightly arched, and the longest, which is 12 centims. in length, has a diameter of 1 millim., tapering to a point. The whole colony is flabellate. In its spines, polyps, and colour it agrees with the other specimen.

This species should be included in Brook's Group A ("Challenger" Report), but it does not approach closely to any of species already included in that group.

Localities :—Deep water off Galle, and Station VIII., deep water, in Gulf of Manaar.

Antipathella elegans, n. sp.—Plate, fig. 10.

A complete, very graceful colony, 13 centims. in height, with a maximum breadth of 5·5 centims. at a distance of 9·5 centims. from the base, which is expanded into a disc-like attachment. At a distance of 3 centims. from the base the main stem bifurcates and the two subsidiaries develop almost equally. The mode of branching is not uniform. The general appearance is dichotomous, but this breaks down in several places where three or four branches arise on one side. The stem and branches are black at the base, gradually passing into golden brown near the apex. All the branches and pinnules are hollow. The diameter of the branches varies very little in the different parts, and the gentle tapering gives the whole colony a very graceful appearance. The axis is 1 millim. in diameter at the base. The spines are short and very much compressed, being somewhat triangular with a very broad base. The upper margin is sub-horizontal, while the lower is convex. They are arranged in very steep sinistrorse spirals and longitudinal rows, the distance between two in a row being four lengths, while that between two in a spiral is one length. From one aspect five can be seen quite distinctly along with the tips of other two, making in all eight spines in a circumference. The spines near the base are shorter, smaller and more conical. They are disposed in sinistrorse spirals and distinct rows, the distance between two in a row being about four lengths.

The polyps are typical. They are situated in a single row on the branches and branchlets, and are very much elongated in the direction of the axis. The distance between the polyps varies in the different parts; they are in some places close together, in others separated by intervals equal to half their length. Very often a line passing through the oral cones is a line of spines, and the polyps occupy a length corresponding to four spines in a longitudinal row. The oral cone is very prominent and the mouth opening is circular. The tentacles vary in different parts according to their state of contraction. The sagittal pair are inserted rather far down, corresponding to spines 1 and 5 on a circumference. In some cases the tentacles have spherical terminations.

This species is chiefly distinguished by the nature and arrangement of the spines, which are markedly different from those of other species, but also by the polyps, which, though typical of the genus, nevertheless bear specific characters.

Locality :—Station LX., outside pearl banks, Gulf of Manaar.

Antipathella irregularis, n. sp.—Plate, fig. 12.

This species is represented by a small complete colony and a fragment. The former is 4 centims. in height and 6 centims. in breadth, the general shape being sub-flabelliform. The branches arise mostly in two planes, but occasionally in a third, leaving one quadrant bare. Frequent fusions occur.

The other specimen consists of a short main stem with a disc of attachment at the base. The stem is only 2 centims. high, and the axis tapers from 1 millim. at the base to a very fine point at the apex. The branches are longer than the main stem and constitute the greater part of the colony. They arise on three sides at a very large angle, so that the expansion is mostly lateral.

The colour of the axis near the base is black, but it passes through a dark amber to a horny yellow in the branchlets. The secondary branches are somewhat elongate and slender and appear slightly flabellate.

The spines near the base of the stem are short, conical, and irregularly disposed; but on the branches a definite arrangement can be traced. There they are compressed and triangular in form, arranged sometimes in a dextrorse and sometimes in a sinistrorse spiral. They are about two lengths apart and five can be seen from one aspect.

The polyps are rather small and are disposed on one side of the stem and branches, so that none appear on the quadrant devoid of branches. They are oval in shape, being elongated in the direction of the axis. The oral cone is low but definite; the mouth is scarcely discernible. The tentacles are comparatively long and delicate, having a broad base and tapering markedly. The distance between the polyps varies, but in most cases there is a valley-like depression between them, giving the surface an undulating appearance.

The distinctive features of the species are the irregular mode of branching, the character and arrangement of the spines, and the nature of the polyps.

Locality:—Station XXIV., off Foul Point, outside Trincomalee, 46 fathoms.

Antipathella ceylonensis, n. sp.—Plate, fig. 2.

Of this species there are two specimens—one complete colony and a broken part of another.

The former is a small, graceful, delicate colony, complete but for the tips of some of the branches. It is 7 centims. in height and 5 centims. in breadth. The main stem is 5 centims. long, and the axis is about 1 millim. in diameter above the disc of attachment, which is 1 centim. broad. The branching is approximately in one plane, and there are signs of fusion in three places. About 1 centim. from the base two branches arise, almost of the same diameter as the main stem. One of these is 4 centims. long, the other is 6 centims. and bears a comparatively large secondary branch. The branching is irregular, but nearly alternate. The branchlets are very slender and arise at different angles, very seldom at an angle less than 60°, and most frequently at right angles.

The spines near the base are short, conical, and distant; those on the pinnules are larger and thorn-like, the lower margin of the compressed triangle being convex. They are equal to about half the diameter of the pinnule and are about three lengths apart. The arrangement is in steep sinistrorse spirals, four being seen from one aspect.

The polyps are disposed on one side of the branches and are elongated in the direction of the long axis. The tentacles are short and are arranged in three pairs, the sagittal pair being inserted at a level slightly lower than the others. The oral opening is circular, and is elevated on a prominent cylindrical projection.

This species comes nearest to *A. tristis* (Duch.), but is distinguishable from it both in spines and polyps.

Locality:—Station XXIV., off Foul Point, outside Trincomalee, 46 fathoms.

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EXPLANATION OF THE PLATE.

Fig. 1. *Antipathella rugosa*, n. sp., dendriform spines, *a–f*, different stages of growth.

„ 2. *Antipathella ceylonensis*, n. sp., arrangement of spines.
(*a*) Main axis; (*b*) Axis of pinnule.

„ 3. *Stichopathes contorta*, n. sp., arrangement of spines.
(*a*) Near base of the colony; (*b*) Towards the tip of the colony.

„ 4. *Antipathes abies*, GRAY, polyps.
(*a*) On main branches; (*b*) On axis.

„ 5. *Antipathella rugosa*, n. sp., polyps on pinnules.

„ 6. *Stichopathes papillosa*, n. sp., polyps near the tip of the colony.

„ 7. *Antipathes gracilis*, n. sp., complete colony. Nat. size.

„ 8. *Cirripathes* (?), n. sp., arrangement of spines.
(*a*) Near base of colony; (*b*) Middle of colony: (*c*) Near tip of colony.

„ 9. *Stichopathes ceylonensis*, n. sp., arrangement of spines.
(*a*) Near base of colony; (*b*) Towards top of colony.

„ 10. *Antipathella elegans*, n. sp., arrangement of spines.
(*a*) Lower part of axis; (*b*) Near top of axis.

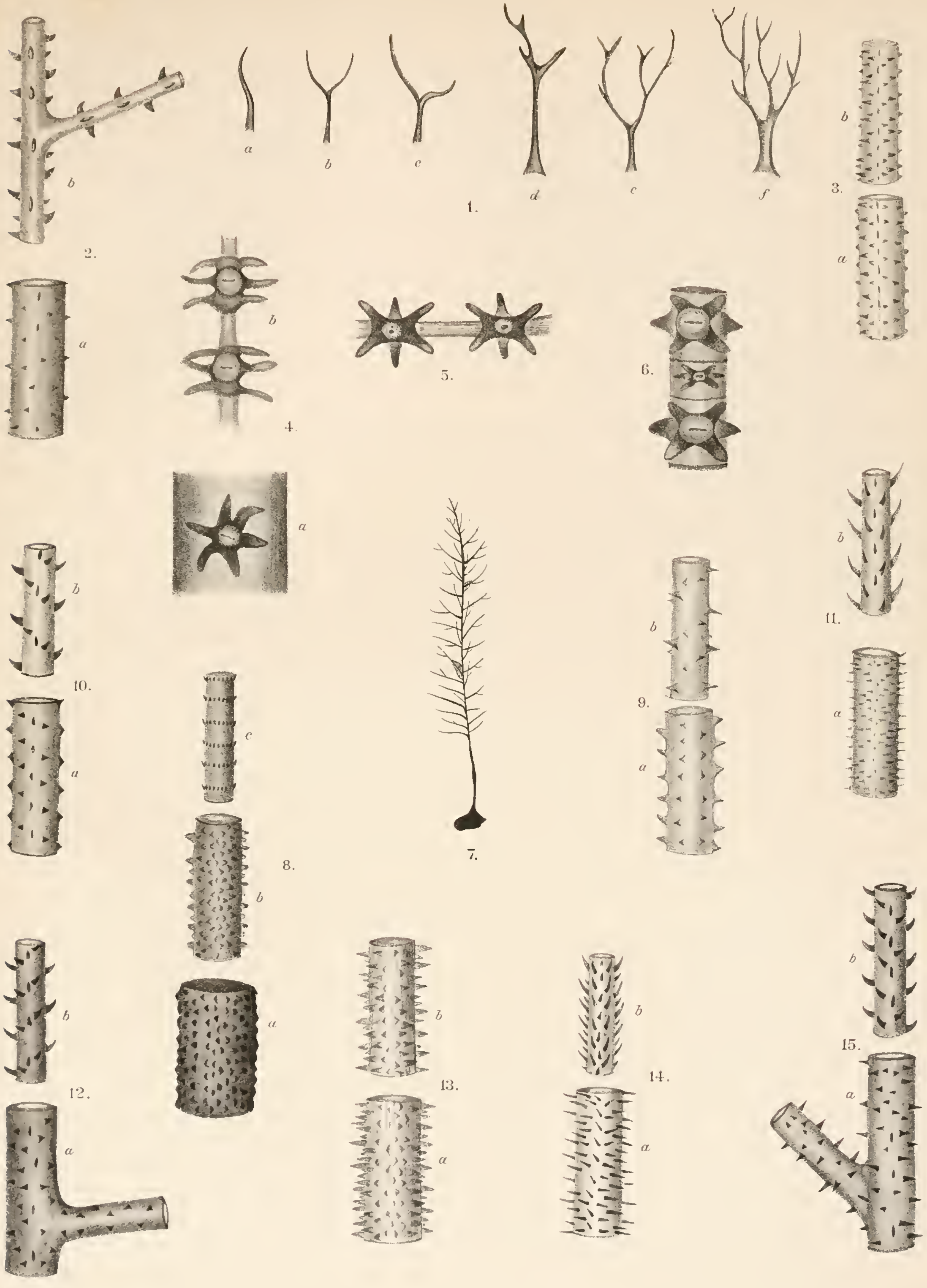
„ 11. *Antipathella rugosa*, n. sp., arrangement of spines.
(*a*) Near base of main stem; (*b*) Part of a pinnule.

„ 12. *Antipathella irregularis*, n. sp., arrangement of spines.
(*a*) Main stem and branch; (*b*) Pinnule.

„ 13. *Stichopathes papillosa*, n. sp., arrangement of spines.
(*a*) Near the base of the axis; (*b*) At the tip of the axis.

„ 14. *Antipathes gracilis*, n. sp., arrangement of spines.
(*a*) On main stem; (*b*) Part of a pinnule.

„ 15. *Antipathes gallensis*, n. sp., arrangement of spines.
(*a*) Main stem and branch; (*b*) Pinnule.



Jas. [illegible] Simp[illegible] del. E. Wilson, Cambridge

Fig. 1, Antipathella rugosa, n. sp.; Fig. 2, Antipathella ceylonensis, n. sp.; Fig. 3, Stichopathes contorta, n. sp.; Fig. 4, Antipathes abies, Gray; Figs. 5 and 11, Antipathella rugosa, n. sp.; Figs. 6 and 13, Stichopathes papillosa, n. sp.; Figs. 7 and 14, Antipathes gracilis, n. sp.; Fig. 8, Cirripathes, n. sp.; Fig. 9, Stichopathes ceylonensis, n. sp.; Fig. 10, Antipathella elegans, n. sp.; Fig. 12, Antipathella irregularis, n. sp.; Fig. 15, Antipathes gallensis, n. sp.

REPORT

ON THE

POLYZOA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH ONE PLATE.]

INTRODUCTORY.

THERE are at least 116 species of Polyzoa in this collection from Ceylon. Of these, 31 had already been found in Indian seas, 32 of the remainder have been reported from Australian waters, 13 from the China Sea, and several from neighbouring but outlying waters to the east, west, and south of the Indian Ocean. Of the rest, some have not been, I believe, recorded from nearer than Florida (7 species), the Queen Charlotte Islands (1), and the Mediterranean Sea (2). Several are cosmopolitan in their distribution, and 19 are British species. Finally there are 16 species and 1 variety which I consider to be new, and which will be described below as :—

Onychocella cucullata, n. sp.
Schizoporella avicularis, n. sp.
,, *viridis*, n. sp.
,, *collaris*, n. sp.
Rhyncopora incisor, n. sp.
,, *corrugata*, n. sp.
Gemellipora protrusa, n. sp.
Lepralia multidentata, n. sp.
,, *purpurea*, n. sp.
Lepralia nitida, n. sp.
,, *ceylonica*, n. sp.
,, *fissa*, n. sp.
,, *triangula*, n. sp.
Smittia trispinosa, var. *protecta*, n.
Phylactella spiralis, n. sp.
Retepora pocillum, n. sp.
Cellepora compacta, n. sp.

Polyzoa are well distributed round the coast of Ceylon. No less than 89 species were found in the Gulf of Manaar, and 32 off Galle. Many of them were obtained in several distinct localities and in great abundance, while other species are represented by one colony each. From the large number of specimens obtained, and the manner in which the colonies are crowded together on the foreign bodies to which they are attached, it may be inferred that the Ceylon seas are a favourable locality for the Polyzoa; but at the same time, from the multiplication of avicularia and of spinous processes of various sorts which characterise these Ceylonese specimens, the impression is derived that there is severe competition and that the colonies have a struggle to hold their own. It is possible that the avicularia, spines and other roughnesses on the surface of the zoarium may protect such species from being smothered by overgrowths of colonies of their own kind; and this seems a very necessary protection in this case, and the need may account for some of the extraordinary calcareous outgrowths of the zoœcia which I have to describe below.

Comparatively few collections of Polyzoa have been made in Indian seas. HINCKS (**16**) reported in 1887 upon a collection made by Dr. ANDERSON in the Mergui Archipelago. KIRKPATRICK (**22**) described in 1895 a collection made by Mr. THURSTON in the Gulf of Manaar. Among HINCKS's series of papers, entitled "Contributions towards a History of the Marine Polyzoa," in the 'Annals and Magazine of Natural History' (**8**), there is a report upon a small collection from Indian seas, and here and there among other papers of this series may be found descriptions of a specimen or two from Ceylon. In all, perhaps, 45 species have been previously described from the seas around Ceylon. Of these, 31 are represented in the present collection; and 85 additional species, including 16 new to science, are now recorded for the first time.

The work has been carried out chiefly in Liverpool, but it is a pleasure to record the help that has been freely given to me in Cambridge and in London. Dr. S. F. HARMER has kindly allowed me to consult his private collections of specimens and notes, and Mr. R. KIRKPATRICK has helped me with those at the British Museum; to both gentlemen I am indebted for advice and suggestions. In conclusion, I should like to express my gratitude to Professor HERDMAN for the privilege of being allowed to handle and name his valuable collection of Polyzoa.

ORDER: ECTOPROCTA.

SUB-ORDER: CHEILOSTOMATA.

FAMILY: ÆTEIDÆ.

Ætea anguina, LINN.

Localities:—Station I., off Negombo, 12 to 20 fathoms; and Station XLVI., off Mount Lavinia, 7 to 12 fathoms.

FAMILY: CATENARIIDÆ.

Catenaria lafontii (AUD.).

Locality:—North of Cheval Paar, 7 to 10 fathoms.

Catenicella elegans, Busk (1).

Locality : Gulf of Manaar (attached to floating oyster cages).

Family : CELLULARIIDÆ.

Scrupocellaria cervicornis, Busk (2).

Locality :—Navakaddu Paar, Gulf of Manaar.

Scrupocellaria diadema, Busk (2).

Localities :—North of Cheval Paar, in Gulf of Manaar, 7 to 10 fathoms ; and Station LXIII., west of Periya Paar, 17 to 55 fathoms (large quantities).

Scrupocellaria scrupea, Busk (2).

Locality :—Gulf of Manaar.

Caberea retiformis (Pourtalès).

The peculiar, unequal development of the fornix, mentioned by Miss Phillips (25), is a characteristic of these Ceylon specimens. The upper half is developed into a long, sharp process, while the lower is scarcely produced below the stem by which it is attached to the zoœcium. Avicularia are present both along the median line and on the oœcia.

Locality :—Off Galle in deep water.

Family : BICELLARIIDÆ.

Diplœcium simplex, Kirkpatrick (20).

Localities :—North of Cheval Paar, 7 to 10 fathoms ; off Manaar ; and off Galle.

Bugula neritina, Linn.

There is one specimen in the present collection which differs from the others, being lighter in colour, less rigid in growth, and with avicularia. Hincks (12) mentions these last as present on some of his specimens, therefore there does not seem sufficient reason for separating the two forms. The avicularia are large, placed on the outer sides of the zoœcia, and have long mandibles. Oœcia are present in the position usual for the species.

Localities :—Palk Bay ; and Gulf of Manaar.

Beania mirabilis, Johnston.

Locality :—Cheval Paar.

Family : CELLARIIDÆ.

Cellaria johnsoni, Busk.

Localities :—Gulf of Manaar ; off Galle, deep water ; and Station XL., 10 miles off Watering Point, 34 fathoms.

Nellia oculata, Busk (2).

Locality :—Gulf of Manaar.

Family : TUBUCELLARIIDÆ.

Tubucellaria cereoides (Ellis and Sol.).

Localities :—Off Galle and onwards up the West Coast of Ceylon, deep water; Navakaddu Paar, Gulf of Manaar (several colonies).

Family : MEMBRANIPORIDÆ.

Membranipora favus, Hincks (8).

There are tubercles between some of the zoœcia in the colonies of this species which otherwise agree with Hincks's description of the species.

Locality :—Gulf of Manaar (on *Conus* shells).

Membranipora irregularis, D'Orbigny.

Locality :—Gulf of Manaar.

Membranipora hastilis, Kirkpatrick (21).

Locality :—Gulf of Manaar.

Amphiblestrum cervicorne, Busk (2).

Locality :—Off Manaar Island (several colonies).

Amphiblestrum papillatum, Busk (1).

Localities :—Station XLVI., off Mount Lavinia, 25 to 30 fathoms; Navakaddu Paar, Gulf of Manaar.

Amphiblestrum granuliferum (Hincks, 3).

Localities :—Gulf of Manaar; off Galle; and off Mount Lavinia (several colonies).

Amphiblestrum marginella (Hincks, 8).

The lateral avicularia of these specimens are more pointed than in Hincks's description, and are directed upwards instead of downwards. The large avicularia occupying a whole zoœcial area are present.

Locality :—Gulf of Manaar.

Amphiblestrum delicatulum (Busk).

The Ceylon specimens show the serrated denticle of this form and have no avicularia. The zoœcia are not quadrangular but of a diamond shape, resembling *one* of the zoœcia in Hincks's figure (3, plate xi.) of this species. There are no knobs such as Hincks describes on his specimens. Oœcia are present, not described before; they are sunk below the membrane of the zoœcium, above the one to which they belong, are finely punctured and have a calcareous arch above the zoœcial orifice. The colony is of a brownish colour and adheres closely to the bivalve shell on which it is growing.

Locality :—Gulf of Manaar.

Siphonoporella bursaria (MacGillivray, **23**).

The Ceylon colonies of this species have avicularia with spatulate mandibles, interspersed here and there among the zoœcia, on separate areas. In old specimens the front wall of the zoœcium is distinctly punctured. With these slight differences the specimens have all the appearance of *Membranipora rossellii* (Aud.) which MacGillivray (**23**, plate xxvi., fig. 4) later named *Amphiblestrum bursarium*. There is even an indication, in his drawing of one of the zoœcia, of a siphon, which is clearly present in the Ceylon specimens. I believe the specimens undoubtedly belong to MacGillivray's species.

Localities :—Off Galle ; off Trincomalee ; and from the Gulf of Manaar (several good colonies).

Family : ONYCHOCELLIDÆ.

Onychocella antiqua (Busk).

Locality :—East Cheval Paar, Gulf of Manaar.

Onychocella abyssicola (Smitt, **26**).

Localities :—Gulf of Manaar ; and off Galle at Station XL., 10 miles off Watering Point, 34 fathoms.

Onychocella cucullata, n. sp.—Plate, fig. 1.

Zoarium incrusting or erect, branching and bilaminar. Zoœcia large and irregularly oval, raised towards the upper end, where the margin is often coarsely beaded. Operculum large and horse-shoe shaped, bent forward along with the raised portion of the zoœcium. Cryptocyst coarsely granular and punctured on the front wall, descending as in *Steganoporella lateralis*, MacGillivray (**24**), to the basal wall of the zoœcium and pierced by a tubular orifice which has an everted rim. Avicularia curved over the top of the zoœcium, usually branched on one side and having the tips of the branches more or less forked. A triangular swollen area, probably œcial, is seen above some zoœcia, having an oval opening covered by a membranous operculum, situated in the centre of the beaded upper margin of the zoœcium to which it belongs.

Localities :—Gulf of Manaar ; and off Trincomalee.

This species appears to be closely allied to *Steganoporella* in the form of zoœcium, but has a smaller operculum and avicularia of the *Onychocella* type. The two forms present in this collection, incrusting and erect, have the same zoœcial and avicularian characters, and cannot therefore be separated. The erect form is represented by broken specimens of about 2 centims. in height, flat and branched in various ways and of a grey colour. The incrusting form has all the appearance of a *Steganoporella* to the naked eye.

FAMILY: MICROPORIDÆ.

Steganoporella buskii, HARMER (17).

There is a large colony of this species measuring about 10 square centims. It is growing in a loose honeycomb-like form and is of a remarkably light and brittle texture. Another colony, the same in detail, is incrusting a seaweed and is much smaller in every way.

Locality :—Cheval Paar, Gulf of Manaar.

Steganoporella sulcata, HARMER (17).

Locality :—Gulf of Manaar.

Steganoporella simplex, HARMER (17).

Localities :—Gulf of Manaar ; and off Trincomalee.

Thalamoporella rozieri (AUD.), form **indica**, HINCKS (3).

Localities :—Gulf of Manaar ; Palk Bay ; and off Galle.

Thalamoporella rozieri (AUD.), form **falcifera**, HINCKS (3).

Locality :—Generally distributed round the Ceylon coast.

FAMILY: CRIBRILINIDÆ.

Cribrilina radiata, MOLL.

Localities :—Off Galle ; Gulf of Manaar ; off Mount Lavinia ; and Station XL., 10 miles off Watering Point, 34 fathoms.

FAMILY: MICROPORELLIDÆ.

Microporella violacea, JOHNSTON, form **plagiopora**, BUSK.

Locality :—Gulf of Manaar.

Microporella ciliata (PALLAS).

Locality :—North of Cheval Paar, 7 to 10 fathoms.

Microporella ciliata, var. **personata**, BUSK (2).

The avicularia on the Ceylon specimens have wing-like membranous extensions of the sides of the mandible. Two of the colonies are of a pink colour.

Localities :—Gulf of Manaar ; and Station XXXIII., south-east of Ceylon, 18 fathoms.

Microporella decorata, Reuss.

Locality :—Gulf of Manaar.

Berenicea prominens, Lx. [= **Chorizopora brongniartii** (Aud.)].

Localities :—Gulf of Manaar ; off Galle, deep water ; and Station XL., off Watering Point, 34 fathoms.

Family : PORINIDÆ.

Porina magnirostris (MacGillivray, 23).

Locality :—Gulf of Manaar.

Gigantopora fenestrata, Ridley.

On the most perfect of the few, small, incrusting colonies of this form there are little branched spines, in between the perforations of the front wall of the zoœcia. The secondary, tubular orifice has a 4-toothed margin and avicularia are very long, reaching from the base of the tube and extending beyond its margin. Where an avicularium is absent the tube has a fissure in its place. Oœcia are present, low down at the back of the tubular orifice, and perforated like the front wall of the zoœcia.

Localities :—Gulf of Manaar ; and off Galle.

Lagenipora spinulosa, Hincks (8).

Locality :—Gulf of Manaar.

Lagenipora tuberculata, MacGillivray (23).

There are several colonies corresponding to MacGillivray's description of this species, but there are also among them some that have the hollow tubercles very much lengthened, ending in points, or being jagged and irregular in outline. These specimens have also simple or branched spines round the margin of the much raised peristome. The front walls of the zoœcia have punctures in between the spines ; the peristome is granular. There are no avicularia, and no oœcia are present.

Locality :—Off Galle.

Family : MONOPORELLIDÆ.

Monoporella albicans, Hincks (6).

An interesting point in the present example of this form is that the oœcia are in most cases set a little "awry," a fact that Hincks thought merely a peculiarity of the colony in his collection. There are none of the large avicularia present here.

Locality :—Gulf of Manaar.

Monoporella lepida, Hincks (5).

Locality :—Station LIII., north of Cheval Paar, 7 to 10 fathoms.

Family: MYRIOZOIDÆ, Smitt.

Schizoporella spongitis (Pallas).

Localities :—Gulf of Manaar ; and off Mount Lavinia.

Schizoporella ampla, Kirkpatrick (20).

Localities :—Gulf of Manaar ; and Navakaddu Paar.

Schizoporella argentea, Hincks (6).

In the single small colony of this species the sinus is wider than Hincks describes and there are no oval avicularia, but in their place the elongated kind as in some of his specimens. There are the two spines above and the granular, silvery surface of the zoœcia with foramina between the granulations.

Locality :—Gulf of Manaar.

Schizoporella aperta, Hincks (6).

There are two spines on the upper margin of some of the orifices of these specimens not described before. No oœcia are present, but in other points the characters agree with those of the species.

Localities :—Gulf of Manaar ; and Navakaddu Paar.

Schizoporella cecilia (Aud.).

The one small colony of this species has raised, irregular-shaped ridges of calcareous matter on the oœcium, and a decided arch above the orifice at the base of the oœcium, also a screen-like process on the front of the zoœcium.

Locality :—Gulf of Manaar.

Schizoporella unicornis, Johnston.

The present specimen has the peculiar long avicularia of the form *longirostris*, Hincks (11), but not the more important feature of that variety, namely the loop-shaped sinus.

Locality :—Navakaddu Paar.

Schizoporella nivea, Busk (1).

There are numerous colonies of this species, loosely attached, being, as it were, folded round the stems of the large zoophyte, *Campanularia juncea*, and having the opposed edges of the zoarium adhering to one another. (See Part II., p. 115, fig. 2.)

Locality :—Gulf of Manaar.

Schizoporella circinata, MacGillivray (23).

The zoœcia of these specimens have the ridge-like mucro of Hincks's (10) species, but not the avicularium. There is a single row of large punctures at the edge of the zoœcium. No oœcia are present on the two small colonies in the Ceylon collection.

Localities :—Off Mount Lavinia ; and off Galle.

Schizoporella sanguinea (Norman).

Avicularia are usually present on these specimens. They are long and pointed and raised, a pair on each zoœcium, situated at their extreme upper angles, above the orifice and directed downwards and inwards.

Locality :—Off Galle.

Schizoporella magnifica, Hincks (11).

The peculiar distinctive oœcia of this species are not present on the one colony in this collection, which is deep red in colour. The long pointed sinus, the pairs of upward pointing avicularia, and the reticulate front wall of the zoœcium, without a raised margin, accord with Hincks's description of the spécies.

Locality :—Off Galle.

Schizoporella depressa, Phillips (25).

There are some colonies of a pink colour corresponding with the figure and description of this species. The orifice of the zoœcium is deeply sunk, the front wall rising into almost an umbo below it, and calcareous ridges radiate from this to the margin, leaving large, loop-shaped areolations between them. The small rounded avicularia, on one or both sides of the orifice, are sunk below the surface, together with the orifice. Oœcia are smooth and hyaline or ridged, and have an oval area on either side of them.

Localities :—Gulf of Manaar ; and off Mount Lavinia.

Schizoporella triangula, Hincks (5).

The specimens of this form in the present collection have the triangular orifice, the raised margins and punctured surface of the zoœcium, with small avicularium pointing downwards from just below the orifice, although this last is smaller and never raised on an elevation. There is a second avicularium lying transversely on a separate area above the orifice. Busk (1) mentions, but does not figure, a second avicularium with a slender, spear-shaped mandible which corresponds with these, with the exception that his are described as lying vertically and these are transversely placed. Where oœcia are present, they take the place of these. They are large, covering nearly the whole of the zoœcium above the one to which they belong, as described by Busk, but are sub-immersed and have no nodules, being punctured like the zoœcium.

Localities :—Gulf of Manaar ; and East Cheval Paar.

Schizoporella subsinuata (Hincks, 9).

There are a few colonies of a grey-white colour, incrusting pieces of broken shell, having the zoœcial characters of this form with the addition of numerous avicularia, which in Hincks's specimens did not exist and which were rare in MacGillivray's (23). They have long, pointed mandibles, and are usually pointing downwards, like those in

MacGillivray's figure (plate cxxxviii., fig. 5), from an upper angle of the zoœcium; but are sometimes below the orifice, transversely placed, or they may be on separate, raised areas.

Localities:—Gulf of Manaar; and Navakaddu Paar.

Schizoporella avicularis, n. sp.—Plate, fig. 2.

Zoarium adnate, of a pink colour; zoœcium punctured, with slightly raised margins. Orifice with a broad sinus and umbo below it. Avicularia here and there large and spatulate, starting from above the umbo, covering over the oral aperture and resting on an extended portion of the zoœcium above. Oœcia large, more finely punctured than the zoœcium and with a calcareous arch over its summit.

Locality:—Gulf of Manaar.

I do not know of any species having an avicularium in the position described above. When the mandible is removed, the zoœcial orifice, with its operculum, appears beneath, in its usual form. There is a specimen, in this collection too, of *S. triangula*, which has apparently a similar arrangement of the avicularium and zoœcial orifice, but it will be necessary to examine more material before coming to a definite conclusion as to the exact relations of these parts.

Schizoporella collaris, n. sp.—Plate, fig. 4.

Zoarium incrusting, of a dull white colour. Zoœcia rhomboidal, punctured, the upper portion slightly narrowed to a neck and bent forward. Orifice with a broad shallow sinus, peristome thickened and forming a triangular bracket-like process in front. Oœcia punctured like the zoœcia, the sides extending to form with the peristome a collar round the orifice.

Locality:—Station XLVI., off Mount Lavinia.

Schizoporella pulcherrima (MacGillivray, 23).

There is a strong resemblance between the "small colony," described by MacGillivray, of this species and the large specimens from Ceylon, although the former has no punctures on the zoœcium, nor is it coloured, while the latter have punctures as well as radiating lines and are coloured a deep red, excepting for one colony, probably old, which is white. The raised margins of the broad zoœcia, the shallow sinus and avicularia on either side of the orifice are the same; these are sometimes quite up to the edge and in an angle of the zoœcium. Oœcia, not described before, are large, covering almost entirely the zoœcium above and embedded in it, punctured like the zoœcium. The orifices of the zoœcia which bear oœcia are larger than those of the others. It is a very striking species.

Localities:—East Cheval Paar; off Galle; off Mount Lavinia.

Schizoporella viridis, n. sp.—Plate, fig. 3.

Zoarium incrusting and forming very large colonies, extending to nearly two feet (50 centims. or upwards) across.

It has a coarse looking, roughened surface and is of a greenish colour, somewhat obscured by a brownish surface layer or membrane; zoœcium prostrate, irregularly oval, ventricose and punctured closely all over the front wall; often with an umbo in its centre, or to one side, which may become tall and massive. Orifice with a deeply rounded sinus, peristome raised above.

Avicularia small and pointed, one or two transversely placed below the orifice, and a few long and sword-shaped, on separate areas, scattered over the zoarium.

Locality :—Coral banks, Gulf of Manaar.

This fine species forms thick massive colonies of many superimposed layers, and spreads over other objects to form very large masses; one colony measures upwards of 53 centims. in length by 18 centims. in breadth and 23 millims. in thickness. The verdigris-green colour is a striking feature, best seen in the thickness of the superimposed layers at the edges of broken pieces; a brown membrane which envelops the zoarium conceals it, somewhat, on the surface. The large ventricose zoœcia and oœcia can be seen by the naked eye as small pimples covering the irregularly undulating surface of the zoarium. The zoœcia are always prostrate, but are heaped and turned in various ways and are seen at various levels.

Schizoporella incrassata, HINCKS (6).

The great variety in appearance of the zoœcia in different parts of one colony is quite as marked in the present specimens as it was in HINCKS's, and, although the variations do not always agree with his, the differences seem to belong to unimportant characters. The primary orifice has, here, sometimes from 2 to 4 spines on its upper margin. A large process, bearing an avicularium, is sometimes to be seen on both sides of the orifice instead of on one side only. The surface of the zoœcium is usually grooved, the grooves radiating towards the centre. Avicularia on raised processes are scattered irregularly over the zoœcia. The peristome forms sometimes a spinous collar, open in front, or the points of the edges of the opening join and leave the opening below like an oval pore. The oœcium agrees with that of HINCKS's species, but that the flat plate covering its aperture is of a dead white, contrasting with the glassy appearance of the rest of the zoarium.

Localities :—Gulf of Manaar; Station XL., 10 miles off Galle, 34 fathoms.

Mastigophora dutertrei, var. **pes-anseris** (SMITT, 26).

Locality :—Station XL., 10 miles off Galle, 34 fathoms.

Rhyncopora bispinosa, JOHNSTON.

The primary orifice of this species varies in one specimen from the usual shallow sinus form to one with a deeper, narrower sinus, which variety has also a crenulated margin as in *Rhyncopora crenulata*, WATERS (27), a species which has, however, no sinus.

Localities :—Gulf of Manaar; and Station XLVI., off Mount Lavinia.

Rhyncopora corrugata, n. sp.—Plate, fig. 5.

Zoarium incrusting, yellow-white in colour. Zoœcia large, distinct throughout, with the secondary orifice prolonged into a tube, widening from the base up and with an uneven margin. An uncinate process at the base of the tube a little to one side of the centre, and an avicularium of small size on the corresponding other side, its beak pointed and forming with the uncinate process a loop-shaped sinus.

Locality :—Gulf of Manaar.

The raised secondary orifice of this species gives it the appearance of a *Lagenipora*, but that the tube is irregularly fluted in outline. It is a good deal smaller than *Rhyncopora incisor*, n. sp., although at first taken to be the same when the two were growing together.

Rhyncopora incisor, n. sp.—Plate, fig. 6.

Zoarium incrusting, of a white colour. Zoœcia crowded, hexagonal, with a deeply areolated margin, a long tubular peristome and even rim.

Primary orifice orbicular with a transversely placed avicularium a little to one side of the centre, an uncinate process on the opposite side becoming very long and pointed. Oœcia behind the tubular orifice, smooth with a circular area on either side.

Localities :—Gulf of Manaar ; and off Galle, 34 fathoms.

The characters of this species are very simple and constant ; the most striking feature is the elongated uncinate process which sometimes projects almost across the orifice, so as to bar the entrance to the tube, and has a curved needle-like point. There is no avicularium to be seen when this stage is reached.

One perfectly preserved colony has the appearance to the naked eye of the pile of white velvet ; the zoœcia almost approach those of *Lagenipora tuberculata* in size and appearance.

Hippothoa flagellum, MANZONI.

Locality :—Chilaw Paar.

Gemellipora glabra, form **striatula**, SMITT (**26**).

Localities :—Gulf of Manaar ; Trincomalee ; and off Mount Lavinia.

Gemellipora lata (SMITT, **26**).

The Ceylon specimens of this form have the yellow colour of the colony, the dark colour of the opercula, more brown than green in these specimens, the conspicuous pores of the zoœcia, the form of orifice and peculiar fold of the peristome below this, as figured by SMITT (**26**, plate vii., fig. 157).

Avicularia are distributed among the zoœcia, on separate areas, but are much larger than he describes and spatulate, not oval.

Oœcia, not described before, are more broad than high, perforated like the zoœcia, with, sometimes, an umbo. The orifices of fertile zoœcia are much larger than those of the others.

Locality :—Gulf of Manaar.

Gemellipora protrusa, n. sp.—Plate, fig. 7.

Zoarium incrusting, of a pale brown colour. Zoœcia rhomboidal, smooth or slightly roughened, front wall much raised, punctured round the margin. Orifice of the usual *Gemellipora* form, sometimes much elongated; peristome often raised above and irregularly lobed. A large avicularium on the front of the zoœcium, directed across it, supported on a raised process; mandible wide at the base, becoming long and pointed; a small avicularium, with rounded mandible, on a raised process on one or both sides of the orifice. Oœcia granular and minutely punctured, open in front, and leaning forward over the orifice.

Locality :—Gulf of Manaar (numerous colonies on Nullipore balls).

There are sometimes two avicularia, in place of the one large transversely placed one; they point outwards to either side of the zoœcium. There is some resemblance in the appearance of this species to *Schizoporella ampla*, Kirkpatrick (20).

Family: ESCHARIDÆ.

Lepralia robusta, Hincks (8).

The central circular pore, alluded to by Hincks, is quite evident on the present specimens, and is sometimes multiplied to three or more of irregular shapes, as seen in an old, worn specimen.

Locality :—Gulf of Manaar (in large quantity on broken shells).

Lepralia poissonii, Audouin.

Localities :—Navakaddu Paar; off Galle and onwards up West Coast, deep water.

Lepralia mortoni, Haswell (19).

Localities :—Gulf of Manaar; off Trincomalee; north end of East Cheval Paar.

Lepralia triangula, n. sp.—Plate, fig. 8.

Zoarium incrusting. Zoœcia punctured all over, covered by a yellow membrane. There are usually scattered spinous processes on the front wall of the zoœcium and also two curved horn-like processes, one on either side below the orifice, which may be avicularia. Orifice longer than broad, with a much raised, thin, often irregularly pointed peristome, forming a collar round it. Operculum with a triangular excrescence having its base attached to the base of the operculum. No oœcia.

Locality :—Gulf of Manaar.

It is possible this species may be a variety of *L. pallasiana*, Moll., as it resembles *L. canthariformis*, Busk, which is probably a variety of *L. pallasiana*, but the peculiar processes on the cell wall and that on the operculum give it a distinctive character.

Lepralia turrita, SMITT (26).

The fresher looking colonies of this species are pink in colour and have pointed tubercles round the margin of the orifice; with age they become white and the tubercles worn down into blunt knobs. There are large spatulate avicularia on the sides of large massive tubercles and small oval ones on more slender tubercles, and also scattered over the zoœcia.

There are very few oœcia, and I have not been able to see perforations on them. They have a semicircular, marked area in front.

Localities:—Gulf of Manaar; Station XL., 10 miles off Galle, 34 fathoms; Navakaddu Paar.

Lepralia multidentata, n. sp.—Plate, fig. 9.

Zoarium incrusting, white. Zoœcia very small, rotund, irregularly placed, usually lying flat, but occasionally standing upright, surface roughened. Orifice arched above, sides widening downwards, base slightly convex, six long slender spines on the upper margin and a long, pointed rostrum below. Sometimes avicularia with rounded mandibles are present on either side of the orifice. Oœcia granular above, smooth in front, with an arched rib between the rough and the smooth portions.

Localities:—Gulf of Manaar; and off Trincomalee.

Lepralia cucullata, BUSK (2).

Localities:—Cheval Paar, Navakaddu Paar and elsewhere in Gulf of Manaar (common on Ascidians and pearl oyster shells).

Lepralia depressa, BUSK (2).

Avicularia in various forms, long and seta-like, or thick and spear-like, or the mandible branched, looking like the leg and foot of a bird.

Localities:—Gulf of Manaar and off Galle.

Lepralia gigas, HINCKS (10).

Localities:—Station LIII., north of Cheval Paar, 7 to 10 fathoms; Palk Bay; Trincomalee (many large colonies, up to 3 inches across); Welligam Bay; and various parts of Gulf of Manaar (growing on pearl oyster shells).

Lepralia purpurea, n. sp.—Plate, fig. 13.

Zoarium forming purplish grey patches, incrusting. Zoœcia small with thick walls, sub-immersed, diamond-shaped, occasionally heaped and upright, smooth and shining or slightly roughened. Orifice arched above, widening downwards, with an almost straight lower lip, peristome slightly thickened with five marginal spines and a sub-oral mucro below the orifice. The tip of this, the bases of the spines and the peristome are of a purple tint. Sometimes an avicularium on a raised process at one side of the zoœcium, varying in size, spatulate and large or small and pointed. Oœcia small, narrow, open in front, two of the spines showing in front.

Locality :—Gulf of Manaar.

Lepralia nitida, n. sp.—Plate, fig. 10.

Zoarium closely adhering, with a shining surface, pale yellow in colour. Zoœcia flat but rising to a prominent umbo situated below the orifice, granular, the granules radiating from the umbo to the margin of the zoœcium which is punctured there. Orifice arched above, narrowing, then widening, and with a convex lower lip. A small round avicularium on either side on a level with the lower margin of the orifice. Oœcia small, rising to a prominent umbo, orifice of the fertile zoœcium much larger than the usual orifice.

Locality :—Gulf of Manaar.

This is a small neat species with little variation of form. The oœcia are merely like a triangular extension of the zoœcium above the orifice.

Lepralia adpressa, Busk (**2**).

The surface of the zoœcium in the present specimen is granular, punctured round the margins only ; the upper portion of the zoœcium is considerably raised ; the lateral lumps carry small round avicularia ; when in old specimens these are absent the lateral processes are seen to be hollow tubes. Sometimes two or three of these processes are present above the orifice and one below in addition.

Locality :—Off Galle, deep water.

Lepralia feegeensis, Busk (**2**).

The oœcium of this species has not been described before. There is one well preserved oœcium on the Ceylon specimen. It is large and irregular in shape, the front wall is marked with large circular pitted areas, punctured in their centres, giving the oœcia a much coarser appearance than the zoœcia, the reverse of what is seen in *Lepralia gigas*, Hincks (**10**). The orifices of fertile zoœcia are broader at their bases than those of others. Avicularia of the usual type, and in the usual position for *L. feegeensis*, are often present in pairs, but usually singly, or there may be none.

Locality :—Gulf of Manaar.

Lepralia cleidostoma, Smitt (**26**).

There is one small colony of this species. It has no oœcia to show the characteristic striæ as a help to identification, and the avicularia are always directed upwards, not outwards. On one of the zoœcia, on the outside of the colony, jointed spines are to be seen, as in Smitt's (**26**), plate xi., fig. 217. A larger, loosely incrusting colony from another locality resembles this so nearly as to make it probable it is one of the same species. The zooecia are larger, avicularia are smaller and turned sideways, as in SMITT's figures. Oœcia are present here, but are punctured, not striated, and they are often half buried in the calcification of the zoarium. There is still a third variety, smaller than either of the above, and with a smooth and glistening surface, with avicularia turned sideways and oœcia faintly striated, but with a small arched area in front. As all these three specimens have the same key-shaped orifice and pointed avicularia I am inclined to think them varieties of the one species.

Localities :—Gulf of Manaar ; and off Galle.

Lepralia ceylonica, n. sp.—Plate, fig. 11.

Zoarium adhering, of a yellowish-white colour. Zooecia in linear series closely set, becoming upright in places, with glistening front walls, pitted and punctured and lumpy. Orifice arched above, with straight sides and slightly concave lower lip, six long sharp spines above and several bosses below the orifice, carrying small avicularia with pointed mandibles on their summits. Oœcia roughened like the zooecia and having scattered raised avicularia upon them.

Locality :—Gulf of Manaar.

Lepralia fissa, n. sp.—Plate, fig. 12.

Zoarium incrusting, forming brown patches. Zooecia finely punctured at the outside of the colony, becoming coarsely ridged further in and having a large umbo occupying most of the area, and a large avicularium on its outer side, with the mandible directed upwards. Orifice broader than long, with a pouting lower lip. Oœcia rounded, smooth, with a large cone-shaped fissure in front.

Locality :—Off Galle, deep water.

Lepralia subimmersa, MACGILLIVRAY (23).

There is one colony, greyish-white in colour, and covering the shell of a univalve mollusc inhabited by a hermit crab. Another colony is of a deep red colour, from a membranous covering still adhering to the zoarium.

Locality :—Gulf of Manaar.

Escharoides verruculata (SMITT, 26).

Localities :—Gulf of Manaar ; and off Mount Lavinia.

Porella malleolus, HINCKS (8).

Localities :—Gulf of Manaar ; off Galle ; Navakaddu Paar.

Smittia trispinosa (JOHNSTON).

There is great variety in the form of zooecia and avicularia among the Ceylon specimens of this species. It is widely distributed around the coast, and apparently very abundant.

Localities :—Gulf of Manaar ; off Galle ; off Mount Lavinia ; and Navakaddu Paar.

Smittia trispinosa, var. **spatulata** (SMITT, 26).

Locality :—Station XLVI., off Mount Lavinia.

Smittia trispinosa, var. **protecta**, nov.

This large variety has the peristome raised and in front, below the orifice, produced into a long spout-like extension. Avicularia, not on every zoœcium, are of enormous size, reaching from above the orifice and bending and spreading so as to cover the whole front wall of the zoœcium, and having a blunt extremity.

There are sometimes two small raised avicularia, one on either side of the orifice. The finely punctured oœcium has a narrow, prominent arched rib across the front.

Locality :—Gulf of Manaar.

Smittia tubula, KIRKPATRICK (20).

The present specimens of this form are of a pink colour. There are usually two avicularia, one on either side of the tubular secondary orifice, pointing upwards. Two of the oral spines, of which there are six, remain in front of the oœcium when present.

Locality :—Gulf of Manaar.

Smittia rostriformis, KIRKPATRICK (20).

Avicularia on these specimens are sometimes pointing downwards, as figured by KIRKPATRICK, but sometimes upwards with the appearance of a spine on either side of the orifice. In both cases the peculiar serrated edge of the beak is plainly visible. Oral spines vary in number from two to six. In other respects the specimens agree with the original description of the species.

Locality :—Station XLVI., off Mount Lavinia.

Phylactella spiralis, n. sp.—Plate, fig. 14.

Zoarium forming small pink patches on shells. Zoœcia arranged in radiating lines, smooth or slightly roughened, areolated round the margin, with a much raised tubular peristome and an avicularium raised to the margin of this on a semi-spiral tube. Primary orifice, having a very wide denticle with sharp lateral points. Secondary orifice, with from two to four spines above. Oœcium behind the tubular peristome, smooth or slightly roughened like the zoœcium.

Localities :—Gulf of Manaar ; off Mount Lavinia ; and off Galle.

This species approaches most nearly to *Phylactella geometrica*, KIRKPATRICK (21), in form, but the one broad denticle instead of three and the difference in the position of the avicularium, which resembles that of *Lagenipora nitens* (MACGILLIVRAY, 23), makes it impossible to mistake the two species.

Mucronella coccinea, ABILD.

Localities :—Gulf of Manaar ; and off Galle.

Mucronella tubulosa, HINCKS (3).

In the Ceylon specimens, which I believe to belong to this species, there is an enormous development of the central mucro, which is here long and spinous ; there is also an avicularium on the inner side of this, either at its base, lying in front of the primary orifice, or at varying heights up this process, always transversely placed and with a sharp curved beak, but varying in size.

These points add to the resemblance between *M. tubulosa* and *Rhyncopora longispinosa,* which Miss JELLY regards as synonymous, but there is missing still, in these specimens, the uncinate process of *Rhyncopora,* unless the curved beak of the avicularium takes the place of this. In the faint indication of a sinus of the primary orifice, the spinous mucro and markings of the oœcia, there is a likeness to a species of quite another genus, *i.e., Cellepora longirostris,* MACGILLIVRAY, as described by Miss PHILIPPS (25).

Localities :—Off Trincomalee ; off Mount Lavinia ; Navakaddu Paar and elsewhere in the Gulf of Manaar.

Mucronella thenardii, AUD.—Plate, fig. 15.

The cross-shaped process, situated below the orifice of the zoœcium in this species, is greatly developed (see fig. 15). Its upright portion is often occupied by a large spatulate avicularium, and, where this is so, one of the arms of the cross is missing, giving a one-sided appearance to the process. Sometimes the arms are duplicated, one pair below the other, and they are always much branched, each branch bearing a small, rounded avicularium on its summit. Slender, spinous processes, resembling the branches in size, are scattered over the front wall and round the margin of the orifice of the zoœcium, and there are sometimes ordinary spines, from two to five in number.

There is a strong resemblance between the characters of this species and those of *M. aviculifera,* HINCKS (14). The slender, spinous, aviculiferous processes are present there, but the cross-shaped mucro is only represented by a small simple mucro, and there are large, lateral avicularia. There is, however, much variation in form and position of the avicularia and of the processes which carry them, even in one small specimen of the present collection, so that it seems possible that the differences represent various stages in the development of one and the same species.

Localities :—Gulf of Manaar ; and off Galle.

Mucronella vultur, HINCKS (7).

There are in the present collection specimens having all the important characteristics of *M. vultur,* as described by HINCKS (7) and MACGILLIVRAY (23) with this exception, that the avicularium on the central mucro has a rounded, instead of a pointed, mandible. There are sometimes small, raised, rounded avicularia scattered over the front wall of the zoœcium in great profusion. Some of the specimens have spinous knobs in front of the oœcia and also one on the summit of this.

Altogether, with the addition of the usual six long marginal spines of the orifice, the colony has a formidable appearance, especially in specimens where the zoœcia are crowded together. The largest colony is partly incrusting and partly sends off free expansions. It measures 8 centims. by 4 centims. and is of a dull pale brown colour and of a very brittle and light substance.

Locality :—Gulf of Manaar (growing over a colony of *Lepralia gigas*, Hincks).

Retepora tubulata, Busk (1).

Locality :—Gulf of Manaar.

Retepora simplex, Busk (1).

Locality :—Off Galle and onwards up west coast of Ceylon.

Retepora apiculata, Busk (1).

Locality :—Ceylon seas.

Retepora pocillum, n. sp.—Plate, fig. 16.

These colonies correspond with *Retepora avicularis*, MacGillivray (23), in size, and the zoœcia in having triangular teeth within the orifice, and below this a loop-shaped fissure, but there are some other additional marked characteristics in these specimens. The zoœcia are rhomboidal in form and have slightly tubular necks crowned by about six spines, which are beautifully jointed in the Equisetum-like form described for *R. monilifera*, MacGillivray (23). These are often broken, but their bases, which, united, form the tubular neck, are visible, and when oœcia are present two are to be seen in front of it, not always of the jointed form. The oœcia have a fissure faintly visible. There is generally a small avicularium with a rounded mandible below the orifice, more or less in the middle of the zoœcium; sometimes there are two of these, one below the other, or rarely one large spear-shaped one, lying across the zoœcium and pointing upwards.

Locality :—Gulf of Manaar.

Family: ADEONIDÆ.

Adeonella subsulcata (Smitt, 26).

The largest colonies of this species in the present collection are about 8 centims. in height. They correspond entirely with Smitt's description, but that there is also a serrated denticle within the orifice, corresponding to that of *A. pectinata*, Busk (1).

Localities :—Station I., off Negombo, Gulf of Manaar; Station XXIX., Trincomalee; Station XLVI., off Mount Lavinia, 25 to 30 fathoms; Station XL., 10 miles off Watering Point, 34 fathoms; and off Galle, deep water.

FAMILY: CELLEPORIDÆ.

Cellepora albirostris (SMITT, 26).

Localities:—Gulf of Manaar; off Mount Lavinia; off Kaltura; and off Galle, deep water. There are large quantities of this species.

Cellepora megasoma, MACGILLIVRAY (23).

There is usually a raised avicularium to one or both sides of the orifice on the present specimens and large scattered spatulate ones here and there. The zoœcia are smooth or slightly ridged. Oœcia thickly punctured all over, with no marked area.

Localities:—Off Galle and onwards up west coast of Ceylon, deep water; Gulf of Manaar (several colonies on worm tubes and stems of Zoophytes); Station XXXII., off south-east coast of Ceylon (on Sponge).

Cellepora rota, MACGILLIVRAY (23).

Localities:—Station LIII., north of Cheval Paar, 7 to 10 fathoms; and elsewhere in Gulf of Manaar.

Cellepora cidaris, MACGILLIVRAY (23).

There is a large quantity of material resembling the description of this form excepting that the columnar processes in between the zoœcia are solid instead of hollow. *C. albirostris*, SMITT, has, in the "Challenger" collection, occasional, solid columns of this sort on the older parts of a colony, but, although the two species *C. albirostris* and *C. cidaris* of the present collection resemble each other pretty closely in some points, neither the long pointed rostrum, nor the broad one with serrated beak, nor the dark operculum, characteristic of *C. albirostris*, are present on the specimens I have considered to be *C. cidaris*. Oœcia, said in *C. cidaris* to be globular and immersed, have an arched area in front, which, being often absent, leaves a cave-like space. There are occasional large spatulate avicularia to be found on raised areas in between the zoœcia, but these are the only points of difference to be seen between the present specimens and MACGILLIVRAY's description of *C. cidaris*.

Localities:—Off Mount Lavinia; Station XL., off Galle, 34 fathoms; and in Gulf of Manaar.

Cellepora compacta, n. sp.—Plate, fig. 17.

Zoarium incrusting, white or purplish in colour. Zoœcia small, upright, rounded, smooth, with a few marginal punctures.

Orifice rounded, with a loop-shaped sinus, and below, rather to one side, a large thick rostrum, sometimes pointed above, having a long pointed avicularium on its side; often other slenderer processes round the orifice and long hollow columns in between the zœcia. Oœcia standing upright, smooth and shining, with a narrow arched ridge in front.

Locality:—Gulf of Manaar.

Sub-order: CYCLOSTOMATA.

Family: CRISIIDÆ.

Crisia holdsworthii, Busk (2).

Localities:—Station LIII., north of Cheval Paar, 7 to 10 fathoms; Station I., and elsewhere in Gulf of Manaar; and Palk Bay.

Family: TUBULIPORIDÆ.

Idmonea milneana, D'Orb.

Localities:—Navakaddu Paar; and Station XL., 10 miles off Watering Point, 34 fathoms.

Family: LICHENOPORIDÆ.

Lichenopora hispida, Fleming.

Localities:—Navakaddu Paar, and elsewhere in Gulf of Manaar.

Lichenopora novæ-zelandiæ, Busk (2).

Locality:—Navakaddu Paar.

Sub-order III.: CTENOSTOMATA.

Family: ALCYONIDIIDÆ.

Alcyonidium mytili, Dalyell.

Locality:—Gulf of Manaar.

Pherusa tubulosa, Lx.

The largest colony among the few present in the present collection is about 3 centims. in height, and its branches spread to about the same in width. Zoœcia are on both sides of the branch, not as in the original description only on one surface.

Locality:—Station LIII., north of Cheval Paar, 7 to 10 fathoms.

Family: ARACHNIDIIDÆ.

Arachnidium fibrosum, Hincks (15).

Locality:—Gulf of Manaar.

Family: VESICULARIIDÆ.

Amathia distans, Busk (1).

Locality :—Gulf of Manaar.

Farrella atlantica, Busk (1).

Locality :—North of Cheval Paar.

Family: BUSKIIDÆ.

Buskia setigera, Hincks (16).

Localities :—Station LIII., north of Cheval Paar, 7 to 10 fathoms; and Palk Bay.

Family: CYLINDRŒCIIDÆ.

Cylindrœcium dilatatum, Hincks (15).

Localities :—Station LIII., north of Cheval Paar, 7 to 10 fathoms; off Galle; and Station I., off Negombo.

Family: VALKERIIDÆ.

Valkeria uva, Linn.

Locality :—Station LIII., north of Cheval Paar, 7 to 10 fathoms.

Order: ENTOPROCTA.

Family: PEDICELLINIDÆ.

Ascopodaria discreta, Busk (1).

One small colony of a reddish colour, growing on a sponge.
Locality :—Navakaddu Paar.

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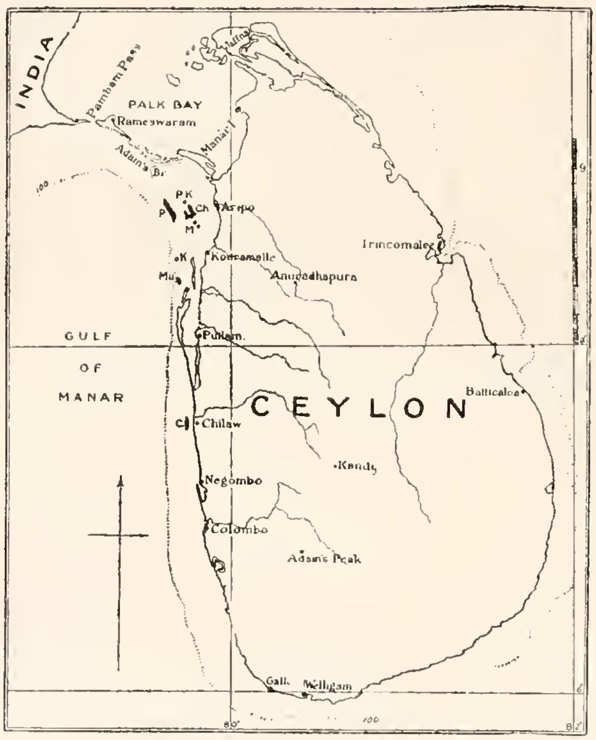
EXPLANATION OF PLATE.

1. *Onychocella cucullata*, n. sp.
2. *Schizoporella avicularis*, n. sp.
3. ,, *viridis*, n. sp.
4. ,, *collaris*, n. sp.
5. *Rhyncopora corrugata*, n. sp.
6. ,, *incisor*, n. sp.
7. *Gemellipora protrusa*, n. sp.
8. *Lepralia triangula*, n. sp.
9. ,, *multidentata*, n. sp.
10. *Lepralia nitida*, n. sp.
11. ,, *ceylonica*, n. sp.
12. ,, *fissa*, n. sp.
13. ,, *purpurea*, n. sp.
14. *Phylactella spiralis*, n. sp.
15. *Mucronella thenardii*, AUD.
16. *Retepora pocillum*, n. sp.
17. *Cellepora compacta*, n. sp.



Sketch-map of the Ceylon coast, showing the principal localities from which specimens were collected. C., Chilaw Paar; Ch., Cheval Paar; K., Karativo Paar; M., Modragam Paars; Mu., Muttuvaratu Paar; P., Periya Paar; P.K., Periya Paar Kerrai.

R T del.   E Wilson, Cambridge

REPORT

ON THE

MEDUSÆ

(HYDROMEDUSÆ, SCYPHOMEDUSÆ AND CTENOPHORA)

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH FOUR PLATES.]

INTRODUCTION.

THE collection of Medusæ brought back by Professor HERDMAN from Ceylon and another forwarded by Mr. JAMES HORNELL were kindly sent to me by Professor HERDMAN for examination. So far as I know there are no previous records relating to the medusæ of Ceylon, except for the Siphonophora which have been specially studied on the spot by HAECKEL. Unfortunately none of his beautiful species occur in the collection.

The specimens come chiefly from two places—Galle, at the south of Ceylon, and the Pearl Banks in the Gulf of Manaar. It is distinctly a littoral collection from shallow water, and the littoral character is shown by the number of Anthomedusæ and Leptomedusæ. The collection has not brought to light any new genera, nor are the species in any way very remarkable, considering that they live within a tropical region, in a sea at about 80° F. From a geographical point of view the collection is a valuable one, as it has increased our knowledge of the distribution of genera.

Some of the specimens had been splendidly preserved and were a pleasure to work with, but many were in bad condition, more or less broken up, and these gave me endless trouble. I have endeavoured, as far as possible, to give such details as I hope will lead to the recognition of the species again, but should any doubt arise when comparing a description or figure with living specimens, I would suggest that it would be better to amend my work rather than describe another species.

[After this report had been sent to the printer I received intimation from Professor OTTO MAAS, of Munich, that he was preparing for publication his account of the Hydromedusæ of the Dutch "Siboga" Expedition. As our respective reports were likely to be published about the same time we agreed to exchange proofs. I wish here to express my thanks to Professor MAAS for his kindness in allowing me to make use of his work, which must be regarded as a valuable contribution towards our knowledge of the Hydromedusæ.

A few of the species in the Ceylon collection were also taken by the "Siboga" in the East Indies, namely:—*Irenopsis hexanemalis*, *Octocanna polynema*, *Mesonema pensile*, *Liriope tetraphylla*, and *Solmundella bitentaculata*.]

The following is a classified list of the species described in this report:—

HYDROMEDUSÆ.

ANTHOMEDUSÆ.

Dipurena sp.?

Cytæis herdmani, n. sp.

Proboscidactyla minima, n. sp.

LEPTOMEDUSÆ.

Laodice indica, n. sp.

Mitrocomium assimile, n. sp.

Eutima curva, n. sp.

Octorchis orientalis, n. sp.

Irene ceylonensis, n. sp.

Irene palkensis, n. sp.

Irenopsis hexanemalis, GOETTE.

Octocanna polynema (HAECKEL).

Æquorea conica, n. sp.

,, *parva*, n. sp.

Mesonema pensile (MODEER).

TRACHOMEDUSÆ.

Gonionemus hornelli, n. sp.

Olindias sp.?

Liriope tetraphylla (CHAM. ET EYS.).

NARCOMEDUSÆ.

Solmundella bitentaculata (QUOY ET GAIM.).

SIPHONOPHORA.

Diphyes chamissonis, HUXLEY.

Cupulita sp.?

Agalmopsis sp.?

Physalia utriculus, ESCH.

Porpita sp.?

SCYPHOMEDUSÆ.

Charybdea sp.?

Nausithoe punctata, KOLL.

Pelagia sp.?

Crambessa sp.?

CTENOPHORA.

Pleurobrachia globosa, MOSER, var. *ceylonensis*, n.

Beroe flemingi (ESCH.).

A Comparison between the Medusæ of Ceylon and those of the Maldives.

It is somewhat hazardous to draw a comparison between the medusoid fauna of Ceylon and that of the Maldives. About that of Ceylon I feel that we at present know but little, in fact, we have just made a beginning in our observations. We know, perhaps, a little more about the medusæ of the Maldives, which have recently been visited by two expeditions—the first under the leadership of Mr. Stanley Gardiner, and the second, which soon followed the first, under the guidance of Professor Alexander Agassiz.

Leaving out the oceanic medusæ, which have usually a wide geographical range, and limiting the comparison to the Anthomedusæ and Leptomedusæ, Mr. Gardiner's collection contained 5 genera and 5 species (3 of which were new species). Professor Agassiz's collection contained 10 genera (1 new genus) and 11 species (6 of which were new species and 3 were not named). With the possible exception of one of the Æquoriidæ, the genera and species were quite distinct in the two collections. Taking the two collections, without any limitations, there is a well-marked difference between them, which is quite as great as if they had come from localities a thousand miles apart. It is difficult to assign a correct reason for such a difference, but probably a different season of the year and the localities visited had much to do with it.

The two Maldive collections contain altogether 14 genera and 15 species of Anthomedusæ and Leptomedusæ. The Ceylon collection contains 12 genera and 14 species (10 of which are regarded as new species). A comparison between the Maldive and Ceylon collections shows that 6 genera (*Dipurena?*, *Proboscidactyla*, *Irene*, *Irenopsis*, *Mesonema* and *Æquorea*) are common to both, but only 2 species (*Irenopsis hexanemalis* and *Mesonema pensile;* the former also occurs at Zanzibar and the latter in the Red Sea). I think that these figures show clearly that the medusoid fauna of Ceylon is quite distinct from that of the Maldives.

HYDROMEDUSÆ.

Order: ANTHOMEDUSÆ.

Family: SARSIIDÆ, Forbes, 1848.

Dipurena, McCrady, 1858.

Dipurena, sp. ?—Plate II., figs. 1 and 2.

Description.—Umbrella about as high as broad. Manubrium extending beyond the margin of the umbrella. Mouth circular. Gonads arranged in several large isolated clusters upon the manubrium. Four tentacles with globular basal bulbs, and with numerous small clusters of nematocysts. Ocellus upon the outer side of each basal bulb.

Size :—Umbrella about 3 millims. in width and height.

Locality :—Galle Bay, one specimen on June 12 and two on August 25.

Notes.—The umbrella of the three specimens is so badly out of shape that a figure of it cannot be given. The manubrium (fig. 2) is a long thin tube, about two to three times the length of the cavity of the umbrella, with an apical knob in the jelly of the umbrella, and with a large terminal stomach which has a circular mouth. The gonads are situated on the manubrium in large roundish clusters, and their size makes them conspicuous. One specimen has four clusters of gonads, another has two clusters. The third specimen has lost its manubrium. The stomach itself also appears to be surrounded with generative cells. The tentacles (fig. 1) are long and flexible, and are closely studded with clusters of nematocysts, except for a short distance next to the basal bulb. The upper half of the basal bulb is globular and embedded in the jelly of the umbrella, the lower part is like a circular band round the tentacle, broader on the inner side than on the outer side. In this band, on the outer side, the ocellus is situated. The ocellus is circular, of a yellowish colour in formalin, and has a small lens.

I have placed this species in the genus *Dipurena* and follow at present HAECKEL'S classification, though I think that this species and *Dipurena ophiogaster* will ultimately have to be removed to another genus. All the other species have the nematocysts on the tentacles confined to a large conspicuous terminal knob, and some in addition have a few large swellings containing nematocysts just above the terminal knob. *Dipurena ophiogaster* has the nematocysts on the tentacles arranged in quite a different manner. They form numerous semi-circular or three-quarter spiral loops round the tentacle when it is in a contracted or semi-contracted state. When the tentacle is fully expanded the nematocysts form minute globular clusters which give a moniliform appearance to the tentacle. The terminal cluster of nematocysts is very small and inconspicuous. The arrangement of the nematocysts of this species from Ceylon is similar to that of *Dipurena ophiogaster* and to that found in the genus *Sarsia.*

The specimens from Ceylon are very much like *Dipurena ophiogaster* which belongs to the British fauna, and it is not possible to point out a character in the structure of the tentacles or the manubrium with its gonads by which they can be specifically separated. As the specimens are in bad condition, I think it is best to leave the specific name in abeyance. They may differ from the *Dipurena ophiogaster* in the shape of the umbrella, in colour, and perhaps in other details.

BIGELOW (1904) found at the Maldives a *Dipurena* which he was not able to clearly distinguish from *Dipurena fragilis*, MAYER, belonging to the fauna of the Tortugas in the West Indies.

Family: MARGELIIDÆ, Haeckel, 1877.

Cytæis, Eschscholtz, 1829.

Margeliidæ with four single perradial marginal tentacles, and with unbranched oral tentacles.

Cytæis herdmani, n. sp.—Plate I., fig. 1; Plate IV., fig. 12.

Description.—Umbrella somewhat bell-shaped, about as high as broad, with fairly thick walls. Velum narrow. Stomach large, about as long as wide, situated on a short peduncle, and extending a little over half-way down the cavity of the umbrella. Mouth circular (expanded) with about 50 to 60 oral tentacles, which are unbranched and evenly distributed. Four broad radial canals. Gonads forming four large perradial swellings, and extending the whole length of the stomach. Four thick tentacles, perradial, with very large basal bulbs, which are somewhat triangular in shape.

Size:—Umbrella about $3\frac{1}{2}$ millims. in width and height.

Locality:—One specimen from Chilaw Paar on March 20, and one from Cheval Paar on November 11.

Notes.—Of these two specimens, one is an adult and the other is an intermediate stage. The stomach is cross-shaped in transverse section, and the gonads occupy the sides of the cross. The oral tentacles have a small round terminal cluster of nematocysts. The four marginal tentacles are thick and have a dark central band of pigment (perhaps a brilliant colour in the sea). A transverse section (fig. 12) shows that the pigment granules are confined to the endoderm cells, which form a solid central band of cells along the tentacle. The pigment granules form a dense layer round the periphery of the endoderm, and are also scattered along the walls of the cells. There is a fairly thick layer of mesoglœa and an extra thick ectoderm which contains an enormous number of nematocysts, closely packed together. The basal bulbs are very large and extend some way up the umbrella. There is a layer of dark pigment along the inner side of the bulb, and a thick whitish mass of cells on the outer side. Sections were not cut of the basal bulb, but the dark pigment granules would probably denote the endoderm and the external whitish cells the ectoderm. The specimen at the intermediate stage in development is about 2 millims. in width and height. It has four marginal tentacles, fewer oral tentacles, and smaller gonads than the adults.

This species is nearly related to *Cytæis nigritina* and *Cytæis macrogaster* of Haeckel. It differs from them in having many more oral tentacles, in the shape of the basal bulbs, and in the structure of the tentacles.

Family: WILLIIDÆ, Forbes, 1848.

Proboscidactyla, Brandt, 1835, ex Browne, 1904.

Williidæ with four radial canals leaving the stomach.

Proboscidactyla minima, n. sp.—Plate II., fig. 3.

Description.—Umbrella fairly thin and probably hemispherical in shape. Stomach divided into four longitudinal lobes. Mouth with a sinuous margin. Four radial canals with lateral branches. Gonads upon the lobes of the stomach. Tentacles short, about 16 to 20, with globular basal bulbs.

Size :—Umbrella about 1 millim. in diameter.

Locality :—Marichchukaddi, on the Gulf of Manaar, in February.

Notes.—There are 12 specimens, but their condition does not permit the production of a figure. I was unable to trace out the branching of the radial canal system, owing to the umbrella of all the specimens being more or less contracted, and to their fragile condition. The stomach is divided longitudinally into four lateral lobes and appears cross-shaped in transverse section. The gonads form lateral swellings upon the sides of the lobes, which do not extend along the top of the umbrella. The tentacles (fig. 3) are very short, about 0·25 millim. in length, and have a globular basal bulb situated in the jelly of the umbrella. On the ex-umbrella, not far from the margin, there are circular clusters of nematocysts, one between every two tentacles. The velum is very narrow. A few of the specimens are about 0·75 millim. in diameter and have 10 to 12 tentacles. Others, a little older, have 14 to 16 tentacles. One specimen has 18 tentacles. A full-grown adult has probably 20 tentacles. This species may be distinguished by the smallness of its size and the position of the gonads on the stomach.

Order : LEPTOMEDUSÆ.

Family : THAUMANTIIDÆ, Gegenbaur, 1856.

Laodice, Lesson, 1843.

Laodice indica, n. sp.—Plate I., fig. 5; Plate IV., figs. 7 to 11.

Description.—Umbrella slightly curved, about two to four times as broad as high, with moderately thick walls. Stomach cross-shaped, fairly large. Mouth with four short lips, having a slightly folded margin. Gonads extending from the stomach to about half-way or close to the margin of the umbrella, forming a large hollow sac upon each of the four radial canals. Tentacles about 60 to 80, with blackish basal bulbs, and without spurs. A large black ocellus upon the inner side of nearly all the basal bulbs. A single cordylus between every two tentacles. Cirri present.

Size :—Umbrella up to 6 millims. in diameter.

Locality :—Off Mutwal Island, West Coast of Ceylon, 12 specimens on March 19; and Galle, 3 specimens, on July 15.

Notes.—The collection contains 15 specimens which are about 5 millims. to 6 millims. in diameter and about the same age. The distance to which the gonads extend from the stomach along the radial canals varies in different specimens. Some have the gonads on the proximal half of the canals, whilst in others the gonads reach nearly to the margin of the umbrella. The gonads first arise in the proximal part of the canals quite close to the stomach, and grow outwards towards the periphery of the umbrella. Owing to the great extension of the walls of the radial canals in the region occupied by the gonads, it is difficult in some specimens to mark the spot where the stomach ends and the canals begin. The gonads look as if they were situated upon lobes of the stomach. The length of the gonads is independent of the development of the generative cells, as a gonad extending over only half the radial canal has large ripe ova. Sections show (fig. 10) that the ova at an early stage in their development are among the endoderm cells, and that later on they move outwards to the ectoderm. The section figured shows an ovum leaving the ovary and breaking through the ectoderm.

The tentacles are closely packed together round the margin of the umbrella, and apparently form two alternating series, one projecting outwards and the other hanging down. Although similar in structure, only those belonging to the former have a conspicuous blackish basal bulb with a conspicuous black ocellus. The latter series have a smaller basal bulb, either colourless or slightly pigmented, and either without an ocellus or with a very small one. The basal bulb is on the inner side of the tentacle ; it is a semi-circular thickening containing nematocysts and granules of pigment, which cover the exterior of the bulb and also extend in radiating lines into the interior. There is no spur-like projection at the base of the tentacles. The cirri (fig. 9) are capable of extending to a great length. There is probably one between every two tentacles, but very few were seen on the specimens. The free end terminates in an oval knob containing large nematocysts (fig. 11). The ocellus is situated on the margin of the basal bulb just below the velum. It is of an intense black colour, spherical in shape, with a circular pit penetrating nearly to the centre (fig. 8).

The cordylus is very small and club-shaped (fig. 9). The interior of club is composed of endoderm cells which are connected with endoderm cells of the circular canal (fig. 7). The structure of the cordylus resembles that of *Laodice calcarata* (see Brooks, 1895).

The specimens from Ceylon come nearest to *Laodice calcarata* which inhabits the North Atlantic. They differ from it in having no spur at the base of the tentacles, in having larger ocelli, and perhaps in colour and in size.

Family: EUCOPIDÆ, Gegenbaur, 1856.

Mitrocomium, Haeckel, 1879.

Mitrocomium assimile, n. sp.—Plate I., fig. 3.

Description.—Umbrella fairly thick, a little broader than high. Velum narrow. Stomach short, with a quadrangular base. Four radial canals. Gonads upon the outer half of the radial canals, forming large oval sacs. Four perradial tentacles.

About 5 to 7 marginal bulbs in each quadrant; the central, interradial, bulb being much larger than the others. A cluster of cirri adjacent to and on each side of the tentacles. About five marginal sensory vesicles, each with two (occasionally three) otoliths, in each quadrant of the umbrella.

Size:—Umbrella 2 millims. in width and $1\frac{1}{2}$ millims. in height.

Locality:—Cheval Paar, in February.

Notes.—There is only one specimen of this little medusa in the collection. It is rather opaque with a yellowish stain, and its margin is badly curled inwards. The umbrella is somewhat contracted, so that it may not be quite so highly arched as figured. The stomach is contracted back. The mouth is wide open and quadrangular in outline, but has probably four lips when closed. The gonads (male) are very large for the size of the medusa. Each gonad is divided into two by a median longitudinal line. The tentacles have large basal bulbs and transverse bands of nematocysts. The cirri are more or less contracted, and have a small terminal cluster of nematocysts. The cirri are apparently confined to the proximity of the tentacles and none were seen scattered along the margin of the umbrella.

As there is only one specimen, I place the species provisionally in the genus *Mitrocomium*. It bears a resemblance to *Mitrocomium cirratum* in having cirri clustered at the base of each tentacle. According to HAECKEL'S definition of the genus it should have 8 tentacles and 16 sense-organs.

Eutima, McCRADY, 1858.

Eutima curva, n. sp.—Plate III., figs. 1 to 3.

Description.—Umbrella probably hemispherical, nearly twice as broad as high, moderately thick. Peduncle of the stomach long, quadrangular in transverse section, and with a conical base. Stomach small, about twice as long as broad. Mouth with four small lips, and sinuous margin. Four radial canals. Gonads along nearly the whole length of the peduncle, one on each radial canal, beginning a little way below the conical base of the peduncle and terminating not far from the stomach. Four perradial tentacles, with long tapering cone-shaped basal bulbs, which are laterally compressed and curve over the margin of the umbrella. About 30 to 35 marginal bulbs in each quadrant of the umbrella, and alongside each bulb usually one, occasionally two cirri. Eight adradial marginal sensory vesicles, each with about 8 to 10 otoliths, which are arranged in a semicircle.

Size:—Umbrella 10 millims. in width and 6 millims. in height. Peduncle about 10 millims. in length.

Locality:—Off Mutwal Island, West Coast of Ceylon, on March 19.

Notes.—The single specimen, although in a good state of preservation, has the umbrella badly compressed and folded, so that it is impossible to figure the whole medusa. It is an adult, as the gonads contain large ova. The basal bulbs of the tentacles are attached to a slight thickening of the umbrella and curl over the margin. The nematocysts along the tentacle are arranged in transverse bands which do not quite meet on the inner side of the tentacle, so that a shallow groove is formed along the inner side, running the whole length of the tentacle. The marginal bulbs have a patch of blackish pigment at their apex.

This species comes nearest to *Eutima mira* and *Eutima insignis*, but is distinguished from them by the shape of the basal bulbs.

Octorchis, Haeckel, 1864.

Octorchis orientalis, n. sp.—Plate III., fig. 4.

Description.—Umbrella probably hemispherical, a little broader than high, and moderately thick. Peduncle of the stomach long, quadrangular in transverse section, and with a broad roundish base. The length of the peduncle is about twice the diameter of the umbrella. Stomach small, about as long as broad. Mouth with four short lips and a deeply folded margin. Gonads upon the peduncle of the stomach and also upon the sub-umbrella. The gonads occupy the greater length of the peduncle, extending along the radial canals, beginning a little way below the base of the peduncle and terminating close to the stomach. The gonads upon the sub-umbrella usually occupy the central third of the radial canals, or the outer half, but do not reach to the margin of the umbrella. Four long perradial tentacles, with long tapering cylindrical basal bulbs. About 18 to 20 marginal bulbs in each quadrant of the umbrella, each one with a lateral cirrus. Eight marginal sensory vesicles.

Size :—Umbrella about 5 millims. to 6 millims. in diameter.

Locality :—Galle Bay, one specimen on June 5, seven on June 12, and two on August 21.

Notes.—None of the specimens are in good condition, the umbrella being so flattened out and crumpled that it is not possible to draw a figure of it. Some of the largest specimens have the gonads upon the peduncle in a series of folds (fig. 4), but it is possible that the folding may be due to the contraction of the peduncle. The gonads upon the peduncle are much larger and longer than those upon the sub-umbrella, the latter forming merely a thin narrow band along the radial canals. The marginal bulbs are very small and inconspicuous. The cirri are very slender and have a small terminal cluster of nematocysts. The sense-organs are situated near the tentacles. They are very small and globular in shape, their otoliths not visible.

Notes on Intermediate Stages.

(*a.*) Umbrella about 2 millims. in diameter. Peduncle about 5 millims. in length, with gonads just appearing upon it. Four tentacles. Cirri present. About 9 marginal bulbs in each quadrant. Eight sense-organs.

(*b.*) Umbrella about 3 millims. in diameter. Peduncle about 6 millims. in length. Gonads just appearing upon the peduncle and sub-umbrella. About 12 marginal bulbs in each quadrant.

This species does not agree with HAECKEL's definition of the genus *Octorchis*, since it has only 4 instead of 8 tentacles, but in other respects it conforms to the generic character. *Octorchis gegenbauri* has been frequently taken by me in British seas. Early and intermediate stages (the latter often with gonads) have 4 tentacles, whereas the fully developed adult has 8 tentacles. I think it would be better to enlarge the generic character so as to include species with 4 and 8 tentacles, than to establish a new genus for species which have only 4 tentacles.

HAECKEL, in his monograph, mentions two species of *Octorchis*—*O. gegenbauri* and *O. campanulatus*, both occurring in the Mediterranean, but probably there is only one species. The specimens from Ceylon are distinguished from the Mediterranean species by the greater length of the gonads on the peduncle.

Irene, ESCHSCHOLTZ, 1829.

Irene ceylonensis, n. sp.—Plate III., figs. 9 to 11.

Description.—Umbrella probably watchglass-shaped, much broader than high, with thin walls. Velum narrow. Stomach short, situated upon a long cylindrical peduncle. Mouth with four lips, which have a folded margin. Four radial canals. Gonads linear, extending from the base of the peduncle to near the margin of the umbrella. Tentacles about 100. Cirri absent. Sensory vesicles, one between every two tentacles, each vesicle with a single otolith.

Size: Umbrella up to about 25 millims. in diameter.

Locality: Galle Bay, one specimen on July 15; Cheval Paar, five in November.

Notes.—The collection contains six specimens differing in age and size, the smallest being about 5 millims. in diameter. All the specimens are more or less damaged. They are in a fair state of preservation, but are stained dead black, probably owing to the use of osmic acid.

The umbrella is flat and thin, but is no doubt slightly curved when the medusa is alive. Only one specimen shows the peduncle fairly well, the others have either lost it or have it twisted up. The gonads form thin narrow bands, either straight or sinuous, extending along the radial canals over the sub-umbrella. In the largest specimens the ova are large and clearly visible. Some of the specimens have a marginal bulb between some of the tentacles, and these bulbs I believe to be the origin of new additional tentacles, and not warts or tubercles, which do not develop tentacles. I am doubtful about the presence of excretory pores at the back of the basal bulbs, as there were no indications of papillæ, but they may be contracted.

The sensory vesicles have one otolith, but occasionally a vesicle was seen with two otoliths, which may have been caused by twinning.

(*a*)	Umbrella about	5	millims. in diameter.	About	28 tentacles.
(*b*)	,, ,,	7	,, ,,	,,	36 ,,
(*c*)	,, ,,	15	,, ,,	,,	72 ,,

Irene palkensis, n. sp.—Plate III., figs. 12 to 16.

Description.—Umbrella watchglass-shaped, about four times as broad as high. Velum narrow. Stomach short, situated upon a long cylindrical peduncle. Mouth with four short lips, which have a folded margin. Four radial canals. Gonads linear, extending from the base of the peduncle to near the margin of the umbrella. Tentacles about 50. Usually two or three marginal bulbs between every two tentacles. Excretory pores opposite the basal bulbs of the tentacles and all the marginal bulbs. Sensory vesicles about 2 to 4 between every two tentacles, each vesicle with two otoliths (variation 1 to 4).

Size :—Umbrella up to 20 millims. in diameter.

Locality :—Palk Bay, north of Ceylon, five specimens on March 16.

Notes.—The five specimens are all in a damaged condition, especially as to the gonads and the margin of the umbrella. The smallest is about 15 millims. in diameter and the largest about 20 millims. The gonads are upon the sub-umbrella along the radial canals. One specimen has the gonads extending from near the margin of the umbrella up to the peduncle, and for a short distance down the peduncle. The number of tentacles is only given from an estimation, as not one specimen has even a quadrant of the margin of the umbrella in a perfect condition. The basal bulb of the tentacle is somewhat globular when the tentacle is contracted, and more cone-shaped and tapering when the tentacle is expanded. On the inner side of the basal bulb just above the velum there projects an excretory pore. These pores are conspicuous and clearly visible when expanded, but almost invisible when contracted. Cirri were specially searched for, but none were seen. The marginal bulbs are small, and to judge from their appearance in one of the specimens, I think that some are capable of developing tentacles. Their number between every two tentacles is variable, usually two or three, sometimes only one. All these bulbs have excretory pores, similar to the pores opposite the basal bulbs of the tentacles. The sense-organs are closed vesicles with generally two otoliths (fig. 14), occasionally three to four otoliths, rarely one. The otoliths possess well-marked eccentric zones, which are conspicuous in specimens which have been apparently killed with a re-agent containing osmic acid.

At first sight *Irene palkensis* and *Irene ceylonensis* look very much alike, but after an examination of the organs on the margin of the umbrella I came to the conclusion that they were distinct species. *Irene ceylonensis* has about twice as many tentacles without a series of marginal bulbs in between them, and there is a difference in the shape of the basal bulbs of the tentacles, but I attach more importance to the sense-organs as a better means of distinguishing between the two species. *Irene ceylonensis* has only one sense-organ between every two tentacles, each sense-organ with a single otolith. *Irene palkensis* has two to four sense-organs between every two tentacles, and each sense-organ usually has two otoliths, occasionally three to four, and rarely one. There is also a difference in the structure of the otoliths.

Irenopsis, GOETTE, 1886.

Eucopidæ with numerous sensory vesicles, and with numerous tentacles. Six gonads in the course of six radial canals. Stomach upon a peduncle.

Irenopsis hexanemalis, GOETTE, 1886.—Plate I., fig. 4; Plate III., figs. 5 to 8.

Irenopsis hexanemalis, GOETTE, 1886, p. 832; CHUN, 1896, p. 5.

Phialidium tenue, BROWNE, 1904, p. 730, plate liv., fig. 4; plate lvii., fig. 16.

Description.—Umbrella like an inverted basin in shape, with a flattened top, about twice as broad as high. Velum narrow. Stomach short, with six lateral lobes, situated upon a short, broad, cone-shaped or semi-globular peduncle. Mouth with six lips, having a deeply-folded margin. Six radial canals. Gonads linear, on the distal part of the radial canals, close to the margin of the umbrella. Tentacles, about 30 to 40. Marginal bulbs about three or more between every two tentacles. Excretory pores opposite the basal and marginal bulbs. Sensory vesicles, usually one, sometimes two, between every two bulbs, each vesicle containing a single otolith (occasionally about two to four). Cirri absent.

Size:—Umbrella up to about 18 millims. in diameter.

Locality:—Palk Bay, 18 specimens on March 16; Cheval Paar, 9 specimens.

Notes.—The collection contains about two dozen specimens and nearly all are in bad condition. The smallest is an intermediate stage measuring 5 millims. in diameter. The stomach is situated upon a short peduncle which is about 2 millims. to 4 millims. in length. The peduncle is variable in shape. In some specimens it is conspicuous, but in others hardly noticeable. When semi-globular, or like a broad inverted cone, it is quite recognisable. In some of the specimens the peduncle is flattened out (whether this is natural or due to preservation I am unable to say), and in this condition the roof of the sub-umbrella appears convex, and the top of the umbrella is very thick. The stomach (fig. 8) is divided into six lobes, and its base seen aborally is like a six-rayed star. It is very short, about 1 millim. in length, and about twice as broad as long. The mouth has six conspicuous lips, which are continuous with the lobes of the stomach, and the margin of the lips is deeply and closely indented with a series of folds. In some specimens the stomach and its peduncle are within the cavity of the sub-umbrella, but those specimens which have an extra thick umbrella may have the stomach projecting a little way outside the cavity.

When a medusa has normally six radial canals, a variation in number may be expected. Medusæ with six radial canals have been derived from a form with four canals, and are much more liable to variation than those with four canals. There are altogether 27 specimens of *Irenopsis*, and six show a numerical variation in the radial canals, their numbers being as follows;—4, 7, 8, 8, 9, 11. The number of gonads also varies with the radial canals. The gonads vary very much in size, and are always situated upon the distal or outer half of the radial canals. Most of the specimens have very short linear or spindle-shaped gonads, about 1 millim. or little more in length, and situated near the margin of the umbrella. Three specimens have the gonads extending over nearly the whole of the distal half of the canals, but not quite reaching to the margin of the umbrella.

The tentacles vary in number according to the size and age of the specimens. The exact number in any one specimen could not be ascertained, as all the specimens have the margin of the umbrella more or less damaged. As a rule, in the largest specimens, there are about five or six tentacles (one specimen has six or seven) between every two radial canals. I estimated the number of tentacles in several large specimens to be about 36, and in one specimen at about 40. About the exact shape of the basal bulbs of the tentacles I am uncertain. In a contracted state they look somewhat globular, but are probably more conical when the tentacle is expanded. The marginal bulbs between the tentacles are very minute and their number is variable. Usually about three are present, but occasionally only one between every two tentacles. There are excretory pores opening above the velum, opposite every basal and marginal bulb. In nearly every specimen these pores are so contracted that their presence is not noticeable. In a few specimens they are well expanded (fig. 5) and form long papillæ. The marginal sense-organs (fig. 7) are closed vesicles, usually with a single otolith, but occasionally with two or three otoliths, rarely with four. There is generally only one between every two marginal bulbs, or about two to four between every two tentacles.

The genus *Irenopsis* was established by Goette for *Irenopsis hexanemalis*, found at Zanzibar. The original description is rather brief and there is no figure. Chun, however, has given a fuller account of some specimens taken at Tumbatu, off Zanzibar. The genus clearly belongs to the sub-family Irenidæ, and is readily distinguished by the presence of six radial canals. As the specimens from Ceylon agree with the descriptions given by Goette and by Chun, I have presumed that they are *Irenopsis hexanemalis*, though I should have liked to see a figure for comparison.

After seeing these specimens of *Irenopsis* I again examined *Phialidium tenue*, which was described by me as a new species in the Report on the Hydromedusæ of the Maldive Islands. The description of this species, based upon a single specimen, was given as follows:—" Umbrella watch glass-shaped and thin. Stomach small, quadrangular in shape, and situated on a semi-globular thickening of the umbrella.

Mouth with four lips and a sinuous margin. Four gonads extending over the outer half of each radial canal. Tentacles 25 in number. One or two minute marginal bulbs between every two tentacles. Sense-organs numerous, one or two, rarely three, between every two tentacles, with a single otolith. Umbrella 15 millims. in diameter." I clearly pointed out that I did not regard the thickening of the umbrella as a definite peduncle, and consequently placed the species in the genus *Phialidium* instead of in *Irene*. The result of the second examination, with specimens of *Irenopsis* for a comparison, leaves no doubt that the thickening of the umbrella must be regarded as a peduncle, so that the species does not belong to the genus *Phialidium*. It resembles *Irenopsis* in the shape of the peduncle, in the position of the gonads, in the number of tentacles, marginal bulbs and sense-organs. The basal bulbs of the tentacles are slightly larger. But it has only four radial canals, four gonads, and a mouth with four lips. If the specimen had been in this collection I should certainly have considered it to be an abnormal *Irenopsis*, having four instead of six radial canals. With four radial canals one would expect to see a mouth with four lips. I think that *Phialidium tenue* had better be regarded as an abnormal *Irenopsis*.

Octocanna, Haeckel, 1879.

Octocanna polynema (Haeckel)—Plate II., figs. 8, 9, 10.

Description.—Umbrella about twice to three times as broad as high, and thick. Stomach flat, octagonal base with eight lateral lobes, about 2 millims. in diameter. Mouth with eight small lips. Eight radial canals. Gonads linear, extending over the outer half of the radial canals and nearly reaching to the margin of the umbrella. Sixteen tentacles. About three to four marginal bulbs between every two tentacles, each having an excretory pore. One marginal sensory vesicle (seldom two) between every two bulbs, each vesicle with two otoliths (rarely with one or three).

Size :—Umbrella up to 12 millims. in diameter.

Locality :—Palk Bay, one on March 16 ; off Mutwal Island, one on March 19 ; Galle, one on August 25.

Notes.—The umbrella of two specimens is plano-convex in shape, fairly thick, and its margin is curled inwards. The third specimen has a very thick umbrella, which is more highly curved than those of the other two specimens, and the cavity of the umbrella is very shallow. The stomach has eight lobes, from which run the radial canals. The mouth is expanded in all the specimens and has eight small lips, corresponding in position to the radial canals. The gonads, in two of the specimens, are on the outer half of the radial canals, but in the third specimen they are more central, occupying the central third of the radial canals. They are linear in shape, increasing in thickness towards the distal end, and show fairly large ova. There are eight tentacles in the smallest specimen (8 millims. in diameter), one opposite each radial canal, and eight large marginal bulbs, one midway between every two tentacles. A few of these bulbs are just beginning to develop tentacles. The tentacles are long and slender, and their basal bulbs are somewhat globular. The excretory papillæ are plainly visible, and project out just above the velum. All the basal bulbs and the small marginal bulbs have excretory pores. The small marginal bulbs are more or less conical in shape, and some look as if they were capable of developing tentacles.

I place this species provisionally in the genus *Octocanna*, as it does not possess all the characters according to HAECKEL'S definition. There are two species of *Octocanna*, both of which were described, without figures, by HAECKEL, and have not since been recorded.

Octocanna octonema has 8 tentacles. Gonads reaching along the whole length of the radial canals. Sixteen sense-organs, each with a single otolith. Umbrella 10 millims. in diameter. Red Sea.

Octocanna polynema has 32 tentacles. Gonads not along the whole length of the radial canals. 60 to 80 sense-organs, each with two otoliths. Umbrella 15 millims. in diameter. Singapore.

Both the above species have four very long oral lips, which HAECKEL includes in the generic characters. The Ceylon specimens have eight small lips. They also possess marginal bulbs and excretory pores which are not mentioned by HAECKEL.

[In the report upon the Hydromedusæ of the "Siboga" Expedition, Professor MAAS describes under the name of *Octocanna polynema*, HAECKEL, some medusæ which appear to me to be identical with the specimens in the Ceylon collection. These specimens I had described in manuscript as a new species of *Octocanna*. As MAAS has emended HAECKEL'S description and transfers the genus from the Æquoriidæ to the Eucopidæ, he has prevented me from introducing a superfluous new species. I quite agree with him as to the desirability of the removal of the genus to the Eucopidæ and have adopted the classification here.]

FAMILY: ÆQUORIIDÆ, ESCHSCHOLTZ, 1829.

Æquorea, PÉRON et LESUEUR, 1809; ex BROWNE, 1904.

Æquoriidæ with numerous simple unbranched radial canals. Stomach circular, with the lower wall fully developed. Mouth capable of closing up.

Æquorea conica, n. sp.—Plate I., fig. 2; Plate II., figs. 16, 17, 18.

Description.—Umbrella somewhat cone-shaped, with a rounded summit, a little higher than broad, and very thick. Velum narrow. Stomach flat and circular, about half the diameter of the umbrella. Oral lips about 16 in number, long and slender. About 16 radial canals. Gonads upon the proximal half of the radial canals, very much laterally compressed. Tentacles about 26 to 30, small and slender; their basal bulbs small and somewhat cone-shaped. Between every two tentacles a very minute marginal bulb and two sensory vesicles (sometimes only one), each with two small otoliths.

Size :—Umbrella up to 7 millims. in width and 8 millims. in height.

Locality :—Pearl banks, Gulf of Manaar.

Notes.—The collection contains six specimens, which are mostly about the same size (5 millims. in width and 6 millims. in height) and age. Some are males and others are females having gonads with large ova. The oral lips have an external rib, with an internal groove which is probably ciliated. In this species the gonads are confined to the proximal half of the radial canals, and hang down as laterally compressed sacs. It is upon the position and shape of the gonads that I base the specific character. Excretory pores along the circular canal are not visible. Four of the specimens have 16 radial canals and 16 oral lips, one specimen has 15 canals and another 18 canals.

Æquorea parva, n. sp.—Plate II., figs. 5, 6, 7.

Description.—Umbrella plano-convex in shape, a little broader than high, very thick. Velum of moderate width. Stomach flat and circular, about one-third the diameter of the umbrella. Oral lips 13 to 16 in number, of moderate length and width. Radial canals 13 to 16. Gonads sac-like, in the central third of the radial canals. Four (perhaps eight) tentacles, with large basal bulbs. About 12 or more marginal bulbs between every two tentacles. About 10 or more marginal sensory vesicles between every two tentacles, or usually one between every two bulbs; each vesicle with two small otoliths.

Size :—Umbrella up to 6 millims. in width and 4 millims. in height.

Locality :—Galle Bay, one on June 5 and two on June 12.

Notes.—The three specimens are about the same size and age. One is a female and the other two are males. The stomach is about 2 millims. in diameter, and its lower wall about 1 millim. in width; the oral lips do not exceed 1 millim. in length. The gonads have lost their original shape, as they have been crushed down by the folding in of the margin of the umbrella. They occupy the central part of the radial canals, and are slightly nearer to the margin of the umbrella than to the stomach. The gonads hang down as sacs, somewhat laterally compressed. The female has large ova. One specimen has 13 radial canals, gonads and oral lips; the other two have 16 radial canals, gonads and lips. Two specimens have only four tentacles, but the third specimen has one interradial bulb which is just developing a tentacle. The interradial bulbs are much larger than the other bulbs and probably have tentacles in a fully developed specimen. The marginal bulbs, which are very variable in size, are somewhat cone-shaped and contain nematocysts. Some of the bulbs have an excretory pore opening on the sub-umbrella just above the velum. One specimen is badly infested with Cercaria.

This little *Æquorea* differs from the other species of the genus in the small numbers of its tentacles, and in the shape and position of the gonads upon the radial canals.

Mesonema, Eschscholtz, 1829; ex Browne, 1904.

Æquoriidæ with numerous simple, unbranched radial canals. Stomach circular, with lower wall quite rudimentary. Mouth nearly as large as the diameter of the stomach and cannot be closed.

Mesonema pensile (Modeer), 1791—Plate II., figs. 11 to 15.

Medusa sp., Forskål (1776, p. 9, tab. xxviii. b.).
Mesonema cœlem pensile, Modeer (1791, p. 32).
Mesonema pensile, Haeckel (1879); Browne (1904, p. 733, pl. lv., fig. 4; pl. lvii., figs. 2–9).

In my Report upon the Hydromedusæ of the Maldive Islands I gave a description of *Mesonema pensile* (Modeer). In this Ceylon collection there are fragments of a specimen which I believe belongs to this species. The specimen is from the Cheval Paar, Gulf of Manaar, and is broken up into about twenty-five pieces, which together represent only a portion of the whole medusa. Fortunately some of the fragments contain all the organs of the medusa, and it is possible, within certain limits, to give a description and to identify the species.

This medusa is so peculiarly constructed that all the organs lie close to the margin of the umbrella. The umbrella is rather like a plano-convex lens in shape and of great thickness. Around its periphery lie the mouth, stomach, radial canals, marginal tentacles, and sense-organs. These organs are all close together, the distance from the oral lips to the margin of the umbrella is only about 20 millims. To judge from the curvatures of the stomach and the margin of the umbrella on the three largest fragments (the largest fragment which contained all the organs measures 35 millims. in length), the diameter of the umbrella should be much larger than that of the largest Maldive specimen, which measured about 60 millims. in diameter. I think that this medusa when alive was probably about twice the size of the largest Maldive specimen.

The stomach (fig. 14) is rudimentary, and its lower wall is about 4 millims. in length. The margin of the mouth is furnished with a large number of long narrow lips, which are strengthened by an external rib. The length of the longest lips is about 4 millims. Among the lips there are many small ones in the course of development. In structure and shape the oral lips are exactly like those of the Maldive *Mesonema*, but they are a little longer. The lower wall of the stomach is also longer, twice the length.

The radial canals are very numerous, and very short; the distance from margin of the stomach to the circular canal is about 9 millims. The radial canals usually run straight from the stomach to the circular canal, and in one fragment the canal system is quite normal, but some fragments show that the short portion of the canals, between the termination of the gonads and the circular canal, has a strong tendency to curve and to send out lateral branches, which occasionally unite with lateral branches from an adjacent canal, or the union of two or three canals may occur, so that just near the margin of the umbrella the radial canal system appears to be very irregular.

The gonads are situated upon the radial canals and extend almost from the stomach to within a short distance of the circular canal, the distance from the termination of the gonad to the circular canal being about 2 millims. to 3 millims. The gonads are arranged in a lateral band along each side of the radial canals. At first a radial canal is merely a narrow, slender, inconspicuous tube (fig. 14, *R.*), then when the gonads begin to develop, the wall of the canal becomes thicker and increases in size. In this specimen the gonads are much larger than in the Maldive specimens. They have the appearance of cylindrical sacs, about 6 millims. in length and 1 millim. in diameter, with the wall slightly crumbled. Between the canals bearing the fully-developed gonads there are, here and there, canals which are of much later growth showing gonads in various stages of development. Some of these canals are at about the same stage as those in the Maldive specimens, showing that the Maldive specimens had not reached their full development.

The tentacles (fig. 12) belong to the same type as those of the Maldive specimens, but the basal bulbs have not such a long lateral extension along the margin of the umbrella. I have again examined the tentacles of the Maldive specimens, and find the extension along the margin to be slightly variable. The tentacles are also much longer and larger than those in the Maldive specimens, but they have the nematocysts arranged in the same manner. The nematocysts are in large clusters, which are laterally situated, on both sides, along the whole of the tentacle (fig. 13).

The marginal bulbs, like the basal bulb, at first sight, as shown by the figures in this Report and in the Maldive Report, do not appear to be similar, but I believe that the difference in general appearance is due to a lateral contraction of the margin of the umbrella of the specimen in this collection. The bulbs are closely packed together, touching one another, and the sense-organs are squeezed out on to the inner margin of the umbrella (fig. 15). This lateral contraction would also explain the shortness of the basal bulbs of the tentacles upon the margin. In the genus *Æquorea*, excretory pores are present upon the inner side of the circular canals, one opposite each tentacle or bulb. In my description of this species in the Maldive Report I did not mention the excretory pores, for the simple reason that I could not see any. But I have now cut a series of sections of a marginal bulb and found the pore in the usual place just above the velum. There is no trace of any external papilla or swelling, but simply a slender, narrow tube running from the circular canal to the exterior. It is just like a slit in the wall of the circular canal.

The sense-organs (fig. 15) are on the inner side of the margin of the umbrella, and are arranged in groups These groups are placed midway between the marginal bulbs. Between two tentacles I counted the number of bulbs and sense-organs, and found that there were 10 bulbs and 20 sense organs. The latter were arranged in numbers thus: 1.1.2.3.1.1.1.2.2.2.2.2. From the examination of other groups of sense-organs it may be said that there are either one or two, rarely three sense-organs between every two bulbs. A sense-organ contains two otoliths. The figure (11) shows the shape of the vesicle and the position of the otoliths, but the minute details of structure are somewhat diagrammatic.

It is impossible to estimate the number of tentacles, radial canals, &c., which the specimen should have, as the fragments are only a portion of the whole medusa. The tentacles are about 5 millims. to 8 millims. apart, and between them there are about 8 to 12 marginal bulbs, and about 4 to 8 radial canals.

Distribution :—Indian Ocean.

Order : TRACHOMEDUSÆ.

Family : OLINDIIDÆ, Haeckel, 1877 ; ex Browne, 1904.

Gonionemus, A. Agassiz, 1862.

Gonionemus hornelli, n. sp.—Plate I., fig. 6 ; Plate II., fig. 4.

Description.—Umbrella hemispherical, with moderately thick walls, about twice as broad as high. Velum fairly broad. Stomach cross-shaped, having four perradial lobes, situated upon a short, broad, cone-shaped peduncle. Mouth with four short lips. Four broad radial canals, upon which are situated the gonads. Gonads small in size, deeply folded and lobed, extending laterally from the canals and close to the velum. Tentacles about 70, arranged in 16 groups, and all have an adhesive disc about half-way down. Sixteen internal sense-organs, oval in shape, with a single otolith.

Size :—Umbrella 6 millims. in width and 3 millims. in height.

Locality :—Pearl Banks, Gulf of Manaar.

Notes.—The single specimen is in an excellent state of preservation and in perfect condition. The gonads are not papilliform, but are deeply folded and extend outwards on both sides of the radial canals. They are about twice as broad as high, and contain ova of a fair size. On one of the radial canals there is an additional gonad, smaller in size, and not far from the stomach. It may be regarded as an abnormal growth, as the other three canals show no signs of a gonad in that position.

The tentacles are arranged in 16 groups, but the grouping is not so well marked as in the genus *Gossea.* The tentacles forming a group are not of the same size, which is due to development. The perradial and interradial groups each contain five tentacles, the adradial four tentacles. The central tentacle in each group is the largest, the tentacles on each side of the central one come next in size; the two outside tentacles vary very much in size, one is always very small. The attachment of the basal part of the tentacle to the ex-umbrella varies in length according to the age of the tentacle. It proceeds furthest up the umbrella in the oldest tentacles and less far in the other tentacles, showing well the arrangement of the tentacles in groups. There is a semi-globular basal bulb on the inner side of each tentacle, and for a short distance the base of the tentacle is attached on its outer side to the margin of the ex-umbrella, being partly embedded in a groove. The tentacles are covered with nematocysts, which are arranged in transverse bands. The adhesive disc is on the outer side of the tentacle, forming a slightly raised elongated loop, and as it extends about half-way across the tentacle it is easily seen. All the tentacles of this specimen are contracted, and in this condition the adhesive disc is about half-way down the tentacle.

The sense-organs are inside the margin of the umbrella, adjacent to the circular canal, and their position is between the groups of tentacles.

Olindias, F. Müller, 1861.

Olindias, sp. ?

There is only one specimen, which is in bad condition. The umbrella is about 6 millims. in diameter. The stomach is fairly large and cross-shaped. The mouth has four lips and its margin is slightly folded. Four perradial canals, and about three centripetal canals in each quadrant. The gonads extend over the outer half of the radial canals and are arranged in papilliform clusters. The margin of the umbrella is torn and damaged. There are two kinds of tentacles; the primary tentacles have a few spiral bands of nematocysts and a horseshoe-shaped terminal cluster, the secondary tentacles have numerous bands of nematocysts. Upon the margin of the umbrella there are a number of large bulbs which look like the basal bulbs of the secondary tentacles which have been broken off, and also a number of small bulbs. An internal sense-organ lies at the base of some of the primary tentacles, but this could only be seen here and there, owing to the opaqueness and damaged condition of the margin.

The specimen may be *Olindias singularis*, found at the Maldives, but it is not in a condition suitable for an accurate determination of the species. It was found amongst sea-weed at Galle, on February 17.

Note on the Olindiidæ.

In my Report on the Hydromedusæ of the Maldive Islands I revised the genera of the Olindiidæ, but did not know till too late that Professor Seitaro Goto had published a paper on "The Craspedote medusa *Olindias* and some of its Natural Allies" in the 'Mark Anniversary Volume.' It was not until several months after the publication of my paper that I was able to obtain a copy of the volume, and later on Professor Goto kindly sent me a reprint of his paper.

Goto has also revised the Olindiidæ, but excludes from the family the genera

Aglauropsis and *Gossea*, which have not an adhesive disc on the tentacles. About the genus *Olindias* we differ, and it is quite likely that I may be in the wrong. We both examined specimens sent out from the Zoological Station at Naples. I came to the conclusion that the primary (ex-umbrellar) tentacles had not a terminal adhesive disc, but GOTO has expressed an opposite opinion. It is an important point in the classification and could, no doubt, be quickly settled by watching the habits of *Olindias* in the aquarium at Naples.

GOTO has investigated the development of the sense-organs of *Olindioides formosa*, GOTO, and has come to the conclusion that they are entirely derived from the ectoderm. On the ground that the sense-organ is ectodermal, GOTO transfers the Olindiidæ from the Trachomedusæ to the Leptomedusæ and places them under the Eucopidæ. In this Report I have left the Olindiidæ in their old place for convenience sake, not that I dispute GOTO's account of the development of the sense-organs, but rather that I am doubtful about their being true Leptomedusæ.

In 1901, when I was examining the medusæ brought back from the Falkland Islands by Mr. RUPERT VALLENTIN (I regret that the report on the collection is still unfinished, but hope to finish it next year), I cut some sections of the sense-organs of *Aglauropsis conantii*. The sense-organ lies in a corner, formed on one side by the ectoderm containing nematocysts on the margin of the umbrella, and on the other side by the endoderm of the circular canal. It is a globular vesicle containing an otolith upon a short stalk. The wall of the vesicle is composed of a single layer of cells which are in contact with the ectoderm, but isolated from the endoderm by what looks like a layer of mesoglœa. As this layer took a definite shape and stained a much deeper colour than the mesoglœa seen elsewhere, I, not knowing its origin, was doubtful about its really being mesoglœa. I was puzzled for a time over the sense-organ, not being sure whether the cells of the vesicle were ectoderm or endoderm, but finally came to the conclusion that the deeply-stained layer between the vesicle and the endoderm had some connection with the sense-organ and regarded the whole sense-organ as endodermal. As the sections showed that the preservation was not suitable for histological work (the specimens were preserved in formalin), I did not attempt to trace the development of the sense-organ.

After reading GOTO's description of the development of the sense-organ of *Olindioides*, I again examined the sections of *Aglauropsis*. I am now inclined towards the view that the vesicle is ectodermal, and that it is cut off from the endoderm by mesoglœa, but before coming to a definite conclusion I should like to see earlier stages in development.

FAMILY: GERYONIIDÆ, ESCHSCHOLTZ, 1829; ex MAAS, 1893.

Trachomedusæ, with four or six radial canals, in the course of which are situated leaf-shaped gonads. Blind centripetal canals. Stomach on a long peduncle. Internal sensory vesicles.

Liriope, Lesson, 1843 ; ex Maas, 1893.

Geryoniidæ, with four radial canals and with four or eight tentacles.

Liriope tetraphylla (Chamisso et Eysenhardt), 1820.

Geryonia tetraphylla, Chamisso et Eysenhardt (1820, p. 357, plate xxvii.).
Liriantha tetraphylla, Haeckel (1879).
Liriope tetraphylla, Vanhöffen (1902, p. 82, taf. x.); Browne (1904, p. 738, pl. liv., fig. 3).

The collection contains 19 specimens; only a few are in fairly good condition There are a few early and intermediate stages, but their condition is not satisfactory for a description. The largest specimens are similar to a figure given by Vanhöffen.

When I wrote the 'Report on the Hydromedusæ of the Maldive Islands' I was not quite certain about the correctness of the identification of a *Liriope* which I called *L. tetraphylla* (1904, plate liv.). I have again examined this specimen (there was only one in that collection) and have come to the conclusion that it must be regarded as *Liriope tetraphylla.* I have failed to find a character by which it could be specifically separated from those in the collection from Ceylon.

Notes on the Largest Specimens.—The shape of the umbrella is similar to that in the figure given by Vanhöffen, and is not so thick or so rounded as in that figured by me in the Maldive Report. The peduncle of the stomach is long and tapering; its length in the largest specimen is about 13 millims. Along the peduncle run four interradial, longitudinal muscle bands, which bifurcate at the base of the peduncle and the two ends curve outwards. The stomach is large and sac-shaped. The gonads vary very slightly in shape. They resemble Vanhöffen's figure, and measure 7 millims. in width and 5 millims. in length. The space between the gonads (measured from the upper margins) is about 2 millims. The radial canals are fairly broad, and that part of the canal between the gonad and the circular canal is much broader than as figured by Vanhöffen and myself. Most of the specimens have three centripetal canals in each quadrant. They are broader and less tapering than those shown in the figures mentioned above. One of the specimens has only one or two centripetal canals in each quadrant. A few of the specimens have eight tentacles, but the majority have only the four perradial tentacles.

Size :—The largest specimen measures 15 millims. in width and 7 millims. in height.

Locality :—Cheval Paar, off Mutwal Island and Chilaw Paar, various dates in March and November; Galle Bay, in June and July.

Distribution :—Atlantic and Indian Oceans.

Order : NARCOMEDUSÆ.

Family : ÆGINIDÆ, Gegenbaur, 1856 ; ex Maas, 1904.

Solmundella, Haeckel, 1879 ; ex Maas, 1904.

Æginidæ with two tentacles and with a stomach having eight pouches.

Solmundella bitentaculata (Quoy et Gaimard), 1833—Plate IV., figs. 1 to 6.

Charybdea bitentaculata, Quoy et Gaimard (1833, tome v., p. 295, plate xxv., figs. 4 and 5).
Æginella bitentaculata, Haeckel (1879).
Solmundella bitentaculata, Browne (1904, p. 741, plate lvi., fig. 3).

Description of the Adult.—Umbrella cone-shaped, usually a little broader than high. Stomach circular and flat, nearly as wide as the umbrella, having eight lateral pouches which are rectangular in shape and about twice as broad as high. Mouth circular, with an everted rim. Gonads on the inner wall of the pouches and also extending over the outer half of the lower wall of the stomach, forming a continuous band. Two opposite tentacles, which are situated above the stomach, and are about two to three times longer than the diameter of the umbrella. Peronial bands and grooves present. Sense-organs 24, perhaps more, usually three in each octant.

Size :—Umbrella up to 9 millims. in height and width.

Locality :—Galle, in February and August ; Modragam Paar and Cheval Paar, in November ; and Trincomalee.

Distribution :—Australasian seas ; Amboina Island (Quoy et Gaimard). Singapore (Bedford ; in Coll. E.T.B.). Indian Ocean ; Maldive Islands (Bigelow, 1904, p. 261, under the name of *Æginella dissonema* ; and Browne).

Notes.—The collection contains 39 specimens ; only a few are in good condition, and most of them are about 3 millims. to 5 millims. in diameter.

The umbrella is cone-shaped and nearly as high as broad. There is a slight variation in its shape, as the apex is more rounded in some specimens than in others. All the specimens have the apex of the umbrella more or less battered down so that it is impossible to note its exact shape, but it is not so pointed as that shown in the figure given by Quoy and Gaimard. The peronial groove below each tentacle is very deep, and goes right back to the wall of the sub-umbrella. The stomach is circular and flat and has eight lateral pouches. The upper wall of the stomach is either flat or slightly convex. The lower wall is also flat, with a circular mouth in the centre. The mouth, when fully expanded, is almost as wide as the diameter of the stomach. Its natural size is apparently about one-third to one-quarter the diameter of the stomach, but when closed the opening is very small. The margin of the mouth has an everted rim, and it does not usually hang down so low as in the specimen figured by me in the Maldive Report.

Haeckel, in his description of *Æginella dissonema*, and also Mayer (1900, p. 66, plate xiv.) state that there are four double perradial canals, each canal being divided into two by a longitudinal septum (called by Haeckel the peronium). The appearance of a double radial canal was seen in the two Maldive specimens, and also very plainly in some of the specimens in this collection, especially when the umbrella had been lightly stained. Transverse sections, however, do not confirm the presence of radial canals, and, after cutting several complete series, I have come to the conclusion that they are a delusion.

Description of the Peronia.—It is in the perradii, without the tentacles, that the appearance of a double canal is best seen, and transverse section in this position shows the "septum" but no canals (fig. 1).

In the two perradii, which have the tentacles, there is a longitudinal groove, the peronial groove, running from the margin of the umbrella up to the tentacle. This groove is very deep, running back to the wall of the sub-umbrella, cutting the wall of the sub-umbrella nearly in two (fig. 2). At the bottom of this groove is the peronial band (figs. 2 and 6), which runs from the margin of the umbrella to the base of the tentacle. The peronial band is a solid cord of ectoderm cells, nearly circular in transverse section, and surrounded by mesoglœa, except on the side facing the peronial groove. In the lower wall of the stomach there are two little funnel-shaped pockets, one under the root of each tentacle. Sections show that the ectoderm of the lower wall of the stomach, at the apex of the pocket, unites with the peronial band, and is continuous with the ectoderm of the tentacle. In the ectoderm of the tentacles there are large round nematocysts. These nematocysts form a conspicuous band along the under or lower side of the tentacle near its base (fig. 6) and then, a little further along, spread all round the tentacle. I have found similar nematocysts in the ectoderm of the pockets in the lower wall of the stomach and scattered among the generative cells (fig. 2) adjacent to the pockets. They are also in the strand of ectoderm between the apex of the pocket and the tentacle, but not in the peronial band, which is between this point and the margin of the umbrella. It seems to me that the nematocysts develop in the lower wall of the stomach in the neighbourhood of the pockets, then migrate into the ectoderm of the pocket and pass along the strand to the ectoderm of the tentacle.

The "septum" in the perradii, without tentacles, has the same structure as the peronial bands connected with the tentacles, but there is no peronial groove and the band ("septum") is completely surrounded with mesoglœa. It starts from the margin of the umbrella, runs up the side of the wall of the sub-umbrella, and at the level of the lower wall of the stomach it curves outwards and passes through the jelly to the ex-umbrella. In its passage through the jelly it tapers out almost to a point, and in some specimens stops a little way short of the ex-umbrella. Its presence marks the former existence of a tentacle, and shows that *Solmundella* is descended from a medusa which had four perradial tentacles.

The appearance of radial canals on each side of a "septum" is, in my opinion, due to the transparent mesoglœa in the short interval between the gastric pouches.

Sections across the margin of the umbrella do not show the existence of a definite circular canal.

Gonads.—Some of the specimens have the gonads confined to the inner wall of the gastric pouches, where they lie in the ectoderm (figs. 1 and 2). The gonads may extend over the lower half of each gastric pouch or over the whole pouch. Some of the large specimens have the gonads not only over the gastric pouches but also over a part of the lower wall of the stomach, forming a continuous ring round the lower wall of the stomach just like the genital ring of a Solmaris. One specimen has the outer half of the lower wall of the stomach covered with ova, which are large and clearly visible ; other specimens have only one quarter or one third of the wall of the stomach occupied with gonads. It appears from the specimens that the gonads first start developing at the bottom of the pouches, and then spread upwards and finally reach the lower wall of the stomach. The smallest specimens have the gonads confined to the pouches, but it is only in the largest specimens that the gonads are on the wall of the stomach.

Tentacles.—My figure of *Solmundella* in the Maldive Report shows that the base or root of the tentacles is curved outwards towards the ex-umbrella. This I now find is not the normal position, but the position occasionally taken when a specimen is in a contracted condition. As a rule the root of the tentacle points towards the centre of the umbrella (fig. 6), and in specimens which do not show signs of contraction it is sometimes clear of the upper wall of the stomach and the curve is scarcely visible. The tentacles have numerous internal transverse septa (fig. 5) which are connected in the centre by an elongated endoderm cell, containing usually two nuclei. The lower part of the tentacle (fig. 4) is somewhat triangular in shape ; along this portion there is a longitudinal muscle band.

Sense-organs.—The smaller specimens have two sense-organs and the largest ones three and perhaps more in each octant. In certain octants I have seen extra bulbs without sense-organs, and these may be the bases of sense-organs which have lost the otolithic part through injury.

A few of the specimens are infested with a Cercaria.

SIPHONOPHORA.

Order : CALYCOPHORÆ, Leuckart.

Family : DIPHYIDÆ, Eschscholtz, 1829.

Diphyes, Cuvier, 1817.

Diphyes chamissonis, Huxley, 1859.

Diphyes chamissonis, Huxley (1859, p. 36, pl. i., fig. 3) ; Browne (1904, p. 742, pl. liv., fig. 6).

The collection contains eleven anterior nectophores, some of which are in very good condition. The specimens are similar to those which were described and figured by me in the 'Report on the Hydromedusæ of the Maldive Islands.'

One specimen is from Galle, in July, but all the rest were from the Gulf of Manaar, mostly in February and March.

The nectophores measure about 8 millims. to 11 millims. in length. The somatocyst shows considerable variation in length and thickness. Some of the specimens have the somatocyst similar in shape and size to that shown in my figure of the species, whereas in other specimens it is longer (the length varies from 2 millims. to $3\frac{1}{2}$ millims.) and much thinner. The length of the hydrœcium is also variable, about one-third to half the length of the umbrella.

ORDER: PHYSOPHORÆ, ESCHSCHOLTZ, 1829.

FAMILY: AGALMIDÆ, BRANDT, 1835.

Cupulita, QUOY et GAIMARD, 1824.

There is one small specimen of a *Cupulita*, from the Cheval Paar, which is very much broken up. I am unable to determine the species.

Agalmopsis, SARS, 1846.

There are two small specimens, from the Cheval Paar, both of which are badly contracted and broken. The nectophores have all disappeared with the exception of a few minute buds, and only one damaged bract remains. The tricornuate tentilla are large and in excellent condition.

FAMILY: PHYSALIIDÆ, BRANDT, 1835.

Physalia, LAMARCK, 1801.

Physalia utriculus, ESCHSCHOLTZ, 1829.

Physalia utriculus, HUXLEY (1859, p. 101, pl. x., pl. xii., fig. 12); BROWNE (1904, p. 744).

Two small specimens were caught off Watering Point, Galle. The float is about 15 millims. in length. There is one main tentacle and several very small secondary tentacles. The gonophores are beginning to develop.

FAMILY: PORPITIDÆ, BRANDT, 1835.

Porpita, LAMARCK, 1801.

Porpita is represented by the remains of a single float, obtained on the Pearl Banks, Gulf of Manaar, and measuring about 35 millims. in diameter. The upper surface of the float has numerous radial rows of stigmata on the back of prominent ridges. It resembles the float of *Porpita umbella*, which is figured by HAECKEL (1888, plate xlv., fig. 5).

SCYPHOMEDUSÆ.

CHARYBDEIDA.

Charybdea, Péron et Lesueur, 1809.

Charybdea, sp. ?

There is a single specimen in the collection from the pearl banks, and it is not in a first rate condition. The umbrella has become soft and limp, consequently it has collapsed and lost its natural shape. The umbrella measures about 75 millims. in length, and is probably cone-shaped. The stomach is very short and flat; the mouth has small lips. The gastric filaments appear to be perradial in position (the top of the umbrella is damaged and crushed in). Each of the four groups is composed of about six tufts of filaments packed so close together as to form a continuous row. The sense-organs are about 10 millims. away from the margin of the umbrella. There are four ocelli on the inner side of each tentaculocyst. The principal ocellus is very large and semi-globular in shape. Above it, a little nearer the base of the tentaculocyst, is a transverse ocellus, forming a narrow pigmented band. The other two ocelli are more lateral in position, and situated between the semi-globular and the transverse ocelli. The ocelli are of a reddish brown colour in formalin. The velarium contains seven unbranched canals between every two tentacles. The gonads form very narrow bands, and appear to be quite immature. The pedalia are about 20 millims. in length and 15 millims. in width. The shape of their wings and the tentacle resemble the figure of *Charybdea grandis* (Agassiz and Mayer, 1902, plate vi.).

This may be an immature specimen of *Charybdea grandis*, but I remain uncertain. A second specimen would have been an advantage for comparison.

CORONATA.

Family: NAUSITHOIDÆ, Haeckel, 1879; ex Vanhöffen, 1902.

Nausithoe, Kölliker, 1853.

Nausithoe punctata, Kölliker, 1853.

Nausithoe punctata, Vanhöffen, 1892, p. 13, Taf. iii., figs. 8 and 9; Mayer, 1900, p. 67, plate xxiii., figs. 67 and 68, plate xxvi., figs. 87 and 88; Vanhöffen, 1902, p. 29; Bigelow, 1904, p. 263, plate vi., fig. 21.

Description.—The umbrella is somewhat hemispherical in shape. At the top of the umbrella there is a distinct hemispherical crown which is separated off from the rest of the umbrella by a conspicuous circular furrow. Just below the circular furrow the radial furrows begin. There are 16 deep radial furrows on the ex-umbrella, one midway between every tentacle and sense organ, terminating at the base of the marginal lobes. The bottom of each furrow is attached to the wall of the sub-umbrella by a septum which divides the distal portion of the stomach into 16 pouches (8 ocular and 8 tentacular). The septum is continued for a little way down the middle of each marginal lobe, separating the prolongation of the stomach in each lobe into two parts. But as the septum does not proceed along the whole length of the gastric prolongation, two completely isolated pouches are not formed. The whole of the ex-umbrella, including the marginal lobes, is closely granulated.

The gastric filaments are arranged in four distinct groups, which are isolated from each other by the four basal angles of the cross-shaped mouth. There are about 10 to 12 filaments in each group arranged in a single row. Each group occupies the whole space between the angles of the mouth.

The mouth is large and cross-shaped, about 3 millims. in length and width.

The gonads vary in shape, and, looked at from the sub-umbrella, appear circular or oval. The largest are about 1 millim. in length and 0·75 millim. in width. Three specimens in one bottle have rose-red gonads, and two in another bottle are of an orange colour. All the specimens are in formalin. One is a male and four are females with large ova.

There are 16 marginal lobes, which are about as broad as long (2 millims.), and have a rounded edge. Between these lobes are the eight tentacles and eight sense-organs, which alternate with each other. The tentacles are of moderate length (about 5 millims.), stiff, and taper to a fine point. The sense-organs have an otolithic sac and a circular reddish pigmented ocellus.

The collection contains five specimens, three of which are in splendid condition. Two were from off Mutwal Island on March 19, and three from Muttuvaratu Paar on March 29. The largest measures 9 millims. in width and 7 millims. in height. Two specimens are 9 millims. in width and 5 millims. in height. The others are slightly smaller.

I have compared these specimens with *Nausithoe punctata* obtained from the Zoological Laboratory at Naples, and feel certain that they belong to this species; in fact, they agree in every detail except in the shape of the ocellus. The Naples specimens have a circular pigmented ocellus on a semi-circular or convex bulb, whereas in the Ceylon specimens the ocellus forms a pigmented ring on a bulb with a flat surface.

The results obtained by the "Valdivia" and "Siboga" Expeditions show that *Nausithoe punctata* has a very wide geographical distribution. It occurs in all the oceans. It was taken by the "Valdivia" off the east coast of Ceylon, and by BIGELOW at the Maldives.

DISCOPHORA.

SEMÆOSTOMATA.

Pelagia.

Pelagia, sp. ?

There are nine very young stages, the smallest 4 millims. in diameter and the largest 8 millims. They have eight tentacles and eight sense-organs. These specimens are too immature for me to identify, as they have not long passed through the Ephyra stage. They are all from the Cheval Paar, Gulf of Manaar.

RHIZOSTOMATA.

Family: LYCHNORHIZIDÆ, Maas, 1903.

Crambessa.

Crambessa, sp. ?

The collection contains two specimens, both from Galle Bay, June and August; one is in fairly good condition and the other is damaged.

Umbrella.—The umbrella is semi-globular, about twice as broad as high, and measures about 75 millims. in width and about 40 millims. in height. The ex-umbrella looks smooth, but a close examination with a lens shows that the surface is closely covered with very minute papillæ, which give it a granulated appearance. The ex-umbrella of one specimen has fine markings which look like a pattern produced by pressure against a tow-net. The pattern forms a network with a mesh of about half a millimetre.

Canal System.—There are eight ocular canals and eight adradial canals. The ocular canals run to the sense-organs, but the adradial canals stop at the circular canal and do not proceed to the margin. The circular canal, which is broad and conspicuous, is situated about 10 millims. from the margin of the umbrella. Between the circular canal and the margin of the umbrella the canal system forms a network of fine meshes. The ocular canals pass through this network and anastomose with it. On the inner side of the circular canal and between the radial canals there is a very coarse network of canals. This network is in communication with the circular canal, but not with the stomach. In one specimen there is a slight anastomosis of the inner network with some of the radial canals, but in the other specimen there is no union.

Margin of the Umbrella.—Some of the velar lobes are about as long as broad, somewhat quadrangular in shape, with rounded corners, and some are narrow and more pointed. There are about eight velar lobes between every two ocular lobes.

Sense-organs.—Eight sense-organs are present. The outer sensory pit is triangular in outline and its surface is folded. The principal folds radiate outwards from the bottom of the pit. The tentaculocyst is apparently without an ocellus, as there is no trace of any pigment. The ocular lobes are much smaller than the velar lobes, and are pointed.

Sub-umbrella Muscles.—In one specimen the sub-umbrella muscles have become detached and a clear view of the canal system is obtained. In the other specimen the muscles are present, and they form a circular band between the periphery of the oral disc and the margin of the umbrella. The circular muscle band is continuous and is not radially interrupted.

Sub-genital Cavity.—The four sub-genital ostia open into a common continuous cavity. The ostia are very large, forming long but narrow slits, about 20 millims. in width, and about as wide as the columns. The entrance is partly blocked in the centre by a large triangular gelatinous knob on the sub-umbrella, and just inside there is another median knob and also two small lateral ones.

Oral Arms.—In a normal specimen there should be eight oral arms of equal length, but in both of these specimens the oral arms are abnormal in number and in length. One specimen has ten oral arms, the four columns bearing respectively 2.2.3.3. arms. The arms show a great difference in size, the largest is about 80 millims., and the smallest about 25 millims. As one arm is much longer than the others, which are all of different lengths, it is probable that the medusa received an injury in the oral arms, and regeneration has followed. The upper arm is very short and is somewhat laterally compressed. In the arm, measuring 80 millims. in length, the upper arm is about 15 millims. and the lower arm about 65 millims. The lower arm has three thin wings bearing oral mouths along the outer edges down to the distal end, which does not bear a gelatinous knob. The oral mouths on the ventral wings are continued along the upper arms to the oral disc, where they meet and form a cross-shaped pattern. There are no special appendages of any kind upon the arms or the oral disc. In the second specimen the arms are broken off close to the arm disc and there are stumps of nine, possibly ten, arms.

Stomach.—The stomach is cross-shaped. The gastric filaments run round the margin of the stomach and also curve downwards and inwards, forming a loop in the base of the columns. It is at the end of the loop that the canal from the oral arm enters the stomach.

The gonads are immature.

The specimens are of a whitish colour in formalin.

So far as I can make out, these specimens belong to the genus *Crambessa*, but I am not able to determine the species. As they are immature they are probably at an intermediate stage in growth and may develop into a species which has already been described.

CTENOPHORA.

ORDER: CYDIPPIDEA, LESSON.

FAMILY: PLEUROBRACHIIDÆ, CHUN, 1880.

Pleurobrachia, FLEMING, 1822.

Pleurobrachia globosa, MOSER, var. **ceylonensis**, nov.

Pleurobrachia globosa, MOSER (1903, p. 7, taf. i., figs. 1–4).

The collection contains about 900 specimens, varying in size from about 2 millims. up to 8 millims. in length. The largest specimen measures 8 millims. in length and 7 millims. in width.

A few are preserved in formalin and these have been used for examination, as they have retained their shape better than those in alcohol. The specimens in alcohol suffer more or less from contraction and shrinkage. When contraction or shrinkage is considerable, the position of the various organs changes so much that it would be quite possible to make two or more species out of a hundred specimens.

Locality :—A few were obtained on the Cheval Paar in March and Modragam Paar in November; the great majority were from Galle Bay in June, July and August.

Description.—The body is egg-shaped, sloping towards the oral pole, and almost circular in a transverse section. There are eight rows (costæ) of ciliated plates, of moderate length, extending over half, or a little more than half, of the meridional surface, beginning and terminating at about equal distances from the aboral and oral poles respectively. Each row contains about twenty narrow ciliated plates (combs). The meridional canals are just as long as the costæ. The two tentacles and their sheaths lie above the level of the stomach. The base of the sheath is in the first fork of the gastrovascular canals, on a level with the funnel. The sheath is like a long cone, tapering from the base, and lying at an angle of about 45 degrees from the perpendicular axis of the body and pointing towards the aboral end of the body. The opening of the sheath on the surface of the body is just under the aboral boundary line of the costæ. At the bottom of the sheath is the base of the tentacle, which is somewhat concave. The tentacles have lateral filaments, but no eolidiform appendages were seen. The transverse canals from the funnel to the meridional canals slope slightly in the aboral direction and join the meridional canals in the middle of their length, slightly above the level of the funnel. The base of the tentacle lies a little way from the funnel, but in a large number of specimens, owing to contraction or shrinkage, the base of the tentacle is adjacent to the funnel. It has contracted back on to the funnel and the top of the stomach.

On comparing the specimens with the figures of *Pleurobrachia globosa* (MOSER, 1903, taf. i., figs. 1–3), I find that they differ mainly in the length of the costæ, which are about half as long again. There is a slight difference in the shape of the body, the specimens from Ceylon taper more towards the oral pole. The position of the tentacular sheath is identical and so also is its sheath opening. As the chief difference lies in the length of the costæ, I hesitate to add a new species to the genus, but prefer to mark the difference by establishing a new variety.

The "Siboga" specimens were obtained in the Malay Archipelago.

ORDER: BEROIDEA, LESSON.

FAMILY: BEROIDÆ, ESCHSCHOLTZ, 1829.

Beroe, P. BROWNE, 1756.

Beroe flemingi (ESCHSCHOLTZ), 1829.

Pandora flemingii, ESCHSCHOLTZ (1829, p. 39, taf. ii., fig. 7).
Beroe pandora, MOSER (1903, p. 23, taf. ii., figs. 8 and 9; taf. iii., figs. 9 and 10).

There are about a dozen specimens in the collection, four of which are in fair condition and the others in fragments.

Description.—The body is conical, compressed in the funnel (transverse) plane, a little longer than wide, and rounded at the aboral end. The mouth is wide and has a fairly thin margin. The costæ are of unequal length; the sub-transversal costæ are about twice or nearly twice as long as the sub-ventral costæ. The meridional canals do not unite with the stomodæal canals. The lateral canals of the meridional canals meander without uniting in the smaller specimens, while in the larger specimens they unite with those from the adjacent meridional canals, forming a coarse irregular network in the outer wall of the body. Short blind canals also proceed from the circular canal around the mouth. The meridional canals on their outer surface are sparsely sprinkled with minute reddish-brown spots of pigment. The gonads are along the walls of the meridional canals, male and female on opposite sides of the canals.

Size:—8 millims. long and 6 millims. wide, 10 millims. long and 10 millims. wide, 12 millims. long and 8 millims. wide. Larger specimens broken into fragments.

Locality:—Off Mutwal Island, March 19, twelve specimens; Galle Bay, July 15, one specimen.

Distribution:—N. Pacific, east of Japan. Malay Archipelago.

Miss MOSER, in her 'Report on the Ctenophora of the "Siboga" Expedition,' has revised the Pleurobrachiidæ and Beroidæ, and has given a useful key for the identification of the species. I have tried to identify these specimens with the aid of the key, but remain somewhat doubtful about the result. The difficulty of the identification is no doubt increased by my want of experience in the group and by the fact that the best specimens are early stages. Taking the unequal length of the costæ and the absence of cilia round the mouth as a guide, the specimens come nearest to *Beroe flemingii.* They do not, however, quite agree in shape, and the lateral canals from the meridional canals do not communicate with the stomodæal canals. Miss MOSER states that the Siboga specimens are identical with *Pandora flemingii* of ESCHSCHOLTZ. This species ESCHSCHOLTZ named after the English zoologist JOHN FLEMING. Miss MOSER, however, has changed the specific name to *pandora,* wishing to retain the generic name *Pandora* as a specific name in honour of ESCHSCHOLTZ. The changing of the specific name of this species is certainly contrary to the International Rules on Nomenclature, and consequently the specific name *pandora* is invalid.

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DESCRIPTION OF PLATES.

All the figures were drawn from specimens in formalin or alcohol; all sense-organs and sections were drawn with a camera lucida.

REFERENCE LETTERS.

A.	Adhesive disc.	*Or.*	Oral lip.
B.	Basal bulb.	*P.*	Peronium.
CC.	Circular canal.	*PG.*	Peronial groove.
Ec.	Ectoderm	*R.*	Radial canal.
En.	Endoderm.	*S.*	Sense-organ.
Ex.	Ex-umbrella.	*Sm.*	Septum.
G.	Gonad.	*St.*	Stomach.
M.	Mesoglœa.	*Stp.*	Stomach (gastric) pouch.
N.	Nematocyst.	*Sub.*	Sub-umbrella.
Oc.	Ocellus.	*T.*	Tentacle.
Ov.	Ovum.	*V.*	Velum.

PLATE I.

Fig. 1. *Cytæis herdmani*, n. sp. (p. 135). Lateral view. × 30.
,, 2. *Æquorea conica*, n. sp. (p. 145). Lateral view. × 10.
,, 3. *Mitrocomium assimile*, n. sp. (p. 137). Lateral view. × 20.
,, 4. *Irenopsis hexanemalis*, GOETTE (p. 142). Lateral view. × 10.
,, 5. *Laodice indica*, n. sp. (p. 136). Oral view. × 15.
,, 6. *Gonionemus hornelli*, n. sp. (p. 149). Lateral view. × 10.

PLATE II.

Fig. 1. Tentacle of *Dipurena* sp. ? (p. 133). Lateral view. × 35.
,, 2. Manubrium of *Dipurena*, showing the gonads and stomach. (Slightly contracted.) × 20.
,, 3. Tentacle of *Proboscidactyla minima*, n. sp. (p. 136). Inner view. × 60.
,, 4. Tentacle of *Gonionemus hornelli*, n. sp., showing the position of the adhesive disc (*A.*) Outer view. Enlarged.
,, 5. *Æquorea parva*, n. sp. (p. 146). Oral view. × 10.
,, 6. Portion of the sub-umbrella of *Æquorea parva*, showing the oral lips (*Or.*), the lower wall of the stomach (*St.*), the gonad (*G.*), and a tentacle. × 20.
,, 7. Sense-organ of *Æquorea parva*. Optical section. × 400.
,, 8. *Octocanna polynema* (Haeckel) (p. 144). Oral view. × 5.
,, 9. Tentacle of *Octocanna polynema*, and also marginal bulbs and sense-organs. Outer view. × 40.
,, 10. Sense-organ of *Octocanna polynema*. Optical section. × 400.
Figs. 11 to 15. *Mesonema pensile*, Modeer (p. 147).
Fig. 11. Sense-organ. Optical section. × 400.
,, 12. Tentacle and marginal bulbs. Outer view. × 10.
,, 13. Clusters of nematocysts on the tentacle. × 80.
,, 14. Portion of the stomach and sub-umbrella, showing the oral lips (*Or.*), the lower wall of the stomach (*St.*), the radial canals (*R.*) and gonads (*G.*).
R′ and *R″* are radial canals at an early-stage development. × 5.
,, 15. Marginal bulbs and sense-organs. × 16.
,, 16. Portion of the sub-umbrella of *Æquorea conica*, showing the oral lips (*Or.*), the lower wall of the stomach (*St.*), the gonads (*G.*) and tentacles. × 10.
,, 17. Gonad (female) of *Æquorea conica*. Lateral view. × 15.
,, 18 Sense-organ of *Æquorea conica*. Optical section. × 400.

PLATE III.

Fig. 1. Manubrium of *Eutima curva*, n. sp. (p. 138), showing the peduncle with gonads and stomach. × 9.
,, 2. Portion of the margin of the umbrella of *Eutima curva*, showing the basal bulb of a tentacle, the marginal bulbs and cirri. Outer view. × 50.
,, 3. Sense-organ, marginal bulbs and cirri of *Eutima curva*. Oral view. × 100.
,, 4. Manubrium of *Octorchis orientalis*, n. sp. (p. 139), showing the peduncle with gonads and stomach. × 10.
Figs. 5 to 8. *Irenopsis hexanemalis.*
Fig. 5. Tentacles and marginal bulbs, showing the excretory papillæ fully expanded. Outer view. × 30.
,, 6. Tentacles, marginal bulbs, and sense-organs (papillæ contracted). × 30.
,, 7. Sense-organ. Optical section. × 400.
,, 8. The stomach and its peduncle. Lateral view. × 10.
,, 9. *Irene ceylonensis*, n. sp. (p. 140). Oral view of the umbrella, showing the stomach and its peduncle, the position of the gonads, and the tentacles in one quadrant of the umbrella. × 3.
,, 10. Sense-organ of *Irene ceylonensis*. Optical section. × 400.
,, 11. Tentacles and sense-organs of *Irene ceylonensis*. Outer view. × 30.
,, 12. *Irene palkensis*, n. sp. (p. 141). Oral view of the umbrella, showing the stomach and its peduncle, the position of the gonads, and the tentacles in one quadrant of the umbrella. × 4.
,, 13. Tentacles, marginal bulbs, and sense-organs of *Irene palkensis*. × 40.
Figs. 14 to 16. Sense organs of *Irene palkensis*. × 400.

PLATE IV.

Figs. 1 to 6. *Solmundella bitentaculata.*

Fig 1. Transverse section of the peronium (*P.*) in the radius without tentacles, also showing the gastric pouches (*Stp.*) and the gonads (*G.*). × 260.

„ 2. Transverse section of the peronium (*P.*) in the radius with tentacles, showing the peronial groove (*P.G.*) × 270.

„ 3. Transverse section across the gastric pouches (*Stp.*), showing the position of the peronium (*P.*) in the radius without tentacles. × 20.

„ 4. Transverse section of a tentacle not far from the base. × 100.

„ 5. Longitudinal section of a portion of a tentacle not far from the distal end. × 270.

„ 6. Sketch showing the peronium (*P.*) running from the margin of the umbrella to the tentacle. * Plane of section, fig. 2. ** Plane of section, fig. 4.

Figs. 7 to 11. *Laodice indica*, n. sp.

Fig. 7. Longitudinal section of a cordylus. × 350.

„ 8. Longitudinal section through the basal bulb of a tentacle. × 150.

„ 9. Tentacle, cirrus, and cordylus. Inner view. × 85.

„ 10. Transverse section of an ovary, showing the escape of an ovum. × 80.

„ 11. Terminal cluster of nematocysts of a cirrus. × 380.

„ 12. *Cytæis herdmani*, n. sp. Transverse section of a tentacle, showing the nematocysts in the ectoderm and the pigment granules in the endoderm. × 40.

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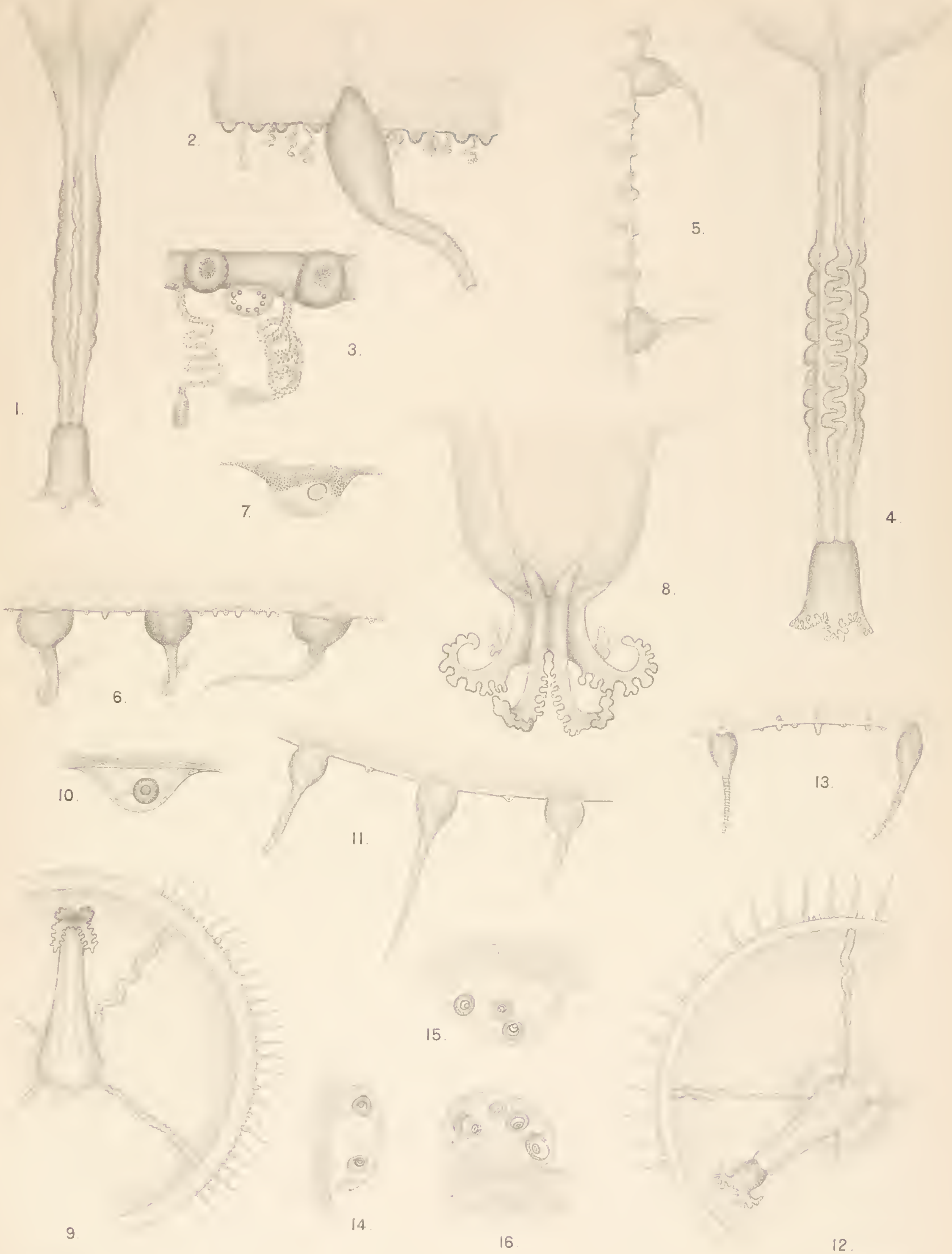
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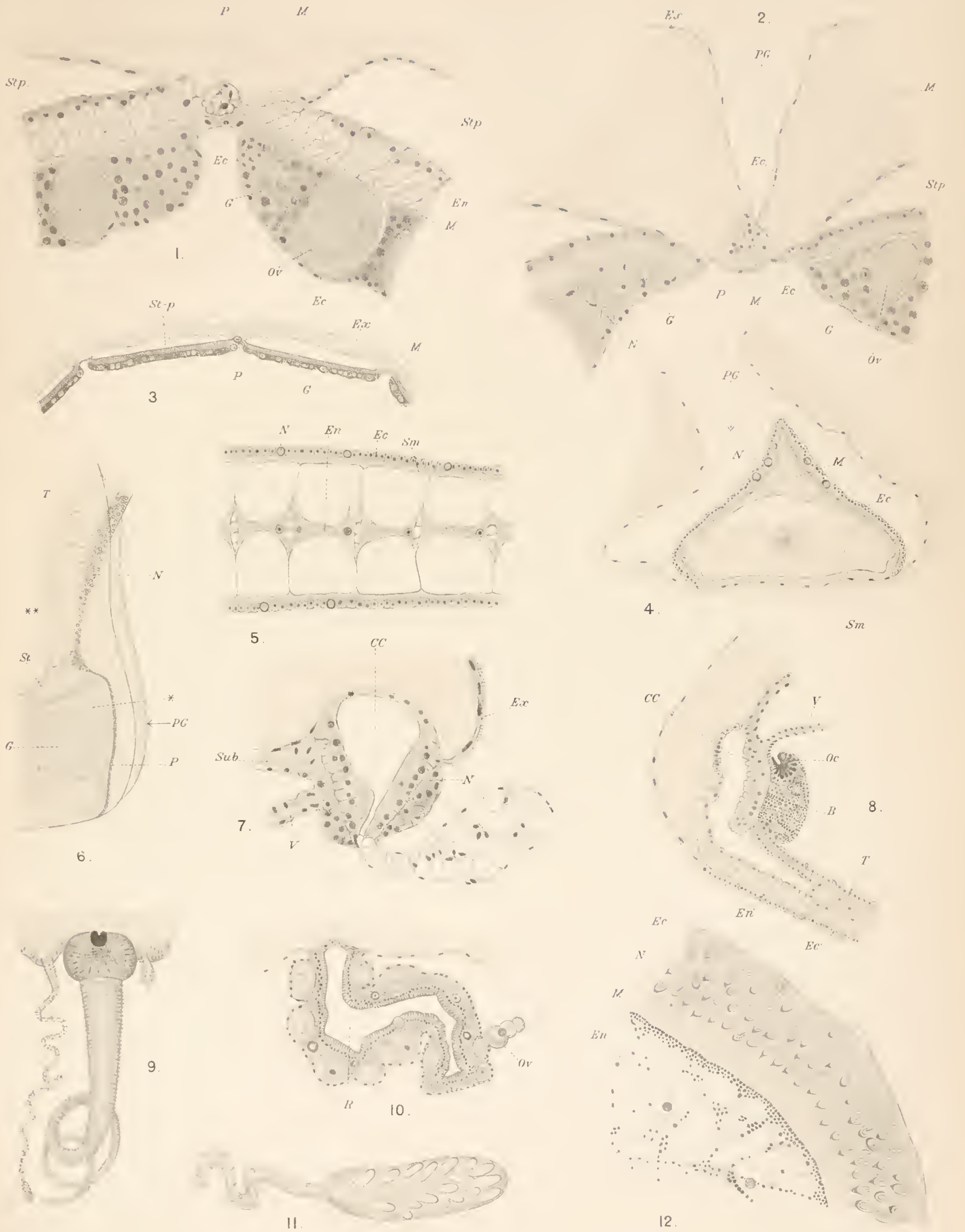
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APPENDIX TO THE REPORT

ON THE

ALCYONARIA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

PROFESSOR J. ARTHUR THOMSON, M.A., UNIVERSITY OF ABERDEEN.

[WITH ONE PLATE AND TWO TEXT-FIGURES.]

A REVISION of the collection of Ceylonese Alcyonarians has enabled me to add to the list given in Supplementary Report No. XX., by Mr. W. D. HENDERSON and myself.*

The additions are :—

Spongodes cervicornis, WRIGHT and STUDER.
,, *involuta*, KÜKENTHAL.
,, *pütteri*, KÜKENTHAL.
,, *microspiculata*, PÜTTER.
,, ,, var. *ceylonensis*, nov.
Chironephthya indica, n. sp.
Suberogorgia köllikeri, WRIGHT and STUDER, var. *ceylonensis*, nov.
,, *rubra*, n. sp.
Caligorgia versluysi, n. sp.
Bebryce indica, n. sp.
Acamptogorgia gracilis, n. sp.
,, *rubra*, n. sp.
Muricella rubra, n. sp.
Virgularia elegans, GRAY.
,, *calycina*, n. sp.
,, *indica*, n. sp.
Fusticularia herdmani, n. gen. et sp., SIMPSON.

One of these (*Caligorgia versluysi*) is hardly an addition, since it replaces *Primnoa ellisii*, VON KOCH (= *Caligorgia ellisii*, = *C. verticillata*). For this correction I have to thank Dr. J. VERSLUYS, Amsterdam. The last on the list, *Fusticularia herdmani*, represents an interesting new genus, which has been separately described by Mr. J. J. SIMPSON, M.A. ('Annals and Magazine of Natural History,' June, 1905).

* By an oversight the two species of *Xenia* (Part III., pp. 271, 273) were misplaced; they should come first in the order Alcyonacea. On p. 289, the title of the family Muriceidæ was omitted in front of *Acanthogorgia*.

Family: NEPHTHYIDÆ.

Spongodes cervicornis, Wright and Studer.

A much weathered specimen, expanded in one plane, 10·5 centims. in height, by 10 centims. in breadth, and 1·8 centims. in thickness. The general colour is yellowish-white, but the polyp stalks and the polyps are covered with orange-red spicules. The polyps themselves are white in colour, but there appear to be minute orange-red spicules on the tentacles.

The polyp stalk is about 2 millims. in length and is covered by longitudinally disposed spicules. At the base of the polyp, which stands at right angles to the Stützbündel, there is a double ring of transverse spicules, from which there arise eight converging triangles, each composed of two pairs of spicules, the basal pair converging at an obtuse angle.

As the colony is markedly flattened, with an irregular outline, with leaf-like lowermost branches, the specimen must be referred to Kükenthal's *cervicornis* group, and among those species in which the polyps have long stalks.

The specimen agrees, on the whole, with *Sp. cervicornis*, Wright and Studer, which seems to be a very variable species, including, according to Kükenthal, *Spongodes rhodosticta*, Wright and Studer.

Locality :—Ceylon seas.

Spongodes involuta, Kükenthal.

A beautiful divaricate colony, without the stalk, but otherwise almost complete. The general surface of the cœnenchyma is white, near the polyps the colour is strengthened by golden-yellow spicules; the spicules supporting the white polyps are deep rose-pink. The dimensions of height, maximum breadth and average thickness are 45, 40, and 12 millims. As the divaricate polyparium has no regular outline and is markedly flattened, the specimen is referable to Kükenthal's *cervicornis* group. As the polyps are borne on stalks 1·5 millims. to 2 millims. in length, the specimen must be included near *Sp. cervicornis*, Wright and Studer. The eight double rows of polyp spicules consist of five pairs of spindles, and thus our attention may be restricted to Kükenthal's *Dendronephthya involuta*.*

Our specimen agrees with this species in the following features :—(1) there are five pairs of polyp spicules in each double row; (2) one of the uppermost in each row projects above the polyp; (3) the polyp stalk is about 2 millims. in length.

Locality :—Ceylon seas.

Spongodes pütteri, Kükenthal.

A divaricate form, with a regular outline, a slightly flattened polyparium, and

* Kükenthal has referred all typical *Spongodes* species to his new genus *Dendronephthya*, but we see little advantage in this.

foliate lower branches, is referable to Kükenthal's *rigida* group, and closely approaches *Sp. pütteri.* Thus the polyparium is a slightly flattened cylinder; the lateral branches are almost cylindrical and sometimes dichotomous; the groups of polyps, usually seven in number, are borne by stalks about 2 millims. to 3 millims. in length; the polyps are supported by eight pairs of converging spicules, one of which projects farther than the others; the longest Stützbündel spicule exceeds 3 millims., is covered with minute thorns, and projects for a little over a millimetre. The spicules closely resemble those of *Sp. pütteri* in form and size, but are of a bright orange colour around the polyps and on the polyp stalks. It seems warrantable to regard this specimen as a colour variety of *Sp. pütteri.*

Locality:—Ceylon seas.

Spongodes microspiculata, Pütter.

This species is represented by a very beautiful small colony,—6·5 centims. in height and 5·5 centims. in maximum breadth. The stalk by which it is attached is 2·5 centims. long and 1·3 centims. in diameter. The lower branches are foliaceous, but above this there are three main branches, one central and two lateral, in length 3 centims., 2·5 centims., and 2 centims. respectively, with an average diameter of 0·8 centim. From these, smaller branches arise on all sides almost perpendicularly, the lateral ones being the longest, so that the whole colony presents a somewhat flattened appearance, the tips so arranged that the contour is regular. The general colour of the colony is orange-red.

The polyps are in clusters of five to eight, seven being the most typical number. They arise from tertiary branches, except on the lower foliaceous part, which is the expanded portion of primary branches. The polyps are almost globular, standing at right angles to a short stalk 1 millim. in length. The Stützbündel is fairly well developed, one long spindle projecting about 0·8 millim. beyond the insertion of the polyp. On the outside of the anthocodia the spicules have a very definite arrangement, consisting of eight double rows of 6 to 7 converging pale yellow spicules, the terminal pairs projecting a little beyond the anthocodia. Between these groups small colourless spindles are scattered irregularly. On the tentacles the spicules are arranged in a biserial manner, approximately at right angles to the long axis.

The spicules are warty spindles of very varied proportions, some long and slender, others short and thick. On the main stem they are of the second type, the following being typical measurements:—1·2 millims. × 0·5 millim.; 1·3 millims. × 0·4 millim.; 2 millims. × 0·4 millim. On the secondary branches they become more elongated and slender, and have a slight yellow tinge. Further up the colour becomes more marked and there is a distinct orange-coloured core. The following measurements were taken:—2·5 millims. × 0·1 millim.; 1·9 millims. × 0·1 millim. Scattered irregularly amongst these there are small elongated thin spindles of a bright red colour of the following sizes :—0·3 millim. × 0·02 millim. ; 0·35 millim. × 0·02 millim. The spicules of the polyps are very minute and are pale yellow or colourless, 0·15 millim. × 0·01 millim.

Locality :—Ceylon seas.

Spongodes microspiculata, var. **ceylonensis,** nov.

Another colony, 8·5 centims. high and 5 centims. broad, belongs to the same species, but as it differs markedly in general form and colour it seems advisable to record a distinct variety. The chief points of difference are :—

(1) It does not extend so markedly in one plane, one of the branches arising more or less at right angles to the plane of expansion ;

(2) The general contour is more rugged ;

(3) The colour approaches purple, even on the main branches, owing to the presence of faintly purplish spicules ;

(4) The spicules are arranged on the main stem and branches more transversely ;

(5) The spicules are long, slender, warty spindles, with a light purple tint in the older parts, becoming darker on the smaller branches which bear the polyps. Those of the polyps are transparent and colourless. Measurements :—On the main stem, 2·2 millims. × 0·2 millim. and 1·2 millims. × 0·2 millim. ; on the smaller branches, 1·4 millims. × 0·1 millim., 1·5 millims. × 0·1 millim. ; around the polyps, 0·6 millim. × 0·01 millim.

The architecture of the polyps is essentially the same as in the former specimen, so that this form must be classed in the species *microspiculata*, though the characters enumerated above justify its position as a new variety.

Locality :—Ceylon seas.

Family: SIPHONOGORGIIDÆ.

Chironephthya indica, n. sp.—Plate, figs. 1 and 14.

A specimen of a reddish-brown colour, consisting of two small branches, about 4 centims. in height and 4 millims. in thickness.

The polyps occur on all sides and a frequent interval is 1 millim. Each is about 0·5 millim. in diameter. The anthocodiæ are almost without exception nearly flush with the general surface of the branch.

The opercular covering consists of eight triangular portions or "points" converging over the tentacles, and at the bases of the triangles there are numerous (5) rows of horizontal spicules forming a circlet or "crown." Each triangular "point" consists of three diverging pairs of spicules arranged *en chevron*, the two outermost enclosing the others. The spicules of the "points" and of the "crown" are reddish-brown to orange-red in colour.

The whole cœnenchyma is covered with large rough spindles, mostly curved in a slightly **S**-shaped manner, some reddish-brown and others very light in colour. Similar internal spicules constitute the rigid substance of the branch around the longitudinal canals, of which four were seen in a cross-section. The knobbed tubercles often present a spiral arrangement.

The following measurements were taken in millimetres :—(*a*) Long stout spindles, 2·3 × 0·2, 2·5 × 0·175, 2·7 × 0·3 ; (*b*) slender smaller spindles, 1·1 × 0·03, 1·3 × 0·04, 1·5 × 0·025 ; (*c*) very small spindles, 0·2 × 0·025 ; (*d*) canal-wall spicules, uncoloured, with relatively long spines, 0·2 × 0·01, 0·16 × 0·01, 0·14 × 0·02, including the spines.

It seems difficult at present to distinguish between the genera *Chironephthya* and *Siphonogorgia*, if indeed they are not one. Hickson has suggested that the name *Chironephthya* be retained for species or facies with a form and mode of branching like *Nephthya*, with anthocodiæ rarely retracted, and with four principal spicules *en chevron* in the points of the anthocodiæ ; and that the name *Siphonogorgia* be retained for species or facies of more massive *Gorgonia*-like form of growth, with anthocodiæ capable of complete retraction within the general cœnenchyma, and with spicules irregularly placed or arranged in a fan-like manner in the points of the anthocodiæ ('Alcyonaria of the Maldives,' Part I., p. 491).

If we apply these distinctions to the present specimen, we find that it agrees with *Chironephthya* in having triangular opercular coverings, but disagrees in having almost all the anthocodiæ completely retracted, and in having, as far as we can judge, a more massive mode of growth. As the minute architecture of the polyps is probably the most distinctive feature, we have referred the specimen to *Chironephthya*.

Locality :—Ceylon seas.

Family : SCLEROGORGIIDÆ.

Suberogorgia köllikeri, Wright and Studer, var. **ceylonensis**, nov.

Several fragments, including a basal piece, of a yellowish colony or colonies with a sclerogorgic axis. The stem is 3 millims. in diameter at the base, and 1 millim. in the thinnest branch of the chief specimen. The greatest length is 8·5 centims.

Verrucæ may arise on all sides, but they are, for the most part, lateral. In the smaller fragments they are altogether lateral and regularly alternate. Their diameter is about 1 millim. Here and there the aperture shows an eight-rayed figure in the fully retracted state of the polyp.

The thin cœnenchyma is marked on opposite sides by two shallow winding grooves.

The spicules include the following forms :—(*a*) Numerous warty spindles, 0·175 millim. × 0·075 millim., 0·225 millim. × 0·075 millim ; (*b*) a few very slender spindles, 0·1 millim. × 0·02 millim.; (*c*) almost orbicular forms, 0·1 millim. × 0·1 millim.; and (*d*) small spindles (0·1 millim. × 0·03 millim.) on the aboral surface of the tentacles, forming in retraction an opercular covering with eight points.

This form closely approaches *S. köllikeri*, Wright and Studer, but there the verrucæ have a diameter of 2 millims. to 3 millims., the polyps are large and prominent, the verrucæ have eight-rayed margins, and the colour is yellowish-brown. But as the differences are hardly more than quantitative, we rank the Ceylonese specimens simply as a variety of the "Challenger" species.

Locality:—Ceylon seas.

Suberogorgia rubra, n. sp.—Plate, fig. 4.

Half-a-dozen fragments of a red colony, with a sclerogorgic very horny axis (1·5 millims. in diameter), with a nutrient canal on each side, with thin friable cœnenchyma, and with close-set, lateral, alternate verrucæ, about 1 millim. in diameter. The completely retractile polyps are white with a slight yellowish sheen, and are supported by groups of small colourless spicules. It is difficult to make out with certainty what the precise arrangement of these spicules is, but in two or three cases eight triangular groups were seen on the polyp wall. In the fully retracted state of the polyps the verruca appears as a rounded hillock beset with somewhat blunt spindles.

The spicules of the cœnenchyma are warty spindles of very varied dimensions. The following measurements were taken in millimetres:—(*a*) yellow spindles, 0·45 × 0·1, 0·3 × 0·1; (*b*) colourless spindles, 0·175 × 0·07, 0·2 × 0·08.

The colour when first examined was a bright red, but it has since become paler and shows a tint of orange. We note this change because it is unusual in Alcyonarians.

The fragments in question most closely approach *S. köllikeri*, Wright and Studer, var. *ceylonensis*, n., but the polyps are much more crowded and decidedly smaller, and both colour and spiculation are different. One of the fragments bore a very minute pearl oyster.

Locality:—Ceylon seas.

Family: PRIMNOIDÆ.

Caligorgia versluysi, n. sp.—Plate, figs. 6 and 15.

The beautiful form which we recorded (Part III., p. 289) as *Primnoa ellisii*, von Koch, appeared to us to agree with the description given by von Koch, and so up to a certain point it does. But Dr. J. Versluys has been good enough to point out to me that von Koch's description is not sufficiently minute to enable one to discriminate between *Primnoa* (or better *Caligorgia*) *ellisii* and other species which have since been defined off. Dr. Versluys was kind enough to examine the specimen from the Ceylonese collection and another from the Indian Museum collection (see Part III., p. 289). He regards them as representatives of two new species, distinct from von Koch's, and closely related to a new species (*C. similis*) which will be described in Versluys' memoir on the Primnoidæ of the "Siboga" Collection. In the "Siboga" material he found that the number and arrangement of the sclerites in the polyps afforded a constant and reliable basis for specific diagnosis.

We have therefore to withdraw the remarks we made on the geographical distribution of *Primnoa ellisii* (= *Caligorgia verticillata*), and we have to record from Ceylon the new species *Caligorgia versluysi*, the particular features of which are discussed in the following note which Dr. Versluys has generously supplied:—

Note by Dr. Versluys.

"I find that the Primnoid collected by Professor Herdman at Ceylon is not referable to *Primnoa ellisii*, von Koch. As it seems to me that von Koch was not justified in separating his species from *Caligorgia verticillata* (Pallas), I shall use the older name in comparing it with Herdman's species.*

The Ceylonese species is decidedly more delicate than *C. verticillata*, and the type of ramification is different. The more important differences are stated in the following table:—

1. Characters of Herdman's Species.	2. Characters of *Caligorgia verticillata*.
(*a*) The colony is dichotomously branched.	(*a*) The colony is pinnately branched.
(*b*) The polyps are arranged in whorls of 3 and occasionally of 2; no higher number was observed.	(*b*) On the thinnest twigs the polyps are arranged in whorls of 3, very rarely of 2; on the thicker branches the whorls mostly consist of 4 polyps.
(*c*) On a centimetre of the twigs about 8 whorls of polyps are found.	(*c*) On a centimetre there are only 5 or 6 whorls.
(*d*) The length of the contracted polyps is less than 0·75 millim.	(*d*) The length of the contracted polyps is 1 millim. to 1·25 millims.
(*e*) The distance between two successive whorls generally varies between 0·6 millim. and 0·75 millim.; sometimes, however, it rises up to 1 millim.	(*e*) This distance is 1 millim. to 1·5 millims.

Of the 8 longitudinal rows of scales, which formed the covering of the polyps in the typical primitive Primnoinæ, viz., a pair of adaxial, inner lateral, outer lateral and abaxial rows, only four rows, the abaxial and outer lateral pair, are well developed in both species. The inner lateral rows are each reduced to a single large distal

* Compare Versluys, 'Primnoidæ; "Siboga" Expeditie, Monograph XIII,' second part, which is in the press.

scale in Herdman's species, against two large distal scales in *C. verticillata.* The outer lateral rows are somewhat reduced in Herdman's species, as they number only 5 scales, against 7 (or 6 if the most basal scale is considered as belonging to the cœnenchyma) in *C. verticillata.* The abaxial rows in this last species consist of 9 scales each, all of nearly the same rounded form, and not extending over the sides of the polyps, which are entirely covered by the scales of the well-developed outer lateral rows. In Herdman's species the abaxial rows are formed by 10 or 11 scales of rather diverse form, as 2 or 3 are somewhat prolonged laterally over the sides of the polyps between the scales of the somewhat reduced outer lateral rows. The upper margin of the polyp scales in Herdman's species is not strongly toothed, but these teeth are well developed and more numerous in *C. verticillata.* In this last species the operculum forms a higher and, consequently, more pointed cone on the top of the polyp. The scales in the cœnenchyma are of the same type, polygonal scales with strongly toothed irregular borders, and with the outer surface covered with radiating and anastomosing prominences.

The species collected by Professor Herdman may also be easily distinguished from all the previously described dichotomously branched species of *Caligorgia*, viz., *C. ventilabrum*, *modesta* and *compressa.** It is more delicate, with smaller polyps, and none of these three species has so few polyps in each whorl, even on its thinnest twigs.

There are, however, two new species in the collection made by the "Siboga" Expedition in the Malay Archipelago, which in their habit, the dimensions of their polyps, and the small number of polyps in each whorl very closely resemble Herdman's species. They will be described in my paper on the Primnoidæ of the "Siboga" Expedition; in this note I can only point out the more important differences between these two species and Herdman's.

One of them, *C. minuta*, is easily distinguished by the much less numerous and proportionately much larger scales in its polyps. The abaxial rows consist of only 5 scales, of which the 4 proximal ones extend over the sides of the polyps, where they replace the outer lateral rows, of which only one large distal scale in the upper margin of the polyps is left.

The other new form, *C. similis*, is more closely allied to Herdman's species. But while its polyps are arranged in whorls of 3, very rarely 2, on the thinnest twigs, on the thicker branches the whorls number 4, perhaps even sometimes 5 polyps. On one centimetre length of the twigs the same number of whorls (8) is found. But the polyps are somewhat larger, measuring from 0·75 millim. to 0·8 millim. in length, sometimes even 1 millim., against 0·75 millim. or less in Herdman's species, and consequently the distance of the successive whorls is on an average somewhat less. The most important differences, however, are found in the polyps; they are shown in the following table:—

* *C. elegans*, Gray, is insufficiently described and a doubtful species.

1. Polyps of Herdman's Species.	2. Polyps of *Caligorgia similis.*
(*a*) The abaxial rows are formed by 10 (or 11) scales each.	(*a*) The abaxial rows are formed by 7 scales.
(*b*) The outer lateral rows are but little reduced, consisting of 5 scales each.	(*b*) Of the outer lateral rows only one large distal scale is left.
(*c*) When the polyps are seen from the side, the distal scale of the inner lateral row is clearly visible.	(*c*) No scale of the inner lateral row is visible when the polyps are seen from the side.
(*d*) The abaxial scales show no well-developed extensions over the sides of the polyps, though such an extension is clearly indicated in some of them.	(*d*) The 5 proximal abaxial scales are produced laterally and replace the missing outer lateral scales.
(*e*) The outer surface of the scales of the polyps is covered with prominences radiating from the nucleus and partly ending in teeth at the upper border of the scales.	(*e*) No prominences are developed; the teeth are few and feeble.

In both species the outer surface of the scales of the cœnenchyma is covered with anastomosing prominences, many of which end in a tooth at the border of the scales. These prominences give a typical appearance to the scales of the cœnenchyma; they are more strongly developed in Herdman's species than in *C. similis.* They are also found in some pinnately branched species of *Caligorgia*, for instance, *C. verticillata* and *C. sertosa.*

From this comparison it may be concluded that the *Caligorgia* in the collection made by Professor Herdman is a new species, recognisable by its dichotomous ramification, its delicate habit, the small number of polyps in each whorl, its very small polyps, and by the comparatively large number of scales covering the polyps.

I have to thank Professor Herdman and Professor J. Arthur Thomson for their kindness in sending me some material to study this species. In many respects it resembles *C. verticillata.* The description given of this last species under the name *Primnoa ellisii*, by von Koch, though excellent and valuable in many respects, does not give many morphological details, especially in regard to the arrangement and form of the scales in the polyps. A renewed investigation was necessary to make out how far it is different from Herdman's specimen. This investigation has shown conclusively that the two are different species, but it is readily comprehensible that Professor Thomson was led by von Koch's description to consider the species as identical."

Locality:—Deep water off Galle.

Family: MURICEIDÆ.

Bebryce indica, n. sp.—Plate, fig. 3.

The collection included several specimens of a Muriceid, which we have, with some hesitation, referred to the genus *Bebryce*. It agrees with this genus in its general features, but differs considerably in its spiculation from *B. mollis*, von Koch, *B. studeri*, Whitelegge, *B. philippi*, Studer, and *B. hicksoni* already described by us (Part III., p. 294). In our account of *B. hicksoni* we referred to what might be regarded as varieties of that species, but some additional specimens which we have studied cannot so be dealt with.

All are dark-coloured irregularly branched colonies, disguised by a growth of monaxonial siliceous sponge, and with one exception spreading in one plane. The exception has seven alternate branches, terminally clavate, on an average 2 millims. in diameter, and is 8 centims. in height by the same in maximum breadth. One of the specimens attained a height of 18 centims.

The verrucæ are prominent truncated cones, usually on all sides of the main stem and branches, but sometimes almost restricted to the sides in the plane of branching. They are about 1·5 millims. in height and breadth, and are separated along one line by intervals of 1·5 millims to 2 millims. Except in a few cases, the polyps are completely retracted and the verrucæ are thickly beset with sponge spicules.

The axis is non-calcareous, light brown in colour, very soft and flexible, and traversed by twisted longitudinal grooves whose depth has doubtless been increased by shrinkage of the core. The diameter of the axis is about 1·25 millims.

When the sponge spicules are carefully removed, the surface of the cœnenchyma exhibits the characteristic *Bebryce* appearance. There is a coherent mosaic of interlocked tuberculate discs, and large pieces can be separated off after slight heating without any loosening of the component spicules. The average thickness of the cœnenchyma is about 0·3 millim.

On the few polyps which could be satisfactorily seen, there were relatively large tuberculate spindles.

The following types of spicules occur :—

(*a*) Almost regular tuberculate quadriradiate forms, with more or less pronounced cruciate arms, and sometimes at least with an internal boss at right angles to the expanded disc, 0·15 millim. × 0·125 millim. in length and breadth of the disc.

(*b*) Irregular quadriradiate forms, with the arms to one side longer and stronger than those to the other side; 0·25 millim. between the tips of the longest arms, 0·15 millim. between a long and a short arm, 0·1 millim. between the two short arms.

(*c*) Approximately square forms, suggestive of amphicœlous vertebræ, with slightly prolonged corners and slightly concave sides, 0·175 millim. × 0·175 millim.; and transitional forms connecting these with the pronounced quadriradiate types.

(*d*) Tuberculate "capstans," with a very slightly marked middle zone, separating two equal portions; and a variety of this "double-club" type with the part to one side of the waist much smaller than the other—a feature prominent in the spicules of some other species of this genus; 0·125 millim. × 0·1 millim. in height and breadth.

(*e*) Small tuberculate forms, more like "double wheels" than capstans; 0·1 millim. × 0·1 millim. in length and breadth, and 0·04 millim. across the "waist."

(*f*) Bent, warty spindles from the polyps, including (1) short, thin, rough forms with relatively long, irregularly disposed tubercles, *e.g.*, 0·35 millim. in length by 0·075 millim. at the broadest part, and (2) longer, smoother forms with relatively shorter, more regular tubercles, 0·5 millim. to 0·6 millim. in length by 0·05 millim. in maximum breadth.

It is unsatisfactory that we have not been able to study the polyps of this species, but there is no doubt that some of the spicules are flattened tuberculate discs with an internal boss, approaching the so-called "scales" of *Bebryce*. If we are right in our diagnosis, *B. indica* is nearest *B. hicksoni*, but there the "scales" were numerous and unmistakable, and quadriradiate or cruciate forms, which are here characteristic, were not seen.

Locality :—West of Periya Paar, Gulf of Manaar.

Acamptogorgia gracilis, n. sp.—Plate, figs. 12 and 13.

A weathered and yet distinctive specimen, 6 centims. in height by 4 centims. in breadth. From a short distance the branches appear pinkish red, and the verrucæ stand out like white papillæ. Closer examination with the lens shows an exquisite mingling of red and colourless spicules, the former producing a somewhat characteristic punctate appearance.

The verrucæ may occur on all sides of the branches, but are for the most part lateral in position; they stand out almost at right angles to a height of about 1 millim. ; they are sometimes opposite, sometimes alternate, and the branch terminates in a pair.

The cœnenchyma presents a rough surface owing to the projecting sharp points of the continuous layer of spicules. The characteristic spicules of the cœnenchyma are continued without marked change up the sides of the verrucæ, the projecting tips being all directed upwards. At the top of the verruca there is a ring of horizontal spicules in two rows, and on this is based an opercular covering of eight parts, each composed of two curved foliaceous spindles.

The axis is brown in colour, non-calcareous, 1·5 millims. in diameter at the base, and rather less than 0·5 millim. in the delicate twigs, where it becomes much paler in colour, almost approaching yellow. It shows at places the chambered appearance seen in some other species of this varied genus.

The spicules include the following types :—

(*a*) Curved warty spindles with a bidentate or otherwise toothed foliaceous expansion from the middle of the curve, 0·3 millim. between the tips by 0·1 millim. at the broadest part ;

(*b*) Clubs with irregularly expanded divaricate ends, 0·25 millim. in extreme length by 0·15 millim. at the broadest part ;

(*c*) Small irregularly stellate forms, 0·1 millim. × 0·1 millim. ; and

(*d*) Forms with four or more rays, 0·3 millim. × 0·2 millim.

Locality :—Ceylon seas.

Acamptogorgia rubra, n. sp.—Plate, fig. 5, and text-fig. 1.

A deep crimson, incomplete colony, 5 centims. in height, giving off in one plane three lateral branches which have an average thickness of about 1 millim. There is also a fragment about 2 centims. in length, with four twigs arising almost at right angles from the main branch, which is slightly over 1 millim. in breadth.

Fig. 1.
Acamptogorgia rubra, n. sp. × 15.

The verrucæ, 0·5 millim. in height by 1 millim. in breadth, are alternate or sub-opposite, and arise at right angles to the axis. Two occur side by side at the end of a branch. The cœnenchyma is thin and presents a very prickly appearance, due to the projecting folia and spines of the beautiful crimson spicules. The axis is yellowish, 0·3 millim. to 0·4 millim. in diameter.

The spicules show considerable diversity of form :—

(*a*) Straight, warty spindles, 0·6 millim. × 0·1 millim. ;

(*b*) Narrow, curved spindles, smooth terminally, warty about the middle, 0·6 millim. × 0·05 millim.

(*c*) Large triradiate forms in which the shortest, almost smooth ray projects externally and often bears a foliaceous expansion, while the two larger rays are denticulate or branched to a very varied degree ; 0·6 millim. in breadth between the tips of the longest rays and 0·4 millim. in height between a line joining these internal tips and the tip of the external ray.

(*d*) Smaller and often simpler triradiate forms, 0·45 millim. in breadth and 0·25 millim. in height, and much smaller.

(*e*) Small, very warty spindles with a foliaceous expansion about the middle, 0·2 millim. × 0·1 millim.

Locality :—Ceylon seas.

Muricella complanata, Wright and Studer.

Reference has already been made (Part III., p. 303) to varietal forms of this species, which seem to vary considerably in detail. Another form deserves to be recorded. It differs from the type in the coloration of the spicules, large yellowish spindles covering smaller transparent ones, and others still smaller which are rose-coloured. Thus the rubbed base of the specimen is bright rose, while the upper parts are ochreous yellow—a difference which seems to be wholly due to the degree of abrasion.

The verrucæ show the characteristic longitudinal grouping of small spindles in eight triangles, but it may be noted that in some cases they occur opposite one another, instead of alternately as in the type, and that the diameter of their base can hardly be said to exceed a millimetre, while that in the type was 2 millims.

Muricella rubra, n. sp.—Plate, figs. 2 and 7.

A minute fragment of a bright-red colony with a relatively thin cœnenchyma filled with long warty spindles.

The verrucæ are crowded and alternate, low and subconical, arising at right angles to the surface, and covered with spindles smaller than those of the cœnenchyma. The polyps are white and stand out conspicuously. The axis is light yellow, non-calcareous, flexible, 0·5 millim. in diameter.

The general spicules of the cœnenchyma are (*a*) large warty spindles, straight or slightly **S**-shaped, 1·2 × 0·2, 0·95 × 0·175 millims.; and (*b*) small warty spindles, 0·5 × 0·1, 0·4 × 0·075 millim. In the polyps the spicules are transparent, slightly warty spindles, 0·25 × 0·04, 0·2 × 0·03 millim.

Locality :—Ceylon seas.

Family: VIRGULARIIDÆ.

Virgularia loveni, Kölliker.

We have already recorded the occurrence of representatives of *V. loveni* in this collection, but another specimen has come to hand which deserves notice, especially as that on which Kölliker based his species was very imperfect.

This is also an incomplete specimen, but very well preserved, and presenting several features which make us hesitate in referring it to *V. loveni* unless Kölliker's diagnosis be somewhat modified. It is about 90 millims. in length, 5 millims. to 9 millims. in breadth, and is altogether pinnule-bearing, except 15 millims. at the broken basal part. The lower pinnules are closely crowded without visible intervals; those on the upper portion are separated on the prorachidial surface by intervals of 1 millim. to 1·5 millims., and overlap on the metarachidial surface. There is a bare tract, 2·5 millims. in breadth, along the prorachidial surface, and up the middle of this there runs a well-marked narrow groove.

The free margin of the pinnule curves like an elongated **S**, and its prorachidial insertion is higher than the other. Most of the pinnules are turned markedly downwards. There were 30 polyps on the pinnules counted, and a single row of zooids extends transversely in the interspace between the pinnules. The polyps are very distinct, but the indentations between the calices are shallow.

The axis, which measures 2·25 millims. in diameter at the base, is cylindrical, whitish, and covered with remarkable indentations and irregular ridges.

This form agrees with *V. loveni* in having up to 30 polyps on the pinnules, an indented ridged axis, the zooids in a single row, and so on; but in Kölliker's specimen the pinnules were 3 millims. to 4 millims. apart, the shape was approximately fan-like, and the calices were scarcely distinct.

Locality :—Ceylon seas.

Virgularia elegans, GRAY.

To this imperfectly described species we refer an imperfect specimen, and if the reference be correct we can make GRAY'S diagnosis a little more definite.

The rachis bears 106 pairs of pinnules; it is 145 millims. in length, including 15 millims. of exposed axis at the broken basal end; its breadth is 2 millims. to 3 millims., and that of the axis 1·25 millims.

The pinnules have a breadth and height of 2·75 millims. × 0·5 millim., 2·75 millims. × 2 millims., 2·25 millims. × 0·75 millim., at the base, middle portion, and top of the rachis. The interval between them is 0·25 millim. at the base and 2 millims. at the top. They bear 18 polyps in a single row.

Locality:—Ceylon seas.

Virgularia calycina, n. sp.—Plate, figs. 8, 9, 10, 11.

An incomplete specimen, 57 millims. in length by 3 millims. to 4 millims. in breadth, altogether pinnule-bearing, except 5 millims. of bare axis at the broken basal end.

The lower pinnules are closely crowded, with no intervals between them, but in the upper portion of the rachis they become distant, being separated by intervals of 1·75 millims. There is a bare streak, about 0·75 millim. in breadth, along the prorachidial surface.

The pinnules are substantial and distinct, though relatively narrow, and their prorachidial insertion is very markedly higher than the other. The curve of their free margin is a crescent. On each of those counted there were 18 very distinct calices, with conspicuous longitudinal grooves. When the polyps are retracted, the calices are ovoid in shape, about 1 millim. in height, with a minute circular aperture. The polyps appear to be arranged, except the first three or four at the prorachidial side, in two alternating rows, but this is simply due to the fact that they are alternately shunted to opposite sides along the margin of the pinnule. The inferior surface of the pinnule is strongly marked by eighteen parallel ridges, each corresponding to a calyx or polyp. On the upper surface there are similar markings, but less pronounced. Some of the polyps contain ova. Here and there a few minute lateral zooids were seen in a row about halfway between two pinnules.

The axis is white and cylindrical, with somewhat delicate and complex markings.

This form should be ranked among those species of *Virgularia* which KÖLLIKER described as having distinct pinnules, distinct calices, zooids in one row or in two rows, with the ventral insertion higher than the dorsal, with non-transparent, crescent-shaped pinnules,—that is to the artificial section including *V. mirabilis* (O. F. MÜLLER) (with 6 to 9 polyps), *V. multiflora*, KNER (with 11 to 15 polyps), and some uncertain forms. But from *V. multiflora* this new form is at once distinguishable by the markedly separate calices, and also by their number, &c. In *V. juncea*, again, the pinnules are very slight, and the calices are not separate; in

V. reinwardtii there are 18 polyps, but the calices are not separate. The present specimen appears to be nearest *V. elegans*, GRAY, but in that species the pinnules are much less distinct, the number of calices is 14 to 24, and the calices are "scarcely separate at the margin."

Locality :—Ceylon seas.

Virgularia indica, n. sp.

Several incomplete specimens, about 12 centims. in length by 5 millims. to 6 millims. in breadth, bearing over 120 pairs of pinnules. About a fourth of these are well developed and are separated by intervals of 0·75 millim. On the upper region of the prorachidial surface there is a bare streak 2 millims. in breadth, which becomes a narrow line in the lower half of the colony. On the lower half of the metarachidial surface there is a deep channel left up the middle between the two rows of pinnules, but higher up this is lost, since the opposite pinnules meet or regularly overlap. There were 15 polyps on all the pinnules counted and the siphonozooids occur in equal number in a row midway between two pinnules or near the base of the upper pinnule. The ovoid calices are distinctly marked off from one another and the translucent pinnule shows grooves and ridges corresponding in number to the polyps. Several ova were seen in the pinnules.

The axis is cylindrical, about 1 millim. in diameter, and covered by a reddish-brown investment. As regards the number of polyps on a pinnule, this form resembles *V. multiflora*, KNER, which JUNGERSEN regards as merely a variety of *V. mirabilis* (O. F. MÜLLER). But the pinnules are much closer together, they often show an S-shaped curve, and they are translucent; the calices are distinctly separated from one another; the axis is flexible and covered with a reddish investment.

It therefore seems necessary to establish a new species.

Locality :—Modragam Paar, Gulf of Manaar.

It may seem remarkable that Professor HERDMAN should have found in a short time within a limited area no fewer than six species of *Virgularia*. This is the more extraordinary since the rich collection of deep-water Alcyonarians made by the "Investigator" in the Indian Ocean does not include a single representative of the genus.

It seems extraordinary, almost suspicious, that the handful of *Virgulariæ* before us should include three new species, in spite of our endeavours to unite these with others previously described. We would therefore note that :—

(1) *V. tuberculata* is conspicuously characterised by its red tuberculated axis and by the six, relatively large, very distinct, barrel-shaped polyps on each small pinnule;

(2) *V. calycina* is conspicuously characterised by its 18 very distinct ovoid calices on each prominently ridged pinnule;

(3) *V. indica* approaches *V. multiflora*, but differs in having the pinnules much

closer, often S-shaped, translucent, with distinctly separated calices, and in other characters.

Family: CAVERNULARIIDÆ.

Fusticularia herdmani, Simpson—Plate, figs. 16 to 22, and text-fig. 2.

I entrusted to Mr. J. J. Simpson, M.A., my private assistant, a small club-like specimen which had been overlooked in the first study of Professor Herdman's collection. It had, indeed, so much resemblance to a corticate sponge that it was originally sent for examination to Professor Dendy. The accompanying text-figure (fig. 2) is a reproduction of a drawing of the colony made by Professor Dendy.

Fig. 2. *Fusticularia herdmani*, Simpson. ×2.

Mr. Simpson has published an account of this interesting form in the 'Annals and Magazine of Natural History,' xv. (1905), pp. 561–5, 1 plate, and has named it appropriately *Fusticularia herdmani*, gen. et sp. n.

The specimen is a small free-living sponge-like colony, 3·7 centims. in length, 1·7 centims. in breadth, and 1 centim. thick. It consists of a flattened ovoid stock separated by a constriction from a comparatively slender trunk 1·2 centims. long and 0·6 centim. in breadth.

The general colour is a dark brown, approaching chocolate.

The zooids are dimorphic, the smaller siphonozooids being scattered irregularly among the larger autozooids, which are separated by distances varying from 1 millim. to 3 millims. The zooids are completely retractile into pit-like depressions, about 0·5 millim. in diameter. The length of a fully expanded autozooid is about 0·75 millim. to 1 millim. and the tentacles measure 0·7 millim.

Three longitudinal canals traverse the colony throughout its entire length.

The cœnenchyma is densely spiculose. The spicules, which vary greatly in form and size in the different parts of the colony, are arranged in bundles supporting the polyp cavities. All are hyaline and smooth and the majority bear blunt digitiform terminations which are often marked by characteristic annulations. The most frequent types are the following: blunt spindles, cylinders, clubs, double barrels and palmate forms. They vary in size from 0·3 × 0·05 millim. in the cortical layer of the stock to 0·45 × 0·025 millim. in the trunk. Among the characteristic features of this genus the following are most noteworthy: (*a*) the minuteness of the zooids; (*b*) the absence of an axis; (*c*) the broadly palmate spicules; (*d*) the elliptical trunk; (*e*) the constriction between stock and trunk; (*f*) the number (3) of canals in the stock; (*g*) the small number of autozooids.

The diagnosis reads:—"A somewhat sponge-like cavernularid, with a flattened ovoid stock separated by a constriction from a comparatively slender sterile trunk; with dimorphic retractile polyps, the autozooids not exceeding 1 millim. in length, the much smaller siphonozooids scattered irregularly among the autozooids; with abundant densely spiculate cœnenchyma, traversed by three longitudinal central canals passing down into the trunk; with smooth hyaline spicules bearing peculiar digitiform terminal processes and showing very characteristic annulations, especially near the ends."

Locality:—Cheval Paar, Gulf of Manaar, 6 fathoms.

Note.—Further inquiry into the history of the specimen listed by Professor Herdman and Mr. Hornell in their diaries as a possible *Corallium* sp. has shown that this tentative identification was mistaken. We therefore withdraw the paragraph referring to this specimen on p. 289 of Part III. of this Report.—J. A. T.

Complete List of the Species of Alcyonaria reported on :—

Order I. : Stolonifera.

Family : Clavulariidæ.

**Clavularia margaritiferæ*, n. sp.

Order II. : Alcyonacea.

Family : Xeniidæ.

Xenia ternatana, Schenck.
,, *umbellata*, Sav.

Family : Alcyoniidæ.

**Bellonella indica*, n. sp.

Family : Nephthyidæ.

Nephthya chabrolii, Aud., var. *ceylonensis*, n.
,, *lobulifera*, Holm.
* ,, *ceylonensis*, n. sp.
**Eunephthya purpurea*, n. sp.
**Paraspongodes striata*, n. sp.
**Capnella manaarensis*, n. sp.
Spongodes bicolor, Wright and Studer.
,, ,, ,, ,, var. *ceylonensis*, n.
,, ,, ,, ,, var. *dubia*, n.
,, *rosea*, Kükenthal.
,, *armata*, Holm., var. *ceylonensis*, n.
,, *dendrophyta*, Wright and Studer.
,, *splendens*, Kükenthal.
,, *cervicornis*, Wright and Studer.
,, *involuta*, Kükenthal.
,, *pütteri*, Kükenthal.
,, *microspiculata*, Pütter.
,, ,, var. *ceylonensis*, n.
* ,, *pulchra*, n. sp.
* ,, *aurantiaca*, n. sp.

Family : Siphonogorgiidæ.

**Paranephthya pratti*, n. sp.
Chironephthya variabilis, Hickson.
* ,, *indica*, n. sp.
Siphonogorgia pustulosa, Wright and Studer.
,, *miniacea*, Kükenthal.
,, *köllikeri*, Wright and Studer.

Order III. : Pseudaxonia.

Family : Briareidæ.

Solenocaulon tortuosum, Gray.

Family : Sclerogorgiidæ.

Keroeides gracilis, Whitelegge.
Suberogorgia verriculata, Esper.
,, *köllikeri*, Wright and Studer, var. *ceylonensis*, n.
* ,, *rubra*, n. sp.

Order IV. : Axifera.

Family : Primnoidæ.

**Caligorgia versluysi*, n. sp.

Family : Muriceidæ.

Acanthogorgia muricata, Verrill, var. *ceylonensis*, n.
* ,, *media*, n. sp.
* ,, *ceylonensis*, n. sp.
**Astromuricea ramosa*, n. sp.
Echinomuricea indo-malaccensis, Ridley.
* ,, *ceylonensis*, n. sp.
Echinogorgia pseudosasappo, Kölliker.
* ,, *multispinosa*, n. sp.
**Heterogorgia verrilli*, n. sp.
**Bebryce hicksoni*, n. sp.
* ,, *indica*, n. sp.
Acamptogorgia spinosa, Hiles.
,, ,, ,, var. *ceylonensis*, n.
* ,, *atra*, n. sp.
* ,, *gracilis*, n. sp.
* ,, *rubra*, n. sp.
Acis orientalis, Ridley.
* ,, *indica*, n. sp.
* ,, *alba*, n. sp.
* ,, *ceylonensis*, n. sp.
,, ,, ,, var. *imbricata*.
Muricella nitida, Verrill.
,, *complanata*, Wright and Studer.
* ,, *ramosa*, n. sp.
* ,, *ceylonensis*, n. sp.
* ,, *rubra*, n. sp.

FAMILY: Plexauridæ.

Plexaura prælonga, var. *typica* (RIDLEY).
„ „ „ *elongata*, n.
„ *antipathes*, KLUNZINGER, var. *flexuosa*, n.

FAMILY: Gorgoniidæ.

Lophogorgia lutkeni, WRIGHT and STUDER.
* „ *rubrotincta*, n. sp.
* „ *irregularis*, n. sp.
Leptogorgia† *australiensis*, RIDLEY, var. *flavotincta*.
„ „ „ „ *perflava*.
„ (?) sp.
**Stenogorgia ceylonensis*, n. sp.
Gorgonia capensis, HICKSON.
Rhipidogorgia sp.

FAMILY: Gorgonellidæ.

**Scirpearella aurantiaca*, n. sp.
* „ *divisa*, n. sp.
„ sp. α.
„ sp. β.
„ sp. γ.
Scirpearia sp.
Juncella gemmacea, VALENCIENNES.
„ *juncea*, PALLAS.
„ *fragilis*, RIDLEY.
„ „ „ var. *rubra*, n.
* „ *trilineata*, n. sp.
Verrucella flexuosa, KLUNZINGER, var. *aurantiaca*, n.
„ „ „ „ *gallensis*, n.
* „ *rubra*, n. sp.

ORDER V.: STELECHOTOKEA

SECTION I.: ASIPHONACEA.

FAMILY: Telestidæ.

Telesto rubra, HICKSON.
„ (*Carijoa*) *trichostemma*, WRIGHT and STUDER.

SECTION II.: PENNATULACEA.

FAMILY: Umbellulidæ.

Umbellula sp.

FAMILY: Virgulariidæ.

Virgularia multiflora, KNER.
„ *loveni*, KÖLLIKER.
„ *elegans*, GRAY.
* „ *tuberculata*, n. sp.‡
* „ *calycina*, n. sp.
* „ *indica*, n. sp.

FAMILY: Pennatulidæ.

Halisceptrum gustavianum, HERKLOTS.
* „ *periyense*, n. sp.
Pteroeides lacazei, var. *spinosum*, KÖLLIKER.

FAMILY: Veretillidæ.

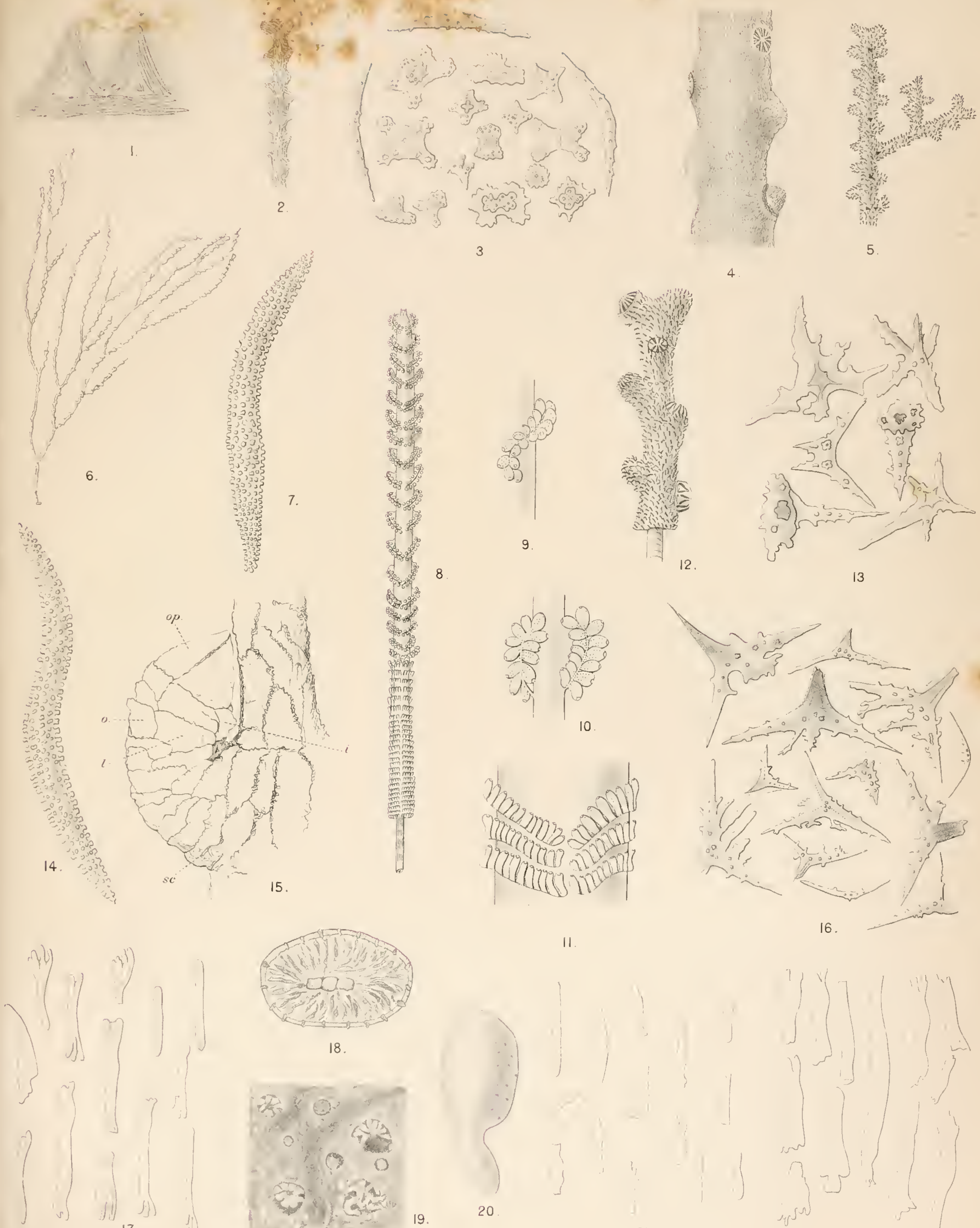
Cavernularia obesa, VALENCIENNES.
**Stylobelemnoides herdmani*, n. gen. et sp.
**Fusticularia herdmani*, n. gen. et sp., SIMPSON.

* There are thus forty-two new species described in this report.

† RIDLEY has changed this title to *Gorgonia australiensis*, 'Journ. Linn. Soc., Zool.,' xxi. (1888), p. 238.
‡ Non *Virgularia tuberculata*, MARSHALL, 1883 (= *Virgularia cladiscus*, JUNGERSEN, 1904).

EXPLANATION OF PLATE.

Fig. 1. *Chironephthya indica*, n. sp.; two groups of anthocodial "point" spicules.
" 2. *Muricella rubra*, n. sp.; showing texture of the surface. × 2.
" 3. *Bebryce indica*, n. sp.; spicules.
" 4. *Suberogorgia rubra*, n. sp.; showing texture and verrucæ. × 10.
" 5. *Acamptogorgia rubra*, n. sp.; showing branching and the alternate verrucæ. × 2.
" 6. *Caligorgia versluysi*, n. sp.
" 7. *Muricella rubra*, n. sp.; spicule.
" 8. *Virgularia calycina*, n. sp.; the entire specimen.
" 9, 10, 11. *Virgularia calycina*, n. sp.; pinnules at various levels.
" 12. *Acamptogorgia gracilis*, n. sp.; showing spinose texture of the cœnenchyma, and the eight triangles of anthocodial spicules. × 10.
" 13. " " types of spicules.
" 14. *Chironephthya indica*, n. sp.; a large curved spindle with tubercles.
" 15. *Caligorgia versluyi*, n. sp. Drawn by Dr. Versluys. *op.*, operculum; *o.*, abaxial row; *l.*, outer lateral row; *i.*, inner lateral row; *sc.*, basal scale of abaxial row, or belonging to general cœnenchyma.
" 16. *Acamptogorgia rubra*, n sp.; types of spicules.
" 17. *Fusticularia herdmani*; spicules of the body parenchyma.
" 18. " transverse section of the stock, showing three central canals.
" 19. " portion of the surface enlarged, showing different stages of retraction of autozooids.
" 20. " entire colony. Natural size.
" 21. " spicules of the cortical layer.
" 22. " spicules of the trunk.



E. Wilson, Cambridge.

REPORT

ON THE

SOLITARY CORALS

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

GILBERT C. BOURNE, M.A., D.Sc., F.L.S.,
FELLOW AND TUTOR OF NEW COLLEGE, OXFORD.

[WITH FOUR PLATES AND FIVE FIGURES IN THE TEXT.]

THE following paper contains an account of a small but remarkably interesting collection of Solitary Corals from Ceylon, which Professor HERDMAN has kindly entrusted to me for identification and description. The collection includes five species of Turbinolidæ, of which two are apparently new to science, three species of Flabellidæ, six species of Fungiidæ and seven species of Eupsammiidæ. There are, in addition, some specimens of *Cyathohelia*, sp. *incert.*, and other colonial corals, but as it is my intention to confine myself to a description of the solitary corals and to species closely related to them, these compound forms will not be included in the present memoir.

As every student of corals knows, the classification and identification of the Turbinolidæ and Eupsammiidæ is attended with no inconsiderable difficulties. The greater number of the genera and species described by MILNE-EDWARDS and HAIME (**35** and **36**) were fossil and the type specimens have been inaccessible to me. The researches of the last forty years have added a considerable number of recent, as well as fossil species, some of which are undoubtedly identical with forms described by older authors; others are undoubtedly new, but many must be regarded as doubtful, for there is ample evidence that varieties have frequently been classed as species, and the identity of recently discovered living genera and species with previously described fossil species has in several cases been overlooked. Hence one cannot deal with any collection of Turbinolidæ and Eupsammiidæ, however small, without entering upon a criticism of these families, and, unfortunately, my claims to undertake such a criticism are limited. A short study of the literature of the subject is sufficient to convince one that no sufficient degree of exactitude can be attained without a study of the original specimens on which the genera and species were founded. But these are largely contained in foreign museums, which I have been unable to visit, or were included in private collections which have been dispersed and are no longer traceable. The British Museum is rich in the possession of the "Challenger" collections and in duplicates of species collected by Pourtalès, but it is singularly poor in Eupsammiidæ, and a careful search among the named specimens of this family failed to bring to light anything that was of assistance in disentangling the difficulties attendant on its classification. I have, therefore, had to rely chiefly on published descriptions and illustrations, and these are, in many cases, too vague and inaccurate to be of material assistance.

I wished, when I undertook this piece of work at Professor Herdman's request, to make a thorough examination of the anatomy of the soft parts as well as of the coralla of the specimens he entrusted to me, but this I found was impossible, as several of the more important species were represented only by a single specimen and it was necessary to dissolve away the soft parts in order to identify the coralla. I have, however, made a tolerably thorough investigation of the anatomy of three forms, *Heterocyathus æquicostatus*, *Heteropsammia michelinii*, and *Dendrophyllia gracilis*. As a matter of convenience this paper will be divided into two sections, the first dealing with the systematic description of the coralla contained in Professor Herdman's collection, the second with the details of the anatomy of the three above-mentioned species.

PART I.—SYSTEMATIC.

Family: TURBINOLIDÆ (*pars.*), M. Edwards and Haime.*

M. Edwards and Haime divided the Turbinolidæ into the two sub-families Caryophyllinæ, with one or more crowns of pali, and Turbinolinæ, without pali. The Caryophyllinæ were further subdivided into Caryophylliaceæ, with a single circle of pali, and Trochocyathaceæ, with more than one circle of pali. The Turbinolinæ were subdivided into the Turbinoliaceæ, destitute of epitheca, and Flabellaceæ, in which "the wall is completely covered by a pellicular epitheca." Martin Duncan, in his revision of the families and genera of the Madreporaria (**13**), abolished the sub-families

* 'Ann. des Sci. Nat.,' 3e sér., t. ix., 1848, and 'Hist. Nat. des Corall.,' t. ii., p. 7, 1857; P. M. Duncan, "Revision of the Madreporaria," 'Journ. Linn. Soc.,' vol. xviii., "Zoology," 1885.

of M. Edwards and Haime depending on the presence or absence of pali, and created in their stead three sub-families Turbinolidæ simplices, Turbinolidæ gemmantes and Turbinolidæ reptantes. The first of these includes nearly the whole of the Caryophyllinæ and Turbinolinæ of M. Edwards and Haime and is divided into seven alliances, viz., Smilotrochoida, Flabelloida, Placotrochoida, Turbinoloida, Trochocyathoida, Discocyathoida and Haplophylloida. Want of space and want of material forbid my entering upon a criticism of Duncan's classification, and I must content myself with remarking that it has been of no great assistance to systematists, and that the older classification of M. Edwards and Haime has been generally preferred to it by recent writers. Both classifications agree in placing the genus *Flabellum* and its allies as a subordinate group of the Turbinolidæ, and the most recent writer on the genus *Flabellum*, Mr. J. Stanley Gardiner (**22**), adopts the classification of Duncan, giving, however, a definition of the "Flabelloida," which I cannot find anywhere in Duncan's paper. As I shall have to enter more fully into the structure and classification of *Flabellum* and its allies in a subsequent part of this paper, I need only say here that I am of the opinion that they differ from all other Turbinolidæ in several important characters, but chiefly in the fact that their wall is a persistent prototheca (Bernard, **4**), which is not thickened externally by a secondary deposit of calcareous substance laid down by an "edge zone" or "perisarc," this latter structure being, indeed, absent. They must, therefore, be classified apart in a family Flabellidæ, and the Turbinolidæ, after the removal of the Flabellidæ, may be defined as follows:—

Corallum simple, or forming colonies by gemmation from the wall or from stoloniform basal outgrowths. The wall is thickened externally by the secondary deposit of calcareous tissue formed by the edge-zone, and is solid, variously ornamented with costæ, granules and spines, the spaces between the costæ sometimes filled up by the deposit. The upper part of the wall commonly formed by the union of the enlarged outer ends of the septa. Epitheca, when present, pellicular or lamellar, closely adherent. The septa commonly exsert and solid. Septal loculi open to the base. Pali may or may not be present. Columella present or absent; when present it may be essential or parietal and of very various shape and composition.

Paracyathus, M. Edwards and Haime.*

This genus is easily recognised by its numerous lobate pali, scarcely distinguishable from the prominences of the columella. The pali, however, should more correctly be described as paliform lobes, as they are clearly thickenings of the inner ends of the septa, and the outermost of the several crowns, at any rate, do not extend to the base. The original definition of the genus given by M. Edwards and Haime, in

* 'Ann. des Sci. Nat. Zool.,' 3e sér., t. ix., p. 318, 1848; 'Hist. Nat. des Cor.,' t. ii., p. 52, 1857; P. M. Duncan, "Rev. Madrep.," 'Journ. Linn. Soc.,' vol. xviii., "Zool.," p. 24, 1885.

1848, was amended in the 'Hist. Nat. des Coralliaires'; in the former the columella was described as "très developpée," the pali as "très élevés," but both these characters are exceedingly variable, and in the 'Hist. Nat. des Coralliaires' the definition of the structures in question runs thus: "La columelle est formée des tigelles qui paraissent naître du bord interne et inférieur des cloisons, et qui sont d'autant plus élevées qu'elles sont plus éxtérieures; sa surface est papilleuse et concave. Les palis paraissent se detacher également de la partie inférieure des cloisons, et se distinguent à peine des tigelles columellaires." The species of the genus are not easy to determine with certainty. LACAZE DUTHIERS (**33**) gives excellent photographs of *P. striatus*, and DUNCAN (**11**) gives several species from different parts of the world, but all these are obviously different from the specimens in Professor HERDMAN'S collection. It should be observed that the initial and therefore solitary corallites of the arborescent *Cyathohelia* closely resemble *Paracyathus*, the septal pali and columella being almost identical, and I am inclined to think that several of the described species of *Paracyathus* are nothing more than young Cyathoheliæ.

Paracyathus stokesi, M. EDW. and H.

There are three specimens of *Paracyathus* in Professor HERDMAN'S collection; they were taken at different times from different localities and differ from one another in details, but their resemblance is sufficiently close to lead me to refer them all to *P. stokesi*, M. EDW. and H. (**35**, plate x., figs. 7 and 7A).

Specimen *a* is from Trincomalee. The corallum is 17 millims. in height; the calice elliptical, its longer axis measuring 13 millims., its shorter axis 8 millims. The calice is depressed at either end of the long axis. The septa correspond very closely with M. EDWARDS and HAIME'S description of *P. stokesi*, but the fifth cycle is incomplete, and the outer ends of the primary and secondary septa are scarcely, if at all, thickened. The costæ differ from those of *P. stokesi*, in being so slightly developed that they are scarcely distinguishable at a short distance below the level of the calice.

Specimen *b* is from Galle. Height of corallum 14 millims.; longer axis of the calice 12 millims.; shorter axis 9 millims. Septal arrangement as in specimen *a*, but the septa are rather thicker externally. The calicular fossa is deeper, the columella less developed, and the septal pali stouter and more prominent than in *a*. The costæ agree exactly with M. EDWARDS and HAIME'S description of *P. stokesi;* they are rather broad, distinct to the base, and thickly covered with granules.

Specimen *c* is from deep water near Galle. Height of corallum 14 millims.; longer axis of calice 7 millims.; shorter axis 6 millims. This specimen resembles *P. procumbens*, M. EDW. and H., from the Eocene of Hauteville, in the following characters. The corallum is curved and the calice inclined to one side; the calice is subcircular and rather deep; the septa are somewhat exsert and their external ends project beyond the lip of the calice; the costæ are somewhat slender and form sharp ridges projecting unequally at different levels, but never prominently. On the other hand, it resembles *P. caryophyllus*, from the Eocene of Sheppey, in having only four cycles of septa. (It seems very probable that these two Eocene species are identical, the presence or absence of a fifth cycle of septa not being sufficient to distinguish them.)

I have no hesitation in referring *a* and *b* to *P. stokesi*, but I am more uncertain about *c*. If it cannot be referred to this species, it cannot be anything else than *P. procumbens;* but a comparison of M. EDWARDS and HAIME's figures (**35**, plate x., figs. 6 and 7) lead me to believe that the latter species is only a variety of *P. stokesi*, and that the three Ceylonese specimens are local varieties of that species.

Paracyathus striatus, PHILIPPI.

Cyathina striata, PHILIPPI, 'Arch. für Natur.,' 1842, vol. 1, p. 48.
Paracyathus striatus, M. EDWARDS and HAIME, 'Pol. foss. des terr. palæoz.,' 1851, p. 25.

A single specimen, from deep water off Galle, which only came into my hands after this paper was written, must clearly be referred to this species.

Rhodocyathus, n. gen.

Corallum simple, free, saucer-shaped, with signs of former adherence. Calice subcircular, wide, shallow. Columella essential, well developed, composed of numerous oblique thin overlapping lamellæ whose upper edges are produced into numerous flattened spines. Septa in six systems and five cycles, the last cycle incomplete. The primary and secondary septa subequal, very exsert, arched at their outer ends and sloping inwards to join the columella; their upper margins furnished with blunt spines; their outer margins produced into sharp and prominent spines where they pass into the costæ; the surfaces of the septa marked with broad radiating ridges corresponding to the marginal spines, the whole surface finely granular. Tertiary septa similar to the primaries and secondaries, but smaller and less exsert. The quaternary much smaller than the tertiary septa, and bending inwards to join the latter near the columella. The quinary septa mostly very small and free at their inner ends; where they are longer they generally become attached to an adjacent septum, usually to a quaternary, but in some cases to a primary, secondary, or tertiary; the inner ends of the quinary and quaternary septa are very thin and cribriform. The costæ corresponding to the first four cycles of septa form distinct fairly prominent ridges covered with fine granulations; those corresponding to the fifth cycle very small; the costæ of opposite ends meet below and cover in the basal scar of attachment.

Rhodocyathus ceylonensis, n. sp.—Plate I., figs. 1 and 1A.

The characters are those of the genus. A single specimen from Trincomalee.

The dry corallum is of a yellowish colour, and measures about 18 millims. in height from the rounded base to the top of a primary septum. The calice is subcircular, measuring 35 millims. in its longer and 33 millims. in its shorter diameter. The columella is oval, measuring 10 millims. × 6 millims., and has a horizontal surface. The specimen was evidently fixed in early life and has become detached, the scar of detachment being healed over in a peculiar manner by the continuation of sixteen costæ round the bottom of the corallum, to meet and fuse with their fellows of the opposite side. These costæ belong to the septal systems at either end of the longer axis of the calice; the costæ of the lateral systems converge below and unite to form two somewhat irregular and not very conspicuous lateral basal prominences. The specimen was completely covered by soft tissues, but these had to be removed to facilitate the study of the corallum.

I have been unable to refer this specimen to any known genus, and have therefore made the new genus *Rhodocyathus* to contain it. The name is descriptive of the shape of the calice, which bears a resemblance to a conventional rose. It differs from all the members of DUNCAN'S Turbinoloida in the characters of the columella. It is distinguished from the majority of the Trochocyathoid alliance by the absence of pali, and its shape and the character of its septa and costæ mark it off from the somewhat vague and all-embracing genus *Ceratotrochus*, as defined by DUNCAN. It cannot be placed in any genus of the Discocyathoid alliance, nor yet among the Haplophylloida. The presence of a columella separates it from all the Smilotrochoida; the character of the columella prevents its being placed among the Placotrochoida; and it certainly is not a Flabelloid. The genus shows most affinity to *Ceratotrochus* and *Deltocyathus*, and may be described as a Trochocyathoid without pali.

Cyathotrochus, n. gen.

Corallum simple, free, without a trace of adherence, forming a short, laterally compressed cone. Costæ moderately prominent near the lip of the calice, but scarcely distinguishable below and indistinguishable near the bluntly pointed base; the primary and secondary costæ somewhat more prominent than the tertiaries, which in turn are rather more prominent than the quaternaries; the costæ corresponding to the primary septum at each end of the longer axis of the calice much more prominent than the rest and continued as sharp ridges about half-way down the corallum, but not forming aliform expansions. Calice elliptical, subplane. Columella essential, with a papillary upper surface, projecting slightly in the calice. Septa in six systems and four regular cycles; the primary and secondary septa subequal, moderately exsert, arched above, with nearly vertical inner margins, their surfaces ornamented with rows of relatively large granules, arranged nearly parallel to the inner margins. Paliform lobes, separated from the septa by a deep but narrow notch, stand in front of the first three cycles of septa and connect them with the columella; those in front of the tertiaries are the largest, but they do not form chevrons or deltas.

Cyathotrochus herdmani, n. sp.—Plate I., figs. 2 and 2A.

Height of corallum, 7 millims.; longer axis of calice, 10 millims.; shorter axis, 7·5 millims. The characters are those of the genus. The septa and the bluntly pointed basal part of the corallum are white, the rest of the wall of a dull Indian-red colour. The wall and costæ are covered with close-set but very fine granules, which can only be distinguished by the aid of a strong lens. A single specimen from the west of Periya Paar.

After some hesitation I have founded a new genus to receive this species, which does not correspond exactly with any described genus of the Turbinolidæ. It is undoubtedly closely allied to *Trochocyathus*, from which it differs only in the form of the pali, which should perhaps be described as paliform lobes rather than true pali, as they are evidently the thickened inner continuations of the septa, separated from the latter by a notch which, although fairly deep, does not extend to the bottom of the septum. These pali, or paliform lobes, form a single crown, not two crowns as in *Trochocyathus*, and they do not form chevrons as in *Tropidocyathus*. The characteristic feature of the species is the keel-like projection of the costæ at each end of the long axis of the corallum, suggesting an affinity to *Tropidocyathus* (*Trochocyathus*) *lessoni*. But in this latter species, as MICHELINS' (34) and ALCOCK'S (3) figures show very clearly, the corresponding costæ are very much enlarged and form aliform expansions extending round the base of the corallum, whereas in *Cyathotrochus* they are but slightly enlarged to form ridges extending scarcely half way to the base.

Heterocyathus, M. EDWARDS and HAIME (35).

Stephanoseris, M. EDWARDS and HAIME (38).

Heterocyathus æquicostatus, M. EDW. and H.

Stephanoseris rousseaui, M. EDW. and H., 'Hist. Nat. des Cor.,' t. iii., p. 56, 1860.
H. philippinensis, SEMPER, 'Zeit. Wiss. Zool.,' xxii., p. 254, 1872.
H. parasiticus, SEMPER, *loc. cit.*
H. pulchellus, REHBERG, 'Abh. Ver. Hamb.,' xii., p. 8, 1892.
H. oblongatus, REHBERG, *loc. cit.*
H. æquicostatus, J. C. GARDINER, 'Mar. Invest. in South Africa,' "Turbinolid Corals," 1904.

Professor HERDMAN'S collection contains numerous specimens of this interesting species, of all sizes, and apparently collected from all the localities in which he dredged.

Mr. STANLEY GARDINER has recently shown how very variable this species is, and has absorbed the various species of SEMPER and REHBERG. The Ceylonese specimens also show great variety, and, though I have not as large a collection for comparison as Mr. GARDINER, I have no doubt of the identity of these specimens with *H. æquicostatus*, and further, I have no doubt that the forms first described by

M. Edwards and Haime as *H. rousseaui* and afterwards as *Stephanoseris rousseaui* are identical with *H. æquicostatus*.

The genus *Stephanoseris* was created, M. Edwards and Haime tell us, to contain the species first described by them as *H. rousseaui*, but subsequently found to possess synapticula, the presence of which involved its removal to the Fungiidæ. Subsequent authors, including Duncan, have accepted the genus *Stephanoseris*, the last-named remarking that he places it with much doubt among the Fungiidæ, for he could not find synapticula in any of his specimens. Omitting for the moment any reference to synapticula, we find that *S. rousseaui* differs from *H. æquicostatus* (1) in having costæ of unequal size, the tertiaries being particularly large; (2) in having four instead of five cycles of septa; (3) in the fact that the septa do not project externally.

Among the specimens in Professor Herdman's collection there are individuals with all the characters of *H. æquicostatus*, and every intermediate grade between these and individuals identical with *S. rousseaui*. Further, I have found well-marked synapticular structures in every individual that I have examined, so there can be no doubt that the forms described as *Stephanoseris rousseaui* are only varieties of the forms described as *Heterocyathus æquicostatus*, and for reasons that I will explain in the latter half of this paper I prefer to retain the latter name and to place the genus among the Turbinolidæ. Synapticula have been found to be common to so many different kinds of corals that their presence is no longer a reason for including any given form among the Fungiidæ. It should be mentioned that the synapticula of *Heterocyathus* cannot be seen on mere inspection of the corallum, as they are hidden by the swollen upper ends of the septa. In order to see them it is necessary to make sections or to grind down the corallum below the level of the exsert septa, when they are at once apparent, as is seen in fig. II. Thus one can easily understand how both M. Edwards and Haime and Duncan, as well as other authors, have failed to recognise their presence. The genus *Psammoseris* is described by M. Edwards and Haime as resembling *Stephanoseris* (*Heterocyathus*) in almost every respect, except that it has no pali. Not having access to the type specimens of *Psammoseris*, I cannot speak with certainty on this subject, but I am inclined to think that the genus was founded upon a variety of *Heterocyathus*, in which the pali are so slightly developed as to be indistinguishable from the papilliform columella. An inspection of Gardiner's excellent photographs of *Heterocyathus* (**23**, plate iii., figs. 13 to 19) shows that such a reduction of the pali is not uncommon. *Psammoseris*, like *Heterocyathus* and *Heteropsammia*, fixes itself in the young state on a gastropod shell, which it subsequently envelops, and in the adult the shell, and the spiral basal cavity continuous with it, is tenanted by a Sipunculid of the genus *Aspidosiphon*. I shall refer to this interesting association in a subsequent part of this paper, and I give in the second part a detailed account of the anatomy and minute structure of the corallum of *Heterocyathus*.

Family: FLABELLIDÆ.

Simple corals, multiplying asexually by transverse fission from a fixed nurse-stock. Corallum more or less compressed and flabelliform or cuneiform. Calice elongated; elliptical or angular at the extremities of the long axis. Septa numerous, increasing in number during the growth of the corallum, chiefly by the addition of new septa in the systems contiguous to the directive septa, in such a manner as to appear to be arranged in a variable number of ternary systems. The columella may be essential and lamellar, or parietal and formed by the union of spines or trabeculæ projecting from the lower ends of the principal septa. The wall is protothecal, and increases in thickness only by addition to the inside surface. There is no edge-zone. Costæ rudimentary or absent. Protothecal spines commonly present. Genera :—*Flabellum*, Lesson, and *Placotrochus*, M. Edwards and Haime.

The Flabellidæ, as characterised above, differ from all the other Turbinolidæ, among which they have hitherto been placed, in the absence of an edge-zone, that is, of soft tissues external to the wall. The wall, as von Koch pointed out (**30**), is an "epitheca," or, if we adopt the more exact nomenclature of Bernard, a "prototheca," that is to say, it is a direct upward continuation of the primitive basal cup common to all Madreporarian corals, of which the development has been carefully described by von Koch (**28**), de Lacaze Duthiers (**33**), and Duerden (**10**). As there are no soft tissues external to the prototheca, it can only increase in thickness by addition from within, and a section of the wall of *Flabellum* shows that the "dark line of growth," which lies in or near the middle of the theca of other corals, is here on the outside. As the wall does not increase in thickness externally, the costæ are very feebly developed, and there is an absence of the ridges, spines, and other external ornamentations formed by the deposit of additional calcareous matter on the outside of the wall by the activity of the calicoblasts of the edge-zone. The spinous processes and rootlets found in most members of the Flabellidæ are hollow, and only become solid by the secondary deposit of calcareous matter within. Thus they differ from ordinary costal spines, and their mode of formation, by local extensions of the lip of the calice, has been indicated by de Lacaze Duthiers (**33**). In all the Turbinolidæ, as here limited, there is a distinct and usually well-developed edge-zone. Hence the wall increases in thickness, both externally and internally, and there are well-developed costal ridges, variously ornamented with granules, tubercles, or spines, or sometimes the furrows between the costal ridges may be filled up by a secondary deposit of an "epithecal" character, formed by the calicoblastic layer of the edge-zone. Moreover, in the typical Turbinolidæ, the septa grow in height well beyond the limits of the protothecal cup, and are either prominently exsert or their peripheral margins are thickened and become attached to one another, forming the so-called pseudotheca of Ortmann. The marked difference in the structure and growth of the wall seems a sufficient reason for separating *Flabellum* and its allies from the rest of the Turbinolidæ, and placing them in a separate family, Flabellidæ, and the septal arrangements and the peculiar mode of multiplication by transverse fission, characteristic of the family, are additional reasons for keeping it apart. GARDINER (**23**) has shown that the genera *Blastotrochus*, M. EDW. and H., and *Rhizotrochus*, M. EDW. and H., must be absorbed. I have not been able to examine DUNCAN'S fossil genus *Thysanus*, and I do not include it in the family Flabellidæ, as here defined, because it has well developed granular and minutely spined costæ, which seem to indicate an external thickening of the wall.

The genus *Placotrochus* was not included by DUNCAN (**13**) in his alliance Flabelloida, but was placed, along with *Sphenotrochus*, *Nototrochus*, *Placocyathus*, and *Platytrochus* in an alliance Placotrochoida, characterised by the presence of an essential lamellar columella. For this I can find no justification whatever. *Placotrochus* has no edge-zone; its wall is protothecal and devoid of costæ; it has the compressed flabelliform or cuneiform shape characteristic of *Flabellum;* it reproduces itself asexually by transverse fission from a nurse-stock, and the truncated free forms have a basal scar exactly like that of *Flabellum;* it has protothecal spines; its septal arrangements are those of *Flabellum*. The only point of difference is the essential lamellar columella, but this cannot outweigh the other characters, and the well-preserved specimens of this genus in Professor HERDMAN'S collection show that the general anatomy of the polyp is the same as that of *Flabellum*, though I have not yet completed my study of its microscopic structure. I have no hesitation in placing it in the family Flabellidæ.

Flabellum, LESSON (1831).

A detailed criticism of this genus has recently been given by GARDINER (**22**), to which the reader is referred. The subdivisions *Subpedicellata truncata* and *fixa*, of M. EDWARDS and HAIME, were shown by SEMPER (**49**) to be purely artificial, and DUNCAN'S subdivisions of the genus (**13**, p. 13) are still more arbitrary and unnatural. SEMPER, and more particularly GARDINER, have shown that most of the living species enumerated in the 'Hist. Nat. des Coralliaires,' must be regarded as varieties of a few distinct species, and the latter author has reduced most of M. EDW. and HAIME'S, as well as SEMPER'S species to varieties of either *F. pavoninum*, LESSON, or *F. rubrum*, QUOY and GAIMARD, the latter species being apparently protean in its characters. I speak with all diffidence, for I have not had the opportunity of comparing a large number of specimens, but I am inclined to think that GARDINER has gone too far.

Flabellum crassum, M. EDW. and H.—Plate I., figs. 3 and 3A.

There are in Professor HERDMAN'S collection two specimens of *Flabellum*, from the pearl banks in the Gulf of Manaar, which agree in almost every respect with SEMPER'S description and figures of *F. irregulare*. Both specimens were preserved in spirit; one I have decalcified, the corallum of the other when cleaned and dried measures

30 millims. in height. The longer axis of the calice measures 16 millims., the shorter axis 8 millims.; the small scar at the base 4 millims. × 2 millims.; thus the ratio of the axes is 2 : 1, agreeing with SEMPER'S description. The corallum is compressed, with rounded directive edges, whose sides form an angle of 23° in the dry specimen, but a considerably wider angle in the decalcified specimen. The wall is constricted at tolerably regular intervals and there are three short and stout spines at varying heights on the directive faces, and two short and corroded spines near the basal scar. The costæ, especially those corresponding to the principal septa, are distinct and are recognisable nearly down to the basal scar. The corallum is tall, and the directive margins of the calice are nearly level with the lateral margins. The fossa is very deep (6 millims.), narrow and slit-like. The parietal columella is formed by the union of trabeculæ given off from the lower ends of the principal septa. There are in all sixty-six septa; the primaries and the secondaries are of equal size and unite in the columella. The twelve tertiaries are nearly equal in size to the primaries and secondaries and also join the columella. The fourth cycle septa are short, excepting those nearest the two directive septa at opposite ends of the long axis of the calice; these are nearly as large as the tertiaries and join the columella. Fifth cycle septa are developed in the chambers between the primary and secondary septa on both sides of the two directive septa, and are equal in size to the lateral tertiary septa. In one chamber nearest to a directive, two sixth-cycle septa are developed, one on either side of a quinary septum (see fig. 3A). (This interpretation of the septal succession differs from SEMPER'S, who explained an exactly similar arrangement by supposing that additional second-cycle septa were developed in each of the terminal systems, but it is clear that what he describes as additional secondary septa are nothing more than third-cycle septa, which have grown to the same size as the primaries and secondaries.) The result of this arrangement is that there appear to be sixteen ternary systems, and, in addition, two small septa in one of the systems. The principal septa have very slightly arched, or nearly horizontal, upper edges; their inner edges descend vertically to the columella, and they are distinctly, though slightly, notched near their insertions on the wall. The surfaces of the septa are thickly covered with fine spinose granules, which have an obscurely radial arrangement. The dry corallum is brilliantly white in colour, and the lower five-sixths of the wall is encrusted by a secondary calcareous deposit, which, on decalcification, proves to be formed by interlacing algal filaments, as described by FOWLER for *F. patagonichum* (14). It is noteworthy that the costæ are more conspicuous in the region of this secondary deposit than they are at the upper end of the corallum.

These Ceylonese specimens are so similar in all respects to the figures and description of SEMPER'S *F. irregulare* that there can be no doubt of their identity. According to GARDINER (22), *F. irregulare*, SEMPER = *F. rubrum*, QUOY and GAIMARD, and there is certainly some resemblance between his (not wholly satisfactory) figs. 26, 30, 31 and the Ceylonese specimens, while the latter can certainly be included in the amended definition of *F. rubrum* given by GARDINER on p. 28. It is further stated that *F. variabile*, SEMPER, is connected with *F. rubrum* by individuals, SEMPER'S species being identified by MOSELEY with *F. stokesi*, M. EDWARDS and H., which in turn is identical with *F. oweni*, *aculeatum*, *spinosum*, *debile*, *sumatrense* and *candeanum*. I must take leave to doubt whether these identifications are correct. That *F. variabile*, SEMPER, is identical with *Flabellum* (*Turbinolia*) *rubrum*, QUOY and GAIMARD, I have no doubt. The characters of the corallum are similar and a comparison of SEMPER'S figure of the expanded polyps (**49**, plate xviii., fig. 1) of *F. variabile* with QUOY and GAIMARD'S figure of *F. rubrum* (**46**, plate xiv., figs. 5 to 9) show a very close correspondence in the coloration of the living animal; in both there are the same six alternating radial bands of deeper red and lighter red or yellow. On the other hand, *F. irregulare*, as described by SEMPER, is red with as many radial white lines as there are principal septa. The colour, no doubt, is variable to some degree, but it must be taken into account, and what I wish to point out here is, that SEMPER is the only author who has paid special attention to the colour of the living polyp; that he had at least as many specimens for comparison as GARDINER; that he found a constant colour-difference between his *F. variabile* and *F. irregulare*, and that the colour of the former, and not that of the latter, corresponds to QUOY and GAIMARD'S figure of *F. rubrum*. It follows, therefore, that *F. variabile* = *F. rubrum*, and, as SEMPER showed beyond all cavil, *F. stokesi*, *oweni*, *aculeatum*, *spinosum*, *debile* and *sumatrense*, all M. EDW. and H., are synonyms of *F. variabile*.

The Ceylonese specimen, which I identify with *F. irregulare*, SEMPER, agrees very closely with *F. crassum*, M. EDW. and H., especially in the characters of the septa, which are notched near their insertion on the wall (**38**, plate viii., fig. 8A), and have thickened and rugose internal borders. SEMPER observes that the two species are very closely allied, differing chiefly in the height of the corallum. There can be no doubt that they are identical; the specific name *crassum* has the priority, and I therefore identify the Ceylonese specimen above described as *F. crassum*, M. EDW. and H.

Flabellum rubrum, Q. and G.—Plate I., fig. 4.

There are three other specimens of *Flabellum* in Professor HERDMAN'S collection: *a* and *b* (locality not recorded), and *c* from deep water near Galle. These are all truncate forms with a fairly large basal scar; their measurements correspond closely, their calices are elliptical, their calicular fossæ wider, and the septa are thinner, and their inner margins less vertical than those of *F. crassum*, and the spines on the surfaces of the septa are longer, further apart, and definitely arranged along radial thickenings of the septa. Their walls are thinner than in *F. crassum*, the costæ are of equal size and very slightly developed, and the corallum is not constricted at intervals as in that species, but only exhibits a succession of somewhat sinuous lines of growth parallel to the curved margin of the calice. The three specimens differ from one another in colour, in the characters of the lower edges of the septa, and of the trabeculæ forming the parietal columella, but their resemblances are so great that I must refer them to one species, viz., *F. rubrum*, QUOY and GAIMARD.

Specimen *a*.—Height, 12 millims.; calice, 15 millims. × 8·5 millims.; scar, 6 millims. × 3·5 millims.; depth of calice, 5 millims. Angle formed by the directive faces of the wall, 37°. The dry corallum is white and has a small directive spine at each end of the scar. The margin of the calice is entire, the directive ends of the calice 2 millims. lower than the sides. There are eighty-two septa, whose character and arrangement are shown in fig. 4. The lower margins of the septa are furnished with sharp spines, but are not sinuous; the septal trabeculæ uniting to form the columella are large and spiniform. The character of the trabecular columella approximates this specimen to *F. profundum*, M. EDW. and H., which is a variety of *F. rubrum*.

Specimen *b*.—Height, 13 millims.; calice, 17 millims. × 8·5 millims.; scar, 7 millims. × 3·5 millims.; depth of calice, 4·5 millims. Angle formed by directive faces of wall, 45°. The dry corallum is of a brownish-grey colour and bears short protothecal spines at either end of the scar. The calicular margin is crenulate, the directive ends of the calice about 2 millims. lower than the sides. There are eighty septa arranged in twenty apparent ternary systems. Eight of the tertiary septa are equal in size to the primaries and secondaries and unite with them in the columella, but four of the laterally placed tertiaries are of smaller size, and either barely reach, or do not reach, the columella. The principal septa are thin, their inner margins slope obliquely into the fossa, their lower edges are expanded and slightly sinuous and terminate in nodular trabeculæ, which unite to form the columella. The septal surfaces bear distinct radial ridges ornamented with spiniform granules. This specimen is clearly identical with *F. crenulatum*, M. EDW. and H., which is a variety of *F. rubrum*.

Specimen *c*.—Height, 13 millims.; calice, 15 millims. × 9 millims.; scar, 8·5 millims. × 4 millims.; depth of calice, 5 millims. Angle formed by the directive faces of the wall, 35°. The wall in the dry corallum is of a deep reddish-brown colour, and the same colour extends half way across the septa, a peculiarity which SEMPER (**49**, p. 250, footnote) says is confined to *F. pavoninum* and *F. distinctum*. The concentric lines of growth on the wall are distinct, the costæ are scarcely recognisable, and there are no protothecal spines. The calicular margin is entire, the directive ends of the calice are about 1½ millims. below the lateral margins. There are seventy-two septa, the tertiaries equal in size to the primaries and secondaries and meeting them in the columella. The fifth cycle is complete in the terminal systems, but incomplete in the lateral systems. The septa resemble those of specimen *b*, but their inner edges are more vertical and their lower ends more decidedly sinuous.

The calicular fossa is rather narrow, and the septal trabeculæ forming the columella short and bluntly spiniform. This specimen might be referred either to *F. rubrum* or *F. stokesi*, M. Edw. and H.; but it cannot be either *F. pavoninum* or *distinctum*, the colour of the septa notwithstanding. These three specimens, therefore, are varieties of *F. rubrum*, Quoy and Gaimard, which is synonymous with *F. variabile*, Semper, but is, in my opinion, distinct from *F. crassum*, M. Edw. and H. (= *F. irregulare*, Semper).

I differ, with some hesitation, from Mr. Gardiner, but I feel bound to point out that his reasons for uniting nearly all the described species of *Flabellum* under *F. rubrum* are not satisfactory. He relies very much on certain numbers and measurements, and he appears to think that if one form is connected with another by some individuals, the two must be reckoned as constituting one species. Now, in the first place, much depends on the numbers or measurements that are chosen for comparison. Two of his characters, viz., the number of septa fusing by trabeculæ and the total number of septa, are characters depending on the age of the coral, and are therefore of little value. His third character, the relation of the length to the breadth of the calicle, is tolerably constant at all ages after maturity, and is therefore better. But whatever characters are chosen, it is not sufficient to set out the results of the measurements in a simple table and to say that, since the average measurements of a number of unequal groups of individuals can be arranged in a continuous series, all the specimens measured must belong to one species. To deal with the statistics of a number of individual forms, proper statistical methods must be employed, or systematic zoology will be thrown into confusion. The extreme measurements—the characters that vary most widely from the mean—of two closely allied species may be expected to overlap, but the fact of their overlapping does not break down the distinction between two species whose mean is different. We have at present no data for determining the range of variation in the species of *Flabellum* by statistical methods, and until such data are available I prefer to place reliance as much upon such characters as the shape of the columellar trabeculæ, the shape and thickness of the septa and the kind and arrangement of the granules on their surfaces, the visibility or otherwise of the costæ, &c., as upon measurements which have been shown to vary very widely according to the age and condition (whether recently liberated or not) of the individual.

Placotrochus, M. Edwards and Haime (1848).

The reasons for placing this genus in the family Flabellidæ have been given above.

Placotrochus lævis, M. Edw. and H.—Plate I., fig. 5.

Three specimens from Periya Paar are referable to this species. Two were preserved with the polyps partly extended, one is dead and corroded. The three specimens vary between the following limits: Height 16 millims. to 12 millims. Calicle from 16 millims. × 7 millims. to 14 millims. × 6 millims. Scar from 6 millims. × 2 millims. to 7 millims. × 2·5 millims. (the smallest specimen has the largest scar). Angle formed by the directive faces of the wall 33° to 40°. They correspond exactly with M. EDWARDS and HAIME'S description, except that the directive faces of the wall show only the merest traces of wing-like expansions, in this respect agreeing with SEMPER'S specimens. This appears to be a very rare species. It is remarkable among the Flabellidæ for the perfectly regular development of the septa, the first, second, and third cycles are equal in size, and appear to form with the intermediate quaternary and quinary cycles twenty-four regular systems (Plate I., fig. 5).

FAMILY: FUNGIIDÆ, M. EDWARDS and HAIME.

Fungia (*pars.*) LAMARCK.

Fungia danai, M. EDWARDS and HAIME (1851).

Two specimens from the pearl banks, Gulf of Manaar, are referable to this species. The larger specimen is subcircular, measuring 18 centims. × 19 centims., and the central part of the upper surface is raised into a prominent convexity. The smaller specimen has no central prominence, but is evenly convex above and concave below.

Fungia dentigera, LEUCKART, 1841.

A single specimen, measuring 16·5 centims. in length, 11 centims. in breadth, and 5·5 centims. in height. According to DÖDERLEIN this is a variety of *F. scutaria*, LINK, but GARDINER (20) has given a sufficient criticism of this author's varieties.

Locality :—Gulf of Manaar.

Cycloseris, MICHELIN (*pars.*) (34).

Cycloseris cyclolites, LAMARCK

Fungia cyclolites, LAMARCK, 'Hist. des Anim. sans Vert.,' ii., p. 236, 1816.
Cycloseris cyclolites, M. EDW. and H., 'Ann. des Sci. Nat.,' 3e sér., xv., p. 112, 1851.

Professor HERDMAN'S collection contains thirty-two specimens of this species, twenty-five of which come from the pearl banks in the Gulf of Manaar, four from south of Modragam, one from off Mutwal Island, two from Trincomalee. The range of variation in this species is considerable. In the thirty-two specimens the diameter of the corallum varies from 42 millims. to 27 millims., the height from 19 millims. to 10 millims., the depth of the basal concavity from 9·5 millims. to 1 millim., the length of the fossa from 15 millims. to 6 millims. There is also a considerable amount of variety in the granulation of the costæ, but the septal characters are closely similar in all the specimens.

Cycloseris tenuis, DANA.

> **Fungia tenuis**, DANA, 'Zoophytes,' p. 290, 1846.
> **Cycloseris sinensis**, M. EDW. and H., 'Ann. des Sci. Nat.,' 3e sér., xv., p. 112, 1851.
> **Cycloseris hexagonalis**, M. EDWARDS and HAIME, *loc. cit.*
> **Cycloseris hexagonalis**, GARDINER, WILLEY'S 'Zool. Results. Solitary Corals,' 1899.

Professor HERDMAN'S collection contains seven specimens, of which the largest measures 40 millims. in diameter, while the smaller specimens vary from 22 millims. to 9 millims. in diameter. The smaller individuals, among which are two somewhat hexagonal forms, agree in all respects with the definition of *C. hexagonalis*, M. EDW. and H., and, allowing for individual variation, with GARDINER'S excellent photographs of this species (**20**, plate xx.). Two of them have definite basal scars, not yet filled up by secondary deposit, and the costæ reach to the edges of the scars; in the other specimens the costæ, and the extent of the central basal granulation, differ to a considerable extent, but the septal characters are quite uniform and none of the septa are fenestrated. In the largest specimen the two last cycles of septa are fenestrated, a character which would attach it to *C. sinensis*, M. EDW. and H. This species however is synonymous with *Cycloseris* (*Fungia*) *tenuis*, DANA, and the latter name has the priority. Except for the fenestration of the lower cycles of septa there is absolutely no difference between the largest and the smaller specimens in Professor HERDMAN'S collection, hence I am of opinion that *hexagonalis* and *sinensis* are merely varieties of DANA'S species *tenuis*, and must be absorbed into it.

Diaseris, M. EDWARDS and HAIME (**37**).

QUELCH (**45**, p. 121) has expressed his opinion that the specimens referred to this genus are nothing more than broken and distorted individuals of *Cycloseris tenuis*, but I cannot agree with him. Professor HERDMAN'S collection contains a specimen of *C. cyclolites*, which has been broken and repaired, and shows considerable distortion and re-arrangement of the septa, but its characters are widely different from *Diaseris*. It is true that the structure of the wall, the septa, and even of the rudimentary columella of *Diaseris* are very similar indeed to that of *Cycloseris*, as M. EDWARDS and HAIME pointed out, but the former genus is sufficiently distinguished by its peculiar method of reproduction by radial division, whence the corallum has the appearance of being composed of a number of lobes with rounded edges, or is divided into wedge-shaped fragments. This method of reproduction has been so sufficiently and clearly described by SEMPER (**49**) that I can add nothing to his account, which is fully borne out by a study of the Ceylon specimens.

Diaseris distorta, MICHELIN.

> **Fungia distorta**, MICHELIN, 'Mag. de Zool. V. Zooph.,' pl. 5, 1843.
> **Diaseris distorta**, 'Ann. des Sci. Nat.,' 3e sér., xv., p. 118, 1851.

Numerous specimens and cuneiform fragments from off Mutwal Island, and some small fragments and specimens from deep water off Galle and from Kaltura.

Diaseris freycineti, M. Edwards and Haime (**37**).

A number of petaloid fragments from the Gulf of Manaar and from off Kaltura appear to belong to this species. As described by M. Edwards and Haime, the septa are of less height, much more closely packed, and have thicker edges than in *D. distorta*. I may add that all the septa are more or less fenestrate. The spirit specimens are of a rich red-brown colour, the upper surface exhibiting black spots near the inner ends of the septa. These spots probably indicate the position of the tentacles, but the specimens are so contracted that I cannot speak with certainty on this point.*

Family: EUPSAMMIIDÆ.

As Semper has remarked (**49**, p. 256), the difficulty of determining the species and even the genera of the Eupsammiidæ is very great. In order to relieve himself of the difficulty, he founded the genus *Rhodopsammia* to include his Philippine specimens, and the genus has been accepted by most subsequent authors, even by Duncan in his critical revision of the genera of the Madreporaria, and this in spite of the fact that, as I shall show, Semper's genus was confessedly provisional.

Semper's definition of the genus *Rhodopsammia* runs as follows:—"Polypary simple or with lateral buds, free or attached, sometimes cylindro-conical, sometimes compressed (not, as Duncan gives it, 'Corallum simple or colonial, free or attached, with lateral buds'). Epitheca absent or rudimentary. Costæ simple, visible from the base upwards, similar, thickly granulated. Calicular fossa rather deep, with a more or less prominent columella consisting of curled leaflets (aus gewundenen Blättchen). The septa narrow, with sharp edges, scarcely rising above the lip of the calice: those of the first cycles equal, extending right down to the columella; those of the third cycle smaller, and also united to the columella; the septa of the remaining—often irregular—cycles much narrower and invariably united to those of the preceding cycle."

This definition differs from M. Edwards and Haime's description of any genus of Eupsammiidæ, as it includes both single and compound, free and attached, forms, but it embraces all members of the genera *Eupsammia*, *Balanophyllia*, *Leptopsammia*, and *Endosammia*, and possibly some species of the genus *Dendrophyllia* as defined by the authors of the 'Histoire Naturelle des Coralliaires,' and it is quite clear, from what Semper says, that he meant at least the first four of these genera to be included in his new genus. Thus (*loc. cit.*, p. 256) he says: "Da mir nun leider das fossile Material fehlt, welches nöthig wäre, um diese Incongruenzen gründlich ausgleichen zu können, so ziehe ich es vor, hier die von mir bei Bohol aufgefundenen 8 Arten ohne

* Professor Herdman's "Field-notes" contain the following colour record of this species when alive:—Station XLIII., off Kaltura, 22 fathoms, "also a living group of four 'flabellums' having upper side dark purple on the outer margin and dark green within, mottled with paler yellowish-green, grey, and deep drab-purple, the septa especially being of the latter colour—the under side is white." The accompanying sketches show that the Coral is a *Diaseris*.

Rücksicht auf ihre Basis als Species einer neuen Gattung zu beschreiben, wobei ich es Anderen überlassen muss, die schon beschriebenen lebenden und fossilen Eupsammidæ nach den durch die philippinischen Formen sich ergebenden Andeutungen zu untersuchen, und mit diesen in systematischen Zusammenhang zu stellen." Notwithstanding SEMPER'S hope that one of his successors would show the proper systematic relation between his Philippine specimens and previously described fossil and living forms, DUNCAN, in his 'Revision of the Madreporaria,' retains SEMPER'S genus *Rhodopsammia*, but removes it from the "alliance" Balanophylloida, to which, on its author's own testimony, it belongs, and places it apart as a genus which cannot be included in any alliance!

The Eupsammiidæ in Professor HERDMAN'S collection include free and fixed, solitary and colonial forms, and most of them resemble one another very closely in such distinctive characters as septal arrangement, columella, and costæ. The solitary forms (with the exception of *Heteropsammia*) must, without doubt, be referred to a single genus, and they agree in all respects with SEMPER'S definition of the genus *Rhodopsammia*. But if we agree with SEMPER and ignore, as we must after the study of a sufficient number of specimens, such variable characters as attachment or its contrary, the presence or absence or the completeness or incompleteness of a fifth cycle of septa, or the relative thickness of the septa, we must recognise that the genus *Rhodopsammia*, SEMPER, includes *Eupsammia*, M. EDWARDS and HAIME; *Balanophyllia*, SEARLES WOOD; *Leptopsammia*, M. EDW. and HAIME; *Endopsammia*, M. EDW. and HAIME, and it becomes a question as to what name shall be used to denote the single genus into which all the other genera are absorbed. The genus *Balanophyllia* was founded by SEARLES WOOD in 1844, and there is no objection to be taken to it on the score of indefiniteness. Therefore, by the rules of nomenclature, it has the priority over the genera founded by M. EDWARDS and HAIME in 1848, and *à fortiori* over SEMPER'S genus *Rhodopsammia* founded in 1872. Hence I suggest the amendment of the definition of *Balanophyllia* in the terms of SEMPER'S definition of *Rhodopsammia*, the latter name being dropped and *Eupsammia*, *Leptopsammia*, and *Endopsammia* merged into *Balanophyllia*.

It is a characteristic, though not a peculiarity of the Eupsammiidæ, that the septa of the later cycles curve towards and are usually united to those of the preceding cycle, and it commonly happens that the septa of what on the ordinary system of reckoning would be called the last cycle are larger than those of the preceding cycle. SEMPER, many years ago (**49**, p. 259), called attention to the inapplicability of M. EDWARDS and HAIME'S law of septal sequence to the Eupsammiidæ as well as to other Madreporaria described in his well-known memoir, but until recently there has been no satisfactory explanation of the apparent irregularity in the septal sequence of these forms, and it has been necessary, in spite of its obvious disadvantages, to retain M. EDWARDS and HAIME'S system of notation in describing the septa of all Madreporaria. But as long ago as 1871, POURTALÈS (**43**) gave a description of the development of *Balanophyllia floridana* which, if it had received the attention it deserved, would have given a full explanation of the peculiarities of the septal arrangement in this genus. POURTALÈS' description is as follows: "The youngest individuals observed have the shape of a truncated cone attached by the base. The wall is quite smooth, imperforate, and the septa, twelve in number, equal and not quite extending to the centre, where the rudiments of the columella are already visible. . . . . The next step is the formation of costæ on the upward prolongation of the wall. They first appear in the shape of sharp points grouped about the origin of the septa. At the same time an opening appears on the border and rather outside of the calicle, opposite each of the secondary septa, which gradually widens inwards, apparently dividing the septum in two. The two borders of that opening become the tertiary septa; the secondary septum is gradually pushed inwards and is replaced by a new one growing out on the same radius from the wall, and but loosely connected with the jointed tertiaries and original secondary. . . . . The interior part of the tertiary septum is now to all intents and purposes a palus. . . . . As the growth proceeds the point of junction of the tertiaries and secondaries moves further into the calicle until it reaches the columella. At this period the older or internal part of the secondary septum has nearly entirely disappeared and the same process of growth goes on with the septa of the fourth cycle which become joined to those of the third." In these few sentences POURTALÈS anticipates the discoveries of several recent authors. The imperforate wall is clearly the basal plate of VON KOCH (= prototheca, BERNARD). The description of the formation of costæ on the upward prolongation of the prototheca agrees exactly with DE LACAZE DUTHIER'S description and figures of the development of these structures in *Balanophyllia regia* (**33**, plate x., figs. 20 and 21). The description of the bifurcation of the peripheral ends of each secondary septum, and the formation of a new secondary septum on the same radius, is in exact agreement with DUERDEN'S (**9** and **10**) account of the septal sequence in *Siderastræa radians*. But, although the credit of priority must rest with POURTALÈS, it is the last-named author who has given a full and perfectly intelligible account of this mode of septal sequence, and has shown in detail the relation between the order of appearance of the septa and that of the mesenteries. In his valuable and beautifully illustrated memoir, DUERDEN has shown that in *Siderastræa radians* the six septa comprised in the first cycle appear simultaneously, and are situated within the entocœles of the six primary pairs of mesenteries. The six septa of the second cycle make their appearance later and occupy the six exocœlic chambers, thus alternating with the six primaries. As growth proceeds the peripheral ends of all the septa become bifurcated, as a consequence of the continuous addition of skeletal nodules to their outer ends, but the angle formed by the bifurcating limbs is much larger in the secondary (exocœlic) than in the primary (entocœlic) septa. The bifurcations become filled up and disappear in the primary septa, but in the secondaries they continue to extend, and presently a second mesenterial cycle is developed, each mesenterial pair being situated within the angle formed by the bifurcated peripheral extremities of the secondary septa. After a time a new cycle of entocœlic septa is formed, each septum within a mesenterial pair of the second cycle, and as growth proceeds these secondary entocœlic septa grow centripetally, and fuse with inner portions of the septa which originally constituted the exocœlic cycle. Thus a stage

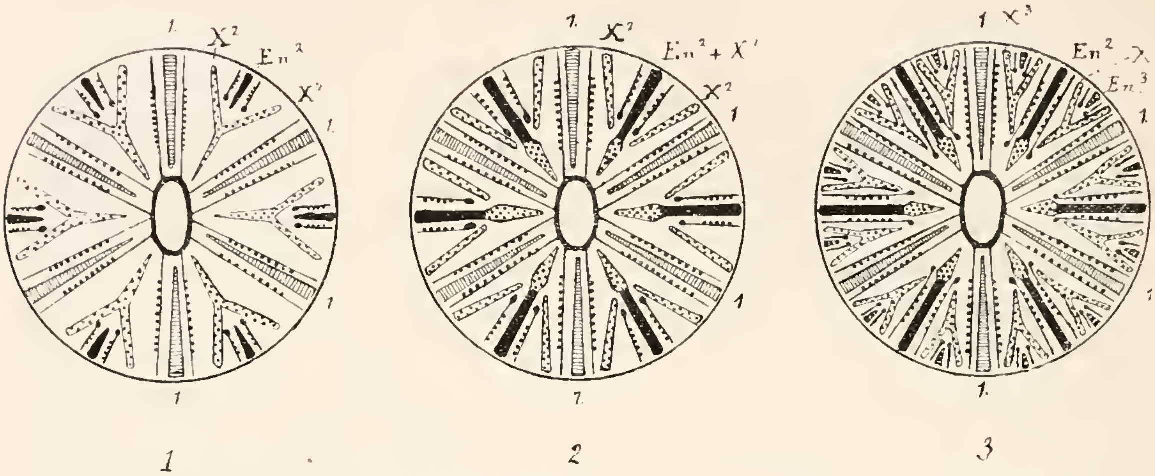


Fig. I. Diagram illustrating the development of the septa, and their relation to the mesenteries in *Balanophyllia floridana* (POURTALÈS), and *Siderastræa radians* (DUERDEN). The primary entocœlic septa are shaded with cross lines; the exocœlic septa are dotted; the secondary entocœlic septa are black; the tertiary entocœlic septa are banded black and white. In fig. 1 the outer ends of the six exocœlic septa have bifurcated to form the secondary exocœlic septa X^2; within each bifurcation a new mesenterial cycle of the second order has been formed, embracing an entocœlic septum of the second order $En.^2$. In fig. 2 the secondary entocœlic septa have grown inwards and fused with the inner limbs of the first formed exocœlic septa, thus forming the *apparent* second cycle of septa $En.^2 + X^1$. In fig. 3 the secondary exocœlic septa X^2 have in turn bifurcated, and in each of the twelve bifurcations a mesenterial pair of the third order is developed, embracing a tertiary entocœlic septum $En.^3$. The primary entocœlic septa are denoted by 1, 1 in all the figures.

is reached in which there are three cycles of septa; two cycles, namely those which are ordinarily reckoned as the first and second, are entocœlic, the remaining cycle, which would ordinarily be reckoned as the third, is exocœlic. But it is clear that each apparently secondary entocœlic septum is a compound structure, its inner end formed of a septum which was actually second in order of appearance, its outer end of a septum which was actually third in order of appearance. And it is further clear that the exocœlic septa, which appear to constitute the third cycle, are really the forked peripheral ends of the septa that were second in order of appearance. The formation of the next cycle of mesenteries and septa follows the same rule. The exocœlic septa become bifurcated at their extremities; new mesenterial pairs of the third cycle are formed within the bifurcations; a new cycle of entocœlic septa is formed within the pairs of third-cycle mesenteries, and these grow centripetally and unite with the inner limbs of the apparently third-cycle septa of the previous stage, the bifurcated outer ends of these same septa constituting the apparent fourth cycle. The further development has not been followed, but it probably continues on the same plan. Thus it appears, as is shown in the diagram above, that at any given stage in the growth of the coral, all the entocœlic septa, after the first cycle, are composite structures, but all the exocœlic septa, forming the apparently last cycle, are the derivatives of the original exocœlic septa which were second in order of appearance. One can scarcely imagine anything more at variance with M. EDWARDS and HAIME's law of septal sequence. DUERDEN has further shown that there is a regular dorsi-ventrality in the mesenterial, and therefore in the septal succession of *Siderastræa radians*. New mesenterial pairs appear first in the dorsal member of the two exocœles of each system. This fact may be of assistance in explaining the irregularities in the apparently last cycle of septa which are so common in the Eupsammiidæ and other corals, but, as I shall show, the same sequence does not seem to obtain in *Balanophyllia* as in *Siderastræa*, and it is quite probable that the dorsi-ventral order of the appearance of the mesenteries varies as much in the Scleractiniæ as it does in the Malakactiniæ.

The convergence and union of the inner ends of the lower orders of septa is a much more common phenomenon than is generally supposed. In the collection of corals forming the subject of this paper, such septal unions occur in *Rhodocyathus*, *Heterocyathus*, and *Paracyathus* among the Turbinolidæ. They are characteristic of the genera *Cycloseris* and *Diaseris*, and, as I have shown elsewhere (6), they are well marked in the anthoblast of *Fungia*. But they are above all characteristic of the Eupsammiidæ, in which the septal arrangement of the adult appears to retain its embryonic character, and it may be inferred from the septal characters of the adults that the septal sequence in the course of development has followed the law of POURTALÈS and DUERDEN. It is obvious that, if this inference is correct, all the adult septa of the apparently last cycle will be exocœlic, while those of the apparently penultimate cycle will be entocœlic and contained within the mesenterial pairs of the last formed, and therefore smallest, mesenterial cycle. In the second part of this paper I shall show that this is the case, not only in *Heteropsammia* and a species of *Dendrophyllia*, among the Eupsammiidæ, but also in *Heterocyathus* among the Turbinolidæ.

It might seem desirable to amend MILNE-EDWARDS and HAIME's method of enumerating the septa, and to adopt a system more consistent with the facts of developmental sequence as now ascertained. But after several attempts to invent a new notation, I have decided to retain the old method. After all, we have only POURTALÈS' and DUERDEN's accounts to go by, and we are by no means certain that what is true of the species they describe is true of all Madreporaria. Future researches may bring to light considerable differences in the septal sequences of different groups, and it would be premature to invent a system of notation that might prove to be inapplicable to new cases. I have therefore retained the old system in describing the

Eupsammiidæ in Professor HERDMAN'S collection, leaving it to be understood that the words "secondary," "tertiary," &c., indicate only the size of the septa, and not their order of succession. And in this connection it may be noted that DE LACAZE DUTHIER'S account (**33**) of the septal succession in *Balanophyllia regia* differs widely from that of POURTALÈS' account of *B. floridana*, and therefore from DUERDEN'S. I am inclined to think, however, that DE LACAZE DUTHIERS missed the actual succession of the development of the septa. An inspection of his figures (Plate x., figs. 23 and 29) will show that they are not inconsistent with DUERDEN'S and POURTALÈS' accounts. In fig. 23, the septa marked 2 are clearly bifurcated at their distal ends, and the sclerite lying within each bifurcation gives every appearance of having been formed independently and having become secondarily united with the inner limb of the bifurcated secondary. In fig. 29 the septum marked 3 is equal in size to, and clearly continuous with, the inner end of the septum marked 2, the latter thinning out very much towards its point of union with the angle of the **Y**. And in the same figure the "tertiary" septum occupies the position of a "quaternary," and the septa that occupy the positions of "tertiaries" are described as subsequent formations. They are clearly the new entocœlic septa formed between the bifurcated peripheral ends of the exocœlic septa marked 3.

Balanophyllia parallela, SEMPER—Plate I., figs. 6 and 6A.

Rhodopsammia parallela, SEMPER, 'Zeit. für Wiss. Zool.,' xx., 1872.
Rhodopsammia parallela, FOWLER, 'Quart. Jour. Micr. Sci.,' xxv., new ser., 1885.

A single specimen from the pearl banks, Gulf of Manaar. Height of corallum 29 millims.; longer axis of calice 18 millims.; shorter axis 13 millims.; depth of calice 8 millims. In this specimen the outline of the calice is not so hexagonal as in the Philippine form described by SEMPER, and the base is narrow and pedicellate, whereas the Philippine forms are free and pointed below. Septa in six systems and five cycles, the fifth cycle being incomplete. The primary and secondary septa are equal in size, similar and somewhat exsert; their outer ends are thickened and porous, their inner ends sharp, entire, and descend nearly vertically to unite with the columella; their sides are ornamented with radiating rows of very small granules; their upper ends more or less fenestrate. The tertiary septa are smaller and their inner ends become thickened and trabecular and pass into the columella; each is joined at two-thirds of its length from the lip of the calice by the quaternary septa. There is an incomplete cycle of quinary septa, which can best be described by saying that the peripheral ends of the quaternaries bifurcate and a small septum is developed between their bifurcated ends in each directive moiety of the four primary systems adjoining the directive septa, and the same arrangement is present in all but one of the four outer moieties of the same systems. The quaternary septa are not bifurcated in the lateral primary system on one side of the coral, and on the other side only one is bifurcated and contains an entocœlic septum in each of the moieties of the system.

In other words, the formation of a new cycle of entocœlic septa has progressed more rapidly at the two directive ends than at the sides, and the sequence is therefore different from that observed by DUERDEN in *Siderastræa radians.*

This specimen is in many respects intermediate between SEMPER'S *Rhodopsammia carinata* and *R. parallela*, and I am inclined to think that these two and *R. amœna* are only varieties of one species. The Ceylonese specimen agrees with *R. parallela* in having vertical inner edges of the primary and secondary septa, in the costæ being of equal size, in the presence of a fifth incomplete cycle of septa, and in the depth of the fossa. In all these respects it differs from *carinata*, but such characters are clearly variable. The calice is less compressed and more regularly oval than in SEMPER'S figures of *parallela*, but FOWLER (**14**) gives a figure of the calice of this species in which the difference between the longer and shorter axes is even less than in the specimen here described, and the septal arrangement is almost identical.

Balanophyllia cumingi, M. EDWARDS and HAIME (**36**)—Plate II., figs. 7 and 7A.

Rhodopsammia ovalis, SEMPER, 'Zeit. für Wiss. Zool.,' xxii., p. 262, 1872.

There are three specimens in Professor HERDMAN'S collection, of which one, from deep water off Galle, so closely agrees with M. EDWARDS and HAIME'S description and figure of *B. cumingi* that I have no hesitation in referring it to this species. It is somewhat larger than the type specimen (the height being 12 millims., the calice 19 millims. × 12 millims.) and the fifth cycle of septa is well developed and nearly complete. The second specimen is from Trincomalee and is a small colony, or rather an aggregation consisting of three dead and decayed corallites, one small and one large living corallite. Of the living corallites the larger measures: height 30 millims., calice 19 millims. × 12 millims., depth of calice 12 millims. Smaller corallite: height 12 millims., calice 8 millims. × 6 millims., depth of calice 5 millims. The larger corallite is identical with the specimen of *B. cumingi*, from Galle, in septal characters, the columella, and the costæ, differing from it only in being longer and turbinate in shape with a narrow base, whereas the Galle specimen is short with a broad base. The septal arrangement is shown in fig. 7A, and it agrees very exactly with SEMPER'S description of *Rhodopsammia ovalis.* The tertiary septa are continued below into the columella, but, as the figure shows, their lower ends converge distinctly towards the secondary septa. The "quaternaries" are inserted very low down on the tertiaries and the quinary cycle is nearly complete, but in the two lateral systems three of the quaternaries adjoining the secondary septa are not bifurcated, nor is the quaternary adjoining a secondary in one of the remaining systems. The smaller corallite in the Trincomalee specimen has a nearly circular calice. The six primary septa are conspicuously larger than the others and pass straight to the columella. The secondary septa are joined just above the columella by the "tertiaries," and the latter bifurcate in all but two instances and a new cycle of entocœlic septa is formed in the bifurcations. This shows that the secondary septa have been formed in the manner described by POURTALÈS and DUERDEN, and that it is only at a later stage of growth that the extension of the columellar trabeculæ overspreads the union of the tertiaries with the secondaries and causes the latter to appear as if they sprung directly from the columella. The primary and secondary septa are much thickened and porous towards their thecal ends.

Balanophyllia socialis, SEMPER.—Plate II., figs. 8 and 8A.

Rhodopsammia socialis, SEMPER, 'Zeit. für wiss. Zool.,' xxii., p. 260, 1872.

A beautiful cornuate specimen from the pearl banks, Gulf of Manaar, clearly belongs to this species, as is shown by its subcircular calice, deep fossa, well-developed and projecting columella, and four fully developed cycles of septa. Its measurements are: height 27 millims.; calice 10 millims. × 9 millims.; depth of calice 6 millims. There are no buds, but a small outgrowth of the theca 3 millims. below the lip of the calice on the opposite side to that drawn in fig. 8 is evidently the commencement of a bud. The primary and secondary septa are equal in size, as described by SEMPER, and their surfaces are covered with very fine granules ("äusserst fein gekörnelt"), but they are only very slightly thickened peripherally, and in this respect resemble *Rhodopsammia affinis*, which, as SEMPER himself says, is probably nothing more than a variety of *R. socialis*. *R. dubia* and *R. incerta*, both SEMPER, again are almost certainly nothing more than varieties of the same species. SEMPER describes the quaternary septa as uniting with the tertiaries close to the columella. In the Ceylonese specimen, as is shown in fig. 8A, the quaternaries do not invariably unite with the tertiaries, and indeed they follow M. EDWARDS and HAIME'S law very closely, the quaternaries nearest the primary septa being, as a rule, the best developed. The infrequent union between the third and fourth cycle septa, however, does not indicate that the septa have not been developed according to POURTALÈS' and DUERDEN'S law, for the latter author shows (**10**, p. 103, fig. 12, *c*) how the bifurcated external limbs of the lower cycles of septa commonly become detached from the inner limb.

A dead and corroded specimen from deep water off Galle seems to belong to this species. The calice was broken so much that its characters were indistinguishable, but a section taken lower down shows that it is peculiar in having a tetrameral instead of a hexameral arrangement. There are four systems: the primary septa are the largest, the secondaries are smaller, but pass direct to the columella, the tertiaries also join the columella, but converge in a marked manner towards the secondaries, and there is a complete fourth cycle uniting with the tertiaries. There is no indication of this arrangement being derived from an originally hexameral arrangement, and it must be regarded as a remarkable variation from the normal.

Balanophyllia taprobanæ, n. sp.—Plate II., figs. 9 and 9A.

Height of corallum 15 millims.; calice 6 millims. × 5 millims.; depth of calice, 3 millims. The six primary septa are much larger than the others, considerably thickened at their thecal ends, and they, and the two septa adjacent to them, are exsert, forming a crown of six prominent points round the edge of the calice. The edges of the primary septa slope rather steeply inwards and then descend vertically into the depth of the fossa without joining the columella; the inner half of the surface of each primary septum is nearly smooth, the outer half bears a number of spinose granules. There are five septa of lower orders in five of the systems and seven in the sixth system (adjoining one of the directive septa), those adjacent to the primary septa being the largest and most exsert; the smaller septa join the columella very deep down in the fossa. Costæ of the six primary septa larger and more prominent than the rest, forming ridges extending nearly half-way down the corallum; the remaining costæ subequal, extending to the base, the perforations between the costæ numerous and relatively large. Columella oval, very prominent, spongy in texture. Buds are formed on opposite sides a little way below the margin of the calice, each bud being astride of a primary costa.

A single specimen from deep water off Galle.

I have founded this species to receive a small and remarkably beautiful coral, which resembles *B. rediviva*, MOSELEY, in the costæ and arrangement of the septa, but differs from it in size, in colour (*B. rediviva* is "reddish coloured," *B. taprobanæ* a brilliant white), and in the fact that the secondary septa are not exsert. These differences can hardly be due to immaturity, as the specimen of *B. taprobanæ* bears two fairly advanced lateral buds.

The septal characters are particularly interesting as being wholly unintelligible unless interpreted in the light of POURTALÈS' and DUERDEN'S work. In fig. 9A it is evident that, in the lateral system on the left hand of the drawing, the inner ends of the septa marked $X.^2$, $X.^3$, are the bifurcated arms of the exocœlic septa of the cycle second in order of appearance; these arms unite together and with the columella very low down in the calice. The septum marked $En.^2$ is clearly the entocœlic septum of the cycle third in order of appearance. In the upper half of the system the exocœlic septum has bifurcated to form the secondary exocœlic septa $X.^3$, $X.^3$, and a new entocœlic septum $En.^3$ is formed in the bifurcation. A precisely similar arrangement obtains in four of the remaining systems, and in each it is the upper member of the exocœlic septa that has bifurcated, giving a dorsiventral arrangement entirely consistent with DUERDEN'S description of the septal succession in *Siderastræa radians*. In the left-hand lower terminal system both exocœlic members have bifurcated and an entocœlic septum is present within each bifurcation. In *B. rediviva* all the systems are similar to this single system in *B. taprobanæ*, and the arrangement would obviously be that which is normal in the Eupsammiidæ, if it were not for the preponderant size of the apparent quaternaries, whose outer ends become more or less intimately united to the primary septa. The condition in *B. taprobanæ* is a step towards the septal arrangement in *B. verrucaria*, PALLAS, and *B. cornu*, MOSELEY. SEMPER (**49**, p. 263), in discussing the validity of his genus *Rhodopsammia*, makes reference to the difference in the septal characters of the former species as shown in MILNE-EDWARDS and HAIME'S figure (**36**, plate i., figs. 6, 6A), but it requires no great amount of ingenuity to show that the difference, great as it may appear at first sight, is really nothing more than a slight variation of the grouping of septa developed according to the sequence established by POURTALÈS and DUERDEN.

It is possible that the specimen here referred to *Balanophyllia*, is nothing more than the initial individual of a colony of *Dendrophyllia*, and the two lateral buds lend some support to this view. On the other hand, the buds, both from their position and character, might very well be similar to those of *B. socialis* or *parallela*, and as the specimen is a solitary one, I have preferred to refer it, provisionally, to the same genus.

Lobopsammia, M. EDWARDS and HAIME (**36**).

The small colony shown in Plate II., fig. 10, agrees very closely with the definition of this genus, hitherto represented only by fossil forms. The structure of the corallites, however, is so similar to that of *Balanophyllia cumingi* that it is hard to draw any distinction between them; the septa and columella are almost identical, and the most that can be said is that the costæ are smaller and the theca decidedly thinner than in the latter species. If this specimen must be separated from *Balanophyllia* on account of its colonial habit, it must be placed with *Lobopsammia* rather than with *Cœnopsammia* because of its elliptical calices and because the mode of aggregation of the colony suggests that it has been formed by fissiparity rather than by gemmation. Moreover, its likeness to *L. cariosa*, GOLDFUSS (**25**, taf. xiii., fig. 7), is sufficient to establish its generic position.

Lobopsammia robusta, n. sp.—Plate II., figs. 10 and 10A.

Colony consisting of a few corallites borne on a very thick and short stem. The individual corallites short, radiating outwards from the stem. Calices oval, somewhat irregular in outline; calicular fossæ deep; columella spongy, with a flat upper surface, not projecting into the calice. Five cycles of septa; the primaries and secondaries subequal, not exsert, with nearly vertical inner edges. The quaternaries are united with the tertiaries near the columella; the fifth cycle is complete except in the lateral systems, and the quinary septa unite with the quaternaries high up in the calice; the lower orders of septa fenestrate with serrated or denticulated margins. Costæ fine, of equal size, extending to the base of the stem.

Height of colony 27 millims.; the largest calice measures 15 millims. × 11 millims.; depth of calice 7 millims.; smallest calice 11 millims. × 8 millims.

A single specimen from deep water off Galle.

Dendrophyllia, de Blainville ('Dict. des. Sci. Nat.,' lx., p. 319, 1830).

Dendrophyllia gracilis, M. Edwards and Haime (**36**).

A portion of a colony, from deep water off Galle, appears to belong to this species. The fragment only included three mature corallites, two of which, with the buds attached to them, were decalcified for the study of the soft parts. The remaining corallite is somewhat broken, but the size, septal characters and mode of budding appear to be those of *D. gracilis*.

Dendrophyllia minuscula, n. sp.—Plate II., figs. 11 and 11a.

Colony arborescent; the trunk and branches slender; the lateral corallites disposed in alternate and opposite pairs. Costæ of equal size, rather prominent, finely granulated. Calice circular, with a fairly deep fossa. Columella formed of a few calcareous trabeculæ, moderately prominent in the fossa. Septa in six systems and three cycles, with traces of a fourth. The primary septa exsert, forming a crown of six points at the edge of the calice. The apparent tertiary septa next in size closely applied to the primaries at their outer ends, their inner ends converging and uniting deep in the calice just before joining the columella. The apparent secondaries short, usually not united to the inner ends of the tertiaries. Height of colony 25 millims.; diameter of calices 2 millims.

A single small colony and a fragment of this very elegant species from deep water off Galle. The large exsert primary septa recall those of *Balanophyllia taprobanæ*, but the corallites are much smaller, the primary costæ are not prominent, and there are three cycles of septa with traces of a fourth in one system only, in the corallite depicted in fig. 11a. This figure shows very clearly that the apparent tertiaries are the exocœlic bifurcated ends of the original secondary cycle, and that the apparent secondaries are the entocœlic septa formed in the angles of the secondaries, and, therefore, are the third cycle in order of appearance.

Heteropsammia, M. Edwards and Haime (**36**).

Heteropsammia michelini, M. Edwards and Haime (**36**).

Numerous specimens from nearly all stations. The septal arrangement and anatomy of this genus are fully described in the second part of this paper.

PART II.—ANATOMY.

1. Heterocyathus æquicostatus, M. Edwards and Haime.

(Plates III. and IV., figs. 12 to 21.)

Gardiner (**23**) has given a short account of the anatomy of this species, but he does not deal with the minute structure of the corallum, and I am able to supplement his description of the anatomy of the polyp in many particulars.

The Corallum.—In the majority of specimens there are forty-eight septa, which, according to MILNE-EDWARDS and HAIME'S system of notation, would be described as being regularly arranged in six systems and four cycles. It will become obvious, however, that the septa have been developed according to DUERDEN'S and POURTALÈS' law, and that what are apparently the quaternary septa are really exocœlic septa belonging to the second cycle in order of appearance. In some few specimens the normal regularity of the septal arrangement is disturbed by the development of one or two additional septa in one or more of the systems. These additional septa are always inserted between the apparent tertiaries and the apparent quaternaries adjacent to them, and suggest the commencement of a fifth septal cycle, but in every system in which they occur there is so much irregularity in the septal arrangement that I attribute their presence to a process of re-growth and repair rather than to the formation of a new cycle. The normal arrangement of the septa is shown in fig. II. There are three cycles of endosepta. The six primaries are prominently exsert and their inner ends bear large paliform lobes just before they unite with the columella. The secondary endosepta are likewise prominent and exsert, and there are two or three prominent vertical pali at the inner extremity of each. The innermost of these pali can with difficulty be distinguished from the vertical upgrowths of the columella, and the outermost is fused to the inner free margin of the septum, so that there is a transition between "true pali" and "paliform lobes." I am inclined to think that the sharp distinction drawn between these paliform structures is artificial and untenable. The inner ends of the third cycle of endosepta converge towards the secondaries and unite with them just outside the columella through the intervention of palial upgrowths. In specimens that have been rubbed down, the pali in front of the secondary and tertiary septa are seen to unite to form a chevron, similar to the chevrons characteristic of *Deltocyathus*.

Between every two endosepta there is an exoseptum, and in the deeper parts of the corallum, *i.e.*, below the level of the exsert portions of the septa, these exosepta are seen to be united to the adjacent endosepta by tangential bars which, although they do not exactly correspond to the similarly named structures of the Fungiidæ, must be described as synapticula. Their arrangement is very regular and characteristic. Each primary endoseptum is joined to the exoseptum on either side of it by a synapticulum which curves downwards and inwards to the fossa. These primary synapticula, as they may be called, are equidistant from the centre of the coral, and are situated nearer the centre than the others, so they form a sort of inner synapticular ring. Each secondary endoseptum is similarly joined to the two adjacent exosepta by synapticula which are situated somewhat further from the centre than the primary synapticula, and similarly the tertiary endosepta are joined to the adjacent exosepta by synapticula still further from the centre and forming an outer ring. Thus there is only one synapticular bar in each interseptal loculus. In longitudinal section the synapticula are seen to be narrow curved bars or partitions, in shape and

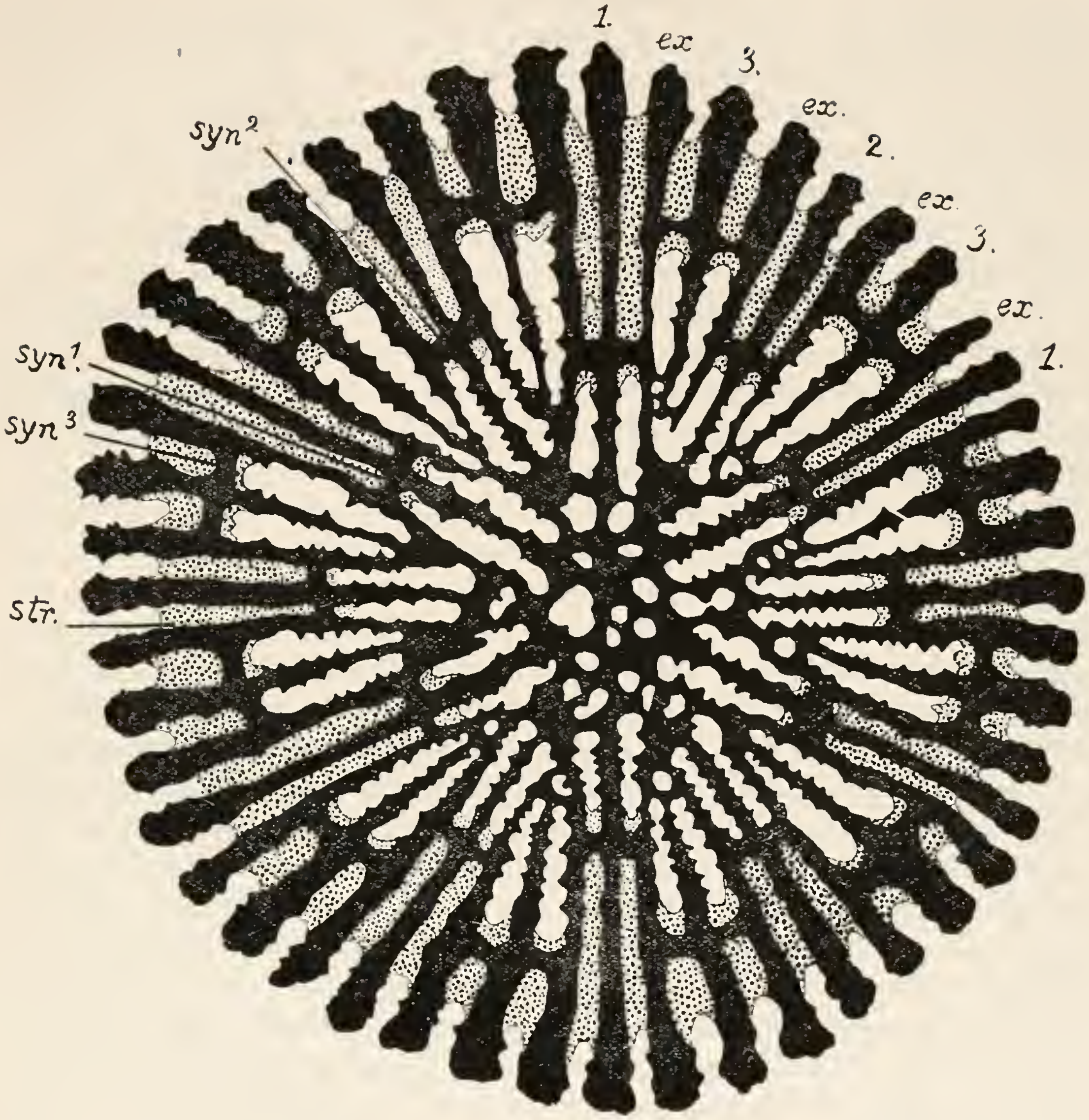


Fig. II. Diagram of a section through the corallum of *Heterocyathus aequicostatus* taken a short distance above the *Aspidosiphon* chamber. The septa and synapticula are black, the stereoplasm is shaded with dots. 1, 2, 3, endosepta of three cycles. *ex.*, exosepta. *str.*, stereoplasm. *syn.*[1], synapticulum connecting a primary endoseptum with an exoseptum. *syn.*[2], *syn.*[3], synapticula connecting secondary and tertiary endosepta with adjacent exosepta.

structure resembling any single synapticulum of *Fungia*. Their lower ends pass into the secondary calcareous deposit in the neighbourhood of the *Aspidosiphon* chamber; their upper extremities end in free margins at heights varying according as they connect a primary, a secondary or a tertiary endoseptum with an adjacent exoseptum.

The exosepta, in addition to this synapticular union, converge towards, and their inner ends unite with, the tertiary endosepta.

In the upper parts of the corallum the synapticula form the only union between adjacent septa, but a little distance lower down, and at some height above the *Aspidosiphon* chamber, the interseptal loculi become largely filled up by a secondary calcareous deposit, which, being of a dark colour from the presence of an abundant brown pigment, stands in sharp contrast to the white septa and synapticula in a rubbed down specimen. This deposit is crystalline in structure, and as it appears to have been formed independently of and subsequent to the original septa and synapticula, it has all the characters of a "stereoplasm," *i.e.*, a thickening on either side of every septum filling up the interseptal loculi. It should be observed that this deposit is most abundant and extends furthest towards the centre in the interseptal loculi adjacent to the primary endosepta; it is abundant, but does not extend so far towards the centre in the loculi adjacent to the secondary endosepta; it is least abundant in the loculi adjacent to the tertiary endosepta (fig. II.).

The structure of the septa is somewhat complicated, and different to anything that has hitherto been carefully figured or described. Each septum is very thin at its inner end and gradually thickens towards its outer or costal extremity. As is shown in Plate III., fig. 12, its inner edge is produced into a number of irregularly shaped teeth or paliform lobes, which merge into the columella, and the impossibility of distinguishing between these paliform septal offsets and true pali has been alluded to above. The faces of the septa are covered with small spiniform granulations which seem to radiate from a centre situated just within the lower end of the synapticulum. These spiniform granules are shown by longitudinal, horizontal and tangential sections to be the extremities of the radiating trabeculæ (using this term in PRATZ's sense) of which the septum is composed. Plate III., fig. 13, is a careful drawing of a horizontal microscopical section through the middle of the corallum, above the level of the *Aspidosiphon* chamber. The thin inner ends of the septa are shown to consist of a series of trabeculæ, standing in a single line, but at intervals diverging from the centre to end in a spiniform granule on the septal surface. Passing from the centre towards the periphery, the thickening of the middle and outermost parts of each septum is seen to be due to the multiplication of the trabeculæ, which no longer form a single line but stand in rows, first two, then three, and finally, at the costal extremity, five or six deep. It can be seen clearly enough in the horizontal section that these trabeculæ radiate not only towards the central and the peripheral ends of each septum, but also outwards towards the two septal surfaces, on which they emerge as the spiniform granules already described. The septum, then, is formed of a number of trabeculæ which radiate in all directions from an imaginary centre situated low down and nearer to the inner than the outer (costal) margin of the septum, and it is apparent that the centrifugal growth of the septum is effected by the addition of new trabeculæ on the outside of those first formed, these new trabeculæ being at first in single series, but in the more peripheral parts becoming arranged in curved rows, two, three, and more abreast. The curved growth lines, showing the successive additions to the septum, and their relations to the rows of trabeculæ, are well shown in the figure, as well as the way in which the outermost trabeculæ in each row from place to place bend sharply towards the surface and end in a spiniform granule.

It will be observed that there is no dark central line and no dark "centres of calcification." The centre of each trabecula is clearer than the surrounding calcareous deposit, and the latter, which appears white by reflected but dark by transmitted light, seems to have a very fine fibrous rather than a crystalline structure, but I could not make out the details clearly in the thinnest sections that I was able to prepare. In longitudinal sections each septum is clearly seen to be made up of a number of trabeculæ radiating like a fan from a centre, and each trabecula appears to be made up of a number of growth segments joined end to end, each segment formed by the fascicle of diverging fibres described by PRATZ and Miss OGILVIE as characteristic of the minute structure of the Madreporarian corallum.

But if no definite crystalline structure can be discovered in the septa themselves, or in the synapticula, the case is different for the "stereoplasm" in the interseptal loculi. This stereoplasm, except where it is heavily charged with brown pigment, appears dark by reflected and light by transmitted light, and, as is indicated in fig. 13, it is clearly made up of coarse crystalline fibres. The orientation of these fibres should be carefully studied, as it affords a proof that the stereoplasm is a secondary structure, and not a simple addition to the thickness of the septa. At the thin innermost ends of the septa the secondary fibro-crystals are disposed at right angles to the long axis of the septum (as seen in transverse, *i.e.*, horizontal section), and here we seem to have the characteristic structure of the Madreporarian septum with a middle dark line or "centre of calcification," &c. But where the stereoplasm is thick and completely fills the interseptal loculus, it displays a number of curved lines of growth, generally emphasized by the deposition of curved bands of dark brown pigment, and it should be noted that, whereas the curved growth-lines of the septa have their convexities directed outwards, the reverse is the case with the growth-lines of the stereoplasm. The fibro-crystals of the latter, as is shown in fig. 13, are arranged in diverging bundles, conformably to the curved lines of growth, in such a manner as to appear to diverge from a stereoplasmic "centre of calcification" which is more apparent in tangential than in horizontal sections. It is obvious that, after the septa and synapticula have been formed, the soft tissues in the deeper parts of the corallum shrink away from the septal and synapticular surfaces both externally and internally, and as they shrink away the calicoblastic layer again enters into activity and deposits the coarsely fibro-crystalline stereoplasm that eventually fills up the interseptal loculi to a greater or less extent.

Concerning the brown pigment, I have very little to say. It appears to be deposited in the form of minute granules between the fibro-crystals, but I found it impossible to make sections sufficiently thin to admit of an accurate study of it.

I have entered at some length into this question of secondary deposit or "stereoplasm," as there appears to be unquestionable evidence of its existence in *Heteroeyathus*, and the minute structure of the corallum of this genus may prove serviceable in the interpretation of the structure of some fossil corals. Miss OGILVIE (**41**, pp. 93–99) denies the existence of a "stereoplasm" in both recent and fossil corals, and she was perfectly right as regards the corals that she describes. There is, however, a close analogy between the secondary thickening or stereoplasm described by VON KOCH (**29**) in *Pholidophyllum* and that of *Heterocyathus*, and it is possible that the structure of *Lonsdaleia indica*, as described and figured by WAAGEN (**51**), may be referred to the same type, but in neither case are the authors' figures sufficiently detailed to enable one to speak with certainty. The description given by FRECH (**19**) of *Idastræa profunda*, and quoted at length by Miss OGILVIE (**41**, p. 99), might be applied with very little correction to *Heteroeyathus*, but in this case again the author's figure is on too small a scale to enable one to judge whether the structure is identical or not with that here described.

General Anatomy of the Polyp.—As described by GARDINER (**23**), the corallum is completely invested by the tissues of the polyp, the latter being interrupted only at the mouth of the *Aspidosiphon* chamber. It must be borne in mind that the young *Heteroeyathus* is attached to and grows round a gastropod shell (usually a *Cerithium*) tenanted by an *Aspidosiphon*, and that the growth of the coral and the Sipunculid proceed *pari passu* till we get the intimate association between the two forms characteristic of their adult condition. The shell, which served for the original habitation of the Sipunculid and the surface of attachment for the coral, is completely overgrown and eventually greatly exceeded in size by the latter. It is evident, then, that as the coral grows, its soft tissues must be folded down all round the edge of the cup to form a "perisarc," using that term in the restricted sense given to it by BERNARD (**4**, p. 21). As the corallum grew round the shell, the perisarc must have kept pace with it; indeed, it would be more correct to say that the soft tissues enveloped the shell, and that their innermost ectodermic or calicoblastic layer secreted the corallum which eventually enclosed the shell, and, growing beyond its limits, formed the *Aspidosiphon* chamber. Eventually the edges of the perisarc, growing round the shell on all sides, meet and unite below, excepting in the region of the mouth of the shell. Thus we get a basal union of the perisarc similar to that observed in *Fungia*, and as in the last-named genus we find that the mesenteries are prolonged into the cavity of the perisarc and divide up the extra-thecal cœlenteron into as many entocœlic and exocœlic chambers as there are mesenteries. The mesenteries, however, do not extend to the centre of the base of the coral. They may be traced as far as the costæ, but die out where the costæ pass into the central irregular basal granulations, and here the soft tissues appear to be supported on the granulations in the manner described by FOWLER (**16**). Above the level of the synapticula, which not only physiologically replace but are in some respects morphologically equivalent to a true theca, the external portions of the exocœles and endocœles are continued into the corresponding internal chambers, and when the polyp is fully expanded the depth of these intermesenterial chambers must be considerable, owing to the relatively great height of the exsert septa. Spirit specimens are, of course, very much contracted, and the soft tissues are everywhere stretched over and down in between the septa, pali and columella to an extent that makes the interpretation of sections a matter of considerable difficulty.

The Tentacles.—These, as stated by GARDINER, are twenty-four in number, one corresponding to each endocœle. Owing to contraction it is somewhat difficult to determine the position of the tentacles in an expanded polyp, but it appears that the twelve tertiary tentacles form an external circlet situated quite at the edge or even outside the margin of the calyx. The six primary and six secondary tentacles form an inner circle within the margin of the calyx; they alternate with one another and the primaries are nearer to, but still at some considerable distance from, the mouth. The tentacles are thickly covered with knob-like batteries of nematocysts, which are conspicuous in sections. Each tentacle is attached at its base to the two members of a mesenterial pair, and the longitudinal muscle fibres of the mesenteries are continued up into and may be traced to the tip of the tentacle. In contraction the tentacles are completely introverted by the action of the muscle fibres, and in spirit specimens, owing to the excessive contraction of the mesenteries themselves, the invaginated tentacles are doubled over the endocœlic septa and each appears in sections to be prolonged downwards into two pockets, one in each mesentery of the pair to which it belongs (fig. III.).

The Peristome and Mouth.—Owing to the distance of the tentacles from the mouth, the peristome is of considerable extent. It is closely contracted against the numerous pali and paliform lobes at the inner edges of the septa, and its contours are scarcely distinguishable in spirit specimens. The mouth is an oval aperture whose size varies very much in spirit specimens; in some it is contracted to a narrow oval, in others it is widely open, giving a clear view of the soft tissues investing the columella. The mouth, according to all received ideas on Actinian anatomy, should open into a stomodæum, but in *Heterocyathus* there is no definite stomodæum, in the sense of a longer or shorter tube lined by a modified epithelium. The ectoderm of the peristome is very thin, and at the lips of the mouth it is somewhat thickened, and, as described below, there is evidence of a distinct sphincter oris and a distinct dilator oris (radiating fibres) muscle in this region. Immediately within the lips, but not uniting to form a complete tube, are the large gutter-shaped "filaments" of the six primary mesenterial pairs which undoubtedly perform the functions of a stomodæum, and may be described as twelve discontinuous portions of the stomodæum, united only by the thickened but not modified ectoderm of the lips. There is no trace of a sulcus or sulculus (gonidial grooves). The reduction of the stomodæum seems to be clearly due to the great development of the pali and the

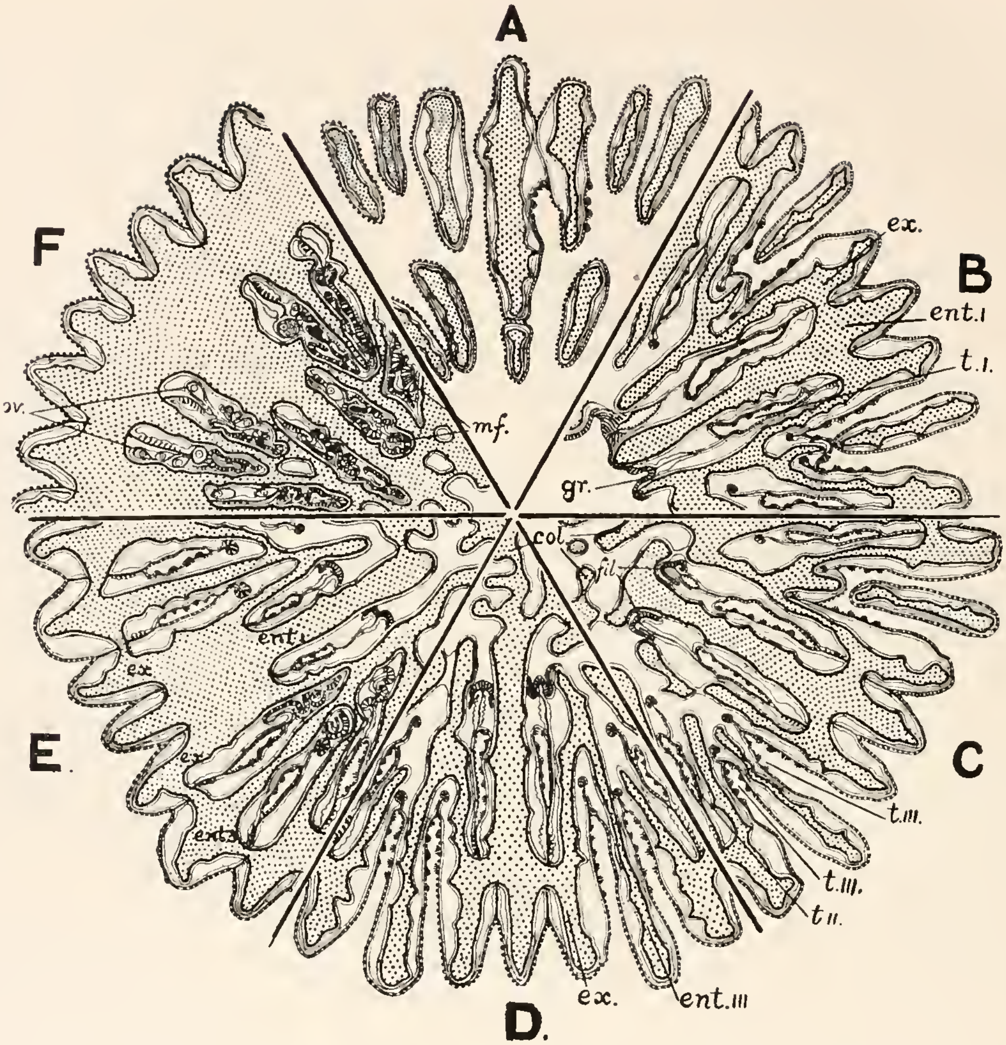


Fig. III. Semi-diagrammatic representation of six successive horizontal sections through the same sextant of *Heterocyathus æquicostatus.* The corallum is shaded with dots; the mesoglœa is represented by a black line, the endoderm by a contour line following the mesoglœa; the ectoderm is blocked. A passes through the exsert portion of the septa, B through the mouth, C and D are sections about 0·25 millim. apart and below the mouth; the interseptal loculi in these sections are not reduced by the formation of secondary calcareous deposit or "stereoplasm." In E a considerable amount of stereoplasm has been deposited in the loculi adjacent to the primary endoseptum. In F all the loculi are reduced by the deposit of stereoplasm and the mesenteries contain ova. *ent.*I., *ent.*II., endosepta of the first and third cycles; portions of the second-cycle endosepta may be seen at the edges of each sextant. *ex.*, exosepta. *fil.*, band-like primary mesenterial filaments. *gr.*, groove leading from the mouth to one of the primary mesenterial filaments. *m.f.*, coiled mesenterial filaments. *t.'*, *t.''*, *t.'''*, introverted tentacles of three cycles doubled over the corresponding endosepta. *col.*, columella.

columellar upgrowths. There is not, in fact, room for a stomodæum in the contracted polyp.

The Mesenteries.—These are of the normal Actinian character and are forty-eight in number, consisting of six primary, six secondary, and twelve tertiary pairs. The muscle banners are well developed, and the directive pairs, as is usual, have the muscle banners on their outer faces. The general arrangement of the mesenteries and their relations to the septa, mouth, and peristome are shown in the diagram, fig. III., A, B, C, D, E, F, which represent six sections of the same sextant of a decalcified specimen of *Heterocyathus* taken at different levels. The six pairs of primary mesenteries extend further inwards than the rest, and they alone reach the mouth. The six secondary pairs are intermediate in length, and the twelve tertiary pairs are the shortest of all. As stated above, the free edges of the primary mesenteries at and below the lip of the mouth are broadened out to form a T-shaped or Y-shaped "filament" (fig. III., D, *fil.*). The inner face (*i.e.*, the face directed towards the central cavity of the polyp) is covered with a very thick ciliated epithelium which passes somewhat abruptly into the thinner but still thick epithelium of the lips. Below the level of the mouth the arms of the T- or Y-shaped filament become free from adjacent tissues and may be traced as broad ciliated bands, which in section appear T-shaped, or Y-shaped, or W-shaped, for a considerable distance below the level of the mouth into the gastro-vascular cavity. As long as they retain this size and shape, they are composed almost exclusively of very long attenuated ciliated epithelial cells, whose nuclei stain deeply and are closely crowded together; there are few glandular elements interspersed among the attenuated cells, and no nematocysts. Towards the bottom of the gastrovascular cavity these bands become smaller, and gradually assume the normal shape of a mesenterial filament; gland cells become more abundant and large nematocysts make their appearance. At the bottom of the cavity the filament is thrown into a complex coil, and is loaded both with gland cells and nematocysts of the large type. It is impossible to say, from a study of sections alone, whether the coiled masses at the bottom of the intermesenterial chambers are acontia, *i.e.*, free offsets of the edges of the mesentery, or simply coiled filaments. GARDINER (21) describes acontia in *Cœnopsammia*, but I am inclined to the opinion that in *Heterocyathus* the structures that might be mistaken for acontia are only coiled mesenterial filaments.

The filaments of the secondary and tertiary mesenteries do not reach the axial gastrovascular cavity, and are easily distinguished from the primary filaments. They are much smaller, especially in the upper part of their course, and have the usual kidney-shaped outline in section. Like the primary filaments they appear to consist almost exclusively of ciliated cells in the upper part of their course, but they soon show glandular cells and large nematocysts (Plate III., fig. 15). At the bottom of the gastrovascular cavity the filaments of the secondary and tertiary mesenteries are thickened and coiled like those of the primaries.

The absence of a definite stomodæum and the extent and importance of the ciliated bands forming the upper ends of the primary mesenterial filaments are features which, though peculiar, are readily explained by a consideration of their relations to the palial and columellar structures. As may be seen in fig. III., C, the hammer-shaped palial process at the inner end of the primary septum cuts off the filaments of the primary mesenteries from the axial space, and in D the palus is seen to have contracted unions with the columellar pillars, cutting off the interseptal loculi from the axial space. It is evident that the broad ciliated filaments, extending far down in these nearly isolated loculi, are the chief if not the only agents in maintaining the circulation in the deeper parts of the loculi. Fig. III., F, shows how much the interseptal loculi become narrowed and isolated in the deeper parts of the coral in consequence of the abundant secondary thickening or stereoplasm.

All the mesenteries are fertile. In female polyps the ripe ova are large, and filled with granules of deutoplasm. I have been unable to make out details to my satisfaction, but the ova, when young, appear to become enclosed in the mesoglœa, and as they increase in size they project from the sides of the mesenteries, still enclosed in a thin mesoglœal envelope, outside of which is a layer of endoderm, forming a sort of follicle. The ripe ova are pyriform and hang in bunches from the sides of the mesenteries, each ovum attached by a slender stalk of mesoglœa and surrounded by its follicle of endoderm cells.

The relation of the mesenteries to the septa affords a strong presumption in favour of the view that these structures have been formed according to Pourtalès and Duerden's law. As has been shown, the septa are alternately exocœlic and endocœlic. The exocœlic septa, which on the usual system of notation would be called quaternaries, are larger than the endocœlic tertiaries, and, as is shown in fig. III., B and C, their inner ends meet and unite in front of the latter. Further than this, in each system the exocœlic septa adjacent to the primaries converge and meet together in front of the secondaries, forming the more or less distinct chevron-shaped pali described above. This union can best be seen in fig. II. As the tertiary endocœlic septa are enclosed within the smallest and therefore the most recently developed mesenterial pairs, and as they are themselves the smallest and least exsert of all the septa, and only unite with the Y-shaped figures formed by the exocœlic septa low down in the corallum (fig. III., B, C, and D), the evidence that they are the most recent in point of formation, and that they and the mesenterial pairs embracing them originated between the diverging Y-shaped outer ends of the exocœlic septa, in the manner described by Pourtalès and Duerden, is sufficiently convincing.

The little canals or tubes, running inwards from the lateral walls of the coral and opening into the *Aspidosiphon* chamber, have been described and figured by several authors, but their minute characters have not yet been investigated. They are almost exactly like the similar tubes in *Heteropsammia*, and the transverse section, Plate IV., fig. 24, of a tube of the latter genus serves equally well for *Heterocyathus*. The resemblance is the more striking because in *Heterocyathus*, an imperforate Turbinolid, there are endodermal canals, usually twelve in number, closely attached to the whole length of the tube, which is itself lined by an invagination of the ectoderm. In *Heteropsammia* these canals form part of the system of endodermic canals characteristic of perforate corals, but their presence in *Heterocyathus* is remarkable. The transverse section has a curious resemblance to a section through a young Actinian with twelve mesenteries and a very wide stomodæum. The ectoderm lining the central tube is curiously modified at its inner end, as will be described below. The tubes vary in number and position. There may be from five to nine of them, and they are not, as a rule, in the same plane, but in the majority of specimens they are more numerous and more closely set together on the side furthest from the mouth of the *Aspidosiphon* chamber. Tangential sections of the corallum show that the tubes are interseptal, and that the stereoplasm filling up the interseptal loculi is interrupted by their presence. Being interseptal, their external openings are always between the costæ.

Histology.—Though Professor HERDMAN'S specimens are exceptionally well preserved, histological details are, as is usual in corals, difficult to determine to one's satisfaction. In what follows I do not profess to give a complete account of the histology of the different tissues, but will confine myself to such details as I have been able to make out to my own satisfaction.

The Ectoderm.—As is shown in fig. III., the ectoderm of the body-wall is more or less deeply infolded between the costæ in spirit specimens. It is thinner where it is stretched over the edges of the costæ and thicker in the furrows between, and this does not seem to be due to contraction in spirit and the consequent stretching of the tissue over the costal edges, but to a differentiation of the ectoderm, which is not only thicker, but more glandular and more richly provided with nematocysts in longitudinal stripes, corresponding to the attachments of the mesenteries. In the thinner stripes of ectoderm corresponding to the costæ the tissue consists almost entirely of columnar or cubical epithelial cells. There are very few gland cells, and few, if any, nematocysts. In the thicker stripes opposite the attachments of the mesenteries the epithelial cells are longer, and there are numerous gland cells and nematocysts of the kind shown in Plate III., fig. 18. The gland cells are of an elongated goblet form, with a compressed nucleus at the base of the goblet and a very thin protoplasmic stalk passing from the nucleus to the mesoglœa. They contain a number of yellowish-brown highly refractive granules, which do not stain with any of the ordinary aniline dyes, or with hæmatoxylin. Similar gland cells are very abundant in the ectoderm of the tentacles. The nematocysts, two of which are shown everted in fig. 16, are elongate oval in shape with a somewhat coarse thread coiled loosely within. The everted threads are covered with long barbs disposed in a spiral. Before eversion these nematocysts contain a flocculent substance which stains bright blue in picro-indigo-carmine, and therefore probably belongs to the class of hyalogens, all of which stain similarly with this dye.

The ectoderm lining the outer moieties of the tubes leading into the *Aspidosiphon* chamber is of the same character as that of the thickened stripes of the body-wall, but it is remarkably modified in the inner moieties of these tubes. It becomes much thicker (Plate III., fig. 17) and has a vacuolated appearance, and in place of the gland cells described above we find elongated pyriform gland cells filled with round granules, which stain deeply in hæmatoxylin. But the most striking feature is afforded by the nematocysts. These are very numerous, closely crowded together, are ovoid in shape and very large, with a thick thread covered with barbs arranged in a double spiral. They contain coarse, closely-packed granules, which stain intensely blue in picro-indigo-carmine. In spite of their much larger size (figs. 16 and 17 are drawn to the same scale) and their different shape, I regard these as modifications of the ordinary nematocysts of the ectoderm of the body-wall. But they are certainly very strikingly modified, and I am at a loss to explain their function, situated as they are at the deeper end of tubes whose function is also problematical.

The ectoderm of the tentacles is raised into a great number of the well-known knob-like "batteries," crowded with small nematocysts of the usual form with a closely coiled spiral thread. Interspersed among these are larger nematocysts resembling those of the body-wall, but usually much longer and narrower. The ectoderm of the peristome is extremely thin, and consists of a cubical epithelium with very few gland cells, and, as far as I could ascertain, no nematocysts. At the lips of the mouth, however, the ectoderm is thickened, and shows some special features not visible in the ectoderm of the body-wall. There are very few gland cells, those which are present containing coarse granules staining blue in picro-indigo-carmine. I could not detect any nematocysts. Muscle fibres, which were scarcely distinguishable in the peristome, are here well developed and arranged radially so as to form a more or less distinct dilator oris muscle. In many sections the epithelio-muscular character of the ectoderm cells becomes evident. The layer of nerve fibres at and between the bases of the ectoderm cells is distinct, and among the epithelio-muscular cells very small attenuated, spindle-shaped cells may be distinguished which may be interpreted as sense cells. This thickened ectoderm passes insensibly into the endoderm at the lower margin of the lips, except at the places where the twelve primary mesenteries reach the mouth. Here it is continued into the very thick ectoderm of the Y- or T-shaped filaments of these mesenteries. In these filaments, as mentioned above, the ectoderm consists almost exclusively of very long attenuated, ciliated, epithelial cells, whose character is sufficiently indicated in fig. 14. There are very few glandular elements and no nematocysts. The coiled filaments of the bases of the primary mesenteries, and nearly the whole extent of the filaments of the secondary and tertiary mesenteries, consist of closely-packed, attenuated, epithelial cells, among which numerous gland cells and nematocysts are wedged in. The gland cells are of two kinds: (1) ovoid vesicular cells with clear contents; (2) pyriform cells containing coarse granules staining deeply in picro-indigo-carmine or hæmatoxylin. The nematocysts are all of the type shown in fig. 18. They are very large, measuring

0·06 millim. in length, and the central thread stains intensely blue in picro-indigo-carmine. They are clearly of the same type as, but somewhat larger than, the mesenterial nematocysts described by GARDINER (21) in *Cœnopsammia*.

As regards the layer of calicoblasts and the desmocytes, they are of the usual character, and I have nothing to add to what I have published concerning these structures in a previous paper (7).

The Endoderm.—As is usual in corals, the highly vacuolated endoderm cells are so badly preserved that nothing very definite can be said of their structure. They differ, however, in different regions of the body. The endoderm cells covering the muscle-banners and the extrathecal continuations of the mesenteries, and also those of the tentacular endoderm, are very long and columnar, and are crowded with Zooxanthellæ. As a rule there is a similar modification just within the mesenterial filaments, this modification being most pronounced in the primary mesenteries. Elsewhere the endoderm consists of a rather low columnar or cubical epithelium, and Zooxanthellæ are more scarce or, in some places, absent. GARDINER (21) lays great stress on the absence of glandular elements in the endoderm, but my observations do not support his conclusions. Glandular elements, it is true, are few or altogether absent, not only in the elongated endoderm above referred to, but in the whole or the greater part of the endodermic investment of the mesenteries. But in *Heterocyathus* the endoderm of the axial gastrovascular cavity, that is to say the tissue investing the pali and columellar upgrowths, is invested by a moderately thick cubical endoderm in which there are few Zooxanthellæ, but numerous ovoid or bean-shaped cells containing clear refractive granules which do not stain with any of the aniline dyes used, nor with hæmatoxylin. These cells are shown in Plate IV., fig. 19. It is, of course, possible that they may be modified nematocysts. Similar cells are found, though not so abundantly, in the endoderm wherever it is opposite a layer of calicoblast, and this would seem to suggest that the function of the cells in question is to elaborate material which is passed through the thin mesoglœal lamina to the layer of calicoblasts and converted into calcareous tissue by the agency of the latter. This view has a certain probability, because the calicoblasts form so thin a layer, and are themselves so retrograde in structure that it is difficult to believe that they are the only agents in the active growth of the corallum. On the other hand, I have observed fragments of copepods and diatoms in the intermesenterial chambers, at some distance from the filaments, and as these have evidently been or are being digested, it is equally possible that these glandular-looking cells in the endoderm may secrete a digestive fluid. At all events the facts do not warrant so sweeping an assertion as that of GARDINER, that the endoderm is excretory but not glandular, or the conclusions as to the homology of the Anthozoan layers that he has founded on it.

In some, but not in all my series of sections, the endoderm, in addition to the glandular elements described above, contained a number of large amœboid cells of various shape, two of which are shown in fig. 20. They were very abundant in one series, but entirely absent in another, and in a third they were rare. They are filled with large refracting granules, which generally stain crimson in picro-indigo-carmine, but in some cases they stain a deep indigo blue. They can be nothing else than amœbocytes, and are probably excretory in function. Their abundance in one specimen and their rarity or absence in others is probably attributable to the different conditions of nutrition of the polyps in question. It is well known that the endoderm of Cœlenterates, *e.g.*, of *Hydra*, presents very different appearances according as the animal has been recently fed or starved, and I have found the most diverse appearances, particularly in the matter of the presence or absence of endoderm cells loaded with granules, in the endoderm of *Hydræ*, according as they had been fed abundantly or starved.

Finally, it may be noted that at the bottom of the axial cavity there are large spaces, and frequently there is a single large central space in the axial gastro-vascular cavity. The endoderm lining these spaces or space is invariably devoid of Zooxanthellæ and gland cells, and has the simple columnar form depicted in fig. 21.

As regards the occurrence of nematocysts in the endoderm, I occasionally found large nematocysts, of the second type characteristic of the tentacular batteries, in the tentacular endoderm, but invariably in close proximity to one of the batteries. I conclude, therefore, that these nematocysts were not formed in the endoderm, but have been forced through the mesoglœa into the endoderm during the violent contraction produced by the action of reagents. Elsewhere I could find no trace of nematocysts of any kind in the endoderm.

2. **Heteropsammia michelini**, M. Edw. and H.

(Plate IV., figs. 22 to 25.)

The remarkable analogies between this coral and *Heterocyathus æquicostatus* have been commented on by several authors. Both are built up round a gastropod shell tenanted by an *Aspidosiphon*, both have an exactly similar spiral *Aspidosiphon* chamber in the adult state. In both there is a minute Lamellibranch commensal with the *Aspidosiphon* within the chamber, and in both there is a number of minute tubes lined by ectoderm leading from the lateral walls of the coral into the chamber in question. The shape and general appearance of the two corals is closely similar, but whereas *Heterocyathus* is always a simple coral, *Heteropsammia michelini* generally exhibits two calices produced by fission of the parent calicle, and *H. multi-lobata* exhibits several calicles. The anatomy of the last-named species has been described by Fowler (18), who notes the following features. The external soft tissues rest on the echinulations of the cœnenchyme; the tentacles are simple, without nematocyst batteries, and are apparently both exocœlic and endocœlic; exosepta and endosepta are present, and certain of the septa fuse centrally, as in *Rhodopsammia*

(*Balanophyllia*); the number of mesenterial pairs is very variable and there are no directive mesenteries; the tubes leading into the *Aspidosiphon* chamber are lined by ingrowths of the body-wall consisting of ectoderm, mesoglœa, and endoderm. No account is given of the histology.

H. multilobata is a well-marked colonial form with several calices, whereas *H. michelini* usually has two calices only, and some of the differences between my observations and Fowler's are no doubt attributable to the difference in habit of the two species. In older specimens of *H. michelini* the septal arrangement is sometimes very irregular, but in young specimens with a single undivided calicle the septa are arranged in a normal manner in six systems and four complete cycles, and their relations are practically identical with those described in *Balanophyllia*, and with a little trouble one may select a considerable proportion of adult specimens, in which two calicles have been formed by fissiparity, in which the septal arrangement differs very little from the normal.

The most interesting results, however, are obtained from specimens with a single elongated but as yet undivided calicle. I made a series of sections through one such specimen and another series through an obviously regular calicle of a specimen in which fissiparity was complete. The sections show that the septa are alternately exocœlic and endocœlic. In the first specimen with an undivided calicle there are two pairs of directive mesenteries defining the primary septa at each end of the long axis of the calicle. A portion of one side of the specimen was destroyed by the ravages of a boring sponge, but in the complete half I was able to count three systems and twenty-six endosepta arranged in four complete cycles, and a single septum of a fifth cycle in the chambers adjoining the directive septa. I have given a diagram of this specimen in fig. IV. The diagram is carefully constructed with reference to a camera drawing of the actual section, but the complexity of the actual drawing is so great, owing to the porous nature of the corallum, and the details are so minute that it is impossible to get them all into any figure of reasonable size other than a diagram.

It will be observed that the arrangement of the septa and their relations to the mesenteries are practically identical to what has been described in *Heterocyathus*. But particular attention should be paid to the exocœlic septa, which are shaded with lines to distinguish them from the endosepta. Nothing can be more clear than the fact that their peripheral ends have been thickened; that chambers have been formed in the thickened ends, whereby the septa became Y-shaped. And, finally, that the quaternary endosepta have been formed between the mesenterial pairs arising in the forks of the endosepta, and in some cases they have and in some they have not united with the inner ends of the exosepta. Moreover it is clear, from the manner in which the inner ends of the exosepta unite in the columella, that the tertiary endocœles must have been formed in exactly the same manner as the quaternaries obviously have been. There could not be a more striking demonstration of the validity of

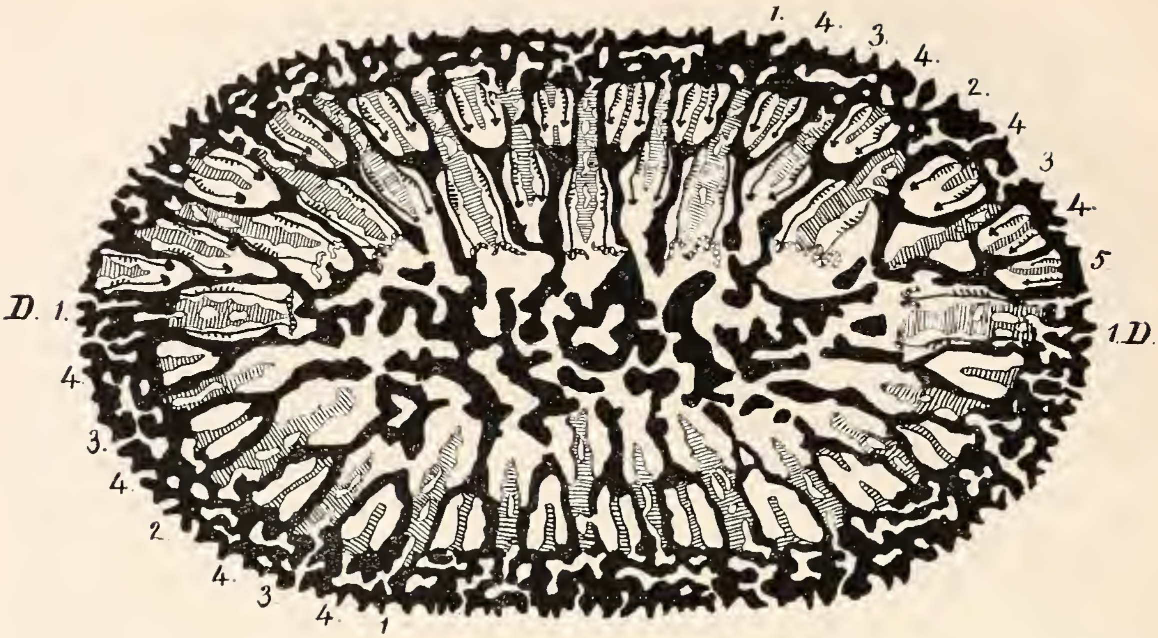


Fig. IV. Diagram of a specimen of *Heteropsammia michelini* in which the calice has not yet divided by transverse fission. The endosepta are cross-shaded, the exosepta, the porous theca, and the columella are black. The mesenteries are indicated in the upper half of the figure but not in the lower. *D*, *D*, directive mesenterial pairs. 1, 2, 3, endosepta of the first, second, and third cycles. 4, 4, fourth-cycle endosepta, each enclosed in a chamber formed by the forked peripheral ends of an exoseptum. In several cases the inner ends of the exosepta may be seen to unite in front of a tertiary endoseptum and to be prolonged beyond the point of union into the columella. 5, an endoseptum of the fifth cycle formed in a bifurcation of an exoseptum adjoining one of the directive endosepta.

Pourtalès and Duerden's law in the case of Eupsammid corals. It should be noted, however, that the quinary mesenterial pairs do not arise according to the sequence observed by Duerden in *Siderastræa*, but are contiguous to the sulcar (dorsal) and sulcular (ventral) primary septa.

My second series of sections, through a polyp which had been formed by transverse division from the original single parent polyp, gave some interesting results. A tracing of a section taken a little above the level of the stomodæum is given in fig. 22. The arrangement of the septa and mesenteries is remarkably regular. There are apparently six systems and three cycles of endosepta, with an additional quaternary septum in the chamber on the right side of the directive septum, that is to say, there is just half the number of endosepta that there was in the elongated and undivided specimen. The endosepta may be classified according to size and relations as primaries, secondaries, and tertiaries, but they cannot have made their appearance in this order, as they were derived from the pre-existing septa of the parent polyp. The number of parental mesenteries has evidently been halved in the process of division. No new septa have been added, but the quaternaries of the parent have become the tertiaries of the offspring.

Another singular fact is the presence of only one pair of directive mesenteries, the absence of the second pair being obviously explained by the division of the parent at right angles to the long axis of the calicle, whereby one pair of directives remained in the one, and the other pair in the other of the offspring. The existence of the single pair of directives in a coral which has doubled itself by a single act of fissiparity confirms the conclusion I arrived at in an earlier paper (**5**), that the absence of directives in many corals is to be explained by the fact that they have multiplied by fission.

To deal briefly with other points in the anatomy of the polyp. The external body wall, as Fowler describes, rests upon the echinulations of the cœnenchyma, and there are no peripheral continuations of the mesenteries. The tentacles are all endocœlic, and therefore correspond in number to the endosepta. In contraction they are introverted, and in this condition are doubled over the inner edges of the endosepta. Thus they are situated nearer the mouth than in *Heterocyathus*, and the peristomial area is correspondingly reduced. The primary and secondary tentacles form a circle nearest to the mouth, the remaining orders form circles at greater distances from it, and it follows from their relations to the endosepta that the tentacles of different orders alternate with one another. In *H. michelini* the tentacles are covered with well-developed batteries of nematocysts; in *H. multilobata*, according to Fowler, they are not.

There is a short, but distinct stomodæum, and I think that I found traces of a sulcus (gonidial groove), but of this I cannot be certain, as both my specimens suffered partly from the attacks of boring sponges, and partly from the fact that grains of quartz sand were lodged in the angles of the mouth and produced imperfections in my sections in those regions. However this may be, the circulation of water in the complex chambers in which the lower parts of the mesenteries are lodged is provided for by means similar to that described in *Heterocyathus*. The filaments of the primary and secondary mesenteries form broad sinuous bands in the upper part of their courses, and it is only deep down in the coral that one meets with the characteristic kidney-shaped sections of mesenterial filaments. The number and arrangement of the mesenteries has been sufficiently described. As far as I could determine, all the mesenteries are fertile, but in the undivided specimen of which I made sections the quaternary mesenteries, especially those in the lateral chambers, were in advance of the remaining orders as regards the maturity of ova contained in them. The ova, and as far as I could make out in a series of longitudinal sections the testes also, are embedded in the mesoglœa of the mesenteries in the manner figured by the Hertwigs for *Actinia*, and do not hang from the sides of the mesenteries in follicles as in *Heterocyathus*.

Histology.—The external tissues were very well preserved, but the reagents had not penetrated well, and the endoderm and mesenterial filaments were in consequence macerated and of little use for histological examination.

The Ectoderm (fig. 23) of the body-wall is relatively much thicker than in *Heterocyathus*, and is richly supplied with gland cells and nematocysts. The character of the epithelial cells is well shown in the figure. The gland cells are of three kinds:—(1) Goblet cells with a central nucleus and filiform internal ends, the wider external end filled with small granules staining deeply in hæmatoxylin or picro-indigo-carmine. (2) Flask-shaped cells with broad internal ends and a narrow neck opening at the surface; these cells are filled with coarse granules which stain in the same way as those of the first variety. (3) A few large vacuolated sac-shaped cells whose contents stain with eosin, but remain colourless in picro-indigo-carmine.

The nematocysts are of two kinds. The small spiral-thread variety is fairly abundant, and here and there are large torpedo-shaped nematocysts with barbed threads, similar to those described for *Heterocyathus*.

The ectoderm lining the small canals leading into the *Aspidosiphon* chamber is not modified as in *Heterocyathus*, but contrariwise, it loses its glandular character and consists almost exclusively of ciliated columnar cells, among which nematocysts of the larger variety with barbed threads are to be found. In some of my sections the lumina of the tubes are packed with everted nematocysts of this kind, which have evidently been discharged when the polyp was killed, and this suggests that these canals serve in some manner as special batteries of nematocysts protecting the commensal Sipunculid. In fig. 25 I have given a representation of the manner in which these chamber canals pass through the general mass of cœnenchymal canals into the *Aspidosiphon* chamber. It will be observed that the endoderm canals, generally twelve or thirteen in number, surrounding them are specially related to the chamber canals and lie parallel to them.

The tentacular ectoderm is raised into large and broad nematocyst batteries containing numerous small spiral nematocysts and a lesser number of those of the larger type. In the peristomial region the ectoderm becomes thinner, less glandular, and contains but few nematocysts. At the lips it again becomes thick, and in this region the nervous layer is thicker than elsewhere, and I was able to observe a few large pale nuclei embedded in the layer of nerve fibrils which appear to belong to gland cells. In this region, as in *Heterocyathus*, the radially disposed muscular fibres of the ectoderm cells are very conspicuous, and one can equally well recognise the circular layer of endodermic fibres forming a sphincter oris.

The ectoderm of the lips passes without any abrupt change into the stomodæum. Here the same elements may be recognised, but in different proportions. The epithelial cells are elongated filiform, and their deeply staining elongated nuclei are closely crowded together. Nematocysts of the spiral and barbed types are fairly abundant, especially the latter variety. The glandular cells are much increased in number, especially the eosinophile cells of the third type. The layer of nerve fibrils at the bases of the cells is relatively thick. This structure is continued without much change into the broad filaments of the primary and secondary mesenteries, but in the lower part of their courses the spiral nematocysts and the basophile gland cells become less numerous, and the number of eosinophile gland cells is correspondingly increased. The coiled mesenterial filaments were too much macerated to admit of accurate observation. I was only able to satisfy myself that they contain numerous large barbed nematocysts, but none of the spiral variety; that the epithelial cells are attenuated and closely packed together in groups, and that there are numerous very large eosinophile gland cells between the groups.

The endoderm was too much macerated to admit of careful study. The cells are evidently highly vacuolated, and their nuclei are unusually small. Zooxanthellæ are abundant in the most external cœnenchymal canals, but are scantily distributed in the deeper parts. In one of my specimens the endoderm was full of granular amœbocytes similar to those described in *Heterocyathus*.

3. Dendrophyllia gracilis, M. Edw. and Haime.

(Plate IV., figs. 26 to 28.)

The anatomy and histology of *D. ramea* has been fully described by von Heider (26), whose observations are so careful and accurate that I have little to add to them. He has given a very full account of the relations of the perisarc (edge-zone or "Randplatte"), and has fully realized the importance of the exosepta and the manner in which the tertiary mesenterial pairs, and the exosepta embraced by them, are formed in the Y-shaped peripheral extremities of these exosepta. The full significance of this observation of course escaped him, as he was unacquainted with Pourtalès' account of the development of *Balanophyllia*, and his memoir was many years anterior to Duerden's recent work.

Dendrophyllia is an arborescent genus propagating by lateral buds. The soft tissues extend for a considerable distance below the lip of the calicle, forming a well-marked edge-zone or perisarc. The septa and theca are thin and fragile, and there are well-marked external costæ corresponding to the septa. Correlated with the presence of costæ is the existence of peripheral continuations of the mesenteries in the perisarc, as has been correctly described and figured by von Heider. There is practically no difference between the septal arrangement of *D. gracilis* and *D. ramea*. In both there are three cycles of endosepta, and the exosepta alternate with the endosepta, forming an apparent quaternary cycle. Von Heider has given an excellent account of the manner in which the apparent quaternary exosepta meet and unite in front of the short tertiary endosepta, and his diagram (*loc. cit.*, plate xxxi., fig. 7) leaves nothing to be desired in clearness and accuracy. It is evident that the septa and mesenteries are formed in strict accordance with Pourtalès' and Duerden's law, and I am able to add this much in confirmation. I made a series of sections through a small lateral bud measuring about 2 millims. in diameter. In this bud there are only twelve pairs of mesenteries. Six pairs, of which two are directives, are well developed and reach the stomodæum; they embrace the primary endosepta, the latter being tolerably well developed as narrow, ridge-like projections in the calicle, but with branched peripheral ends passing into the network of trabeculæ forming the cœnenchyme. Alternating with the endosepta are six exosepta of approximately the same size, whose peripheral ends bifurcate and enclose chambers in which are the mesenterial pairs of the second cycle. These secondary mesenteries are unequally developed, but not, as far as I could determine, according to any regular sequence. Each pair embraces an endoseptum, which in some cases is very rudimentary, but in other cases has grown centipetally and has united with the inner limb of the Y-shaped exoseptum (fig. V). Thus we see that in the bud the

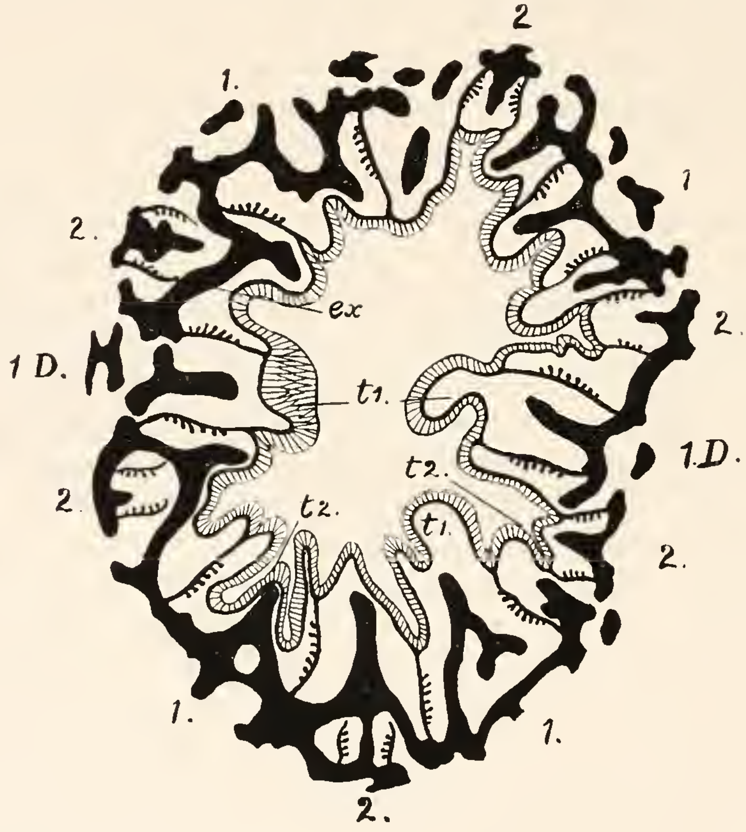


Fig. V. Semi-diagrammatic section through a young bud of *Dendrophyllia gracilis*. 1, 2, the primary and secondary cycles of endosepta embraced by the corresponding mesenterial pairs. *D*, *D*, the two pairs of directive mesenteries. *ex*, an exoseptum with forked peripheral ends, within which a pair of secondary mesenteries enclosing a secondary endoseptum is developed. t^1, t^2, tentacles of the first and second cycles corresponding to the endosepta.

secondary mesenteries, and the endosepta embraced by them, are formed between the bifurcated outer ends of the exosepta, and show the same relations to the latter that the tertiary endosepta show in the adult. This is a clear proof of the nature of the septal sequence.

Von Heider counted eighteen tentacles in one-half of a specimen of *D. ramea.* My specimens of *D. gracilis* were too much contracted to enable me to count with certainty, but I found, both in the bud and in the adult, indications of a cycle of exotentacles alternating with the primary and secondary endotentacles. The exotentacles appear to be simply introverted, and do not enter into close relations with the mesenteries. The endotentacles, as in *Heteropsammia,* are introverted and doubled over the inner edges of the endosepta. As far as I could determine, there are twelve exotentacles in the adult, alternating with the primary and secondary endotentacles. Thus there would be thirty-six tentacles of both kinds, and my observations agree with von Heider's.

The stomodæum is relatively longer than in *Heteropsammia,* measuring fully 1 millim. in length in the contracted spirit specimen, and in the expanded polyp it is probably much longer. I could find no trace of sulcus or sulculus. The stomodæal ectoderm extends some little way down the free edges of the primary and secondary mesenteries, as in *Heterocyathus* and *Heteropsammia,* but not so far as in these two genera, and eventually it gives place to a normal mesenterial filament.

As regards the histology, I have not very much to add to what has been published by von Heider. In *D. gracilis* the ectoderm of the body-wall is peculiar, and unlike anything that I have seen in any other coral. It is difficult to obtain a clear idea of its structure in sections, but it appears, as shown in fig. 26, that the cells are large and vacuolated, and form a thickened cell-wall, which, from its staining properties, seems to be of the nature of an intercellular substance. The walls of adjacent cells cohering together give a semi-cartilaginous consistency to the whole tissue, which no doubt forms an efficient protection against the numerous sponges and other organisms that infest the majority of corals. Embedded in the ectoderm cells are nematocysts of three kinds: (1) the common spiral-thread nematocyst measuring 0·02 millim. in length, more or less; these are very scantily distributed. (2) Medium-sized elongated nematocysts, about 0·028 millim. long and 0·005 millim. broad (fig. 27B) with a loosely and irregularly coiled thread; these are abundant. (3) Large elongate oval nematocysts about 0·035 millim. long and 0·01 millim. broad. According to Gardiner (**21**) the medium-sized nematocysts are developing stages of the spiral 0·02-millim. nematocysts, and this may be the case. It is not easy to speak with certainty on this point from a study of sections only, but there is some reason to think that the medium-sized nematocyst, as I have figured it, is really a third variety. In the first place they are very abundant in the ectoderm of the body-wall, whereas the small spiral nematocysts are very scantily represented there; in the second place they occur in the stomodæum in which no other nematocysts are to be found. Von Heider found two kinds of nematocysts in the ectoderm of *D. ramea,* the small spiral 0·02-millim. variety, and the large elongate oval variety, measuring in this case 0·05 millim. in length. He describes the latter as filled with a coarsely granular material, but without a thread, and a large proportion of these nematocysts in *D. gracilis* present this appearance; but others may be found in which a thick thread loosely wound in a spiral of few turns is clearly distinguishable, and it is scarcely open to doubt that the forms filled with granular material are simply unripe. In fig. 27C I have drawn a nematocyst of this variety which seems to throw some light on the development of the thread. In the centre of the capsule is the pointed end of the thread (much longer than in *Cœnopsammia*) surrounded by a granular sheath which seems to be differentiating to form the eversible portion of the capsule. At the base of the capsule the granular sheath widens out and forms a rounded mass in which an irregularly and imperfectly formed coil can be distinguished: this I take to be the middle portion of the thread in course of formation. Near the point of the thread, and outside the granular sheath surrounding it, is a spiral of five turns closely wound round the granular sheath: this must be the terminal portion of the thread differentiated from the granular sheath at the same time that the latter gave rise to the eversible portion of the capsule. The capsule itself is lined by a rather thick granular layer. It should be observed that in these nematocysts the terminal part of the thread is wound round the eversible sheath near the aperture for the extrusion of the latter. GARDINER (*loc. cit.*, plate xxxiv., fig. 14) figures it at the opposite end of the capsule, but in *Cœnopsammia* the eversible sheath is only one-third the length of the capsule. In *Dendrophyllia*, moreover (VON HEIDER agreeing with me in this), there is a distinct spearhead-shaped tip to the thread, as in *Euphyllia*, whereas GARDINER found no such armature in *Cœnopsammia*.

In the "batteries" of the tentacles there are, as usual, very numerous and closely crowded nematocysts of the small spiral variety, and among them a considerable number of the second variety described above, which, if GARDINER is right, are to be regarded as early stages of the spiral variety. I think, however, that they are really a different form of nematocyst. I was able to distinguish a fine fibril passing inwards from the bases of many of the small spiral nematocysts, and in some cases I could observe that this fibril passed into a fine layer of protoplasm surrounding an oval nucleus, and that from this a fine branching fibril passed into the layer of nerve fibres overlying the mesoglœa (fig. 27A). The ectoderm of the peristome is very thick as compared with *Heteropsammia* and *Heterocyathus*, and contains a large proportion of gland cells and the same nematocysts as the ectoderm of the body wall. The stomodæal ectoderm, as VON HEIDER remarked, is composed almost exclusively of elongated cells of the columnar type; they are almost certainly ciliated, but the cilia had been destroyed by the action of alcohol. There are few gland cells, those that are present being of the flask-shaped finely granular type, in the stomodæum and very few nematocysts. All the nematocysts that I was able to recognise belong to the second variety described above.

The mesenterial filaments are crowded with gland cells and nematocysts, the latter all of the same medium-sized variety as those of the stomodæum, and this fact leads me to think that GARDINER was in error in describing this form as a stage in the development of the small spiral variety. The mesenterial filaments are relatively small, and the absence of the largest ectodermal nematocysts is explained by the fact that there is no room for bodies of such size.

The endoderm is remarkable chiefly for the fact that Zooxanthellæ are very sparingly distributed in the mesenterial epithelium, and the epithelio-muscular cells are for the most part clearly defined and but little vacuolated. The muscular processes of the cells are remarkably well developed. Scattered through the endoderm, but somewhat sparingly, are minute nematocysts, about 0·01 millim. long, containing a loosely and irregularly coiled spiral thread. Each is contained in a transparent cuticle, and there is a flattened nucleus to one side of and *outside* the nematocyst itself. In the somewhat similar endodermic nematocysts of *Flabellum*, GARDINER (22) figures the nucleus inside the capsule of the nematocyst. The mesoglœa of *D. gracilis* is relatively thick, no doubt in correlation with the unusually great development of the musculature, but I could find no trace of structure in it. The desmocytes, described by VON HEIDER as calicoblasts, are well developed and form tassel-like groups at the points of attachment of the mesenteries to the theca, but otherwise present the usual features.

It is evident that the three forms whose anatomy is described in this memoir do not differ in any important points of anatomical or histological structure from the normal Actinian type, which has been shown by many authors to be characteristic of the polyps of Madreporarian corals. There are, indeed, minor characters, both anatomical and histological, which have a certain interest, but none of them can be regarded as having any classificatory value. One's attention is arrested by the presence of both endotentacles and exotentacles in some genera and of endotentacles only in others. But when we see that in the Eupsamniidæ, a well-defined family, only endotentacles exist in *Heteropsammia* while *Dendrophyllia* possesses both endo- and exotentacles, this character does not appear to be of much value. Moreover, owing to the great difficulty experienced in counting and localising the tentacles in spirit specimens, the information we possess on this point is not altogether trustworthy, and before any attempt is made to use the tentacles as an aid in determining the affinities of different genera of corals, it will be necessary to accumulate a large number of facts based on the study of living or well-preserved expanded polyps.

But a much more promising field is offered to the future investigator by the study of the relations of the septa to the mesenteries, especially by the developmental sequence of the endosepta and their connections with the exosepta, if present. My chief object in this paper has been to show that it is possible, by a study of the relations of hard and soft parts in the adult corals, to determine whether the septal sequence follows the rule established for *Balanophyllia* by POURTALÈS and *Siderastræa* by DUERDEN, and I have given sufficient evidence to show that the peculiar septal arrangement of the Eupsammiidæ, which has been commented upon by many authors, is due to the sequence in question. I have further shown that the septal arrangement in *Heterocyathus*, an imperforate coral, can only be interpreted upon the same principle, and DUERDEN'S account of the development of *Siderastræa* is of itself sufficient evidence that a similar mode of septal sequence prevails both in perforate and imperforate corals.

On the other hand, it is clear from VON KOCH'S (32) and DE LACAZE DUTHIER'S (33) account of the development of *Caryophyllia*, that POURTALÈS and DUERDEN'S rule is by no means applicable to all corals, but that, contrariwise, there is another and distinct mode of septal sequence which is either independent of the formation of exosepta, or in which the part played by the exosepta is very different.

It is tempting to suppose that there are two principal modes of septal development among corals, typified by the Eupsammiidæ, *Heterocyathus* and *Siderastræa* on the one hand, and *Caryophyllia* on the other hand, and that the presence or absence of exosepta will indicate the group to which any given coral belongs. But while I think that it is very possible that a solution of many classificatory difficulties may be found by extensive investigations on the lines laid down by DUERDEN, I must recognise that it would be premature to make any positive statements in the present state of our knowledge. There can, I think, be very little doubt that forms like *Mussa*, *Euphyllia*, and *Galaxea*, which have endosepta only, cannot have been developed on the same plan as *Siderastræa*, but must have followed the mode described by VON KOCH for *Caryophyllia*. But this statement cannot be extended to all forms known to possess endosepta only. GARDINER (22) has shown that in *Flabellum* the new cycles of septa are at first exocœlic, and that in the course of growth a pair of mesenteries is formed in connection with each exoseptum, in consequence of which the exosepta become endosepta. I have shown (6) that the same rule holds good for the anthoblasts of *Fungia*. Though our evidence is not complete upon this point, I believe that this will be found to be the usual mode of septal formation in all corals which have only endosepta in the adult condition. It must be borne in mind that a coral in the course of growth increases not only in height but in diameter. As a consequence of its constantly expanding perimeter, the peripheral ends of the original radial structures (the primary and secondary septa) become further and further removed from one another, and the polyp forms new radial folds between which new radial calcareous structures are formed to fill up the gaps between the diverging septal extremities. These new radial structures are the exosepta or their equivalents. In those cases in which the exoseptal formations acquire a very intimate union at the time of their appearance with the adjacent endosepta, further peripheral growth is accompanied by a bifurcation or splitting of the peripheral ends of the exosepta, and a newer set of radial folds with corresponding calcareous structures is formed within their bifurcated extremities, as in the Eupsammiidæ, *Siderastræa*, &c. In other cases further peripheral growth is provided for by the formation of new radial folds *on* *either side of* instead of between the forked peripheral ends of the exosepta, and these latter, as a consequence of the formation of new mesenterial pairs embracing them, become in their turn endosepta. But, whichever the mode of peripheral growth, it is obvious that the so-called "theca," about which so much discussion has taken place, is really the result of the formation of radial structures in connection with peripheral growth, and is not a circumferential structure. An examination of the figure in the text, fig. IV., will make this clear. Here the different stages of peripheral growth are clearly marked by the different distances from the centre of the insertions of the primary, secondary, tertiary, and quaternary mesenteries. The wall or theca must at each stage have been formed by the trabecular offsets of the peripheral ends of the exosepta united to the endosepta, and it is clear that the perforate "theca" of the adult is nothing more than a network of trabeculæ formed by the peripheral ends of the exosepta and endosepta. In *Heterocyathus* the wall is formed by the intervention of the synapticula, which must be regarded as being formed simply by very short radial folds between the outer ends of the septa, and are therefore quasi-septal structures, as has been pointed out for *Fungia* by Miss OGILVIE. In many corals the wall is formed by simple apposition of the thickened peripheral ends of the septa, giving rise to the so-called "pseudotheca." In others it is formed by the so-called "euthecal" pieces, which are really nothing more than very short radial structures intervening between the peripheral ends of the septa, but not produced internally so as to form septa. In the present state of our knowledge it would be unprofitable to pursue the subject further, but I may repeat that the whole tendency of recent investigation has been to show that a true theca, that is to say, a circumferential structure independent of the radial growths, or septa, is always to be referred to the prototheca, as defined by BERNARD, and that all other so-called "thecal" structures are in reality radial growths, formed in radial folds of the polypal walls, between previously existing radial structures. Further, it would seem from the most recent embryological investigations, which are confirmed by a study of adult structure, that there are two ways in which the new radial growth may take place: (1) by the simple formation of new radial folds between every pre-existing radial fold (*Caryophyllia*, &c.); (2) by the bifurcation of every alternate radial fold and the formation of a new radial fold in every space formed by such bifurcation (*Siderastræa*, *Balanophyllia*, *Heterocyathus*, &c.).

It is possible, but it would be rash to make a positive assertion at present, that these two modes of peripheral growth will be found to be of primary value to the systematist.

It may be worth while, in conclusion, to observe that the following corals have been found to have endosepta only:—*Mussa*, *Euphyllia*, *Madrepora durvillei*, *Madracis asperula*, *Duncania*, *Galaxea*, the lateral polyps of *Madrepora variabilis*. The following have been found to possess both exosepta and endosepta:—*Astroides*, *Stephanotrochus*, *Balanophyllia*, *Heteropsammia*, *Dendrophyllia*, *Heterocyathus*, *Madrepora aspera*, the apical polyps of *Madrepora variabilis, Lophohelia, Seriatopora, Amphihelia, Stephanophyllia, Stephanaria, Sphenotrochus, Caryophyllia, Trochocyathus, Bathyactis.*

In *Flabellum* and *Fungia* there are both endosepta and exosepta, but the latter eventually become endosepta on the formation of mesenterial pairs embracing them. The list is incomplete, but it suffices to show that little reliance can be placed on the mere presence or absence of exosepta. On the other hand, I believe that it is of importance to discover in every coral whether the new endosepta are formed in the forked peripheral extremities of the exosepta, or simply by the formation of a new pair of mesenteries in connection with a radial upgrowth.

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EXPLANATION OF PLATES I., II., III., AND IV.

Fig. 1. *Rhodocyathus ceylonensis*, n. sp. Lateral view of the corallum. × 2.

,, 1A. ,, Diagram illustrating the arrangement of the septa. 1, 1, primary septa. 2, secondary septa. 3, 4, 5, tertiary, quaternary and quinary septa.

,, 2. *Cyathotrochus herdmani*, n. sp. A view of the corallum showing the paliform lobes, *p*, and one of the carinated directive costæ, *c*.

,, 2A. *Cyathotrochus herdmani*, n. sp. Calice from above. The numerals indicate the cycles of septa.

,, 3. *Flabellum crassum*, M. Edw. and H. Profile view of the corallum. *b.s.*, basal scar. (× 2.)

,, 3A. ,, ,, The calice viewed from above. The numerals indicate the different cycles of septa.

,, 4. *Flabellum rubrum*, Quoy and Gaimard, var. *profundum*, M. Edw. and Haime. The calice viewed from above, showing the different cycles of septa 1 to 5, and the parietal columella formed by spiny outgrowths from the lower ends of the septa.

,, 5. *Placotrochus lævis*, M. Edwards and Haime. The calice viewed from above, showing the regular arrangement of the septa and the essential lamellar columella.

,, 6. *Balanophyllia parallela*, Semper. Profile view of the corallum. × 2.

,, 6A. ,, The calice viewed from above.

,, 7. *Balanophyllia cumingi*, M. Edwards and Haime. View of a colonial aggregate of corallites. Nat. size.

,, 7A. *Balanophyllia cumingi*. Diagram of the septal arrangement. The numerals indicate the cycles of septa.

,, 8. *Balanophyllia socialis*, Semper. Profile view of the corallum.

,, 8A. ,, Diagram of the septal arrangement.

,, 9. *Balanophyllia taprobanæ*, n. sp. Profile view of the corallum, showing the enlarged primary costæ and one of the lateral buds, *b*.

,, 9A. *Balanophyllia taprobanæ*, n. sp. Calice viewed from above. 1, 1, the enlarged primary entocœlic septa. *X.*^{2}, the secondary exocœlic septum of the left-hand lateral system. *X.*^{3}, *X.*^{3}, tertiary exocœlic septa of the same system. *En.*^{2}, secondary entocœlic septum; and *En.*^{3}, tertiary entocœlic septum of the same system.

,, 10. *Lobopsammia robusta*, n. sp. Lateral view of the colony.

,, 10A. ,, ,, Diagram of the septal arrangement. The numerals indicate the cycles of septa.

,, 11. *Dendrophyllia minuscula*, n. sp. Profile view of the colony. × 2.

,, 11A. ,, ,, A calice viewed from above. 1, 1, primary entocœlic septa. *En.*^{2}, secondary entocœlic septum. *X.*^{2}, *X.*^{2}, secondary exocœlic septa (largely magnified).

,, 12. Side view of a primary septum of *Heterocyathus æquicostatus*, showing the septal trabeculæ emerging on the surface as spiniform granulations. *A.c.*, *Aspidosiphon* chamber. *p.*, pali and paliform lobes. *str.*, stereoplasm represented by cross shading. *syn.*, synapticulum.

,, 13. Portion of a horizontal section through the corallum of *Heterocyathus æquicostatus*, showing the diverging trabeculæ of which the septa are composed and the pigmented stereoplasm largely filling up the interseptal loculi. *S.*, *S.*, septa. *str.*, stereoplasm external to, and *str.*^{1}, stereoplasm internal to *syn.*, the synapticula.

,, 14. Section through a band-shaped primary mesenterial filament of *Heterocyathus*, some little way below the lip of the mouth. *c.e.*, ciliated epithelio-muscular cells of the filament. *en.*, endoderm. *mg.*, mesoglœa. Zeiss. Obj. D, Oc. 4.

,, 15. Section through a convoluted mesenterial filament of *Heterocyathus*. *en.*, endoderm. *gl*^{1}., *gl*^{2}., two varieties of gland cells. *n.*, nematocyst. Zeiss. Obj. D, Oc. 4.

Fig. 16. Section through the ectoderm of the body-wall of *Heterocyathus*. *gl.*, gland cells. *mg.*, mesoglœa. *n.*, *n.*, nematocysts. *nv.*, nervous layer. Zeiss. Imm. $\frac{1}{12}$. Comp. Oc. 4.

„ 17. Section through the inner end of one of the canals leading into the *Aspidosiphon* chamber in *Heterocyathus*. *gl.*, gland cells. *n.*, *n.*, ovoid nematocysts with granular contents. Zeiss. Imm. $\frac{1}{12}$. Comp. Oc. 4.

„ 18. A nematocyst 0·06 millim. in length from the convoluted mesenterial filaments of *Heterocyathus*.

„ 19. Endoderm covering the septa of *Heterocyathus* showing *gl.*, glandular looking cells, which may be degenerate nematocysts. An isolated cell is shown to the right of the figure. *zo.*, zooxanthellæ. Zeiss. Imm. $\frac{1}{12}$. Comp. Oc. 4.

„ 20. Endoderm of *Heterocyathus* showing *am.*, amœboid cells full of granules. *cal.*, calicoblasts. Zeiss. Imm. $\frac{1}{12}$. Comp. Oc. 4.

„ 21. Columnar endoderm from the axial gastro-vascular cavity of *Heterocyathus*.

„ 22. Semi-diagrammatic representation of a horizontal section through *Heteropsammia michelini* a little above the stomodæum. The corallum is black. The mesenteries, peristomial, tentacular and external ectoderm are represented by red lines. 1, 2, 3, the several cycles of endosepta. 4, a single endoseptum of the 4th cycle. *D.*, the single pair of directive mesenteries. $t.^1$, $t.^2$, $t.^3$, the several orders of tentacles, introverted and doubled over the endosepta.

„ 23. Ectoderm of the body-wall of *Heteropsammia michelini*. *en.*, endoderm. *gl.*1, goblet-shaped gland cells with granular contents. *gl.*2, flask-shaped gland cell. *mg.*, mesoglœa. $n.^1$, spiral nematocysts. $n.^2$, large nematocyst. *zo.*, zooxanthellæ. Zeiss. Imm. $\frac{1}{12}$. Comp. Oc. 4.

„ 24. Transverse section through a canal leading into the *Aspidosiphon* chamber in *Heteropsammia*. The histological details are indicated diagrammatically. *ec.*, ectoderm lining the canal. *en.c.*, endoderm canals surrounding the central ectodermic canal. *mg.*, mesoglœa. Zeiss D. Oc. 2.

„ 25. Modified ectoderm of the body-wall of *Dendrophyllia gracilis*, showing the thickened walls of the ectodermic epithelium. *mg.*, mesoglœa. n^2, medium sized nematocysts, 0·028 millim. in length n^3, large nematocysts, 0·035 millim. in length. Zeiss. Imm. $\frac{1}{12}$. Comp. Oc. 4.

„ 26. Nematocysts of *D. gracilis*. Zeiss. Imm. $\frac{1}{12}$. Comp. Oc. 4.

„ 26a. A spiral 0·02-millim. tentacular nematocyst, its inner end prolonged into a fine nerve fibril.

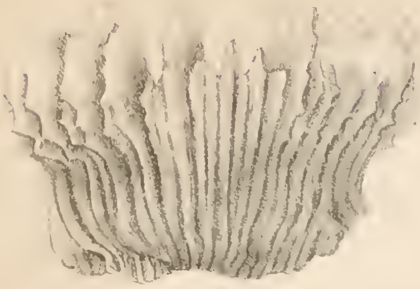
„ 26b. Nematocyst from the stomodæum or mesenterial filament.

„ 26c. Developing nematocyst from the external ectoderm (see text).

„ 26d. A ripe nematocyst from the external ectoderm.

„ 26e. The same diagrammatically represented.

„ 27. Four endoderm cells from a mesentery of *D. gracilis*, showing *n*, an endodermic nematocyst. *m.p.*, muscular processes. Zeiss. Imm. $\frac{1}{12}$. Comp. Oc. 4.



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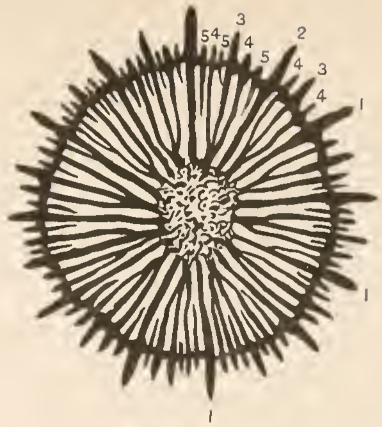

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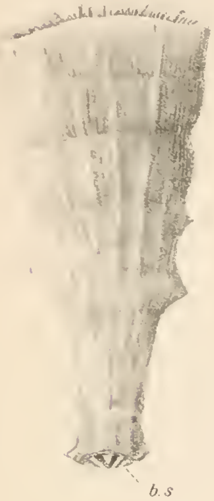

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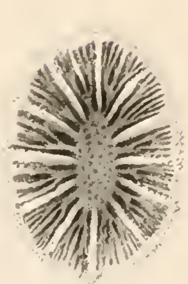

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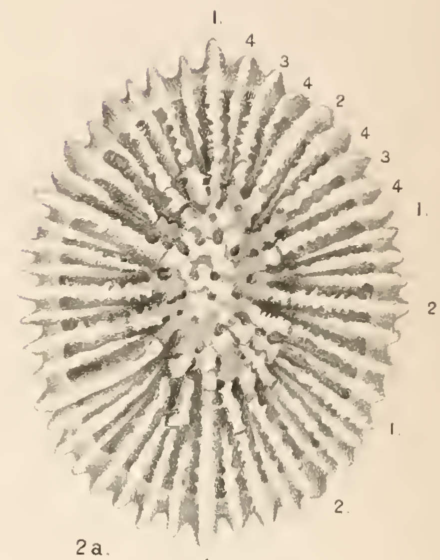

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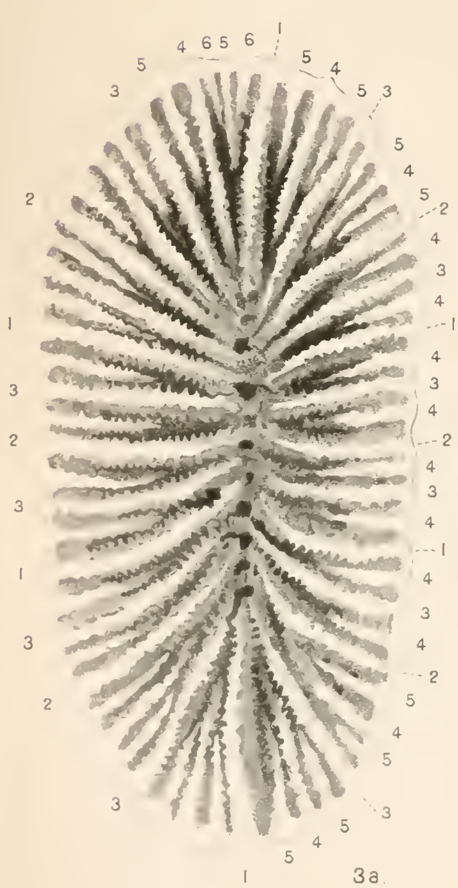

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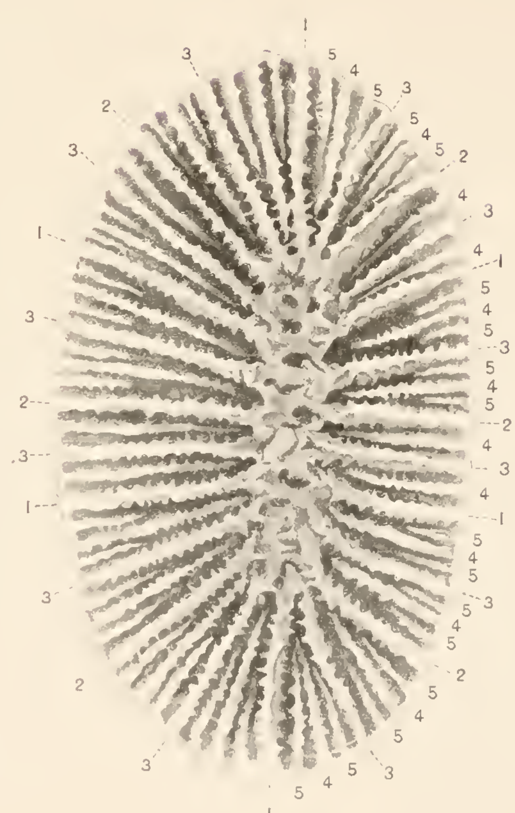

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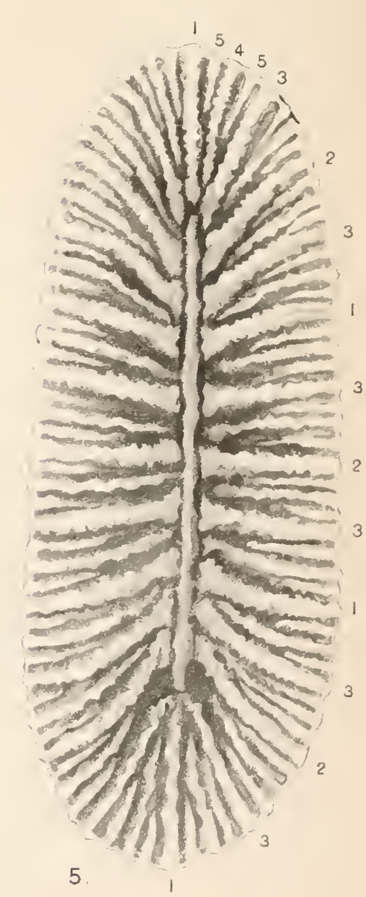

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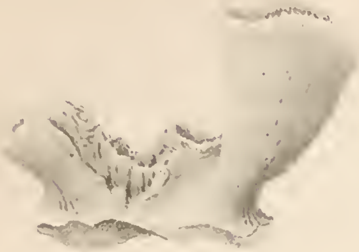

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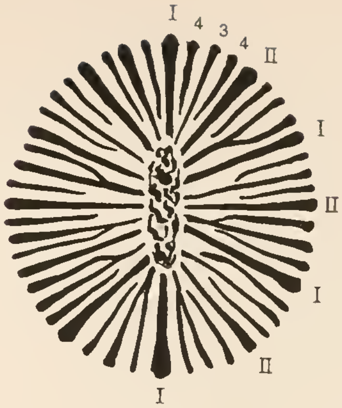

FIG. 8a.

FIG. 8.

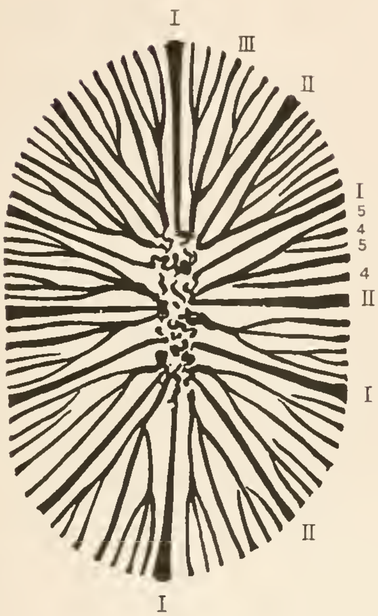

FIG. 7a.

FIG. 9a.

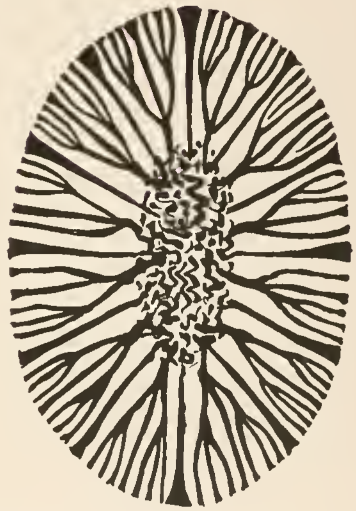

FIG. 10a.

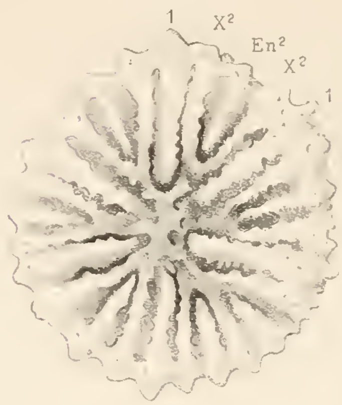

FIG. 11a.

FIG. 10.

FIG. 9.

FIG. 11.

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FIG. 12.

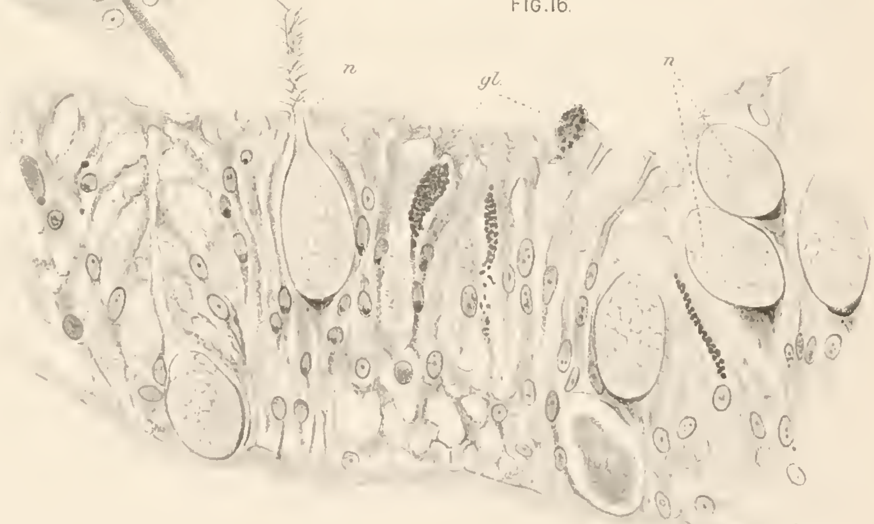
FIG. 13.

FIG. 18.

FIG. 14.

FIG. 16.

FIG. 15.



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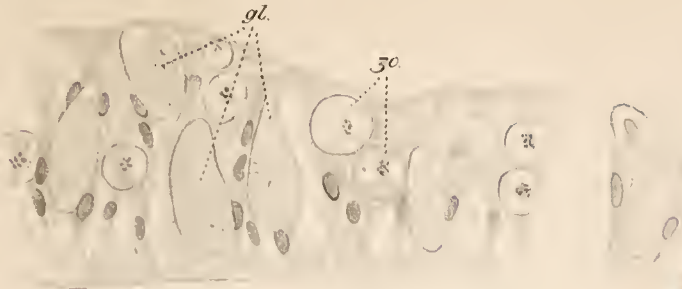

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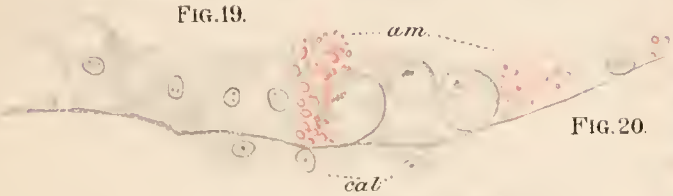

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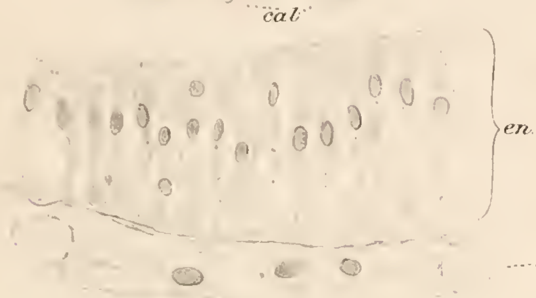


FIG. 21.

FIG. 22.

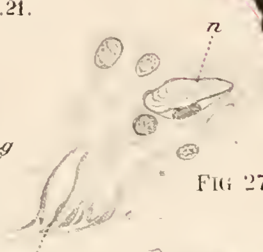


FIG. 27.

FIG. 24.

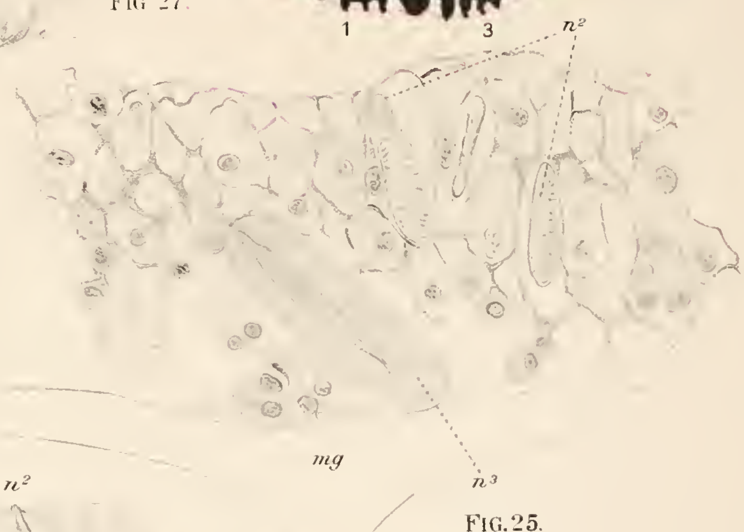


FIG. 25.

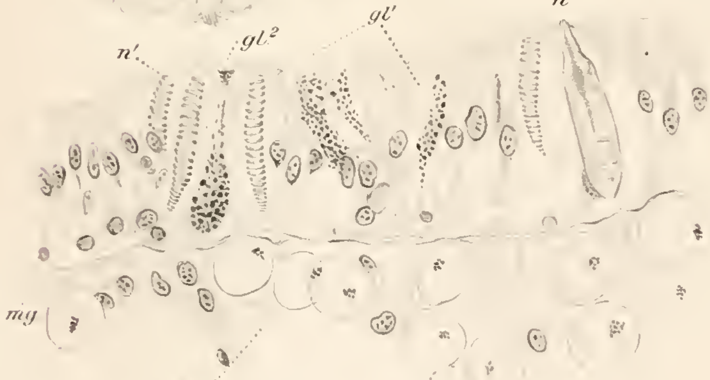
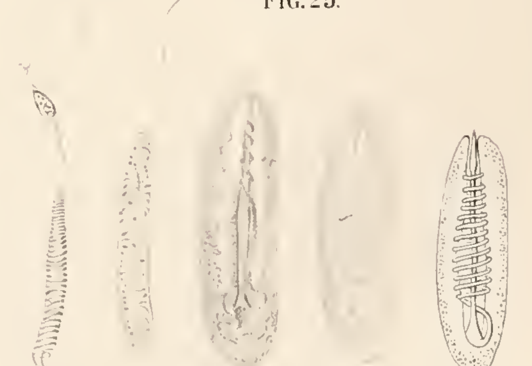


FIG. 23.



26a. 26b. 26c. 26d. 26e.

E. Wilson, Cambridge

REPORT

ON THE

POLYCHÆTA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

ARTHUR WILLEY, F.R.S.,

DIRECTOR OF THE COLOMBO MUSEUM.*

[WITH EIGHT PLATES.]

THIS collection of Polychæta is the most extensive which has been brought together from the coast of Ceylon. There are only three older collections of any magnitude from Ceylon upon which reports have been published, namely, that of SCHMARDA, worked out by the traveller himself and published in 1861 ('Neue Wirbellose Thiere'); a small series gathered by Mr. HOLDSWORTH and described by GRUBE in 1874 ('P. Zool. Soc., London'); lastly, another small series collected by Dr. HANS DRIESCH and described by MICHAELSEN in 1892 ('J. B. Hamb. Anst.,' ix. 2). Of these older collections the most important was the Schmarda collection, which included the discovery of the remarkable genera *Gastrolepidia* and *Bhawania*, the latter not being represented in Professor HERDMAN's collection.

The material was handed over to me at Professor HERDMAN's suggestion by Mr. JAMES HORNELL in September, 1904. A further consignment which had been

* EDITORIAL NOTE.—In order to save delay, I have, with Dr. WILLEY's consent, undertaken to see this Report through the press without sending proofs to Ceylon. I have to thank Mr. ARNOLD WATSON and Mr. CYRIL CROSSLAND, both of whom are familiar with the group, for their kindness in reading the proofs along with me. The only change of any importance we have had to make is the name of the new genus on p. 251. Dr. WILLEY had proposed *Hololepidia*, but we regarded this as being practically the same as MOORE's name *Hololepida* ('Proc. Acad. N.S. Philad.,' 1905) applied to an allied but distinct Polychæte, so we altered the title of WILLEY's genus to *Hololepidella*.—W. A. HERDMAN.

taken to England, consisting mostly, but not entirely, of duplicates of some of the species contained in the first set, was sent out to me by Professor HERDMAN. These had also passed through the hands of Mr. ARNOLD T. WATSON, who kindly forwarded to me such notes and drawings as he had made, some of the latter being reproduced on Plate VIII. A species of *Polydora* which attacks the pearl oyster was subsequently forwarded by Mr. HORNELL.

Some new facts of systematic importance relating to previously described species are recorded here. Among the species described as new are some of considerable interest, *e.g.*, *Autolytus orientalis*, *Branchiomma quadrioculatum*, *Ceratonereis falcaria*, *Grymæa cespitosa*, *Halosydna zeylanica*, *Leprea inversa*, *Paramarphysa orientalis*, *Serpula watsoni*, *Thalenessa stylolepis*.

The occurrence of *Onuphis conchylega* and the recovery of *Harmothoe dictyophora* are also noteworthy features of the collection.

FAMILY: AMPHINOMIDÆ.

Chlœia flava (PALLAS)—Plate I., figs. 1 and 2.

Chlœia ceylonica, GRUBE, 1874, "Ann. Ceylon," 'P. Zool. Soc.,' p. 326.
Chlœia flava (SAV.), GRUBE, 'Ann. Semp.,' 1878, p. 10.

Four rather small specimens from Station LVI., Dutch Modragam Paar, 9 fathoms; average length about 28 millims., with 24 setigerous segments. Another smaller specimen is also in the collection.

Examples of dorsal and ventral bayonet setæ, the former barbed, are shown in Plate I., figs. 1 and 2. The branchiæ commence on the fourth segment; mediad of the violet tinted dorsal cirrus of the first four segments there is an accessory cirrus, that on the fourth segment being very slender. The caruncle of this well-known species is attached to the first two segments, and is produced backwards over the next two; it consists of an upper and lower series of lamellæ, those of each series united together in a zigzag manner by their lower ends; those of the upper series are further united together in couples along the crest of the caruncle.

The Amphinomidæ are not, I believe, as a rule, rapacious Annelids, but swallow sand and small stones, &c. Probably they are preyed upon by the Aphroditidæ, since the small specimen (No. 64) was penetrated by some of the enormously long barbed spines of *Hermione*.

A small worm taken in 24 fathoms, at Station LXIII., west of Periya Paar, seems to be a form of the same species; it is 9 millims. long, 20 segments. The tentaculum impar is nearly as long as the caruncle, and, like the dorsal cirri and the stems of the gills, deep purplish crimson in colour. No colour marks were observed along the back, and the crimson cirri stood out prominently from the midst of the very long and delicate setæ. Branchiæ commence as usual on the fourth segment; accessory dorsal cirrus observed on the first three segments only, as described by GRUBE; the folds of the caruncle are more open, less closely set than in older worms. No barbed setæ were found. Unlike *Hesione ceylonica* (q. v.), young individuals of *Chlœia flava* do not possess the full number of segments characteristic of the adult.

Eurythoe complanata (Pallas).

Several examples of this species, whose distribution coincides with that of coral reefs, were obtained from Aripu Reef and at Galle, ranging in length up to 200 millims. and in breadth up to 17 millims. over the setæ. Branchiæ commence on the second setigerous segment and there is one dorsal cirrus to each parapodium. The caruncle is inserted into the first three setigerous segments.

Eurythoe latissima (Schmarda, *op. cit.*, p. 141) is a synonym of this species.

Eurythoe longicirra (Schmarda).

(See Schmarda, 'Neue Wirbellose Thiere,' ii., 1861, p. 142.)

Whether or not this is an exceptional form of *E. complanata* I am unable to decide, but it is certain that the caruncle is inserted upon the first four setigerous segments and overlaps the fifth.* The branchiæ commence on the second setigerous segment, and there is one dorsal cirrus to each parapodium.

Length 40 millims., width 5·5 millims. One specimen, from Aripu Reef.

Family: APHRODITIDÆ.

Hermione malleata, Grube—Plate I., figs. 3 and 4.

Hermione malleata, Grube, 'Ann. Semp.,' 1878, p. 17.
Hermione ridgewayi, Hornell, 'Ceylon Pearl Oyst. Rep.,' Part I., 1903, pp. 16 and 74.

Two specimens from old Dutch Modragam Paar, 9 fathoms, Station LVI.; one specimen from Aripu Reef, 18th March, 1902.

The malleiform processes described by Grube are clearly not definite morphological structures, but merely dermal folds associated with the elytrophores and branchial tubercles, the latter being transversely elongate.

This species is the Oriental form representing the Mediterranean species *Hermione hystrix*. I have satisfied myself on this point by actual comparison of the material from Ceylon with specimens of *H. hystrix* procured from the Stazione Zoologica at Naples for the special purpose of this investigation. The only serious divergence in Grube's description relates to the palps, which he describes as being smooth. His specimen only measured 16 millims. in length, and the palps, when examined under low magnification by transmitted light, appear smooth, though in reality they are beset with minute papillæ. The Neapolitan specimens of *H. hystrix* are larger and darker than the Ceylon worms; the elytra thicker and more opaque.

A complete Ceylon worm measures 30 millims. long by a width of 12 millims. over

* For further remarks on this point see Ehlers, 'Florida-Anneliden,' 1887, p. 30.

the neuropodia; fifteen pairs of elytra covering the back; length of dorsal glochideal spines up to 10 millims. (Plate I., fig. 3). Eye-peduncles rounded. Cirrophores and neuropodia thickly covered with minute rounded papillæ; neuropodia 3 millims. long. Ventral surface beset with similar papillæ. Tentaculum impar, tentacular cirri, dorsal cirri and first ventral cirrus with distal clavate tip articulated to the main shaft, which is expanded at this point. Palps 13 millims long, beset with six longitudinal rows of minute spiniform papillæ. The elytral segments carry on each side a flabellum of curved smooth-tipped setæ radiating dorsad and a backwardly directed fascicle of long brown glochideal setæ; below the dorsal setæ there is a tuft of fine silken threads. The neuropodia carry furcate setæ with or without an accessory tooth (Plate I., fig. 4). The portion of the notopodium from which the flabellum arises is adnate to the elytrophore.

Pontogenia indica, Grube—Plate I., fig. 5.

Grube, 'Ann. Semp.,' 1878, p. 18; Herdman, "*Palmyra aurifera,*" 'Ceylon Pearl Oyster Report,' Part I., Narrative, 1903, p. 75.

The close resemblance between *Pontogenia indica* and *Palmyra aurifera* (see Grube, *op. cit.*, pp. 13–14) is one of the remarkable facts of Polychæt taxonomy.

The specimen was obtained from a living coral block in 6½ fathoms, one mile north of Muttuvaratu Paar, Station LIX. It measures 20 millims. in length and has 45 segments. The head is retracted within the anterior segments and beneath the anterior elytra, the second pair of elytra overlapping the ommatophores. The ceratophore is marked off from the frontal border of the prostomium and the ommatophores extend to this level. The palps are beset with longitudinal rows of delicate recurved papillæ. By pressing the ceratophore back a tuberculum faciale with granulated surface may be seen extending from the prostomium to the anterior border of the mouth. Each ommatophore carries two eyes, but as the pigmented areas overlap there appears to be only one eye in certain lights (Plate I., fig. 5). The paleæ which form flabella projecting over the elytra are utrinquedentate, as described by Grube. The dorsal setæ which occur in addition to the paleæ are long, delicate, colourless and numerous, and constitute a tela tomentosa over the elytra, concealing the latter, but not felted together so as to form an inextricable tangle. The two rows of distantly placed denticulations with their points directed towards the apices of the paleæ are not always visible in one view, and the paleæ then appear to be denticulate along one side only.

Family: POLYNOIDÆ.

Iphione muricata, Savigny—Plate I., fig. 6.

Polynoe peronea, Schmarda, 1861; 'Neue Wirbellose Thiere,' ii., p. 157.

Locality:—Gulf of Manaar. One specimen of the typical yellowish brown colour; length 17·5 millims., breadth over the setæ 8·5 millims. The head is withdrawn between the anterior segments to such an extent that four pairs of elytra had to be removed in order to expose it (Plate I., fig. 6). The antennæ converge from the anterior pinnacles of the head towards the middle line, and then run side by side close together; one of them may sink down at a lower level, and then one only remains in view. They are subglabrous, being very sparsely and minutely papillose. SCHMARDA observed one antenna only, which he described as a tentaculum impar erroneously. There is no doubt as to the identification of the present specimen with SCHMARDA's species; the only question is whether it is co-specific with SAVIGNY's *I. muricata* (GRUBE, 'Ann. Semp.,' 1878, p. 21).

An elytron from the mid-body shows a concave anterior border, a large gold-coloured outer surface and a smaller pale inner portion directed obliquely forwards and overlapped by neighbouring scales. The whole surface of the elytron is divided up into polygonal, mostly hexagonal areas, and these again into numerous secondary areoles. The main areolation resembles that of *Harmothoe dictyophora*, but differs in some details; the areas are largest on the inner (mesial) portion of the scale, smaller along the outer and posterior borders; the secondary areolation is highly characteristic and was noted by SCHMARDA. Focussing through the superficial secondary areolation, another reticulum, which may be called the interstitial reticulum, comes into view, the meshes of which do not coincide with the former. The interstitial mesh-work shows nodal dilatations with a refringent body in each, like a nucleus, very clear in caustic potash. Proceeding to the pigmented portion of the scale, the surface enclosed by the secondary areoles becomes elevated to form low papillæ, which, near the outer border, assume the form of inclined spines. Posteriorly, certain of the primary areas become elevated to form long stout aculeate spines terminating distally in a pair of prominent horns and covered by numerous secondary spines, as figured by SCHMARDA. The secondary spines become larger distally, so that the main spine sometimes presents a more or less trifid appearance at the summit. The dorsal setæ are excessively numerous and bipinnate. The ventral setæ show a well-marked subterminal dilatation, a verticillate tract, and a smooth curved apical portion.

As for *Iphione muricata*, GRUBE makes no mention of the secondary areolation of the elytra, a highly remarkable feature; and he states that the outer and posterior margin of the scale is fimbriated, which is not so in *I. peronea*. Across the major diameter of the scale I counted about 30 primary meshes, and across one of the latter about nine sharply defined secondary areoles. There are 29 segments, 13 pairs of elytra. The anus is dorsal and is bordered by the last pair of elytra. SCHMARDA says the last segment has "zwei kleine Endfortsätze," but I cannot see them. The dorsal and ventral cirri, the palps and tentacular cirri are papillose. The tentacular cirri are concealed below the palps in dorsal view.

A smaller specimen, 5 millims. wide, shows a wide membranous fringe round the outer and posterior border, not yet areolated; there are no fimbriæ; about 17 primary meshes across the scale. The antennæ adhered together and broke away from their peduncles.

Lepidonotus carinulatus, Grube (1869)—Plate I., figs. 7 to 11.

(See Grube, 'Ann. Semp.,' 1887, p. 26.)

Localities:—South-west Cheval Paar, one specimen, broken in half, and several specimens mostly fragmentary; Chilaw Paar, Station LXIX., one specimen.

The antennæ and dorsal cirri show a very slight distal dilatation followed by a flagelliform terminal process. The cirri and palps are smooth; dorsal setæ more slender than ventral, 20 to 30 in number, disposed in three concentric arcs, the setæ of the dorsal arc being shorter than the rest. Ventral setæ about 25, bidentate and fringed (Plate I., fig. 11).

Elytral papillæ carinulate and spheroidal on the surface, echinulate and stellate near the fimbriated border; in some elytra the echinulate papillæ extend over the surface to the region of the scar. Elytra deciduous and body fragile; twelve pairs of elytra. Exserted pharynx with fringe of nine dorsal and nine ventral marginal papillæ. Some elytra become narrower towards the inner side than at the outer side, others are nearly equally wide throughout, with concave anterior border. Patches of dark brown pigment are scattered over the surface. The fimbriæ of the outer border are densely placed, those at the posterior border are sparser. Some scales are much less papillose than others; in a highly tuberculate scale the carinulate papillæ occupy the anterior and inner (mesial) portions; the echinulate papillæ occur at the posterior border, extending thence over the scar, this region being somewhat elevated; the echinulate papillæ near the outer border are smaller and less hirsute than those of the posterior border, sometimes presenting a more or less stellate appearance (Plate I., fig. 10). The prostomium (cephalic lobes) with eyes and antennary bases (ceratophores) is shown on Plate I., fig. 7.

Observations on a larger specimen, in which some of the elytra were better preserved in position, show that the dominant macroscopic character of the species lies in the difference between the elytra of the anterior region and those of the middle and posterior regions. The anterior scales (only those of the fourth and fifth segments are present in the specimen) are much smaller than the rest, they are placed subtransversely and their surface appears verrucose under low magnification. The more posterior scales show a finely granulose surface, they are about twice the size of the anterior scales (excluding the scales of the first pair, which are generally small and round, and are absent from this specimen), and they are longitudinally elongate, the anterior end narrower. All scales show a large opaque whitish patch in the region of the scar, and all are fimbriated externally. The length of the specimen is 17 millims.; total width over the setæ 5 millims. Along the posterior border of the elytra there are small saucer-shaped elevations which appear to be the bases of deciduous fimbriæ.

Microscopic examination shows that the verrucose appearance of the anterior scales is due to the presence of large numbers of spheroidal echinulate papillæ (Plate I., fig. 9). These papillæ do not occur on the posterior scales, which owe their granulose appearance to the ordinary carinulate papillæ (Plate I., fig. 8), small stellate papillæ and smooth globoidal papillæ.

The elytra of this species show an analogy with those of Marenzeller's *Lepidonotus pleiolepis* from Japan, which, however, possesses fifteen pairs instead of the usual twelve pairs. Some individuals show a narrow black ring round the lower part of the subterminal dilatation of the dorsal cirri. In a specimen with extruded proboscis the outline of the prostomium was nearly circular.

This species appears to be the most abundant and typical representative of the genus *Lepidonotus* on the Ceylon pearl banks.

Lepidonotus cristatus, Grube.

Grube, 'Ann. Semp.,' 1878, p. 27; Gravier, 'Ann. Mer Rouge,' 1901, p. 212.

A fine example of this species, 43·5 millims. in length, 17 millims. wide over the setæ, was taken on the Galle Reef under a boulder, 7th June, 1902.

The smooth-bordered elytra show a large tumid bilobed transverse crest. The ventral setæ have the usual laciniate fringes on the region of the subterminal dilatation and end in a smooth curved tip. The distal portions of the antennæ, tentacular cirri, dorsal cirri and first ventral cirrus, up to the subterminal bulb, are coloured black.

Gravier describes for the first time the modified ventral setæ of the second segment, which are characterised by the possession of a very long verticillate tract.

Lepidonotus trissochætus, Grube.

Grube, 'Ann. Roth. Meer.' (Ehrenberg coll.), 1869; 'Ann. Semp.,' 1878, p. 25.

Locality:—South-east Cheval Paar. Length of the specimen 12 millims., breadth over the setæ 5 millims.

This species is distinguished by the possession of two kinds of setæ in the dorsal ramus of the parapodium, and these setæ are very numerous. There are rather short, stout, transversely spinulose setæ of a common type, and enclosed by these are numerous fine smooth capillary setæ ending in a point, a short distance below which there is a delicate dilatation, as in a spear-head without barbs; these may be called hastate setæ. In the anterior half of the body the hastate setæ do not project beyond the spinulose setæ which surround them, and cannot therefore be seen without adopting special measures. In the posterior half the hastate setæ project far beyond the short spinulose setæ, which occur like a sheath at the base of the bundle; they project here as far outwards as the ventral setæ. The resulting difference between the anterior and posterior dorsal fascicles as seen under low magnification is very pronounced. It is, however, probably due to a temporary protrusion of the setæ, but it may serve to account for the alleged difference between *L. trissochætus*, GR., and *L. indicus*, KINBERG. The hastate setæ can clearly be retracted and protruded at will. In one segment they are projecting on one side, retracted on the other. The elytra are sparsely covered with smooth obtuse pustules of varying sizes, the smaller and more numerous occupying a submarginal position. The margin of the elytron is quite smooth.

As indicated by GRUBE in 1869, this species presents a cryptocephalous condition, as in the later described species *L. cryptocephalus*, the head being concealed below a projecting collar formed by the second segment. The dorsal cirri are smooth, with a terminal flagellum and a subterminal swelling. The palps are beset with conical papillæ, and terminate in a smooth attenuate extremity (seen in one of the palps only). The ventral setæ have simple hamulate extremities (not bidentate) with the usual subterminal fringes.

Halosydna zeylanica, n. sp.—Plate I., figs. 12 and 13.

Total length about 15 millims., width 2 millims. to 2·5 millims. Commensal on Astropecten, Ceylon seas.

Body much flattened, extremely fragile, elytra smooth, colourless, covering the dorsum, leaving parapodia exposed, lightly attached to the elytrophores. The prostomium is divided by a shallow linear groove into two halves, upon which no eyes were observed, and the bases of antennæ and tentaculum are somewhat concealed below the frontal border of the head, though arising at one level, as seen in frontal view. The number of segments may be as many as 50, but this will depend upon age and variation, and the same applies to the number of the elytra, the highest number observed being 24 pairs.

The chief character is presented by the distribution of the elytra on the following segments :—II., IV., V., VII., IX., XI., XIII., XV., XVII., XIX., XXI., XXIII., XXVI., XXIX., XXXII., XXXIII., XXXV., XXXVII., XXXIX., XLI., XLIII., XLV., XLVII., XLIX. The peculiarity here is the occurrence of successive elytra on segments XXXII. and XXXIII., a point which I have verified on three specimens. In the specimen of which the elytral formula is given above, the elytra were lost from a number of the posterior segments but present on No. XLIX.

The dorsal ramus of the parapodium is very small, and the setæ which issue from it are few in number, plain and hyaline. Foreign particles adhere to all the setæ individually throughout their exposed portions. The ventral setæ have the form shown in Plate I., fig. 13, a plain apex slightly curved, and at some distance removed from it a dilatation with a projecting semilunar cusp. The number of ventral setæ varies, but is about 12.

The ventral cirri are shorter than the ventral ramus, arising from a prominent base. The dorsal cirri are plain structures occurring on the segmenta nuda, arising from a projecting base which lies obliquely outwards and backwards when seen from above. The dorsal cirri are highly deciduous. They exceed the length of the parapodium (Plate I., fig. 12). The dorsal ramus and elytrophore of a foot from an elytra-bearing segment appear to carry long vibratile cilia. No tubercles were observed on the segmenta nuda. The ventral ramus is richly furnished with decussating muscles. The elytra are orbicular, glabrous, with few "veins" ramifying out from the scar.

Harmothoe dictyophora (Grube)—Plate I., figs. 14 to 16.

Polynoe dictyophorus, Grube, 'Ann. Semp.,' 1878, p. 44.

Locality:—East side of Cheval Paar. Length 12 millims., breadth over the setæ 4·75 millims.

Prostomium normal, anterior eyes placed in the centre of the lateral border (Plate I., fig. 15). Antennæ ciliate; palps beset with numerous minute blunt papillæ; dorsal cirri densely ciliate, the long filiform papillæ ceasing at the base of the terminal filament; no dilatation below the terminal filament. Dorsal setæ numerous, verticillate spinulose, but the whorls are not complete, only occupying three parts of the circumference of the setæ; the shorter setæ of the dorsal bundle are distinctly stouter than the ventral setæ; ventral setæ without exception conspicuously bidentate, dilated at a point variously remote from the apex and spinulose thereafter (Plate I., fig. 16). The spinulose tract of the superior ventral setæ is much longer than that of the inferior.

Thirty-five segments; fifteen pairs of elytra covering the back. Exposed portions of the elytra divided into polygonal areoles carrying chitinous spines and filiform papillæ; some of the areoles are densely pigmented dark brown. Some of the spines are bifurcated, such spines being particularly prominent on the round elytra of the first pair. The outer fimbriæ of the elytra are longest and densest, these are followed posteriorly by a group of papillæ with globular tips, and these again by shorter filiform papillæ (Plate I., fig. 14). It should be noted further that the ventral cirri also carry short blunt papillæ, scattered and not very numerous.

Grube founded the species upon a single elytron.

Hololepidella, n. gen.

A Polynoid; antennæ arising at a lower level than the tentaculum impar; segments and elytra numerous.

Hololepidella commensalis, n. sp.—Plate I., figs. 17 to 20.

Station I., off Negombo, 12 to 20 fathoms, on *Clypeaster humilis*.

This species appears to be allied to *Polynoe venosa*, Grube ('Ann. Semp.,' p. 43), in which however there were only 18 pairs of elytra and 42 segments in the single individual examined. The number 18 is a generic character of *Acanthicolepis*, McInt. (= *Dasylepis*, Mgn.), but it seems likely, though not certain, that a polymeric Polynoid with more than 18 pairs of elytra will pass through a stage with 18 only. At any rate, *Polynoe venosa*, Gr., does not belong to the genus *Acanthicolepis*.

Those polymeric Polynoidæ in which the paired antennæ arise at a lower level than the tentaculum impar appear to be inadequately classified. Malmgren's genera *Nemidia* and *Enipo* are at most only sub-genera of Schmarda's *Hemilepidia*.

All Polynoidæ (*s. str.*) in which the antennæ arise at a lower level than the tentaculum are placed in the sub-family Harmothoina. The genus *Polynoe* (*s. str.*) is polymeric, having more than 45 segments in the fully formed condition. It comprises two sections:—(1.) *Hemilepidia*, Schmarda, in which there are 15 pairs of elytra restricted to the anterior region of the body. This section comprises the following species:—*Polynoe scolopendrina*, *Hemilepidia erythrotænia*, *Nemidia torelli*, and *Enipo kinbergi*. (2.) *Hololepidella*, *n.g.*, in which the elytra are not so restricted. Very possibly Grube's *Polynoe venosa* belongs here in spite of its few segments. The species now described also belongs to this section.

In *Hololepidella commensalis* the small antennæ clearly arise at a lower level than the tentaculum (Plate I., fig. 20). The elytra are pale, delicate, translucent, smooth, large, orbicular, covering the back; the first pair with central insertion, the others with excentric insertion near the anterior margin becoming submarginal in the posterior region; there is an indication of nervures radiating out from the scar of insertion, as in *P. venosa*. The elytra are inserted upon segments II., IV., V., VII., IX. * * * * * XXI., XXIII., XXVI., XXIX., XXXI., XXXIV., XXXVI., XXXVIII., XL., XLII., XLV.; segment XLIV. has an elytrophore on the left side, a branchial tubercle and cirrophore on the right side. There are 46 segments present, incomplete behind; in a fragment of the posterior end the alternation of cirrophores and elytrophores, the former sometimes skipping one segment, sometimes two, seems to be continued to the end of the body, but it is not always easy in this region to distinguish between a cirrophore and an elytrophore.

Head hexagonal; ground colour of body nearly black (becoming brown after a length of time in spirit) with a pale ridge across each segment between elytrophores and branchial tubercles respectively. Palps, antennæ, tentacle and cirri smooth; first ventral cirrus long, the rest short, with swollen basal portion and terminal flagellum. Dorsal cirri dark brown, tapering to a pale blunt point which may be slightly swollen, but without subterminal dilatation. The setæ are pale; dorsal setæ, about 8, broad parce-serrulate, much shorter than the ventral setæ; superior ventral setæ obliquely laciniate towards apex, giving the appearance of alternate serrulations, inferior ventral setæ with subterminal dilatation, curved simple tip and normal fringes (Plate I., figs. 17 to 19).

This species is one of those which easily undergo fragmentation, so that the length cannot be given; the width is 2 millims.

Gastrolepidia clavigera, SCHMARDA.

(SCHMARDA, 1861, 'Neue Wirbellose Thiere,' ii., p. 159.)
Gastrolepidia amblyphyllus, GRUBE, 'Ann. Semp.,' 1878, p. 46.
Gastrolepidia clavigera, HERDMAN, 'Ceylon Pearl Oyster Report,' Part I., 1903, pp. 29, 79.

Localities:—Station XVIII., off Rameswaram, 7 to 8 fathoms; Station LXI., off Periya Paar, 12 to 14 fathoms.

The lateral portions of the sterna of the segments are produced into conspicuous imbricating lamellæ, arching below the bases of the parapodia. They are semilunar folds, but if a segment is detached from the body and looked at from behind, they appear to be subcordate, as figured by SCHMARDA. The dorsal elytra are inserted upon segments II., IV., V., VII. * * * * * * * XXIII., XXVI., XXIX., XXXII., XXXV., XXXVI., XXXVIII., XXXIX., XLI., XLIII., XLV., this enumeration being based upon one specimen from which all the elytra had fallen off; the other specimens were smaller and showed fewer elytrophores, so that the peculiar distribution of the posterior elytra could not be confirmed. Dorsal setæ curved, stout, shorter than the ventral setæ, with as many as forty serrulations along the convex border; superior ventral setæ with not less than fifteen laciniate fringes; inferior ventral setæ stronger than the rest, with curved simple tips, subterminal dilatations and about eight fringes. The antennæ are inserted at a slightly lower level than the tentaculum. Dorsal cirri clavate, mostly lost. Beyond the club there is a terminal flagellum shown by GRUBE, omitted by SCHMARDA.

FAMILY: ACOËTIDÆ.

Panthalis, KINBERG.

This is a genus of Acoëtidæ characterised by the reversed imbrication of the anterior scales.

The family to which it belongs agrees with the Aphroditidæ (*s.str.*) in having pedunculate eyes; with the Sigalionidæ in the polymeric body; with Polynoidæ in having only setæ simplices; with Iphionidæ in having serrated jaws. It is clearly a family of composite affinities and its members possess an extraordinary interest, regarded from bionomical and anatomical points of view. They manufacture a felted tube woven from chitinous silken fibres which appear to be homologous with the fibres composing the dorsal felt of *Aphrodite*, that is to say, modified setæ which issue from the dorsal ramus of the parapodium and are contained within a convoluted sac intruding into the body cavity. The tube-forming habits of *Panthalis œrstedi* have been admirably described by Mr. ARNOLD T. WATSON in the 'Transactions of the Liverpool Biological Society,' vol. ix., 1895, pp. 169 to 188.

Two species of *Panthalis* were described by GRUBE from the Philippines, and very fortunately both of these are represented in Professor HERDMAN'S material from Ceylon, so that I am able to supplement GRUBE'S diagnoses with additional facts and figures.

Panthalis melanonotus, Grube—Plate I., figs. 21 to 27.

Grube, 'Ann. Semp.,' 1878, p. 48; also Part I., 'Ceylon Pearl Oyster Report,' p. 71.

Locality:—Station LIV., south of Rameswaram, 40 fathoms. One specimen.

A typical cirrus-bearing parapodium from the anterior region has the following structure:—(i.) A short dorsal cirrus consisting of a stout basal portion and an acuminate apical portion; (ii.) the dorsal ramus supported by a flexible acicula and penetrated by the tomentose setæ which are employed in weaving the tube; (iii.) the ventral ramus with four kinds of setæ, dorsally a small bundle of very fine serrulate setæ, then a bundle of long delicate penicillate setæ, then a central group of stout so-called aristate setæ; lastly, a ventral bundle of long spinulose setæ (Plate II., figs. 24 to 27). At the tip of the aristate setæ there is an alveolus. From the 28th segment the peduncle upon which the dorsal cirrus is inserted acquires a geniculate appendix, containing a prolongation of the internal tissues, possibly a diverticulum of the gut, but of this I cannot be certain without transverse sections. A few segments farther back an ovate or subcylindrical appendix appears on the squamiferous segments, in the same position as that occupied by the cirriform branchia of the Sigalionidæ, also containing the same kind of tissue as that which occurs in the geniculate process above described. The surface of these processes is not ciliated (Plate I., figs. 22 and 23).

Panthalis melanonotus appears to be an Indo-Pacific representative of the Mediterranean and Atlantic *P. œrstedi*. The accounts given of the eyes of the latter are rather puzzling. Von Marenzeller* denies the existence of eyes, although the ocular peduncles are present. Mr. Watson, in the article referred to above, has omitted to note the presence or absence of black pigment,† stating that the sight of the animal is good, each reddish-coloured eyestalk being faced with a clear lens, and having at its tip a rounded papillated appearance.

In *Panthalis melanonotus* the stalked eyes are very large and provided with abundant black pigment, in the centre of which is a lens; the eyes are subspherical, occupying the extremity of the clavate peduncles. In addition there is, as described by Grube, an eye-spot on each side of the prostomium behind the ocular peduncle; between and slightly behind the sessile eye-spots the median tentacle arises. The antennæ are small and largely concealed by the eye-stalks and were not seen by Grube (Plate I., fig. 21).

The extruded pharynx bears distally thirteen papillæ above and the same number below, forming a terminal crown; the median dorsal papilla is enlarged and the median ventral is lost from the specimen. The palps show pigment spots and appear glabrous with a simple lens, although minute papillæ can be found with the microscope, especially towards the apex, but there is no marked distinction between apical and

* V. Marenzeller, 'Polychæten des Grundes,' Vienna, 1893, p. 28.

† Mr. Watson informs me that no black pigment is visible in the eyes of the specimens of *P. œrstedi* now in his possession.—W. A. Herdman.

basal portions, such as occurs in the next species. The body is incomplete behind, upwards of fifty segments being preserved; total width of anterior region 6 millims. The specimen is well preserved.

Panthalis nigromaculata, Grube—Plate I., figs. 28 to 32.

(Grube, 'Ann. Semp.,' 1878, p. 50.)

Locality:—Station II., North of Negombo, 9 fathoms. One specimen.

Antennæ arising from the frontal margin of the prostomium; the tentaculum impar of about the same length, from the occipital margin. Only one pair of eyes observed on the slightly protuberant lateral borders. Palps short and stout, the anterior half densely fimbriate. Dorsal cirri short, ventral cirri subarticulate at tip. Each foot (after the first few pairs) is provided with a silk-producing gland which is apt to remain in the body after the extraction of the parapodium, the silken strands being drawn through the orifice of the notopodium.

The anterior elytra are inversely imbricate, inserted upon the elytrophores near the posterior border; the third elytra touch in the middle line behind the head (Plate I., figs. 28 to 31). The elytra were observed on segments II., IV., V., VII. and all subsequent odd segments up to XXXI., after which the body was quite flaccid and collapsed, full of the gold-coloured glistening silken coils and firmly attached to the tube at the posterior end.

The anterior portion of the tube was mostly free from the body of the worm, though slightly connected therewith by loose silken strands. The elytra are subtranslucent, colourless. The extruded proboscis carries a crown of marginal papillæ, eleven above, thirteen below; the median dorsal papilla is barely larger than the others. The setæ differ from those of *P. melanonotus* considerably. The dorsal group of setæ in the ventral ramus consists of small spinulose setæ, the spinules arranged in three remote whorls, below which the seta is slightly dilated; next a few fringed setæ; then the strong aristate setæ in two groups above and below the acicula; finally the ventral group of spinose setæ (Plate I., fig. 32). There are no penicillate setæ.

Length of anterior portion, including the proboscis, 13 millims.; width about 3 millims. Length of the posterior flaccid portion about 13 millims.

Family: SIGALIONIDÆ.

Psammolyce zeylanica, n. sp.—Plates I. and II., figs. 33 to 43.

Locality:—Ceylon Seas. One specimen, incomplete.

A fragment comprising about thirty setigerous segments, length 17 millims., body width 5 millims., 8 millims. over the setæ. The dorsum is completely encrusted with fine particles, chiefly calcareous débris, leaving the setæ exposed at the sides. The elytra are thin, transparent and triangular, the base of the triangle directed forwards. The basal area is clear, but the hinder area bears a luxurious growth of club-shaped and capitate papillæ to which the foreign particles adhere. The anterior pair of elytra probably meet or overlap, but in general the elytra are confined to the sides of the body, leaving the mid-dorsum free. Nevertheless the latter is covered with sand grains which adhere to dermal capitate papillæ (Plate I., fig. 33).

The prostomium, carrying two pairs of eyes, is overshadowed by the massive ceratophore. There are no paired antennæ on the prostomium, these having become adnate to the cirrophores of the buccal segment which carry the tentacular cirri and bundles of plumose setæ (Plate I., fig. 34). The lower side of the ceratophore carries a pair of dermal folds or lobes, which project from the sides below and inwards. The ventral surface is not encrusted, but is thickly beset in each segment with transverse rows of not very long acuminate papillæ which are continued upon the ventral surface of the parapodia. The ventral middle line is depressed. Amongst the bases of the acuminate papillæ are scattered minute globular papillæ reminding of those present in *Hermione*. The cirrophores (appendages of buccal segment) lie between the palps and the head, so that it is difficult to remove a cirrophore without the palp of the same side; the palps are glabrous.

The simple plumose setæ of the buccal segment have been mentioned above. In the second segment in addition to the plumose setæ there are compound setæ of the form represented in Plate II., fig. 36, with filiform apex of the appendix, the shaft being plumose. The ventral cirrus of the second segment is stout and long, nearly twice as long as the parapodium, and arises from a distinct basal joint. In the third segment compound setæ of more usual form appear, the shafts being stout and smooth except towards the extremity where they are squamose (Plate II., fig. 37); the appendices are lost. The dorsal cirrus of this segment has the articulated structure shown in Plate II., fig. 35. In the fourth segment the shafts of the compound setæ are still squamose distally; the appendix is elongated, curved at apex with a slight truncation jutting out below the apex. In a parapodium of a normal body-segment (anterior third of body) there is a dense dorsal fascicle of finely plumose capillary setæ, followed by a superior ventral group of moderately stout compound falcigerous setæ with subelongate appendices; then a central group of stout compound setæ with shorter appendices; finally an inferior ventral group of slender setæ with elongate appendices (Plate II., figs. 38 and 39). Sometimes the apex of the appendix is clearly bidentate, varying from this condition to smooth (Plate II., fig. 40). The ventral border of the parapodium is beset with acuminate filiform papillæ and some spheroidal papillæ (Plate II., fig. 41). The elytra are notched and lobed, especially at the inner border (Plate II., fig. 42).

Psammolyce rigida, GRUBE—Plate II., figs. 44 to 47.

GRUBE, 1868, 'Ann. Roth. Meer.' (Frauenfeld); 'Verh. zool.-botan. Ges. Wien,' p. 631, 1878; 'Ann. Semp.' (Philippines), p. 55.

Locality:—Station LIII., 10 miles north of West Cheval Paar. Three specimens, one complete, 115 millims. long, tapering gradually behind; 8 millims. wide over the setæ.

This species has the same general appearance as the *Psammolyce arenosa* of the Mediterranean. It is probably distinct in minor points, though I cannot specify what these points are without comparing actual specimens.

It differs from the preceding species in the following superficial respects:—

Ps. zeylanica.	*Ps. rigida.*
1. Colour fuscous.	Colour fulvous.
2. Calcareous grains predominate.	Quartz grains predominate.
3. Venter beset with capillary papillæ, *i.e.*, Venter hairy.	Venter beset with globular papillæ, *i.e.*, Venter tuberous.
4. Terminal portion of dorsal cirrus of third segment slenderer and shorter than its peduncle.	Terminal portion of same cirrus tapering and longer than its peduncle.

The parapodial armature of the two species shows such close correspondence that the slight differences which are observable could easily be attributed to individual variation, but the differences noted above under Nos. 3 and 4 would seem to preclude the possibility of regarding them as co-specific. Unfortunately I have no information as to the precise locality of the *Psammolyce zeylanica*. In Professor HERDMAN'S 'Narrative' of his expedition, *Psammolyce* is recorded from two stations, LII. and LIII. The latter is that from which the present species was dredged in 7½ to 9 fathoms, "bottom muddy sand with some dead shells;" the former station may be the locality of the other species, "between north of Cheval Paar and Vankali reef; depth 3 to 6 fathoms; bottom sand."

The difference noted above in respect of the adventitious coating of sand-grains is only of local significance as indicating a difference of habitat. The tuberculation of the ventral surface of the body is the most obvious character of this species. The low rounded dermal tubercles are placed close together without reference to segmental limits and not in rows, forming an even, elastic sole on each side of the depressed neural tract. The dermal tubercles are continued upon the parapodia, especially in the posterior two-thirds of the body, where they are thickly covered. Besides these spheroidal dermal tubercles there are tufts of filiform papillæ like those shown on Plate II., fig. 41. These occur on the base and summit of the parapodia, at the base of the ventral cirrus, and there is a ventro-lateral tuft on each segment between the tubercular tract and the parapodia.

Other substantial differences between the two species are shown in the figures. The elytra are formed upon the same model in both, and they are not safe objects for comparison, since they vary from segment to segment. Those of *Ps. rigida* have a concave anterior border, those of *Ps. zeylanica* are straight. The scar of insertion is short in the former, elongated in the latter (Plate II., fig. 46). The setæ of the second segment have a shorter appendix (Plate II., fig. 47). An important difference appears in the stout setæ from the centre of the ventral fascicle. In Plate II., figs. 43 and 44, two of these setæ, one from the right sixteenth foot of each species, are shown side by side. In *Ps. zeylanica* the declivity of the articular surface of the shaft is greater, and below the apex of the shaft there is a very distinct semilunar cusp which is not present in the seta of the same order in *Ps. rigida*. The other setæ show close correspondence, and here, as there, some of them are distinctly bidentate, but the difference noted appears to be constant.

Sthenelais zeylanica, n. sp.—Plate II., fig. 48.

A fragment with extruded proboscis, 15 millims. long, 5 millims. wide, in company with *Hyalinœcia camiguina*, was dredged off Foul Point, Trincomalee, Station XXV., 8 fathoms.

This species is closely allied to *Sthenelais boa*, but differs in several well-marked points. The prostomium carries four eyes in front, two on either side of the stout ceratophore with its aliform lobes (characteristic of the genus); the tentaculum impar borne upon the ceratophore is not very long, about as long as the ceratophore and the prostomium together; the palps are long, nearly as long as the extruded proboscis. The free margin of the latter carries both dorsally and ventrally a row of eleven evenly disposed papillæ.

The scales are carried on the usual segments II., IV., V., VII., IX. * * * * * * * * XXVII., XXVIII., XXIX., &c., becoming consecutive at segment XXVII. In the condition of extruded proboscis the dorsum of the third segment hardly shows, and the first two scales appear to occur on consecutive segments until they are pressed apart. The general character of the scales (their pronounced reniform shape, the tuberculation of the surface and the fimbriation of the margin) resembles that described and figured by Professor McIntosh for *Sthenelais boa* ('Ray Soc. Mon.,' 1900); the fimbriæ of the outer margin are acuminate, others which occur on the posterior margin are blunt; the tubercles are thickly scattered over the whole surface except near the anterior border of the inner lobe and near the corresponding border of the outer lobe; brownish pigment occurs all over the exposed portion of the scale.

The characters upon which I rely for specific differentiation are presented by the parapodia of the body-segments. In *Sthenelais boa* there are four principal groups of setæ, the dorsal plumose capillary setæ, the superior ventral plumose spiniform setæ, the mid-ventral compound bidentate falcigerous setæ, and the inferior ventral compound setæ with articulate bidentate appendix (*cf.* McIntosh, *op. cit.*, 1900). In *Sth. zeylanica* instead of the group of superior ventral spiniform setæ we have, composing this group, a few of the same kind of slender compound setæ with articulate appendix as occur in the inferior ventral group, and the spiniform setæ are not represented in the ventral ramus of the parapodium. The setæ themselves are not sensibly different from those of the corresponding forms in *Sth. boa* (Plate II., fig. 48). The ciliated cushions or ctenidia (McIntosh) on the upper surface of the foot beneath the cirriform branchia are the same as in *Sth. boa*, but the disposition of stylodes is different, particularly as regards the two long stylodes which proceed from the base of the ventral cirrus in *Sth. zeylanica* (Plate II., fig. 48).

Sthenolepis, n. gen.

The genera *Thalenessa* and *Leanira* are characterised by the presence of a very small tentaculum impar inserted directly upon the prostomium, not borne upon a ceratophore. The compound setæ of *Thalenessa* are a variety of the falcigerous type with bidentate appendices; those of *Leanira* are spinigerous.

Sthenelais and *Sthenolepis*, n. gen., are characterised by the presence of a long tentaculum impar borne upon a ceratophore which is provided with a pair of spatulate appendages. The compound setæ of *Sthenelais* are falcigerous like those of *Thalenessa;* those of *Sthenolepis* are spinigerous as in *Leanira*.

All the species of *Leanira* described by Professor McIntosh in the "Challenger" collection are to be ranged in the genus *Sthenolepis*. In this genus the scales are generally smooth.

Sthenolepis japonica (McIntosh)—Plate II., fig. 49.

Leanira japonica, McIntosh, '"Challenger" Polychæta,' 1885, p. 154.

A headless posterior fragment of a Sigalionid worm, labelled "*Leanira* sp.," was dredged at Station XXXV., off Galle, 7 fathoms. An anterior fragment of the same species with same locality and date was contained in another bottle in company with *Glycera lancadivæ*.

The different preservation of the two pieces gives them a different aspect, but the structure of the parapodia shows that they belong to the same species. The thin translucent smooth elytra embrace the body so closely as to be inconspicuous; in front they meet in the middle line and overhang the head; further back they leave the mid-dorsum exposed and then approximate again.

The long tentaculum, accompanied by a pair of equally long tentacular cirri, projects straightly and stiffly forwards; the spatulate appendages are nearly as long as the ceratophore; at the base of the latter on each side of the prostomium a small eye is visible from above. The ends of the parapodial rami are furnished with a rich growth of stylodes; the dorsal setæ are very numerous, long, slender, and transversely fringed; from the dorsal end of the ventral ramus a compact tuft of about 20 spinulose simple setæ issues; the rest of the ventral setæ are compound spinigerous, the appendices are not very long and present a peculiar intrinsic laminated structure. Between the cirriform gill and the dorsal fascicle are three ctenidia. The ventral cirrus has a rounded protuberance some distance beyond its insertion (Plate II., fig. 49). The body is slender, the anterior region having a width of 2·5 millims. across the body, 4 millims. across the setæ.

A much smaller complete specimen from the same locality is also contained in the collection and shows to perfection a feature which is present in the larger individual. The anterior setæ of the buccal segment are exceedingly long and slender, as long as the tentaculum and tentacular cirri, and they embrace these appendages in such a manner that the whole complex bears the appearance of a compact flabellum.

There is a great quantity of mucus surrounding the specimens which was apparently produced by the Glycerids with which they were preserved, and this no doubt binds the setæ and tentacles fortuitously together, but the extremely delicate porrect fascicles of long hair-like setæ are highly characteristic. Another point which should be noted is the greater length of the appendices of the compound setæ in the anterior segments. In the smaller specimen there are fewer spinulose or verticillate setæ in the superior fascicle of the ventral ramus, and the stylodes appear to be less numerous; in fact, in a parapodium from the mid-body I only see one verticillate seta as in *Leanira japonica*, McInt. Although the Japanese worm retained no scales, yet it seems probable that the Ceylon specimens are co-specific. In these the scales adhere firmly to the body.

Thalenessa digitata, McIntosh—Plate II., figs. 50 to 52.

> **Thalenessa digitata**, McIntosh, "Polychæta," '"Challenger" Rep.,' 1885, p. 140 (off the Admiralty Islands in 16–25 fathoms).
>
> **Thalenessa im-thurni**, Hornell, 'Ceylon Pearl Oyster Report,' Part I., 1903, pp. 16, 49, and 52.

Taken off Galle (Station XXXVIII.) and off Panadure (Station XLV.) down to 25 fathoms.

Three small frontal antennæ; the lips of the anterior four pairs of setigerous parapodia are produced into conspicuous membranellæ and also carry numerous stylodes; the first five setigers contain setæ with long, jointed appendices, such setæ being numerous in the first four feet, scarce in the fifth, and thereafter absent, only setæ with unjointed appendices being found (Plate II., fig. 50). All these points correspond closely with Professor McIntosh's description and figures.

The elytra do not cover the back; the first two elytra are smaller than the rest, and the first has a smooth margin, destitute of fimbriæ; a typical elytron is subtriangular in shape, the outer border provided with about a dozen compound fimbriæ, more frequently with four divisions each (Plate II., fig. 51), but there may be as many as six branches, or only three, two, or one. The elytra are attached to segments II., IV., V., VII., IX., * * * * * * * XXV., XXVII., XXVIII., XXIX., &c., becoming continuous at segment XXVII. Cirriform branchiæ are present in all setigerous segments, two clear ctenidia on the dorsal surface of the foot, one attached to the peduncle of the gill. Ventral cirrus long, projecting beyond the foot. No papillæ on the ventral division of a typical foot from the middle region.

Thalenessa oculata, McIntosh, is apparently another form of *digitata*, slightly differing from the type. It is interesting to take note of the differential shifting of parts which has taken place, for example in such genera as *Thalenessa* and *Iphione.* In the former the palps are concealed below the cirrophores of the tentacular cirri (Plate II., fig. 52); in the latter the cirrophores of the tentacular cirri are concealed below the palps (Plate I., fig. 6).

Thalenessa stylolepis, n. sp.—Plate III., figs. 53 to 56.

Localities:—Station LVII., 11½ to 36 fathoms; and Station LVI., Dutch Modragam Paar, 9 fathoms; specimen incomplete behind; taken out of coral block.

This must be the worm referred to on p. 74 of the 'Ceylon Pearl Oyster Report,' Part I., as *Sigalion mathildæ.**

The chief characters, which typify a new section of the genus *Thalenessa*, are the possession of a pair of small frontal antennæ and an equally small median occipital antenna; the insertion of the elytra upon high peduncles; and, in the anterior region, the absence of the cirriform branchiæ from the scaleless segments.

Prostomium large, flattened, shield-shaped, with three notches or emarginations, two at the frontal border from which the paired antennæ arise, one at the occipital border from which the tentaculum impar arises (Plate III., fig. 53). Only one pair of eyes was observed occupying a central position behind the frontal emarginations. The cirrophores of the buccal segment are porrect, sub-median and adnate to the prostomium. The line of division between the frontal border and the cirrophores is at the same time the line of concrescence of these structures, so that the antennæ are virtually inserted into the base of the cirrophores, a condition leading to that found in *Sthenelais, Sthenolepis* and *Psammolyce.* The palps are long and smooth.

The elytra are pedunculate, the elytrophores rising like stout pillars from the dorsum, as in *Eulepis;* the elytra are firmly attached to the elytrophores; proceeding outwards from the latter below each elytron is a rather long cirriform appendage which does not occur on the intervening segments (segmenta nuda); the latter show a small tubercle in the line of the elytrophores. The elytra are placed on the usual segments up to the 27th, when they begin to be continuously successive. They carry 12 to 13 (or fewer) plumose fimbriæ (Plate III., fig. 56), which project straight outwards from the outer border, followed by a few simple filiform papillæ. The elytra of the first pair are smaller than the following, rounded, not accompanied by cirriform appendage. The remaining elytra cover the dorsum, their inner borders meeting so as to form a tunnel along the length of the body; on the inner side of each elytrophore a small ctenidium projects into the tunnel, a pair of these ctenidia being inclined towards one another in each body-segment (Plate III., fig. 54). As mentioned above, the cirriform branchiæ of *Thalenessa stylolepis* are confined to the elytrophores. The dorsal ramus of the parapodium (Plate III., fig. 54) carries a bundle of numerous long simple fringed setæ, the fringes appearing in side view as a

* The plumose fimbriæ of the elytra exactly resemble those of *Sigalion mathildæ* as figured by Professor McIntosh (1900).

series of projecting overlapping scales; mediad of the dorsal fascicle the simple setæ are shorter and hyaline. The ventral ramus carries a superior bundle of simple whorled setæ, the verticillate tract short. All the remaining ventral setæ are of the compound falcigerous type, bearing very long, many-jointed, tapering, bidentate appendices, the number of joints being as many as ten. The compound setæ of the middle group are characterised by the possession of squamose (fringed) shafts, while the more slender setæ of the inferior group have plain shafts. A parapodium from the posterior region (near the 60th segment) shows the dorsal ramus projecting clearly beyond the ventral, and in the ventral fascicle, in addition to the compound setæ with the long, jointed, flexible appendices, there are two stout setæ with short unjointed appendices provided with a gaping beak (Plate III., fig. 55). Between 50 and 60 segments are present in the imperfect specimen described above, which is 35 millims. long with width of 3 millims. without the setæ, 4 millims. over the setæ.

Family: PHYLLODOCIDÆ.

Anaitis zeylanica, n. sp.—Plate III., figs. 57 to 60.

Locality:—South of Manaar Island, 8 to 9 fathoms. One specimen, proboscis retracted.

The dorsal phyllodes are broadly ovate (cordate-lanceolate) and pedunculate, as they are in a dozen other species. Head rounded; eyes large; tentacular cirri normal, elongate. Proboscis (dissected) consists of two well-separated portions, a thin-walled proximal or adoral portion densely crowded with papillæ not serially disposed; a thick-walled distal portion with six prominent rows of large subtriangular papillæ, six or seven in a row.

Setæ, ten in a parapodium, the shaft terminating in a triangular apex fringed at the sides and articulating on one side with a long flagelliform strongly serrulate appendix (Plate III., fig. 57). Anal cirri (one preserved) of moderate length, acuminate with stout basal portion. Body slender, length 38 millims.; total width under 2 millims.

The setæ appear heterogomph in side view, homogomph in frontal view (Plate III., fig. 58). I am afraid they offer no reliable diagnostic character, unless it is their size. In this, however, as in other points they resemble the setæ of *Phyllodoce sancti-josephi*. The shape of the head and of the phyllodes is shown on Plate III., figs. 59 and 60.

Carobia castanea, Marenzeller.

Marenzeller, 'Südjapan. Ann.,' i., 1879, p. 127 (p. 19 of reprint).

This species is distinguished from other Oriental Phyllodocidæ by its deep red colour.

The red dorsal phyllodes are cordate and the setæ are distinguished from all others in this collection by their rather short appendices destitute of serrulations and the wide, nearly horizontal articular end of the shaft, as figured by von Marenzeller.

Notophyllum laciniatum, n. sp.—Plate III., figs. 61 and 62.

Station V., off Chilaw Paar, Gulf of Manaar, 11 fathoms. One specimen.

This Phyllodoceid worm is characterised by a relatively short and thick body and by the possession of broad closely imbricating scales or phyllodes (foliaceous dorsal cirri); the anterior phyllodes conceal the occipital region of the head, meeting across the middle line, the rest leave the mid-dorsum exposed. There are as many as ninety segments. The specimen measures about 20 millims. in length and 3 millims. in breadth.

The head is simple, with two large eyes in the posterior half, between which arises a brown-tinted tentaculum impar. The somewhat fusiform antennæ arise between the eye-region and the anterior border, and the fusiform palps, with rather long terminal flagellum, arise nearer the middle line from the under side of the frontal region. The left antenna was lost from the specimen. The four pairs of tentacular cirri are closely aggregated in the cephalic region, only two of them are seen from above, the second and fourth, the latter being the longest. The first cirrus is more massive than the others.

The great character of the species is given by the presence of three cirriform occipital or nuchal lappets, which hang backwards on each side from the back of the head (Plate III., fig. 61). This feature also occurs in *Phyllodoce multicirris*, Grube ('Ann. Semp.,' p. 100), which is clearly a closely allied species, differing in the structure of the head, especially in the decided possession of four eyes. The setæ and phyllodes also exhibit minor differences. Each occipital lappet has a pale border and a brown centre. The dorsal phyllodes have the same shape and arrangement as figured by Grube for *Ph. multicirris*, but they do not show the round surface markings of that species. The ventral phyllodes also have the same peculiar disposition, inserted high up near the extremity of the parapodium and lying outspread behind the pharetra setarum.

In the setæ the articular end of the shaft shows a character of its own. There are as many as 21 setæ in a ventral fascicle from the anterior region; most of them are broken. In optical section the ends of the shafts appear deeply excavate, the articular fossa bounded by stout refringent walls (Plate III., fig. 62). The dorsal ramus is represented by the lobe upon the summit of which the dorsal phyllode is inserted; it is penetrated by a single slender acicula. The appendices of the compound setæ are rather long and minutely serrulate.

Phyllodoce dissotyla, n. sp.—Plate III., figs. 63 to 66.

Station V., off Chilaw Paar, Gulf of Manaar, 11 fathoms. One specimen, 25 millims. long by 1 millim. broad; proboscis not extruded.

The head is longer than broad; the antennæ do not stretch back to the eyes; the eye shows a clear lens (Plate III., fig. 63). There are four pairs of long tentacular cirri of normal form. The dorsal phyllodes are rounded, not lanceolate, and strongly pedunculate. The setæ, 18 in a fascicle, are heterogomph, the articulation of the appendix distinct; the appendix with serrulate edge (Plate III., figs. 64 and 65).

The dominant specific character was ascertained by removing and opening the retracted proboscis, the adoral portion of which is beset with longitudinal rows of rounded normal papillæ; in two of the rows, probably median dorsal and median ventral (since they are separated from one another by normal rows), there are three large triangular papillæ placed one behind the other, with normal papillæ in front and behind in the same rows. These modified papillæ are denser than the rest and are noticeable under low magnification with a simple lens (Plate III., fig. 66). They are quite definite, two sets of three on opposite sides of the proboscis.

The phyllodes and setæ are also characteristic, but the determining character is given by the papillæ of the proboscis.

Phyllodoce foliosopapillata, Hornell—Plate III., figs. 67 to 69.

'Ceylon Pearl Oyster Report,' Part I., 1903, p. 16 and p. 28, "Yellowish green Phyllodocid."

Station XVII., outside Periya Paar, 11 fathoms.

The specimen, which is incomplete behind, has a length of 135 millims. (141 millims. with extruded proboscis); about 207 segments; ventral width between the parapodia 2 millims.; over the parapodia 5 millims. The proboscis is firm and sexangulate; towards the base it is traversed by transverse rugæ, and behind these, at the level of the head on each side, there are six rows of transversely elongate, foliate papillæ, 5 or 6 in the first row, 8 or 9 in the second, 10 in the third, and again decreasing below; at the free margin I counted 14 or 15 rounded papillæ (Plate III., fig. 67). The foliaceous dorsal cirri, which may be called phyllodes to distinguish them from the elytra of the Aphroditidæ, are borne upon broad peduncles to which they are strongly adherent. In this specimen the phyllophores are filled with ova (Plate III., fig. 68).

There are as many as 25 compound setæ in a parapodium. The long flexible spiniform appendices are serrulate along one border, but in some of them the serrulations are obscure or even obsolete. The setæ differ from those of other species in the presence of a long stout spur at the head of the shaft, which sometimes projects considerably beyond the neighbouring denticulations, even more so than in the example figured (Plate III., fig. 69).

Closely apposed to the sides of the prostomium is a pair of lateral nuchal organs (Plate III., fig. 67). The prostomium is broader than long, deeply emarginate behind, and in the notch there is an occipital papilla, such as occurs also in *Phyllodoce madeirensis* and other species.

The insertion of the four pairs of tentacular cirri is the same as in *Ph. madeirensis*, namely, on each side :—

Segment I., one tentacular cirrus ;
,, II., two tentacular cirri ;
,, III., one tentacular cirrus and a cirrus ventralis foliaceus.

The first appearance presented is that of two cirri in the first segment, but closer examination showed that this appearance is deceptive. The longest is the dorsal cirrus of the second segment, stretching back over eleven segments.

Phyllodoce macrolepidota, SCHMARDA—Plate III., figs. 70 and 71.

SCHMARDA, 'Neue Wirbellose Thiere,' ii., 1861, p. 83, Taf. xxix., fig. 229.
Phyllodoce tenuissima, GRUBE, 'Ann. Semp.,' 1878, p. 95.

Locality :—Galle Habour, on oyster cage. One specimen.

Body very long and slender, 200 millims., with a width of 3 millims. in front, over the setæ ; more than 350 segments. The proboscis is only half extruded, and this portion is inflated and soft ; it carries six longitudinal rows of broad, flattened, arcuate, dark-coloured papillæ on each side in front of the head-region, 8 to 10 papillæ in a row, and, in addition, a median dorsal row of six papillæ. The general arrangement of the papillæ and the presence of the median row are features which characterise *Ph. madeirensis*, LANGERHANS, of which this may be an Oriental representative, but it has nearly three times the length and about twice as many segments as in the type-species of LANGERHANS. There are 17 setæ in a parapodium (Plate III., fig. 70) ; they do not offer any striking character (Plate III., fig. 71). The head is about as long as it is broad, with rather large eyes in the centre of the posterior cephalic convexity on each side ; it is acutely notched behind, but the specimen does not show a nuchal papilla. There are two rather short, stout, subulate anal cirri.

Phyllodoce sancti-josephi, GRAVIER—Plate III., figs. 72 and 73.

GRAVIER, "Ann. Polychètes de la Mer Rouge," 'Arch. Mus. Paris (4 ser.), ii., 1900, p. 196.

Station V., off Chilaw Paar, Gulf of Manaar, 11 fathoms. Two specimens.

These worms differ from the type in the shape of the head and in the apparent absence of an occipital papilla. The widening of the head is correlated with the extrusion of the proboscis, and the occlusion of the papilla may be due to the same cause. One of the specimens has a length of 55 millims. and a total width in front of 2 millims.

The proboscis in its general consistency and in the presence of a posterior rugose portion resembles that of *Ph. foliosopapillata*, but the papillæ, of which there are six rows on each side, extend over the rugose region in front of the head (Plate III., fig. 72). In the second specimen the proboscis shows six prominent angulations in front of the rugose portion.

The head itself, under the condition of extruded proboscis, is about as broad as long and not deeply notched behind. On each side of the prostomium there is a prominent lateral nuchal papilla. The phyllodes resemble those of *Ph. macrolepidota* in shape and proportion, the dorsal phyllode being distinctly pedunculate and its axis occupied by a rete mirabile, from which radial vessels proceed to the margins. The parapodium carries twelve setæ of normal type (Plate III., fig. 73), though, as shown by M. GRAVIER, the number varies within narrow limits in different regions of the body. The number which I have given holds good for the mid-region. A foot from the posterior region has sixteen setæ.

Pterocirrus ceylonicus, MICHAELSEN.

This species is well characterised by the five long slender subequal prostomial appendages, longer than the prostomium. The remarkable winged ventral cirrus of the second segment which, seen from above along its thickened dorsal border, looks like an ordinary tentacular cirrus, is a generic feature of first importance. The dorsal phyllodes are more lanceolate than that shown in Dr. MICHAELSEN'S figure, "Polychäten von Ceylon," 'Jahrb. Hamburg. Wiss. Anstalt,' 1892, ix., 2, p. 103, otherwise I have nothing to add to his description. The colour of the preserved specimens is dark greenish-brown. Locality :—Ceylon Seas.

FAMILY: HESIONIDÆ.

Hesione ceylonica, GRUBE.

GRUBE, "Ann. Ceylon" (Holdsworth coll.) 'P. Zool. Soc. London,' 1874, p, 327.

Locality :—Numerous specimens from various stations.

This is probably a geographical form of *Hesione splendida*, SAVIGNY, which is characterised by the possession of one pair of frontal antennæ; eight pairs of tentacular cirri; sixteen pairs of uniramous parapodia; four distinct eyes; pigment disposed more or less in longitudinal bands or streaks. SAVIGNY was in error regarding the minute antennæ, and the illustrations do not correspond with the text in certain particulars, hence confusion has arisen.

The Ceylon specimens range in length of body from 9 millims. to 36 millims. ; in the latter case the ventral width between the parapodia is 4 millims., over the setæ 11 millims. In all cases the full number of setigerous segments, namely 16, is present. The extruded proboscis shows a median dorsal callosity or hard papilla (not seen in the smallest specimen) a short distance from the base, like that figured by AUDOUIN and MILNE-EDWARDS (1834) in *H. pantherina*. The compound falcigerous setæ have bidentate appendices with a spiniform guard arising below the denticulations. The guard may be worn away.

A specimen of 14 millims. length had a ventral width between the parapodia of 2 millims., over the setæ nearly 5 millims.

Hesione genetta, Grube. (See Grube, 'Ann. Semp.,' 1878, p. 104.)

One specimen from Chilaw Paar, Station LXIX.

This species is distinguished from the members of the *splendida* group by its very characteristic and enduring pigmentation. At the junction of the first and second setigerous segments there is a broad dark transverse band passing from one side to the other across the convex dorsum. Behind this band the segments are marked by transverse brown spots which are sometimes confluent. The cuticle is highly iridescent; the body flexed ventrally and the ventro-lateral borders elevated, leaving a median neural groove between them. The prostomium is quadratic; two frontal notches from which the minute antennæ arise; eyes barely visible. The body is shaped like that of *H. reticulata*, von Marenzeller (South Japan), and resembles the body of a caterpillar, as remarked by von Marenzeller. Length 13 millims., inclusive width 3 millims.

Irma limicola, n. sp.—Plate III., figs. 74 to 76.

This species is founded upon a single example which occurred in one of the mud-tubes of *Loimia montagui* from Palk Bay. It is not very well preserved in consequence of having been trapped in such a narrow recess. Its length is 20 millims., width 3 millims., with upwards of 50 segments.

The head is transverse, the eyes widely separated, the anterior and posterior eyes of each couple crescentic and closely approximated. From the frontal border of the prostomium on each side two equal cephalic appendages (antennæ and palps) curve backwards, lying over the eyes and sides of the prostomium. The biannulate proboscis is extruded. No tentaculum impar could be observed. Six tentacular cirri are present on each side of the buccal segment, placed in a dorsi-ventral manner, the upper and lower of the group being shorter than the intermediate.

The dorsal ramus of the parapodium is intimately connate with the cirrophore of the dorsal cirrus into which an acicula extends, and from a slight protuberance on the lower side of the cirrophore a bundle of very fine capillary setæ emerges (Plate III., fig. 74). The compound setæ of the ventral ramus are numerous, about fifty in each fascicle. They are falcigerous, carrying very long appendices curved at the tip and bidentate, the apical tooth frequently connected with the minor tooth by a limbus. The superior setæ of the ventral ramus have appendices about one-half shorter than the average; the inferior setæ, *i.e.*, the most ventrally placed setæ, carry quarter-sized appendices (Plate III., figs. 75 and 76). The relations of the dorsal and ventral cirri and the lip of the parapodium are shown in the figure (Plate III., fig. 74). Repeated examination failed to reveal any trace of a tentaculum impar in *Irma limicola*. In this respect it approaches the genus *Castalia*, Sav., as amended by M. Sars ('Christ. Vid. Selsk. Forh.,' 1861, p. 88), but there are no coronary papillæ on the proboscis and no jaws.

The definition of *Irma* should be modified as follows :—

Proboscis nuda; palpi biarticulati; antennæ 3 (interdum 2 observatæ); oculi 4; cirri tentaculares 12; pedes quasi biremes; ramus dorsalis vestigialis cum articulo basali cirri dorsalis connatus, setas dorsales capillares gerens aut nullus; setæ ventrales compositæ falcigeræ; aciculæ binæ.

The fact of an acicula passing into the cirrophore indicates the primitive biramous nature of the foot in those species where dorsal capillary setæ do not occur, exactly as in the analogous case of *Podarke*, EHLERS. The absence of a median antenna in *I. limicola* is puzzling, and will remain so until more material is obtained. The species described by me as *Oxydromus aucklandicus* ('"Southern Cross" Collections,' London, 1902, p. 281) should be transferred to the genus *Irma* as now defined.

FAMILY: SYLLIDÆ.

Typosyllis taprobanensis, n. sp.—Plate III., figs. 77 and 78.

Localities:—East side of Cheval Paar; and South-west Cheval Paar, Gulf of Manaar.

This is a variable species, one specimen seemed to resemble *T. variegata*, the next *T. krohni*, the differences being in part substantial, in part due to the fact that the pharynx of the one was on the point of being projected, that of the other was retracted completely.

Antennæ and cirri moniliform; in the first specimen (length 19 millims., width 1·5 millims.) the paired and unpaired antennæ were about equal in length to each other and to the palps, the paired rather slenderer than the impar, shorter than the dorsal cirri; the latter, not deciduous, longer alternating with shorter and slenderer; the first ventral tentacular cirrus slender, not much longer than the palps; head transverse, partially concealed below the buccal segment; pharynx, on the point of projection from the mouth, lined by thick dark-brown cuticle (showing dark purplish-black through the skin) carrying a subterminal dorsal tooth coloured the same as the chitinous intima; proventriculus, with about 37 rows, finely tessellated, glistening whitish with delicate flush.

In the second specimen the median antenna was long, showing 36 joints; most of the dorsal cirri were lost, that of the 5th setiger showed 42 joints, that of the 64th setiger upwards of 30 joints; the pharynx and proventriculus, seen by transparency, exactly resembled those of the first specimen and decided the specific identity, but were differently placed, being retracted; the pharynx extended from the 7th to the 15th setigerous segment, the proventriculus from the 15th to the 25th setigerous segment; colour of the first 24 setigerous segments:—two brown transverse bands in each segment; total number of segments 150; length 30 millims.

The setæ of both corresponded in general characters, differing in a manner shown in the figures (Plate III., figs. 77 and 78). In the anterior segments there are about

12 to 16 compound falcigerous bidentate setæ lying below 5 aciculæ; the aciculæ become reduced to 3 and posteriorly to 2; the setæ also undergo changes, the shaft becoming stouter and the appendix shorter; the shaft further assumes a characteristic dilatation of varying intensity below the joint (Plate III., figs. 77 and 78).

The anal cirri showed 24 joints; no median caudal process was observed. The head of the second specimen was normal, rounded, not transversely elongate, the latter condition apparently resulting from the commencing extrusion of the pharynx. The palps are quite separate, with distinct subfrontal insertions, a wide proximal half and a narrower distal halt.

In *Typosyllis variegata*, according to VON MARENZELLER,* the palps are fused together at the base. The Ceylon species would appear to be related to *T. krohni*, as described by LANGERHANS.† The difference noted above in respect of the shafts of the setæ may be correlated with the difference of age and size of the specimens of *T. taprobanensis*.

Haplosyllis spongicola (GRUBE)—Plate III., figs. 79 and 80.

GRUBE, 'Arch. Naturg.,' 1855, p. 104; MARION et BOBRETZKY, 1875, 'Ann. Marseilles,' p. 24.
Syllis hamata, CLAPARÈDE, 1868; LANGERHANS, Madeira, 1879, 'Z. f. w. Z.,' xxxii., p. 527; ST. JOSEPH, 'Dinard,' 1886, part i., p. 142; 1895, part iv., p. 185.
Syllis violaceo-flava, GRUBE, 'Ann. Semp.,' 1878, p. 115; see also LANGERHANS, Madeira, part iii., 'Z. f. w. Z.,' xxxiv., p. 128.

A small specimen, 4·5 millims. long, was taken from between the whorls of the operculum of a large Serpulid [*Pomatostegus actinoceros*], off Panadure, Station XLV., 25 fathoms.

Over 40 setigerous segments; setæ brittle, many of them with the tips broken off. The proventriculus is long, occupying segments 13–25, but the body is contracted. On examining the specimen *in toto*, it is common to see two hamate unguarded acicular setæ projecting from a parapodium, one of which is stronger than the other; both of these setæ have a bidenticulate apical tooth as figured by MARION and BOBRETZKY, and by LANGERHANS. (In *Haplosyllis djiboutiensis*,‡ GRAVIER found, in one individual, the apical tooth of the stronger seta simple.) The pharynx is armed in front with a single conical tooth surrounded by a crown of ten soft papillæ (Plate III., fig. 80). The head is shown in Plate III., fig. 79.

Syllis gracilis, GRUBE (1840).

(*Cf.* ST. JOSEPH, "Ann. de Dinard," part i., 'Ann. Sci. Nat.' (7) i., 1886, p. 158; part iv., t. xx., 1895, p. 190.)

Locality:—South-west Cheval Paar. Three specimens.

1. About 180 segments; length 45 millims.; body contorted; diameter uniform,

* 'Adriat. Ann.,' ii., 1875, p. 147.

† "Wurmfauna Madeira," i., 'Zeit. f. wiss. Zool.,' xxxii., 1879, p. 529.

‡ GRAVIER, "Ann. Mer Rouge," 1900, 'Arch. Mus. Paris' (4) ii., p. 147.

about 1 millim. without feet, 2 millims. inclusive. Anterior setæ compound, falcigerous, bidentate, in about 30 segments; thereafter simple furciform setæ; in the posterior segments some of the furciform setæ become quasi-compound. Dorsal cirri of about 40 anterior segments long, with a tendency to alternate longer and shorter; afterwards they become shorter, subfusiform, still alternating. Tentaculum impar with 27 joints; paired antennæ, about 16 joints; dorsal tentacular cirrus, 18–20 joints; first dorsal cirrus, 34 joints; posterior dorsal cirri, 8–12 joints. Pharynx black in segments 3–20; proventriculus in segments 20–28.

2. Length 15 millims., 83 segments followed by about a dozen regenerating segments showing small compound setæ of the usual type. Compound setæ in anterior 28 segments.

3. Length 22 millims.; segments 118; compound setæ in 28 anterior segments; in segments 29–90 simple furciform setæ; in segments 91–118 the falcigerous bidentate setæ re-appear. Pharynx brown in segments 1–13; proventriculus 14–20. Tentaculum impar moniliform, 18 joints; dorsal cirrus of first setiger longest, with 20 joints.

Autolytus orientalis, n. sp.—Plate IV., figs. 81 to 84.

Locality:—Found in plankton, 2nd and 3rd March, 1903, North-east Cheval. Several stoloniferous specimens; total length 10 to 20 millims.

In the example figured (Plate IV., fig. 81) there are 29 setigerous segments in the anterior or parent individual. The parapodia contain two aciculæ and numerous, upwards of 20, compound falcigerous setæ; the head of the shaft is laciniate and the appendix is minutely bidentate and minutely fringed (Plate IV., fig. 84). The dorsal cirri are rather short, lanceolate, petaloid, with strong basal articulation. The second dorsal cirrus, *i.e.*, the cirrus of the first setiger, is the longest. The rounded reduced palps, joined together in the middle line along their own length, are only visible from below (Plate IV., fig. 83). The pharynx is long and has a sigmoid flexure; it is armed in front with a circle of 44 denticles, larger and smaller irregularly alternating (Plate IV., fig. 82). The proventriculus shows 28 glandular rows.

Family: NEREIDÆ.

Nereis indica, Kinberg.

Kinberg, 'Annulata nova—Nereidum dispositio nova,' 'Öfv. Akad. Forh.,' 1865, p. 169.

Locality:—Galle, from buoy; one female containing ova.

Length 50 millims., inclusive width 4·5 millims. Tentacular cirri not long, reaching to third segment; antennæ $\frac{3}{4}$ length of prostomium; palps long with narrow terminal appendix; eyes large, equal, the posterior rather closer together. Body incomplete behind, 77 setigerous segments.

Feet subequal; dorsal cirri of anterior segments about twice as long as the blunt dorsal ligule; ventral cirrus not reaching the tip of the ventral ligule; in the middle segments the neuropodia and the bases of the cirri become membranous, the dorsal ligule becomes elongate and acuminate,* the dorsal cirrus exceeding it by about one-fifth only; in the posterior segments the dorsal cirri are upwards of four times the length of the dorsal ligule. Dorsal setæ homogomph spinigerous; superior ventral setæ homogomph spinigerous and heterogomph falcigerous; inferior ventral setæ heterogomph spinigerous and heterogomph falcigerous. The shafts of all the setæ are striated and all the appendices are strongly fringed (setulose); the falciform appendices are entire at the apex, not bidentate.

The proboscis was retracted and was dissected out:—I., 1; II., 12–12 (oblique acervi); III., 10 (triangular acervus); IV., 15–15 (three unequal rows); V., 0; VI., 6–6 (irregular); VII. and VIII., biserial, anterior row large alternating paragnaths; paragnaths of the posterior row half as large and one and a half times as numerous as those of the front row.

Nereis unifasciata, n. sp.—Plate IV., figs. 85 to 88.

Locality:—South-east Cheval Paar.

A small Nereid (length 11 millims., incomplete behind) characterised by the presence of a dark brown collar across the whole of the dorsum of the second setigerous segment. The buccal and the first setigerous segments are pale brownish at the sides, but there is no band across them. Commencing from the intersegmental groove between the fourth and fifth setigerous segments there are about twelve pairs of small intersegmental brown spots on the back. The feet are equal and resemble those of *Ceratonereis pectinifera* (p. 272) in the general proportions of parts (Plate IV., figs. 85 and 86). The two worms were collected at the same time and place.

The distribution of the setæ in the foot is as follows:—Dorsal, homogomph spinigers; superior ventral, homogomph spinigers and heterogomph falcigers; inferior ventral, heterogomph spinigers and falcigers. The heterogomph spinigers are not completely heterogomph, but, at least in the middle and posterior segments, present a condition which might be described as hemigomph (Plate IV., figs. 87 and 88). This small detail affords the only real distinction between the armature of the feet of this species and that of *Ceratonereis pectinifera*. The proboscis was not extruded, and, although as a rule I do not attempt the description of small Nereids unless the proboscis is extruded, I was anxious to test the specific value of the colour-markings and of the setæ. The dissected proboscis showed paragnaths in the adoral division, those of the order VI. in small acervi, of VII. and VIII. in a single row as in *Nereis trifasciata*, Grube. It is therefore not a *Ceratonereis*.

I cannot state any differences between the armature of the proboscis of this species and that of *Nereis trifasciata*.† The fact that such a minute detail as the presence

* The inferior lip of the notopodium is also produced as a ligule, the inferior dorsal ligule, resembling the superior ligule throughout, but rather shorter.

† Except that the maxillæ show seven teeth.

of hemigomph instead of homogomph spinigers in the inferior ventral fascicle is sufficient to indicate fundamental divergence is interesting. The third tentacular cirrus stretches back to the end of the seventh segment as in *N. trifasciata.*

Nereis ehlersiana, GRUBE. (GRUBE, 'Ann. Semp.,' 1878, p. 71.)

Locality :—Station LXIX., Chilaw Paar.

The anterior portion of the body comprises 15 segments (14 setigerous); the dorsal cirri of the first seven setigerous segments are modified, unequally elongate and foliaceous. A normal parapodium from the anterior region shows reduced rounded ligules, moderate dorsal cirrus much longer than its ligule, short ventral cirrus; dorsal setæ homogomph spinigerous; superior ventral homogomph spinigers and heterogomph falcigers; inferior ventral heterogomph falcigers.

Ceratonereis falcaria, n. sp.—Plate IV., fig. 89.

Locality :—South-west Cheval Paar, two specimens.

About 107 segments with an even diameter of 2·5 millims. up to the region of the 55th segment, then rapidly attenuating; length 27 millims. Frontal border notched so that the antennæ are borne upon ceratophores as in *C. tentaculata*, KBG., and *C. excisa*, GR. Eyes large, in a rectangle. Tentacular cirri moderately long; dorsal cirri more than twice as long as the dorsal ligules; ventral cirri of the two middle quarters of the body with basal lobules.

The distinctive character of the species is afforded by the setæ. In the first sixteen segments the setæ of the dorsal fascicle are homogomph spinigerous; of the superior ventral fascicle homogomph spinigerous and heterogomph falcigerous; in the inferior ventral fascicle heterogomph spinigerous and heterogomph falcigerous; the shafts are striated, the appendices fringed and the falciform appendices are simple, not bidentate. After this the dorsal setæ undergo a change, becoming homogomph falcigerous with a deeply set, strongly bidentate appendix without guard (Plate IV., fig. 89). Transitional forms between the two kinds of dorsal setæ are to be observed, namely, setæ in which the appendix is shorter and stouter than in the normal spinigerous setæ. Paragnaths :—I., 0; II., 5–5; III., 7 (in one row); IV., 10–10. Maxillæ with about six denticulations. In the character of the paragnaths this species approaches *C. vulgata*, KINBERG, from Honolulu. The change of dorsal setæ from spinigerous to falcigerous is remarkably diagnostic.

Ceratonereis pectinifera, GRUBE—Plate IV., figs. 90 and 91.

GRUBE, 'Ann. Semp.,' 1878, p. 66.

Locality :—South-east Cheval Paar.

A small Nereid, 17 millims. in length, almost the only one in the collection with the proboscis extruded. The systematic importance of the paragnaths of Nereidæ is well known, and a particular illustration of it is afforded by this species in comparison with *Nereis unifasciata* (q. v.). Antennæ shorter than proboscis, eyes in a wide trapezium or subrectangle; third tentacular cirrus reaches back to seventh segment. Posterior segments with brown glandular tracts on the dorsal sides of the segments and on the bases of the parapodia (Plate IV., fig. 91). Feet equal, dorsal cirrus longer than dorsal ligule; in the anterior feet there are prominent labia pharetrarum (Plate IV., fig. 90).

Dorsal setæ homogomph spinigerous; superior ventral setæ homogomph spinigerous and heterogomph falcigerous; inferior ventral setæ homogomph spinigerous and heterogomph falcigerous. The paragnaths do not quite agree with GRUBE'S formula, but I think nearly enough to determine the species:—I., 0, II., a double oblique row, 3 or 4 larger in the hinder row, 4 or 5 smaller in the front row; III., 1; IV., an acervus of 8, two very small in front, three rather larger in the middle and three still larger behind. The actual length of the third tentacular cirrus is about 2 millims.

The Ceylon specimen seems to agree with GRUBE'S *C. pectinifera* in all characters except the mouth-parts and with *C. lapinigensis* in respect of the mouth-parts. The maxillæ show 5 blunt teeth. Perhaps the two forms are co-specific. The arrangement of the setæ in the foot is not described by GRUBE in either of his species. The peculiarity here is the occurrence of homogomph spinigerous setæ as well as heterogomph falcigers in the inferior ventral group. In *Ceratonereis costæ*, according to EHLERS ('Borstenwürmer,' p. 525), there are only falcigerous setæ in the inferior ventral group. It is uncommon to find homogomph spinigers in the inferior ventral fascicle.

Platynereis bengalensis, KINBERG—Plate IV., figs. 92 to 94.

Muttuvaratu Paar, March 29. One specimen, incomplete behind, 45 setigerous segments, width over setæ 4 millims.

Description of a foot from anterior region (9th foot of right side):—Dorsal cirrus normal, $2\frac{1}{2}$ times the length of the dorsal ligule, which is short, rounded, and bulky; inferior dorsal ligule like the superior; ventral ligule like the dorsal ligules; ventral cirrus not reaching the end of the ventral ligule. Dorsal setæ homogomph spinigerous; superior ventral setæ homogomph spinigerous and heterogomph falcigerous (appendices simple, fringed, short); inferior ventral setæ heterogomph, spinigerous and falcigerous.

Description of the 44th foot of right side:—A large brown glandular tract divided into two portions at base of dorsal cirrus; ligules obtusely pointed, more than half the length of the dorsal cirrus (ventral ligule rather shorter than the two dorsal ligules and narrower at its base). Dorsal setæ homogomph spinigerous and falcigerous; superior ventral homogomph spinigerous and heterogomph falcigerous; inferior ventral heterogomph spinigerous and falcigerous. The appendix of a dorsal falciger is guarded and unfringed; its extremity is boldly hooked, and at the vertex of the hook there is a small tooth in front of which the guard makes another slight projection (Plate IV., fig. 92). The appendix of a superior ventral falciger in this foot is fringed along its lower portion, guarded along its upper half (Plate IV., fig. 93). The appendices of the other ventral falcigers of this foot and of the other feet, and also in many other species of Nereidæ, are minutely guarded quite at the apex beyond the fringe; a double contour at this point indicates a rudimentary guard, as may be realised by comparison with the structure of the superior ventral setæ here described (Plate IV., fig. 93).

The parapodium (44th) from the middle region of the body described above closely resembles that figured by GRAVIER for his *Platynereis insolita* ('Arch. Mus. Paris' (4), iii., 1901, p. 198), and, in fact, could not be distinguished from it. The only difference seems to lie in the structure of the appendices of the dorsal falcigerous setæ which have a smooth rounded vertex without any prominence in *P. insolita* (*loc. cit.*, p. 198, fig. 206). The same setæ with tooth on the vertex occur also, two in number, in the 19th foot of the Ceylon specimen.

The tentacular cirri are long, the third pair extending over 16 segments. The proboscis was retracted and had to be dissected out:—Paragnaths of the orders I., II., III., and V. absent; of the order IV. (Plate IV., fig. 94) in several more or less complete rows (as in the type). Antennæ as long as the palps, eyes in a trapezium.

FAMILY: ONUPHIDÆ.

Diopatra amboinensis, AUD. & M.-EDW.—Plate IV., figs. 95 to 97.

Station V., off Chilaw Paar, 11 fathoms.—One specimen with tube.

Another empty tube was taken from the Muttuvaratu Paar, 29th March, 1902.

The tube is characteristic, encrusted with unequal pieces of coarse broken shells which stand out at right angles to the wall of the tube, being attached thereto by one edge, giving the impression of pieces of shell threaded together; some of the fragments are nearly entire shells, as much as $\frac{3}{4}$ inch long, the majority are smaller; seaweed may grow on the shelly covering; the tube is from 3 to $3\frac{1}{2}$ inches long, and presents a tabulate appearance owing to the disposition described above.

The body of the specimen, which is incomplete behind, is flattened, 4 millims. wide. The dorsal side is brown coloured, with a dark hæmal line and a shining cuticle; the lateral parapodial tracts show up whitish in the preserved state; ventrally there is a pale neural tract flanked by two broad brown submedian bands, followed on the outside by the series of broad whitish ventro-lateral tori or cushions which resemble the uncinigerous tori of a Terebellid without the uncini, and doubtless serve to facilitate the passage of the worm up and down its tube. The first five setigers are much larger than the rest, with a ventral and porrect inclination, and carry ventral cirri instead of tori. The spiral penicillate branchiæ commence on the sixth segment (*i.e.*, fifth setigerous segment). Towards the fortieth segment they become reduced and finally cease in the region of the sixtieth; in the mid-region they are more than twice the length of the stout, subulate dorsal cirri.

The prostomial tentacles are somewhat pigmented, especially at the base, where the long flagelliform portion is inserted into the 10- or 12-ringed basal peduncle. The frontal antennæ have a stout pigmented basal portion, followed by a narrower apical portion, the whole as long as the peduncle of the lateral tentacle. The tentacular cirri arising from the border of the single apodous buccal segment are as long as the peduncles of the submedian tentacles, or slightly longer. The eye-tracts occur behind the submedian tentacles. The broad rounded palps have a teat-like apex. In the protruding jaws I counted 8 teeth on the right saw, 7 on the left, about 10 on the right arc, 8 or 9 on the left, and 5 teeth on the left impar. The lower jaw-plates or laminæ ventrales have thin white calcareous end-pieces with simple border and rounded divergent apices; the mandibles have the usual form (Plate IV., fig. 95).

This species is closely related to *Diopatra neapolitana*. Its differentiation from any other species of the genus will probably depend upon the character of the setæ in the anterior modified parapodia, about which our information is rather deficient, so far as I am able to judge from the literature of *Diopatra*. It is equally closely related to *Diopatra semperi*, Grube ('Ann. Semp.,' p. 282 = *D. luzonensis*, p. 138), but the latter has very short frontal antennæ and the calcareous caps of the lower jaw-plates are trilobate; the anterior setæ are not described. The identification of the present species cannot be considered final until fresh material for comparison is obtained from Amboina or adjacent parts. A preparation of the first left foot of *D. amboinensis* from Ceylon shows about 18 setæ projecting. There is a dorsal group of about six long, simple, curved acuminate, non-limbate capillary setæ; the rest have a bidentate apex beyond which the pointed guard projects (Plate IV., fig. 96-97). The anterior appendages possess other characteristic features besides the setæ which they carry. The lips of the orifice of the pharetra setarum are triangulate, an anterior short truncate border followed by a long stout cirriform posterior median lobe and a smaller ventral ligule; I do not know of any other species of *Diopatra* in which this third ligule has been described. Sometimes it is appressed against the median lobe and so concealed from view on the slide, but it can be found with a simple lens on the body of the worm. In Grube's description of *D. semperi* (= *D. luzonensis*) the diagnostic features of the anterior modified parapodia are not given. From the parapodia of the mid- and hind-body two aciculæ project with bifid apices as figured by Ehlers ('Borstenwürmer,' Taf. xii., fig. 15) for *D. neapolitana*. The scalprate setæ of the posterior segments have numerous fine denticulations (over 20), whereas according to Ehlers they are few (about 8) in *D. neapolitana*. The filaments of the branchiæ are long.

Onuphis basipicta, n. sp.—Plate IV., figs. 98 and 99.

Station XXXV., Galle, 7 fathoms. One specimen in company with *Glycera laneadivæ*. Length 23 millims., width 1 millim.

Patches of brown pigment on the bases (ceratophores) of the antennæ; submedian antennæ longer than the median (tentaculum impar); ceratophore of the median antenna normal, nearly one-third the total length of the antenna, less than one-half the length of the ceratophores of the submedian antennæ which are nearly one-half the total length of these appendages; ceratophores of the lateral antennæ about three-fourths the length of the submedian ceratophores, about two-thirds of the total length of the lateral antennæ.

The above proportions, the moderate length of the median and the considerable length of the submedian and lateral ceratophores are characteristic. The submedian antennæ stretch back over ten segments. The tentacular cirri were lost, one was observed detached. Setæ of the body-segments comprise 6 to 8 simple capillary with two bidentate guarded acicular setæ and three acuminate aciculæ; a small bundle of fine capillary setæ passes into the dorsal cirrus, sometimes extending far along the cirrus. Dorsal cirri normal, subulate. Branchiæ commence as a simple filament on the first setiger and remain simple for 7 or 8 anterior segments, then becoming pectinate with 5 or 6 processes.

The first setiger contains the dorsal bundle of setæ for the dorsal cirrus and a ventral fascicle comprising one simple capillary seta, six characteristic tridentate compound setæ and an acicula (Plate IV., figs. 98 and 99). The second setiger resembles the first, but contains in the ventral fascicle three simple setæ and five compound setæ of the same type as in the first. The posterior lingule of these anterior parapodia is long, acuminate, cirriform.

This species is determined by the combination of characters afforded by the ceratophores, setæ, and branchiæ. It occupies an intermediate position between *O. longissima*, Gr., and *O. teres* (Ehlers). The shape of the frontal antennæ is also important; these are broad, almost foliaceous, divergent, subtriangular appendages, neither filiform, fusiform, nor subulate. Their shape is liable to vary in different states of contraction and only the combination of characters can be relied upon. The setæ give the best indications, the peculiar setæ of the anterior parapodia and the simple setæ of the body-segments.

Onuphis conchylega, Sars (1835).

Localities:—South of Manaar, 8 to 9 fathoms; and from Station LII., Cheval Paar, 3 to 6 fathoms.

It is somewhat surprising to find this species which is common at Plymouth occurring also off the coast of Ceylon. Its flattened tube, covered with large horizontally placed shell fragments, is so characteristic that it is impossible to name it differently from the type. This species should be the type of the unfortunate genus *Northia*, of Johnston. I have carefully unravelled the confusion which this genus has caused, and the result is that I agree with the Baron de St. Joseph that it should be dropped. The species has wide distribution (see Ehlers, 'Florida-Anneliden,' 1887, p. 73) and is synonymous with *Diopatra eschrichti* (Œrst.).

The shelly tube is 40 millims. long by 10 millims. wide. The tentaculum impar stretches back over 12 segments; the prostomial tentacles are smooth, the basal joints short, subequal, pauci-annulate. The tentacular cirri are slender, elongated, acuminate, much longer than the narrow buccal segment, about as long as the prostomium. Branchiæ simple, commencing on the 8th setiger; stout, acuminate, appearing flattened towards the base. Anal cirri long, slender, filiform. First three setigers porrect, the first dorsal cirrus shorter than the following; the fourth setiger slightly porrect. Ventral cirri of first and second setigers subulate; of the third, shorter, obtuse, and fleshy; of the fourth reduced to a slight projection of the first torus ventralis.

A large female measures 30 millims. long by 3·25 millims. wide; a smaller specimen is 17 millims. in body-length (excluding the antennæ), and the branchiæ are flattened. The frontal antennæ are short, ovate. In the first foot there are no setæ associated with the dorsal cirrus; the setæ of this foot comprise two acuminate aciculæ, three bidentate acicular setæ which project, and one or two bidentate quasi-compound setæ. A gill-bearing foot carries six limbate capillary setæ, two aciculæ, and two bidentate acicular setæ, the prongs of which are gaping and subequal; there are no setæ passing to the dorsal cirrus.

Onuphis dibranchiata, n. sp.—Plate IV., fig. 100.

Locality:—Galle lagoon, low-tide, 3rd August, 1902. Several fragmentary specimens.

The annulate bases of the prostomial tentacles are well developed, nearly equal, the submedian slightly exceeding the others, and the median less than the rest; the submedian peduncles are less than one-third of the total length of the appendage; the median peduncle is barely one-fourth of the total length of the tentaculum impar, and the lateral peduncles are about two-thirds the total length of the lateral antennæ. The submedian peduncles show twelve annulations in addition to the distal collar-like portion into which the flagellum is inserted.

In the above proportions it will be noted that the lateral antennæ resemble those of *Onuphis basipicta*. The frontal antennæ are short and fusiform. The subulate tentacular cirri are inserted behind the submedian antennæ and slightly exceed the length of the buccal segment. The branchiæ commence as a simple filament on the first foot and continue simple on the first 17 parapodia, becoming bifid thereafter and considerably longer than the dorsal cirri. The first dorsal cirrus is tumid at the base, rather shorter than the first gill-filament, equal in size and shape to the posterior ligule of the first foot.

The setæ of the first foot do not afford such satisfactory distinction when compared with the corresponding setæ of *O. basipicta* as might have been hoped. There is a bundle of internal setæ associated with the dorsal cirrus; then three stout aciculæ ending in narrow flexible points; next several slender quasi-compound setæ like those of *O. basipicta*, but in some of them the third tooth is absent. Besides these setæ there are two stout setæ, tridentate (one damaged), which are not compound (Plate IV., fig. 100). These clearly represent the acicular setæ in the first foot. A parapodium from the anterior half of the body contains three aciculæ, a bundle of simple capillary setæ, two bidentate acicular setæ, and a small bundle of internal capillary setæ associated with the dorsal cirrus, passing nearly to the apex of the cirrus. The width of the worm is 3 millims.; the median antenna stretches back over 7 segments.

Onuphis holobranchiata, Marenzeller—Plate IV., fig. 101.

Station V., off Chilaw, Gulf of Manaar, 11 fathoms.

One specimen contained in a membranous tube coiled up between the valves of a Lamellibranch, adhering to one of the valves (Plate IV., fig. 101). The length of the coiled mass was 13 millims.; calcareous particles adhered to the borders of the tube; the whitish end of the tube projected beyond the posterior edge of the shell, like a siphon, to the length of 21 millims.; diameter 2·25 millims., a few shell-fragments and other calcareous débris attached. No part of the worm protruded from the mouth of the tube. After extraction of the anterior portion of the worm, which broke away from the rest of the body, it proved to be an Onuphid allied to *Onuphis holobranchiata*, Marenzeller.

The submedian ceratophores show about 10 annulations and a terminal collar; they are less than one-fifth the total length of the appendages; half as long again as the median ceratophore and equal to the lateral. The lateral ceratophores are half the total length of the appendages to which they belong. The median antenna stretches back over 21 segments, but the body has a dorsal flexure in the preserved state; the submedian antennæ are longer than the median. The frontal antennæ are obtusely subulate, coloured brown at the base. The tentacular cirri are shorter than the buccal segment, which is rather longer than the prostomium, and has a concave anterior dorsal border.

The first four parapodia are porrect, decreasing in size to the fourth, and occupying a ventral position. After the fourth, the line of parapodia bends up in a conspicuous arc to a more dorsal position. The first foot is not greatly enlarged, not longer than the buccal segment; the dorsal cirrus and posterior ligule are equal and similar and longer than the bulk of the foot. The unifilar branchiæ commence on the first foot. The first foot contains a small bundle of fine setæ passing to the dorsal cirrus, two aciculæ and four tridentate compound setæ. A parapodium from the region between the 40th and 50th segments contains, besides the internal setæ of the dorsal cirrus, four or five capillary setæ, three scalprate or comb setæ, four aciculæ, and two bidentate acicular setæ.

There are two discrepancies between the above description and that furnished by Marenzeller ('Südjapan. Ann.,' i., 1879, p. 24), and, in addition, the peculiar character of the habitaculum has not been described before. According to

Marenzeller, the buccal segment is three times as broad as long, and the tentacular cirri equal it in length. This feature may be attributed to the method of preservation. The second point relates to the lateral ceratophores which according to the author of the species are nearly twice as long as the submedian. This may be an individual variation, an abnormality, or the distinction of a local race. Unfortunately the length of the lateral ceratophore, in proportion to the total length of the antenna, is not stated. The calcareous ends of the laminæ ventrales of the jaws show an emarginate frontal border, agreeing closely with von Marenzeller's figure.

Hyalinœcia camiguina, Grube.

Grube, 'Ann. Semp.,' 1878, p. 142.
C. Crossland, "Maldive Polychæta," 'P. Zool. Soc. London,' 1904, p. 281.

Localities:—Several specimens, Station XXV., $\frac{3}{4}$ mile west-north-west of Foul Point, Trincomalee, 8 fathoms. Station XLIII., off Kalutara (Kaltura); one specimen in company with *Pectinaria* tubes. Station XLV., off Panadure; several specimens.

The tubes, 65 millims. to 70 millims., are faintly ringed at intervals of about 2 millims., and sometimes the annulation shows the double crescentic arrangement described by Grube. In the Ceylon specimens, the branchiæ commence almost constantly on the 22nd foot (23rd segment); once I found the first gill on the right side on the 21st foot. I only observed aciculæ with simple blunt rounded apices protruding from the first modified parapodium, but in the second foot may be found bidentate aciculæ and a compound seta as figured by Crossland, as well as acuminate forms. This species is closely allied to *H. tubicola*, of which it is clearly a local representative. A full account of the hyaline tube which is guarded internally by valves has been given by Mr. Arnold T. Watson ("On the habits of Onuphidæ," 'Trans. Liverpool Biol. Soc.,' vol xvii., 1903, p. 303).

Family: EUNICIDÆ.

Eunice afra, Peters (1855).

Crossland, "Polychæta of Zanzibar," 'P. Zool. Soc. London,' 1904, vol. i., p. 289.

(1.) Station V., off Chilaw, Gulf of Manaar, 11 fathoms. In this specimen branchiæ commence on the 19th foot, becoming successively 3-filar, 4-filar, and 6-filar, decreasing behind and leaving about 30 abranchiate posterior segments; they are inconspicuous, barely stretching halfway to the mid-dorsal line; body flattened and ribbon-like behind the anterior branchiferous region; length 75 millims., width 5·5 millims.

(2.) Galle, 14th February, 1902. Fragment of anterior region; gills begin as a bud on the 16th foot and rapidly attain the maximum of 5 filaments; calcareous caps of laminæ ventrales present; pale collar on the fourth setigerous segment; prostomial tentacles with violaceous annulations; body-colour of preserved specimen dark olive-green; width over the setæ, 5 millims.

Eunice antennata, Savigny.

Crossland, "Polychæta of Zanzibar," 'P. Zool. Soc. London,' 1904, vol. i., p. 312.

Locality :—South-east Cheval Paar, on pearl oysters, very numerous.

The pectinate branchiæ commence on segment VIII. (6th foot), the first gill is multifilar; they diminish towards the middle and then increase again both in size and number of filaments posteriorly. In some specimens small branchiæ commence on the 5th foot, in others on the 7th foot, very rarely on the 3rd and 4th foot. Antennæ and cirri moniliform. The acicular setæ show a third smaller tooth over the two main prongs; the compound setæ of the posterior feet are characterised by the presence of a third denticulation in a similar position to that in the acicular setæ.

Eunice coccinea, Grube.

Crossland, "Polychæta of Zanzibar," 'P. Zool. Soc. London,' 1904, vol. i., p. 297.

Station V., off Chilaw, Gulf of Manaar, 11 fathoms, two specimens.

The differentiation of this species from *E. afra* depends chiefly upon examination in the fresh condition. The colour is leucostict, but *E. leucosticta* is regarded as a synonym of *E. afra*. There is a pale collar on the 6th segment, so there is in *E. collaris*, which is another synonym of *E. afra*. Branchiæ commence on 13th foot, biramous on 15th, triramous and greatly exceeding the dorsal cirrus from 20th to 50th, long unifilar on 60th, decreasing and ceasing about the 90th, leaving upwards of 70 posterior segments without branchiæ and with rudimentary dorsal and ventral cirri. Another broken specimen had quadrifilar branchiæ. Complete specimen small, coiled, about 45 millims. long, width of anterior gill-bearing region 3 millims.; segments about 170; compound setæ normal; acicular setæ bidentate.

All characters are misleading except the shape of the body; the head is narrow, the body widening out markedly in the anterior region; the hind-body is rounded, not flattened; the intersegmental grooves are coloured brown. The general form of the body decides me to refer the present specimens to *E. coccinea*. *E. coccinea* apparently bears the same relation to *E. afra* that *E. murrayi* does to *E. antennata*.

Eunice indica, Kinberg.

Gravier, *op. cit.*, 1900, p. 242; Crossland, *op. cit.*, 'P. Zool. Soc. London,' 1904, p. 318.

Station V., off Chilaw, 11 fathoms, one small specimen, incomplete behind.

Prostomium seen from above with frontal border entire; tentacles smooth; compound setæ with projecting guards, best seen in the branchial segments; acicular setæ from the postbranchial segments with trifid tip, the apex equally bidentate, and a large subapical tooth.

Another specimen was associated in the trawl with *Phyllochætopterus ramosus* from Galle, Station XXXVIII., 17th February, 1902, depth 22 fathoms.

Eunice martensi, Grube—Plate IV., figs. 102 to 104.

Grube, "Mitth. über Euniceen," 'Schles. Ges.,' 1877; Breslau, 1878, p. 24.

Locality:—One specimen, labelled "Purple violet Eunice," taken from Buoy, Galle.

The dorsum of the 6th segment is pale; segments streaked longitudinally violaceous; antennæ and cirri banded violaceous and white. Segments 178, incomplete behind; length 100 millims.; width (ventral) over the feet 8 millims., over the setæ 10 millims. Antennæ nearly smooth, quasi-articulate, cirri smooth; tentaculum impar and submedian antennæ equal to seven segments, but the former ends bluntly and has probably been longer; dorsal cirri long throughout and smooth.

Branchiæ begin as a bud on the 7th segment (5th foot), plurifilar on the 8th, in subsequent segments acquiring 14 filaments; in the 17th segment the branchial stipe is shorter than dorsal cirrus, in the 28th it is equal to the cirrus, and in the 48th longer than the cirrus (Plate IV., fig. 102). The general distribution of the branchiæ and the number of filaments will be understood from the following enumerations, the Roman numerals giving the number of the segment:—

VII.,	VIII.,	XVII.,	XXVIII.,	XLVIII.,	LX.,	LXXI.,	CXIV.,	CXL.,	CLXX.
1.	4.	13.	13.	14.	14.	14.	12.	10.	5.

In the anterior segments there are 8 or 9 dorsal capillary setæ and about 20 compound falcigerous bidentate setæ in the ventral fascicle (Plate IV., fig. 103); the two-pronged ventral acicular setæ commence at the 35th foot (Plate IV., fig. 104); comb-setæ (scalprate setæ) more numerous posteriorly, with about 12 denticulations.

Jaws:—R. II.–6; L. II.–6; L. III. (the unpaired sinistral jaw-piece)–7; R. IV.–9; L. IV.–4.

This species belongs to that section of *Eunice* characterised by multifilar branchiæ and long dorsal cirri extending from end to end of the body. The type of this section may be taken to be *E. tentaculata*, Quatrefages (1865, i., p. 317), from South Australia (Bass Strait, Tasmania). Another example is the original *E. elseyi*, Baird (1870), from Queensland (not *E. elseyi*, McIntosh), which is synonymous with *E. aequabilis*, Grube, 'Schles. Ges.,' 1877, Breslau, 1878, p. 24, from Cape York.

Eunice murrayi, McIntosh.

Crossland, "Polychæta of Zanzibar," *op. cit.*, 1904, p. 310.

(1.) Station XLV., off Panadure (Pantura), depth 25 fathoms, inhabiting a tube on the under side of a *Spondylus* valve; a polynoid was in the same tube.

Prostomium wide, frontal border deeply emarginate; antennæ moniliform; the tentaculum impar longe-articulate, stretching back over 18 segments; gills with 12 pinnæ; guards of compound setæ slightly projecting; total width in anterior region, 4 millims. The tube which accompanies the specimen is encrusted with sand and Foraminifera.

(2.) South-east Cheval Paar; occurring with *Eunice antennata*.

Branchiæ commence unifilar on segment V. (3rd foot), trifilar on VI. and VII., sexfilar on VIII., then multifilar; they decrease rapidly after the 30th foot and cease after the 43rd. Antennæ submoniliform, impar stretching over 11 segments. Setæ normal; acicular setæ trifid, as many as four in the posterior segments.

Eunice siciliensis, GRUBE.

GRAVIER, "Ann. Mer Rouge," 'Arch. Mus. Paris' (4 ser.), ii., 1900, p. 261.
CROSSLAND, 'P. Zool. Soc. London,' 1904, p. 323. [= *Eunice valida*, GRAVIER.]

Station V., off Chilaw, Gulf of Manaar, 11 fathoms. Also from South-west Cheval Paar, 13th November, 1902.

Branchiæ commence on the 62nd setiger and remain simply filiform throughout. This well-known and widely distributed species can be recognised by the incurved rami of the lower jaw-plates.

Eunice tubifex, CROSSLAND.

Station LIX., Muttuvaratu Paar, without tube.

This is a worm of large size, one specimen measuring 120 millims. by 5 millims. It is distinguished by the occurrence of spinigerous setæ in the anterior segments and falcigerous setæ in the posterior region. I have nothing essential to add to the excellent description given by Mr. CROSSLAND ('P. Zool. Soc. Lond.,' 1904, p. 303).

The branchiæ commence as a small bud on the 20th segment and continue as a single filament, increasing in length to the 45th segment, after which a second filament appears. By the 100th segment there are still only three filaments; by the 200th there are four long filaments. Further back the number of branchial filaments increases to five, all arising from a very short axis; filaments subequal, much longer than dorsal cirrus; the latter increases somewhat posteriorly.

Some statements in a footnote on p. 308 of Mr. CROSSLAND's paper require to be modified. SCHMARDA's account of *Eunice depressa* from Auckland, New Zealand, which also possesses the two kinds of compound setæ, is fuller than many of his descriptions; this worm is, however, a *Marphysa*, since, as shown and stated by SCHMARDA, tentacular cirri are absent. GRUBE named two species of *Eunice* with spinigerous setæ from the Philippines, namely, *E. impexa* and *E. megalodus*, but records no distinction between the anterior and posterior setæ.

There is a headless fragment over 150 millims. long accompanying the specimen above described.

Marphysa chevalensis, n. sp.

Locality :—South-east Cheval Paar, Gulf of Manaar.

This species belongs to the same group as *Marphysa depressa* (SCHMARDA, 'Neue Wirbellose Thiere,' ii., 1861, p. 127, New Zealand) and *M. fallax*, MARION et BOBRETZKY

('Ann. Marseilles,' 1875, p. 13). Its interest lies in its occurrence here, not in its supposed differences from its two allied forms, since there are no differences which are figurable. The character of the group depends upon the presence of two kinds of compound setæ, spinigerous and falcigerous, in the parapodia. The special feature of the Ceylon representative depends upon the distribution of the branchiæ. Length 25 millims., width 2·75 millims.; 104 setigerous segments.

The frontal border of the prostomium is emarginate and the division is continued as a shallow median groove along the dorsal surface of the head. Branchiæ commence as a small filiform process on the 11th foot, uniramous from 11th to 19th foot, biramous from 20th to 25th, triramous from 26th to 68th, decreasing and ceasing at the 85th foot. Dorsal cirri fusiform, decreasing in size posteriorly. Anal cirri subulate, smooth, with ring of brown pigment at base; ventral anal styles minute filiform. Compound setæ, falcigerous and spinigerous, the spiniform appendices longer and shorter; both kinds of setæ occur together from the first parapodium, but in the specimen now being described only the spinigerous form was observed in the posterior segments.

In the anterior parapodia a dorsal fascicle of limbate capillary setæ, a central group of three aciculæ and the ventral fascicle of compound dimorphic setæ; in the posterior parapodia the dorsal fascicle contains limbate and scalprate setæ; there is a central group of two aciculæ, a ventral fascicle of compound setæ and a ventral bidentate acicular seta. A second specimen, darker coloured, anal cirri black, showed both kinds of setæ in the posterior feet; branchiæ from 10th to 55th foot; maximum number of three filaments observed on one foot only; length 9 millims.; width nearly 2 millims; segments about 73.

Paramarphysa orientalis, n. sp.—Plate IV., fig. 105.

Locality:—South-east Cheval Paar, Gulf of Manaar. Several specimens.

Length 21 millims., width 1 millim.; 91 setigerous segments.

Prostomium almost entire, a shallow groove only dividing the front; antennæ short, about the length of the prostomium, tentaculum impar somewhat longer. There is an eye-spot on each side of the head between the bases of the submedian and lateral antennæ. Bidentate ventral acicular setæ begin on the 26th foot; a segment or two behind this the main aciculæ become dark coloured; there may be two acicular setæ in the posterior parapodia. The superior fascicle of capillary setæ shows slight difference in anterior and posterior regions, the limbate tract being shorter and more convex behind; comb-setæ with long marginal laciniæ occur as far forwards as the 9th foot. The compound bidentate falcigerous setæ are normal, not markedly different in front and behind, distinguished by the slight inflated appearance of the end of the shaft (Plate IV., fig. 105).

Only one other species of *Paramarphysa* has been described to my knowledge, namely, *P. longula*, Ehlers ('Florida Ann.,' 1887, p. 99).

Lysidice collaris, Ehrenberg and Grube.

Grube, 'Ann. Semp.,' 1878, p. 166; Gravier, 'Arch. Mus. Paris' (4 ser.), ii., 1900, p. 272. Crossland, 'P. Zool. Soc., London,' 1904, p. 284.

Station V., off Chilaw, Gulf of Manaar, 11 fathoms. One specimen; length about 15 millims. Several other specimens in the collection.

Nematonereis unicornis, Schmarda.

Schmarda, 'Neue Wirbellose Thiere,' ii., 1861, p. 119. (Atlantic Ocean.)

Locality:—South-west Cheval Paar, Gulf of Manaar. Two specimens.

In the smaller specimen the head is entire and rounded; in the larger slightly emarginate; a pair of large eyes at the back of the head and between them a small occipital tentaculum impar about the same length as the prostomium. There are no tentacular cirri; no branchiæ; two achætous buccal segments. The larger specimen is a mature female.

In the parapodia the dorsal cirrus is short, subulate, about as long as the pharetra setarum; a central acicula separates the setæ into superior and inferior groups, the former consisting of simple capillary setæ, the latter of compound, bidentate, falcigerous setæ. In the posterior bundles there is also a guarded bidentate acicular seta, the subterminal tooth much larger than the apical tooth. The jaws are pale and normal:—II. 5–4, III. 4.

Family: LUMBRICONEREIDÆ.

Aglaurides fulgida (Sav.)—Plates IV. and V., figs. 106 and 107.

Gulf of Manaar. Several specimens.

The largest measured as much as 7 inches in length, a few segments missing behind; dorsum very convex; width 5 millims.; width including setæ nearly 9 millims.; segments narrow and very numerous; dorsal cirri large, foliaceous; head rounded to triangular in shape.

The characterisation of the cirrobranchiate Eunicea is at present somewhat obscure, and it is not rendered less so by the fact that the present species agrees identically with Schmarda's *Œnone diphyllidia* from Jamaica in respect of the size and shape of the dorsal cirri, the buccal and the parapodial armatures.* (Plate V., fig. 107.)

The buccal segment is of double nature, as in *Lumbriconereis*, the intersegmental groove being plainly visible at the sides and continued forwards to the edge of the mouth, so that the processus oralis of the second segment borders the mouth below. Dorsally the buccal segment lies over the back of the prostomium like a collar, the groove between the collar and the head deepening into a profound sinus, in which three minute papilliform occipital tentacles are occluded. In front of the tentacles there are four eyes, two large lateral eyes and two small submedian eyes, the latter

* *Cf.* Ehlers, 'Florida-Anneliden,' 1887, p. 109, Taf. 34.

sometimes simple, sometimes multiple (Plate IV., fig. 106). The arrangement of the eyes is the same as in *Œnone diphyllidia*, and they can easily be found by raising the margin of the collar. The presence of the antennæ or occipital tentacles is the one feature in which *Aglaurides* is believed to differ from *Œnone*, and in view of the absolute identity of the other parts this divergence appears remarkable.

In *Aglaurides*, especially if the material be well preserved, the mere pulling back of the collar will not always suffice to discover the prostomial tentacles. I have found it necessary to divide the collar by a longitudinal incision before the antennæ come into view. They are extremely fugitive structures, not too easily found even in half-macerated examples, so deep do they lie within the recesses of the nuchal sac. In *Aglaurides erythrœensis* recently described by GRAVIER ['Arch. Mus. Paris' (4th ser.), t. ii., 1900, p. 278] from the Red Sea the character of the jaw-pieces seems to differ from that of the corresponding parts in *A. fulgida*. The reader is left with the impression, that while "les pièces correspondantes sont plus développées à droite qu'à gauche," yet on the whole they are subequal, and only one half is figured on the plate. Otherwise the species is indistinguishable from *Aglaurides fulgida*, the shape of the head varying as mentioned above. The author does not mention the radices maxillarum, which in *A. fulgida* are very long, longer than the rest of the upper jaw, as in *Maclovia* and *Halla*, not short as they are in *Lumbriconereis* and *Lysarete*.

In addition to the characters presented by the antennæ and the details of the jaws as described and figured by EHLERS ('Borstenwürmer,' 1868, p. 408) the genus *Halla* (= *Cirrobranchia*, EHLERS) differs from *Aglaurides* in having two entire apodous segments behind the head, a peculiar processus oralis being furnished by the first segment. *A. fulgida* has been recorded from Ceylon by MICHAELSEN, 'Jahrb. Hamburg. Wiss. Anst.,' ix., 2, p. 99).

Aracoda obscura, n. sp.—Plate V., figs. 108 to 112.

Station XLIII., off Kaltura. A single specimen, incomplete behind, 16 millims. long, 1 millim. wide, in an empty *Pectinaria* tube.

Colour nearly black, with strongly iridescent tough cuticle. Prostomium pear-shaped or conical, nearly equal to the four next segments (Plate V., fig. 111); two distinct achætous segments in front, without processus oralis of the second segment. The usual long posterior ligule on the parapodia. There are six or seven simple curved limbate setæ in the parapodium; in some the limbus is nearly plain, in others denticulate as shown in Plate V., fig. 112. The dilated portion of the setæ is finely and obliquely striated.

The only way to identify the species of this and allied genera of *Lumbriconereidæ* is by the character of the jaws. These are black and overlap, consequently they are difficult to see in themselves and not easy to prepare from such a small specimen. The principal feature in this case is provided by the jaw-pieces of the first pair which are subequal and without a special terminal hamulus distinct from the dentate portion (Plate V., fig. 108). The jaw-pieces of the second pair are the most difficult to make out satisfactorily; one side, so far as I could ascertain, showed three large teeth, and a long edentulous shaft reaching back to the radices maxillarum (Plate V., fig. 110); on the other (probably the left) side the second jaw-piece, which was fractured near the apex, showed a strong apical tooth and a long posterior dentate portion (Plate V., fig. 109). There are, as usual, five pairs in all, the fifth being a simple hamulus. As stated above, the diagnostic character is the absence of a pronounced diastema between the apical tooth and the succeeding teeth of the first pair of jaws.

FAMILY: GLYCERIDÆ.

Glycera lancadivæ, SCHMARDA—Plate V., figs. 113 to 116.

SCHMARDA, *op. cit.*, 1861, p. 95; MICHAELSEN, 'Jahrb. Hamburg. Wiss. Anst.,' ix., p. 102.

Locality:—Galle, 14th February, 1902. Two specimens.

This species is a representative in these waters of the Atlantic *Glycera capitata*, and is characterised by the absence of branchiæ and by the biligulate anterior lip of the parapodium, the posterior lip being rounded and slightly emarginate. It appears to present a dimorphism analogous to that existing between *G. capitata* and the variety *G. setosa*. In the typical form the parapodia are longer than in the second form; we may refer to these as A and B respectively. In both, the body segments are biannulate, and there are two kinds of compound setæ differing in the structure of the articular end of the shaft; in one kind the transparent guard projects beyond the edges of the cup, in the other the guard is level with the cup and shows fine sulcations (Plate V., figs. 113 and 114). In form A, the ligules are fusiform and approximately equal in bulk, the ventral ligule rather longer (Plate V., fig. 115). In form B, the ligules are obtuse and the ventral ligule, besides being longer, has about twice the bulk of the dorsal ligule (Plate V., fig. 116). If these specimens had been taken at different times and places they would probably have been described as separate species. The extruded proboscis (form B) is covered with minute papillæ arranged irregularly, and of two kinds, acuminate and rounded, the former greatly predominating. Length of specimen of form A (incomplete behind), upwards of 60 millims.; form B, complete with subulate anal cirri, 45 millims. long, including the proboscis (7 millims.).

FAMILY: SPIONIDÆ. [See also p. 325.]

Polydora hornelli, n. sp.—Plate V., fig. 117.

From pearl oysters, Gulf of Manaar.

It is hard to say whether this species is really distinct from *Polydora ciliata;* the differences, so far as can be judged from preserved material and published records, are very slight, but such as they are, they seem to afford ground for separation when taken in conjunction with the geographical distribution and the character of the host.

The general appearance of the anterior end resembles that figured by CARAZZI* for *P. ciliata*. The ground colour is chocolate brown, and this pigment occurs upon the peristomium and upon the greater part of the caruncle; the latter projects beyond the front of the peristomium, terminating in two rounded lobes, divided from one another by a shallow notch. The proportions of the caruncle are characteristic; it is inserted over the length of the peristomium and over the first two segments of the trunk; in the region of the first setigerous segment there is a slightly dilated pale area causing an interruption of the brown pigment; there is a patch of pigment in the centre of this area which I shall call the ocular area, although I could not distinguish definite eye-spots; on each side of the ocular area on the dorsum of the first setigerous segment, midway between the caruncle and the margin of the body, there is a very small cirrus; at the outer margin of the same segment, on each side, there is another cirriform appendage, below which occurs a capillary fascicle; the latter appendage is shown in CARAZZI's figure, but not the former; the portion of the caruncle in front of the ocular area is longer than the portion behind it. The remaining segments of the body carry notopodial and neuropodial setæ, the 2nd, 3rd, 4th and 6th segments with capillary setæ only. The notopodial setæ of the 5th setigerous segment are modified, consisting of an oblique row of eight large brown acicular setæ with two not fully formed in reserve, each acicular seta being accompanied by a delicate colourless spatulate seta. The acicular setæ of the 5th segment differ from those figured by CARAZZI for *P. ciliata;* in *P. hornelli* these setæ are not toothed, but a convex limbus or vane occurs below the curved apex (Plate V., fig. 117). [See Mr. ARNOLD WATSON'S "NOTE" on p. 325—W. A. H.]

From the 7th segment the neuropodial series of capillary setæ are replaced by a single row of about a dozen bidentate guarded acicular setæ not differing in structure from those of *P. ciliata* as figured by Professor McINTOSH in 1868.† The branchiæ also commence on the 7th setigerous segment, but the material is so fragmentary that I cannot say where they end. The diameter of a large specimen is 1·5 millims. No other dorsal setæ beyond the modified setæ and their spatulate attendants were observed in the 5th segment, but a bundle of very delicate neuropodial setæ occurs at their base. The 5th segment is firm and the fore-body porrect. The 2nd, 3rd, 4th, and 6th setigerous segments carry a short cirriform notopodial ligule behind the dorsal fascicle. The long peristomial tentacles are lost from most of the specimens.

FAMILY: CAPITELLIDÆ.

Notomastus zeylanicus, n. sp.—Plate V., figs. 118 and 119.

Locality:—East Cheval Paar, 8 fathoms.

Anterior fragment of small individual. The first two segments are achætous; the

* D. CARAZZI, "Revisione del genere *Polydora*, BOSC, e cenni su due specie che vivone sulle ostriche," 'Mitth. Zool. Stat. Neapel,' xi., 1893, see Taf. ii., fig. 4.

† See also T. WHITELEGGE, "Report on the Worm Disease affecting the Oysters on the Coast of New South Wales," 'Rec. Austral. Mus. Sydney,' 1890, vol. i., No. 2.

eleven following segments are biannulate and carry dorsal and ventral fascicles of capillary setæ. The unciniform setæ commence on the 14th segment, the dorsal torus containing a single row of 19 setæ, the ventral torus a single row of 34 (Plate V., fig. 119). From the mouth projects a median tongue-like lobe. The head is half withdrawn into the buccal segment, but by pressing the latter backwards an acervus of eye-spots at the side of the head can be seen (Plate V., fig. 118).

Family: OPHELIIDÆ.

Armandia lanceolata, n. sp.—Plate V., fig. 120.

Locality:—South of Manaar Island, 8 to 9 fathoms.

One specimen about 17 millims. in length; 29 pairs of parapodia, the last three or four of which are very small; 22 pairs of cirriform branchiæ commencing on the 2nd setigerous segment; eleven pairs of lateral eyes situated in front of the parapodia from segments VII. to XVII. inclusive; no cephalic eyes observed. This is a slender worm 1 millim. in diameter; body pale.

Ophelioids of this group show a striking resemblance to *Amphioxus* in shape, size, habits, distribution, consistency, translucency, and movements. This has been remarked previously by Lo Bianco (1893) in the case of *Armandia polyophthalma* and by me (1896) in New Guinea waters.* Although infinitely removed from each other in morphology, *Armandia* and *Amphioxus* are closely approximated in bionomics. It is a case of true homoplasy; there is no question of affinity, nor of mimicry, nor of parallel evolution.

The ventral musculature in this species is so arranged as to cause two prominent longitudinal ventro-lateral ridges, like metapleural folds, extending uninterruptedly from the mouth to the base of the anal siphon, leaving a narrow deeply depressed median ventral tract, the neural groove, between them; and a lateral groove above on each side of the body in which the parapodia lie. The branchiæ can be kept lengthwise lodged within the lateral groove. The anal siphon is a narrow membranous tube terminating in a circular orifice fringed by not less than 12 subulate papillæ, subequal.

In *Armandia leptocirrus*, Grube ('Ann. Semp.,' p. 194) there are 33 pairs of gills,† a pair to each of 34 segments excepting the first; the lateral eyes are said to commence on the fifth setigerous segment and to occur on the ten following segments. Sometimes the eyes may be absent or lost from some of the ommatophorous segments. In this specimen of *A. lanceolata* they are complete on the right side, but on the left side missing from the 11th to 13th segments. The first eye occurs on the 7th setigerous (6th branchiferous) segment, the last on the 17th setigerous (16th branchiferous) segment. The anal siphon has a marked ventral flexure in the

* Cav. Lo Bianco, 'Atti Acc. Napoli,' v., 1893; A. Willey, 'Quart. Journ. Micro. Sc.,' vol. 39, August, 1896, p. 219.

† Given as 22 pairs by a misprint.

preserved specimen. The simple capillary setæ issue in two bundles, a dorsal bundle of five long setæ and a ventral bundle of about eight shorter setæ.

The anterior end of the body is produced as a transparent rostrum which terminates in a white appendix (Plate V., fig. 120). The mouth lies below on the level of the base of the rostrum, and the paired nuchal organs occur behind at a distance from the mouth, equal to the latter's distance from the frontal extremity. The long simple gills are traversed by blood-vessels.

Armandia leptocirris, Grube. ('Ann. Semp.,' 1878, p. 194.)

Locality:—Cheval Paar, Gulf of Manaar.

This species is twice as bulky as *A. lanceolata.* The essential differences are not easy to specify by the examination of preserved material only. Length 21·5 millims., diameter 2 millims.; 37 setigerous segments; 27 gills, commencing at the second setigerous segment; 20 marginal anal papillæ, larger and smaller intermixed; 14 lateral eyes, commencing in front of the 6th gill. Nuchal organs lie in front of the mouth; metapleural ridges commence at the sides of the mouth. The most striking feature of the specimen here described is the occurrence of several small cirriform papillæ protruding from the buccal orifice. Notopodia and neuropodia minute, contiguous.

Another example from Modragam Paar does not show the buccal papillæ protruding.

Polyophthalmus australis, Grube—Plate V., fig. 121.

Two specimens from east side of Cheval Paar, one measuring 15 millims. long by 1 millim. wide; the other 8 millims. by 0·5 millim.

The setæ are extremely delicate and not obvious at first examination. The head is rounded, the body with characteristic pigment markings figured by Grube ('Ann. Semp.,' p. 196), and the anus is surrounded by a circlet of papillæ. The body has the consistency of that of an *Ophelia.* When placed in fluid of different density from that in which it had been kept, it twitched convulsively like a Nematode.

In the smaller specimen there are 26 setigerous segments, capillary setæ in separate dorsal and ventral fascicles, the latter issuing from a convex crateriform elevation. The ciliated apparatus of the head, not figured by Grube, is shown on Plate V., fig. 121. The lateral eyes were not distinct.

Family: FLABELLIGERIDÆ.

Stylarioides parmatus, Grube—Plate VIII., fig. 5.

Stylarioides parmatus, Grube, 'Ann. Semp.,' 1878, p. 199.
Stylarioides iris, Michaelsen, 'Jahrb. Hamburg. Wiss. Anst.,' ix., p. 108.

Muttuvaratu Paar. Four specimens, one very small.

The distinction between *S. iris* and *S. parmatus* is based upon the number of long and gorgeously iridescent setæ of the second segment. These are disposed round the head in four bundles ; each bundle may contain up to 10 setæ. GRUBE found only six setæ in each bundle. The setæ of the third segment are much more slender and shorter than those of the second, but equally numerous, though the number of setæ in both these segments varies, probably in many cases through accidental loss. The caudal extremity of the body may be recurved as in *Pallasia*, as noted by Mr. WATSON, but, unlike *Pallasia*, the segments are all setigerous (Plate VIII., fig. 5).

FAMILY: MALDANIDÆ.

This family may be divided into three sub-families :—Clymeninæ, Rhodininæ, and Nicomachinæ. For the identification of the worms belonging here it is essential that the whole body should be preserved. There is a fragment of a Nicomachine Maldanid, of which only the six anterior setigerous segments have been preserved, obtained in 14 fathoms to the west of the northern end of the Periya Paar at Station LXI. In the absence of the anal segment it is unfortunately impossible to assign it to its proper genus with any certainty.

Nicomache truncata, n. sp.—Plate V., figs. 122 and 123.

Its head is extremely characteristic, the front vertical with a median crest widening out below into a transverse ridge which overhangs the mouth (Plate V., fig. 123). The peristome is indistinguishably fused with the prostomium, and the two together compose a remarkably short head. This is followed by a short first setigerous segment with the capillary fascicle in the centre ; next a slightly longer segment with the capillary fascicle nearer to the anterior than to the posterior border ; thereafter the segments become elongated, the setæ and tori occupying an anterior position in each segment. Below the first and third capillary fascicles there is a large acicular seta ; below the second there are three acicular setæ on the left side, one only on the right (Plate V., fig. 122).

FAMILY: AMMOCHARIDÆ.

Ammochares orientalis, GRUBE—Plate V., figs. 124 and 125.

GRUBE, 'Ann. Semp.,' 1878, p. 204.

Station LIV., south of Adam's Bridge, 4 to 40 fathoms. One specimen.

Total length 28 millims., width 1·5 millims., tapering to less than half this size behind. Length of the laciniate gills, 2 millims. ; length of first segment 2·5 millims., of second 3 millims., third 3·75 millims., fourth 3·25 millims., fifth 2·5 millims. Total number of setigers 22 pairs ; the last eight segments are quite short and were detached from the rest of the body. The first uncinigerous torus occurs below the fourth capillary fascicle. The œsophageal nerve-collar becomes confluent with the ventral nerve-cord in the region between the first and second fascicles (Plate V., fig. 124).

The first segment is a composite one, comprising three pairs of capillary fascicles unaccompanied by uncinigerous tori; of these the third pair has not been noticed by GRUBE (Plate V., fig. 125). On the dorsal side in the middle line, slightly in advance of the first pair of fascicles, there is a peculiar nuchal organ flush with the surface of the body (Plate V., fig. 125). The uncini are arranged in a polystichous manner in the tori; as many as 20 rows of peculiar minute uncini of a type best defined as ammocharine; when examined *in situ* they look like the separated teeth of multidentate uncini. The capillary setæ are linear, non-limbate, finely squamose towards the acute apex.

Tube tough, mucoid, encrusted with sand grains which are arranged with considerable regularity in an imbricating manner. Wider in front, tapering behind, the tube is much longer than the contained worm, being about 60 millims. The lips of the anterior and posterior orifices are approximated at their respective ends, so that the openings of the tube appear closed. The specimen was taken in company with *Panthalis nigromaculata*. The structure and habits of the Ammocharidæ form the subject of a paper by Mr. ARNOLD T. WATSON in 'Journ. Linn. Soc.,' Zoology, vol. xxviii., 1901, pp. 230–260, plates 23–25.

FAMILY: CHÆTOPTERIDÆ.

Chætopterus appendiculatus, GRUBE—Plate V., fig. 126.

GRUBE, "Ann. Ceylon" (Holdsworth coll.), 'P. Zool. Soc. London,' 1874, p. 328.
HERDMAN, 'Ceylon Pearl Oyster Report,' Part I., 1903, p. 80.

Locality:—Station LXII., near Periya Paar, 7 to 13 fathoms.

There are ten thoracic segments, the last two carrying uncinigerous tori and the last bearing a large aliform notopodium. The penultimate thoracic tori are separated by a deep median ventral notch; the last thoracic tori are confluent across the middle line. Uncini of the last thoracic torus mostly 6-dentate, some 5-dentate; uncini of a ventral abdominal torus 8-dentate.

In GRUBE'S original description, which was based upon a large specimen 124 millims. long, the tube measuring 364 millims. by 22 millims. in diameter, the uncini of the posterior ventral tori are said to have nearly 20 teeth. This is a large number for *Chætopterus*, twice the normal number,* and might conceivably be due to the uncini lying appressed, end to end, as they frequently do.

Of the thoracic parapodia the first, fourth, and ninth are the shortest in the specimen under examination. The fourth contains seven broad modified setæ of the type characteristic of the family. In this case these setæ show a finely crenulate or beaded distal border (Plate V., fig. 126). The fore-body of the specimen measures 5·25 millims. long by 3·5 millims. broad, hence much smaller than MARENZELLER'S *Ch. cautus* from Japan, where the corresponding measurements were 20 millims. by 10 millims., and there were 20 to 30 chætopterine setæ in the fourth parapodium.

* *Cf.* CROSSLAND, "Maldive Polychæta," 'P. Zool. Soc. London,' 1904, vol. i., p. 276.

The tube is pergamentaceous, finely fibrous, thinly encrusted with mud and calcareous minutiæ. The posterior notopodia adhered firmly to the inner wall of the tube and were greatly elongated.

Phyllochætopterus herdmani (Hornell)—Plate V., figs. 127 to 132.

Spiochætopterus herdmani, Hornell, 'Ceylon Pearl Oyster Report,' Part I., 1903, p. 16.

Locality :—Galle shore, under stones.

Narrow cylindrical tubes encrusted with relatively coarse sand-grains and hard fragments of all kinds, including Foraminifera. The worms outside their tubes are soft and convoluted, and the hinder portion of the body is very fragile. The three regions of the body behind the buccal region are the thoracic region, with ten (in one case nine) setigerous segments ; the branchial region, consisting of two segments ; finally the abdominal region with as many as 40 to 50 segments. The ventral wall of the thoracic segments is thickened to form a large glandular cushion, and the lateral wall of each abdominal segment is marked by a long narrow brown tract between the dorsal and ventral divisions of the parapodium on each side ; sometimes this pigment tract is very dark. Above its dorsal end occurs the clavate notopodium, and below its ventral end the neuropodium, subdivided into two narrow uncinigerous lobes. The head is surrounded by an incomplete collar, open dorsally (Plate V., fig. 127) ; above and behind the dorsal ends of the collar occurs the second pair of tentacles, supported by a bundle of three long delicate internal setæ. The long spirally coiled tentacles of the first pair are inserted immediately in front of the second pair, and are still retained in some of the specimens.

The first parapodium contains about twenty spatulate or vane-tipped setæ, arranged in general in a single row, forming a dorsiventral monostich. The length and width of the vane varies ; sometimes it terminates in a point, generally its border is broken up into shreds (Plate V., fig. 131). The second parapodium resembles the first, and so does the third as a rule, but in one specimen there are five modified setæ (resembling those which usually occur only in the fourth parapodium) intercalated between the normal spatulate setæ (Plate V., fig. 129). The fourth parapodium contains, in addition to the spatulate setæ, eight or nine modified flattened setæ (Plate V., fig. 128). The remaining thoracic parapodia contain the usual setæ. A notopodium from the second branchial segment contains 16 or 17 long internal setæ in the inner division of it. The plan of a branchial segment is shown on Plate V., fig. 130. The borders of the notopodium below the distal expanded bifid portion are densely ciliated. The dorsal body-wall of the branchial region appears to be glandular.

Next to the notopodium comes a gill, a thin membranous expansion folded upon itself in the preserved specimen ; this passes below into a wing-like dermal fold with free surfaces and a thickened outer border, which is the uncinigerous torus. The uncini in a neuropodium of a branchial segment have 9 to 11 denticulations ; when

9 or 10 occur they are distinct, when 11 are present the apical tooth is very small. The abdominal notopodia carry a bundle of four spatulate setæ. The abdominal uncini show 10 or 11, perhaps sometimes 12 denticulations. All the uncini show the peculiar ribbed structure noted by previous authors in other species (Plate V., fig. 132).

This species is closely related to *Phyllochætopterus aciculigerus*, described by Crossland from the Maldive Group (' P. Zool. Soc. Lond.,' 1904, p. 278). The aspect of the anterior region varies greatly according to the state of the preserved material; when well protracted and hardened, it resembles the condition figured by Crossland for *P. elioti* from Zanzibar (*cf.* Plate V., fig. 127), except for the absence of eyes in *P. herdmani*.

In nine specimens there are ten pairs of thoracic parapodia, in one specimen nine pairs, the latter being the number given for *P. aciculigerus*. The principal substantial difference appears to be due to the presence in the last-named species of a glandular cirrus of uncertain homologies arising from the centre of the neuropodial tori of the first branchial segment.

Phyllochætopterus ramosus, n. sp.—Plate V., figs. 133 to 136.

Locality:—A thick cluster of slender brown translucent ramifying tubes (Plate V., fig. 133), overgrown and welded together by foreign incrustations of other tubicolous and colonial organisms and vegetable growths, trawled off Galle, at Station XXXVIII.

A fairly complete worm measures 25 millims. in length, its tube twice this length, and 1·5 millims. in diameter. The first region of the body consists of 15 segments; the fourth parapodium contains one, sometimes two broad flattened modified setæ (Plate V., figs. 134 and 135). The second or branchial region comprises about 16 segments. As the worms were all preserved inside their closely investing tubes, the branchial region is not preserved sufficiently well to show details clearly. Practically it may be distinguished from the third or abdominal region by its long styliform notopodia, each supported by not more than four internal slender setæ. The abdominal notopodia are clavate papillæ, each supported by a single seta. The long tentacles are coloured with brown patches which give them a banded appearance; they are followed by the small second pair of tentacles. The prostomium carries a pair of elongated eye-spots.

This species represents *P. pictus*, Crossland (' P. Zool. Soc., London,' 1903, p. 174), from which it differs in the character of the modified setæ of the fourth parapodia, the number of branchial segments and the character of the tubes. In the anterior branchial region the uncinigerous tori encircle the sides of the body, appearing like silver bands by reflected light. The uncini are excessively numerous in these bands, and are disposed in a polystichous manner, nine or ten closely packed rows. Each uncinus shows about twenty minute teeth, the lower end terminating in a blunt, curved process (Plate V., fig. 136).

Family: CIRRATULIDÆ.

Cirratulus cylindricus, Schmarda—Plate VI., figs. 139 and 140.

Schmarda, 1861, 'Neue Wirbellose Thiere,' ii., p. 59.

Localities :—Galle, East Cheval Paar, &c. Associated with *Eupomatus heteroceros*, *Eunice antennata*, &c.

The paired dorsal acervi of tentacular cirri occur on the fifth setigerous segment, a double row on each side separated by an interval across the middle line. The body is short and thick, simply flexed, not twisted, and equal at both ends; length 16 millims., diameter upwards of 3 millims.; setigerous segments 130. The head is round and short, crescent-shaped, the mouth gaping below. Capillary setæ commence on the fourth segment, the ventral acicular setæ appear on the 19th setigerous segment, the dorsal acicular setæ on the 23rd; the capillary setæ are continued to the end of the body.

In *C. dasylophius*, Marenz., the tentacular acervi occur on the dorsum of the third and fourth setigerous segments; the ventral aciculæ begin on the 29th, the dorsal on the 43rd. In *C. comosus*, Marenz., the tentacular acervi occur on the seventh setigerous segment; the ventral aciculæ begin on the 42nd, the dorsal on the 85th. Both these species are from South Japan. The acicular setæ afford no diagnostic character in themselves.

Another, and perhaps more typical, individual of 30 millims. (from Galle, 4th August, 1902), which I assign to this species, shows the same form of head, but the dorsum of the anterior segments is elevated, and the tentacular acervi extend over more than one segment (Plate VI., fig. 139). The gill-filaments are inserted high up on the body, remote from the dorsal fascicles; the ventral acicular setæ commence on the 11th setiger, the dorsal about the 26th. The frontal border shows pigment specks (Plate VI., fig. 140).

In another specimen of 35 millims. from East Cheval Paar, 8th November, 1902, 8 fathoms, the ventral acicular setæ commence on the 9th setigerous segment, as many as six in one fascicle in the anterior segments, becoming less numerous and stouter behind; the dorsal acicular setæ are more slender than the ventral, and commence on the 25th setigerous segment. The first lateral branchial filament appears on the first setigerous segment, the transverse acervi occur in the region of the 7th and 8th body-segments (*i.e.*, 4th and 5th setigerous segments). Behind the acervus the segments carry one pair of branchiæ inserted at slightly different levels, lateral and more dorsal.

Cirratulus complanatus, n. sp.

Station XLV., off Panadure, 25 fathoms. Three specimens.

The length of the ribbon-shaped body is 33 millims., greatest width 5 millims. The body is much flattened, giving a flattened rectangle in section; the head pointed, elongate conical. The tentacular acervi occur on the dorsum of the second setigerous segment, *i.e.*, the fifth body-segment, the first three segments being as usual achætous. In one specimen a small gill occurs on the third achætous segment. Both dorsal and ventral acicular setæ are present in the 36th setigerous segment. Gill-filaments only occur in the anterior region of two complete individuals. The gill-filaments and tentacular filaments give the appearance of a dense tangle in front, the rest of the body being bare.

The species differs from *C. dasylophius*, Marenzeller, in the position of the tentacular cirri, the distribution of the gill-filaments and the shape of the body.

Heterocirrus typhlops, n. sp.—Plate V., fig. 138.

Locality :—South-west Cheval Paar, Gulf of Manaar.

A very small worm, total length 10·5 millims., diameter less than half a millimetre. Capillary non-limbate setæ in both fascicles; dorsal and ventral acicular setæ commence at the first setigerous segment; they resemble those of *Cirratulus;* the ventral acicular setæ are two in number, more curved and thicker than the dorsal. The disposition of such cirriform appendages as remain is shown on Plate V., fig. 138.

Family: AMPHICTENIDÆ.

Pectinaria panava, n. sp.—Plate V., fig. 137.

Locality :—Ceylon Seas.

The specific name is the vernacular word for comb, referring to the comb of paleæ. Nuchal disc subcircular, carrying a transverse series of twenty paleæ, divided by an interval into two linear groups of ten each; the paleæ terminate in curved setiform apical processes. At each ventro-lateral angle of the disc, at the outer ends of the paleal series, there is a tentacular cirrus; a similar pair of cirri occurs on the second segment. In front of and below the paleal crown there is a wide semilunar membrane carrying not less than 32 laciniæ frontales. Below the frontal membrane are the grooved tentacles surrounding the mouth. Third and fourth segments branchiferous; ventral portions of 3rd, 4th, 5th and 6th segments elevated, the crests traversed by transverse muscles; the crest of the 4th segment is produced on each side as a blunt lateral lobe below the gill; on the posterior surface of the lobe there is a pinhole aperture. Seventeen capillary fascicles commencing from the 5th segment; uncinigerous tori from the 8th; uncini with about eight teeth, reduced towards the base (Plate V., fig. 137). Scapha acetabuliform, with terminal supra-anal semilunar valve and two rows of dorsal paleæ at the base, 7 paleæ on each side.

This species is chiefly characterised by the number of paleæ, which however is likely to vary, and by the large number of the laciniæ frontales, which are filiform processes along the edge of the frontal membrane.

FAMILY: SABELLARIIDÆ.

Pallasia pennata (PETERS)—Plate VIII., figs. 1 and 2.

Sabellaria pennata, PETERS, "Ueber die Gattung *Bdella* SAV. und die in Mossambique beobachteten Anneliden," 'Arch. f. Naturg.,' xxi., 1855, p. 42; also 'Monatsber. Berlin. Akad.,' 1854, p. 613 (quoted from GRUBE, 'Ann. Semp.,' 1878, p. 220).

Hermella bicornis, SCHMARDA, 1861, 'Neue Wirbellose Thiere,' p. 24.

Locality:—This worm occurs off the west coast of Ceylon either singly or in large colonies, and builds a tube of coarse sand-grains cemented together, so as to form a sandstone of excessive hardness which is capable of withstanding the full force of the waves during the South-west Monsoon. It is evidently an important factor in the preservation of the coast line. Sometimes the tubes are still further protected by a Nullipore covering. The internal diameter of a large tube is about 6 millims.

The specific name given by SCHMARDA refers to the presence of a pair of large brown hooks bent towards the middle line, placed at the dorsal ends of the peristomial lobes which, with their armature, constitute the paleal crown. There is usually only one pair of hooks, but I have seen a specimen with three hooks (two on one side), and PETERS describes four hooks (two pairs) in the single specimen examined by him. Each peristomial lobe terminates anteriorly in a truncate dorso-ventral crescent-shaped area, from the inner and outer arcuate borders of which the modified bristles or paleæ arise. The number of paleæ in the inner row varies roughly between 20 and 30; the number in the outer row between 30 and 45. The paleæ of the outer row are long curved spines, slightly widened and strongly serrated along the distal three-fifths of their length; towards the apex of the palea the serrations are larger on the concave border than on the opposite border; all are directed towards the apex of the palea. The paleæ of the inner row are acuminate, smooth, and more slender than those of the outer row. In side view a series of 8 to 12 subulate papillæ occurs below the outer row of paleæ, the most dorsal papilla being placed behind the hook on each side, as shown in Mr. WATSON's drawing (Plate VIII., fig. 1).

Dorsally the peristomial lobes are confluent across the middle line up to the level of the hooks; ventrally they are separated down to the level of the mouth. The inner surface of each peristomial lobe is beset with numerous tentacular cirri arranged in rows, the columns being indicated externally by crenulations of the ventral border of the lobe (Plate VIII., fig. 2). On each side of the mouth occurs the neuropodial cirrus of the buccal segment, and at the base of this a bundle of capillary setæ. The second segment is distinct dorso-laterally, merging into the peristome below; it carries a bundle of neuropodial setæ, above and adjoining which there is a triangular lappet; farther up the side follows another triangular lappet and dorsally the first cirriform branchia (Plate VIII., fig. 1). The third, fourth, and fifth segments carry on each side a neuropodial fascicle of long, rather narrow spatulate setæ with laciniate tips ending in a point, and a laterally placed notopodial fascicle of similar setæ with a wider spatulate portion, disposed in a single series; in both fascicles the spatulate setæ are accompanied by more slender limbate setæ; dorsally these segments carry stout cirriform branchiæ. Next follow the uncinigerous segments, as many as 50 in number, after which the recurved achætous caudal extremity terminates the body.

The first 20 to 30 uncinigerous segments carry dorsal branchiæ; all carry ventral fascicles of fine capillary setæ, and the first three are provided with ventral ligules adjoining the capillary fascicles; the capillary setæ carry projecting laciniate scales or minute thecæ, overlapping like the cups of a Sertularian Hydroid. Adjoining the mouth, between the latter and the neuropodial cirri or ligules of the buccal segment, there is a pair of fleshy labial processes, which Mr. Watson identifies as tube-building organs (Plate VIII., fig. 2).*

It is possible that the Ceylon form may be varietally distinct from the Mozambique type, and should be known as *P. pennata*, var. *bicornis*.

Family: TEREBELLIDÆ.

Leprea inversa, n. sp.—Plate VI., figs. 141 and 142; Plate VII., fig. 197.

Station V., off Chilaw, Gulf of Manaar; 11 fathoms. One specimen.

The body-length, exclusive of tentacular cirri, is from 30 to 40 millims.; width in front 2·5 millims. The segments are numerous and the body much contorted. The anus is surrounded by a funnel-shaped pygidium. The branchiæ are inserted without reference to particular segments, the third gill occurring high up on the dorsal surface over the third or fourth setigerous lobe, the second over the first setiger and the first gill in front. Between the first and second gill there is a papilla. The first gill occupies the most ventral position and is the smallest in size, not more than one-third of the bulk of the second gill, the latter having about one-half to two-thirds the bulk of the third. There are eight ventral thoracic scutes behind the tumid labium; the first shield following after the labium is deeply grooved transversely; the scutes end sharply in the region of the 8th and 9th uncinigerous tori. The uncinigerous tori and the capillary fascicles are continued to the posterior extremity of the body; from the 7th torus (11th segment) backwards the uncini are biserially disposed. The tentacular cirri are not deciduous; no eyes were observed. The capillary setæ of the anterior segments are very narrowly limbate, with a slight twist towards the apex, but quite simple; those from the middle and posterior segments are geniculate (Plate VI., figs. 141 and 142).

In the anterior region, behind the ventral scutes, the median ventral tract is depressed between the tori. In the posterior abdominal segments the uncini (Plate VII., fig. 197) are still biserial. The proportions of the branchiæ, the difference between the anterior and posterior capillary setæ and the number of ventral

* A note upon the nature of the structures which, in the Sabellariidæ, surround the mouth, appeared in the 'Journal of the Marine Biological Association' (Plymouth), New Series, vol. vii. (1904), p. 301.

scutes are the principal features which differentiate this species from *Leprea ehrenbergi* (GRUBE), MARENZELLER ('Südjapan. Ann.,' part ii., 1884, p. 5 of reprint).

Polymnia labiata, n. sp.—Plate VI., figs. 143 to 145.

Locality:—One specimen from the pearl banks, Gulf of Manaar; another from Aripu Reef. The former inhabited a membranous tube encrusted with coarse unequal sand-grains and calcareous fragments (including an entire small Naticoid shell); the latter has a large test-like tube encrusted with foreign particles, mostly very small and chiefly calcareous. It appears that the incrustation of the tube of Terebellids affords no trustworthy evidence of specific identity except in particular instances. The tube in question is nearly six inches long, with a diameter of half an inch. The abdominal region of the contained worm had undergone fragmentation, but the other specimen from the pearl banks is complete; length about 115 millims., width of thorax 7 millims., segments upwards of 120. The transition from the torigerous to the pinnigerous region is not very abrupt, the diameter of the body gradually decreases and the anterior pairs of pinnæ may be rather wide and set low in the integument, resembling the tori. The well-marked scuta ventralia end between the ninth and tenth pairs of tori, leaving six clear pairs of tori behind the scutigerous region. When the ventral wall of the thorax is much contracted there is an appearance of ill-defined scuta being continued to the posterior end of the thoracic (torigerous) region. The tori of the right and left sides are always widely separated, not approximating in the mid-ventral line.

The diagnostic characters by which this species is to be distinguished from its congeners (in the absence of information concerning colour) are afforded by the structure and proportions of the uncini. The uncinus consists of three principal parts, the hook, the shaft or neck, and the manubrium; the relative dimensions of these parts appear to be constant for the species. The uncini of *P. labiata* are noticeable on account of the length and slenderness of the neck; the basal angle of the manubrium, which lies deepest in the integument, is produced into a short gubernaculum resembling the "Muskelfortsatz" of the uncinus of *Pista* (v. MARENZELLER, 'Adriat. Ann.'). The denticulations of the uncinus offer no tangible distinction and present considerable variety both in number and dimensions. Generally the main hook is surmounted by a pair of smaller hooks of the second order, followed by another row of three denticulations of the third order (the middle tooth usually much longer than the lateral) occupying the vertex of the uncinus. Occasionally accessory denticles may be observed on the brow of the uncinus (Plate VI., figs. 144 and 145).

No *Polymnia* was described by GRUBE from the Philippines. One species, *P. congruens*, v. MARENZ., is known from South Japan, differing clearly from *P. labiata* in the shape of the uncini, and in the number of scuta ventralia. GRUBE's *Terebella sarsii* from the Philippines ('Ann. Semp.,' p. 223) has three pairs of arborescent gills but no lateral lobes, conforming to *Nicolea* in the latter respect.

The description was based upon a single indifferently preserved specimen. If confirmed it will probably form the type of a new genus or sub-genus intermediate between *Polymnia* and *Nicolea*.

The labium and lateral lobes of the third segment are of the same nature as the corresponding processes in *Loimia* (Plate VI., fig. 143).

Polymnia socialis, n. sp.—Plate VI., figs. 146 to 148.

Locality:—Narrow sand-encrusted tubes of a small Terebellid were adhering to the tubarium of *Phyllochætopterus ramosus*, trawled off Galle at Station XXXIX., 16 to 30 fathoms. One of the larger tubes measured about 50 millims. in length, 2 millims. in diameter. Three pairs of arborescent gills, the first (longest) extending forwards beyond the upper lip. Seventeen pairs of capillary fascicles, sixteen pairs of thoracic tori, uncini uniserial in the first six tori, biserial and opposite in the rest, uniserial again in the abdominal pinnules, which are supported by fine sustentacular setæ. Capillary setæ simple, narrowly limbate. The band of scuta ventralia is well set off from the surrounding parts, rounded in front, attenuate behind, ending as a whitish streak in the region of the 13th–14th tori, but continued behind this point as a colourless median streak into the anterior abdominal region; behind the 9th torus the band of scuta becomes paler, whitish.

The dorsal surface of the worm is smooth and convex, not showing segmental divisions in the region of the thorax. The first segment which forms the lower lip is long below and deeply cleft, the right half slightly overlapping the left (Plate VI., fig. 146). The lateral lobe of the second segment, seen in side view, appears as a sub-elliptical or semilunar, symmetrical free dermal fold. The uncini are remarkable for the number of denticulations on the vertex, which exceed the narrow limits suggested by von Marenzeller for the genus. The vertex of the uncinus, when seen from above, shows a rosette of twelve denticulations, and attentive examination shows that these are arranged in arcs across the vertex. The general formula for an uncinus of this species, according to Marenzeller's system of notation ('Adriat. Ann.,' iii., 1884, p. 163, or p. 13 of reprint) would be as follows:—1, 22, 333, 4444, 55555. The rosette which appears in vertical view is formed by the teeth of third, fourth and fifth orders (Plate VI., figs. 147 and 148).

The limbus of the capillary setæ is, at least in some of them, wider over a sub-terminal tract than more distally, spreading like a pair of narrow fins on either side of the seta. The terminal portion presents a very narrow obscurely striated border. This is merely the continuation of the limbus, and is not like the laciniate plumose structure of the terminal filament in *Amphitrite*. In some setæ from one of the specimens the terminal portion is marked off by a shallow constriction from the bulk of the shaft. This is not a constant feature however, and the setæ of the larger individual end normally in a simple point.

Length of fore-body without the tentacular cirri (which are present knotted together and calling for no remark) 13 millims., width 2 millims., total length of body 20 millims.

Polymnia triplicata, n. sp.—Plate VI., figs. 149 to 152.

Locality :—Galle, 4th August, 1902. Several specimens.

This is another tribranchiate Terebellid of small size, with fragile body and highly deciduous tentacular cirri. Length of a specimen, incomplete behind, 35 millims. ; thorax barely wider than rest of body, 3 millims. in diameter, with 17 setigerous segments ; abdominal portion with 34 pinnigers. Another abdominal fragment had 80 segments.

The second, third, and fourth segments (the fourth being the first setigerous segment) carry lateral lobes of approximately equal size (Plate VI., fig. 149). The scuta ventralia are 14 in number, counting from the second segment ; they end sharply on the 13th setigerous segment, leaving four setigerous (thoracic) segments without ventral shields. The central portions of the scuta are slightly marked off from the anterior and posterior borders, but otherwise they are simple, not biannulate nor areolated.

The arrangement of the anterior thoracic segments seems to differ considerably from the condition observed in *P. labiata*. As shown on Plate VI., fig. 143, there is, in *P. labiata*, a large lower lip with free sinuous border, considered as belonging to the second segment (*i.e.*, the first branchiferous segment) and followed by another achætous segment (the second branchiferous segment) carrying prominent lateral lobes. In *P. triplicata* the lower lip is followed by two achætous segments carrying lateral lobes, and also bearing the first and second pairs of gills. It appears, therefore, that in *P. labiata* and in the species of *Loimia* the much larger lower lip is a product of the fused first and second segments, while in *P. triplicata* the first and second segments are distinct below, the former alone carrying the lower lip. In this and in other respects (number of scuta, &c.), the present form offers a striking analogy to *Lanice triloba* described by Fischli from Ternate,* and were it not for the existence of the generic distinction, which is not apparent at the surface, the two species would probably be ranged together.

The enumeration of the anterior segments and the nature of the prostomium of Terebellidæ are matters of some obscurity. On Plate VI., fig. 149, the thin half-collar which overhangs and protects the mouth like an epistome or upper lip is seen in side view ; at the back of it are the scars of insertion of the tentacular cirri, followed by a clear surface of a segment showing numerous eye-spots. Then follow the gills on the second, third, and fourth segments. The uncini are much smaller than in *P. labiata*, and usually only one denticulation of the third order is to be observed (Plate VI., figs. 151 and 152). The dorsal portion of the thoracic segments becomes biannular, commencing from the region of the eighth torus (Plate VI., fig. 149).

* H. Fischli, "Polychäten von Ternate," 'Abh. Senckenberg. Ges.,' xxv., 1900, p. 122.

The branchiæ (as in *Lanice triloba*, FISCHLI) show very clear-cut dichotomous ramifications, the main stem of each gill dividing near the base into two main branches. In the biserial tori the uncini of the two rows are alternate and opposite, (*i.e.*, base to base), those of the anterior row progressive, of the posterior row retrogressive. In *Lanice triloba*, the uncini of the biserial tori are inverted (*i.e.*, vertex to vertex), as in *Loimia*, though in structure they resemble the uncini of *Polymnia*.

Loimia annulifilis (GRUBE)—Plate VI., figs. 153 and 154.

Terebella annulifilis, GRUBE, 'Ann. Semp.,' 1878, p. 225.

Locality :—Galle shore, under stones. Eight specimens.

Tube encrusted with coarse, rather large shell and coralline fragments up to 8 millims. or 9 millims. in diameter. In most specimens the body-wall of the dorsal thoracic region has ruptured, and a coil of the gut is protruding. Diameter of thorax up to 9 millims. ; length of body about 150 millims. ; abdomen coiled ; more than 200 segments.

Uncini from the first torus, 5-dentate ; from the third torus, 5-dentate (Plate VI., fig. 153) ; from the sixth, 5-dentate, the fifth tooth becoming smaller and in some uncini obsolescent ; from the ninth torus, 4-dentate in both rows ; from the twelfth, 4-dentate ; from the sixteenth, 4-dentate ; from the twenty-seventh torus (which is borne upon the eleventh abdominal pinnule), 4-dentate. From these enumerations it follows that the uncini of the first six uniserial thoracic tori are 5-dentate, of the last ten biserial thoracic tori and of the uniserial abdominal pinnules 4-dentate. No such distinction is recorded by GRUBE among the five species of *Loimia* described by him from the Philippines. In some of the uncini from the anterior tori there seem to be indications of a sixth tooth, and in one uncinus from the first torus there are six distinct teeth.

The first pair of arborescent branchiæ greatly exceeds the second and third in size, quite overshadowing them. Seen with low magnification, they present a densely racemose or finely tufted appearance, due to the fact that the digitations arise in groups from the main stem and thicker branches, curving inwards like the half-closed fingers of a hand.

According to the accepted interpretation of the anterior complex of the Terebellidæ, the buccal segment is destitute of appendages and sense-organs (segmentum buccale nudum), but is produced ventrally into a large free labial fold, which closes the ventral opening of the horse-shoe-shaped collar or epistome formed by the prostomium surrounding the mouth above and in front. The hinder portion of the prostomium looks uncommonly like a cephalic segment and carries the tentacular cirri, which are ringed with purplish colour as in GRUBE'S *Loimia annulifilis*. The buccal segment is the first body-segment, and is here practically non-existent above, though represented below by the prominent labium. The second body-segment is the first branchiferous segment, well-marked dorsally, obsolete ventrally. The third body-segment or second branchiferous segment is evident above and below, and is produced outwardly into two ear-shaped lateral lobes, between which there is a narrow rim representing the ventral portion of the segment. Behind this follows ventrally the first ventral scute belonging to the fourth body-segment, which is at the same time the third gill-bearing segment and the first setigerous segment. The fifth body-segment is the first uncinigerous segment, and the uncini are arranged uniserially in the first six pairs of uncinigerous tori; the ten following tori carry uncini in two rows. The twentieth body-segment is the last thoracic segment. Then follows the abdominal region, which is destitute of capillary setæ, the uncini being borne in single file upon the abdominal pinnules. The first scutum differs from those which follow by its large size and corrugated surface. There succeed to this nine plain scuta ventralia, becoming narrower and longer behind. After this again the scuta become subdivided by transverse grooves, finally ceasing between the penultimate thoracic tori. The posterior subdivided scuta present a dark colour in the preserved material (Plate VI., fig. 154). There are 17 fascicles of capillary setæ, which have a fibrous internal structure, the fibres separating out when the seta is crushed or broken. Some of the setæ, however, which were presumably broken before death, show a clean fracture. It may be noted in conclusion, that in one specimen the scuta between the eighth and ninth uncinigerous tori are divided by a cross furrow.

Loimia crassifilis (Grube).

Locality :—East side of Cheval Paar.

One very small individual of 20 millims., including the tentacular cirri; the latter are banded as in *L. annulifilis*. There are ten clear scuta ventralia, after which these become quite obscure, but the tori remain separated by a wide decreasing median ventral tract to the end of the thorax. Uncini from the fourth torus 4-dentate, with an occasional rudimentary fifth tooth at the apex; from the biserial tori 4-dentate, the fourth tooth small; from the abdominal pinnules 5-dentate, namely, four clear teeth and a rudimentary apical tooth. The above corresponds with Grube's description ('Ann. Semp.,' p. 226), "uncini pectiniformes dentibus tororum 4," although his specimen was a very large one. The abdominal region is slender and even; the thoracic region tumid; about 67 segments.

Loimia medusa (Savigny)—Plate VI., figs. 155 to 159.

Savigny, 'Syst. des. Ann.,' p. 86 (quoted from Grube, 'Ann. Semp.,' p. 228).

(1.) Three specimens from Aripu Coral Reef, about 80 segments, width of thorax 10 millims.; total length nearly 90 millims., of which 30 millims. belong to the thorax; abdomen subcylindrical, varicose, simply flexed (not spirally coiled), narrower than thorax (Plate VI., fig. 155). Uncini from the first torus 6-dentate; from the third some 5-dentate, some 6-dentate; from the fifth 5-dentate; from the biserial tori and abdominal pinnules 4-dentate. There are five pairs of tori behind the scuta ventralia. The last plain scutum corresponds with the seventh pair of tori; the rest are subdivided, terminating after the eleventh tori. The subdivided scuta are dark-coloured. The three pairs of branchiæ are subequal.

(2.) Two more small worms which I assign to this species were taken from the South-west Cheval Paar. These also have five pairs of tori behind the scuta, but the junction of the undivided and subdivided (or anterior and posterior) scuta occurs at the level of the eighth tori, clearly so in one, approximately so in the other specimen. One has 52 segments with a length of 36 millims., the abdominal segments being closely compressed; the other has about 64 segments with a length of 45 millims. Uncini from the first torus 6-dentate, from the third also 6-dentate; from the fifth 5-dentate; from the biserial tori and abdominal pinnules 4-dentate. Part of a tube is encrusted with small shell-fragments of various sizes.

(3.) There are two other well-preserved worms taken from the Aripu Coral Reef, which afford the peculiarity of an accessory or eighteenth pair of capillary fascicles. The uncinigerous tori which accompany these fascicles are narrower than the preceding, thus affording a graduated transition from the tori to the pinnules. This is particularly so in one of the specimens where the accessory tori are much narrower than in the other. The tubes constructed by these worms are encrusted with coarse sand-grains with a scanty admixture of calcareous fragments.

The scuta ventralia are much narrower than in the first or typical variety, an appearance which may be partly due to the state of protraction of the body and the method of preservation (Plate VI., fig. 156). On account of this fact, together with the difference of the tubes and the presence of eighteen pairs of capillary fascicles, I will call this variety *angustescutata*, in order to facilitate future reference. The uncini from the first torus are mostly 6-dentate (Plate VI., fig. 157), the sixth tooth frequently reduced and sometimes obsolete; in the fourth torus the uncini are 5-dentate (Plate VI., fig. 158); from the biserial tori and abdominal pinnules, 4-dentate (Plate VI., fig. 159). The body of these worms resembles that of the typical form, though somewhat more slender; 83 segments, length about 100 millims., abdomen varicose, width of thorax 8·5 millims. The lateral lobes of the anterior segments resemble the corresponding structures in *L. annulifilis* (*q. v.*).

Loimia montagui (Grube)—Plate VI., figs. 160 to 163.

Terebella montagui, Grube, 'Ann. Semp.,' 1878, p. 224.
Loimia montagui, Marenzeller, 'Südjapan. Ann.,' ii., 1884, p. 205.
Not **Terebella montagui**, Quatrefages, 'Hist. Nat. Ann.,' ii., 1865, p. 361.

A large number of cylindrical worm tubes are labelled "No. 32, *Terebella*, Palk Bay." Many of the tubes are in short lengths, the more complete measure upwards of 100 millims. (4 inches) in length, with a diameter of 9 millims. They are coated with a thick dense layer of fine mud presenting a smooth surface, the lips of the terminal orifices approximated, so that no sign of the contained worm appears externally. I found two worms only belonging to the tubes.

The body is narrowed anteriorly (in the region of the scuta ventralia) and attenuated behind; in the middle region it is inflated and somewhat varicose; segments about 100, length about 85 millims., width of thorax in front 4 millims., behind the scuta 5 millims. (Plate VI., fig. 160). Counting the composite sternite of the 2nd, 3rd, and 4th segments as the first scutum, there are eight clear scuta followed by a rather ill-defined ninth. After this there is no trace of further scuta, the median ventral tract separating the tori uncinigeri is wide and smooth, and the length of body between the successive tori gives the worm a remarkable appearance. In the first torus the uncini are mostly 6-dentate, the sixth tooth sometimes large, sometimes rudimentary, and many uncini in the same torus are 5-dentate (Plate VI., figs. 161 and 162). In the fourth torus not one 6-dentate uncinus was observed, only 5-dentate uncini with a sprinkling (about 5 per cent.) of 4-dentate uncini. In the biserial tori only 6-dentate uncini were found in both rows (Plate VI., fig. 163). An abdominal pinnule contained 7-dentate uncini, the seventh tooth usually small and occasionally obsolescent, but clear enough to characterise the region.

In ventral view (Plate VI., fig. 160) this worm presents distinguishing features depending upon the size and limited number of the scuta ventralia, the absence of subdivided scuta behind the main series, and upon the divarication of the metathoracic tori. In the character of the uncini the species corresponds closely with *Loimia montagui*, Gr., as described by Marenzeller ('Südjapan. Ann.,' 1884, ii., p. 9, reprint), who, however, does not describe a definite succession of uncini such as I have noted above, namely, the 6-dentate uncini of the first torus, followed by a reduced denticulation in the succeeding uniserial tori, and this again by an increased denticulation in the biserial tori and a further increase in the abdominal pinnules. It agrees with *L. montagui* again in the triangular shape of the lateral lobes of the third segment and in the presence of a whitish glandular tract on each side of the dorsal surface over the capillary fascicles, extending from the gill-region to the eighth setigerous segment, where it ends in a point.

Although von Marenzeller records eleven scuta ventralia for *Loimia montagui* from Japan, and Grube ten for the example described by him from the Philippines; the former author specially notes that the most sharply circumscribed scutes are those from the second to the eighth inclusive, which accords with the variety from Palk Bay. Neither Grube nor von Marenzeller refers to the tube, which, in the case of Terebellidæ, may or may not be a matter of importance. Nor is any information given as to the nature of the locality. Both of these points, in the present instance, have a special interest, bearing upon the identification.

Loimia variegata (Grube).

Terebella variegata, Ehrb., 'Monatsber. Ak. Berlin,' June, 1869, p. 30 of reprint; Grube, 1878, 'Ann. Semp.,' p. 227.

One specimen in a thin membranous tube encrusted with shell-fragments and sand-grains was present in the same bottle with *Eupomatus heteroceros*, *Eunice antennata*, etc.; no locality being given: probably South-east Cheval Paar.

In the second of the above-quoted publications GRUBE makes the important correction that the uncini are not 4-dentate, as previously stated, but 5-dentate. This species resembles *L. medusa* in the number of scuta ventralia, and consequently in the occurrence of five pairs of tori behind the scuta. These posterior tori touch one another in the middle line in their respective segments.

The specimen in the preserved state has a nearly uniform pale flesh tint, only the branchiæ, which are matted together, showing up dark. There is no great contrast between the diameter of the thorax and that of the abdomen; the latter is sub-cylindrical, smooth, somewhat varicose. The total length is about 80 millims., and the number of segments about 60, the maximum width 7 millims., thus presenting a close numerical correspondence with GRUBE'S original type. The scuta ventralia are narrow as in the angustescutate variety of *L. medusa*. This species is said by GRUBE to differ in colour from *L. medusa*, but in the preserved state the chief characteristics are the nearly even diameter of the body, the uncini of the biserial tori and abdominal pinnules which are 5-dentate, to which may be added the pale flesh colour. The fifth denticulation at the vertex of the uncinus is small but distinct. The average width of the thorax (excluding the capillary fascicles) may be estimated at 6 millims., that of the abdomen at about 5 millims. At the same time, if it were not for the quinquedentate uncini, I should probably have placed the worm under *L. medusa*.

In the living condition more fundamental differences may come to light. The worm was closely invested by its tube. The preserved specimens of *L. medusa* have a dark neutral colour in marked contrast with the pale flesh colour of this worm. A second smaller specimen shows very clearly the quinquedentate uncini of the abdominal pinnules. In this case the abdominal region is more attenuated, and the scuta ventralia end rather sooner, so that there are six pairs of tori behind them.

Grymæa, MALMGREN, 1865.

Three pairs of acervi of filiform branchiæ.

Capillary fascicles commencing from the second segment (first branchiferous segment) and extending to the posterior abdominal region.

Tori uncinigeri commencing on the fourth (? or fifth) setigerous segment. Uncini avicular, uniserial.

MALMGREN says the tori commence on the fifth setigerous segment, but in a specimen of the type species, *Grymæa bairdi*, MALMGREN, collected off Norway by the Rev. Canon NORMAN, which I had the opportunity of examining at the British Museum some years ago, they commenced on the fourth setigerous segment.

Grymæa cespitosa, n. sp.—Plate VII., figs. 164 and 165.

One specimen, incomplete behind, was obtained, in 40 fathoms, south of Rameswaram Island, at Station LIV.

The fragment comprises twenty-two setigerous segments, total length about 30 millims.; width of thoracic region 3 to 4 millims.; thorax straight, porrect, abdominal region bent, with smooth, convex, turgid dorsum. The pharetræ setarum are high, upwards of 1 millim. in front, decreasing gradually backwards. The simple, narrowly limbate setæ issue in two principal bundles from between the oblique lips. The ventral portions of eleven segments from the second are flattened, forming broad ventral shields subdivided by transverse grooves. There are nine torigerous segments in the thoracic region, the posterior thoracic segments being nearly as long as broad. The thoracic tori graduate insensibly into the abdominal tori, which are sessile, not pinnuliform. The uncini have the form shown in Plate VII., fig. 165, and the general formula 1–22–3. In side view the three tiers of teeth show clearly.

The branchial filaments are numerous, forming dense coils. Those of the first acervus commence low down near the ventral surface. They break away easily from the body in groups. The tentacular cirri, plainly grooved on the lower side, are much stouter than the branchial filaments (Plate VII., fig. 164). The three branchiferous segments also carry capillary fascicles, the first uncinigerous torus occurring on the first post-branchial segment. The branchiæ arise from the anterior parts of the segments in front of the corresponding capillary fascicles.

Family: SABELLIDÆ.

Branchiomma acrophthalmos, Grube—Plate VII., figs. 166 and 167.

This is the oriental form of the well-known *B. vesiculosum.*

Locality:—East Cheval Paar, Gulf of Manaar.

Baron de St. Joseph has shown that the character of the limbate setæ of the European species varies at different ages, being spatulate in the young.

The Ceylon specimen is a fragment comprising 16 segments, 21 millims. long (including the gills), 3 millims. wide; 15 radioles* in each gill; gills banded about six times purple and whitish. Each radiole carries a subterminal eye, the two dorsal eyes being the largest. The definition of *Branchiomma* given by de St. Joseph (1894, 'Ann. Sci. Nat.,' xvii., p. 249) states "Soies dorsales d'une seule sorte au thorax." In the Ceylon specimen the dorsal fascicles of the thorax appear to contain, and in fact do contain, two distinct kinds of setæ, normal limbate to the number of eleven, and spatulate (Plate VII., fig. 166) to the number of nineteen. The thoracic tori are biserial, containing a row of avicular uncini and a row of cuspidate setæ.

Grube describes ('Ann. Semp.,' 1878, p. 258) the collar as trilobate, apparently overlooking the ventral incisure which divides the two acuminate ventral lobes. These are in close juxtaposition and give the appearance of the simple wide triangular lobe described by Grube. The dorsal portions of the collar show a characteristic form, the free border deeply emarginate externally and reflected round the base of the gill-supports (Plate VII., fig. 167). There are eight thoracic segments.

* See definition of this term on p. 308.

Branchiomma quadrioculatum, n. sp.—Plate VII., figs. 168 and 169.

Locality :—Aripu Coral Reef. One specimen, apparently incomplete behind, 48 segments.

Thorax 4·5 millims. long, 2 millims wide. Abdomen 13 millims. long. Eight thoracic segments. Gills 6 millims. long, banded with three or four purplish vittæ; 14 radioles in each. Collar with median incisura ventralis, a deep median dorsal notch and a still deeper submedian dorsal notch on each side. The four most dorsally placed gill-rays carry subterminal eyes, of which the dorsal pair are larger than the subdorsal pair (Plate VII., fig. 168). Seen from below, pressing the gills aside, laciniæ buccales are brought into view, including a flattened median tongue which rises up straight between and below the antennæ, and on either side of it an arcuate membranous fold. The buccal setæ are normal, capillary, limbate; thoracic setæ normal limbate and subspatulate; thoracic uncini biserial, an anterior row of cuspidate uncini * and a posterior row of avicular uncini (Plate VII., fig. 169). Abdominal setæ 15, limbate; abdominal uncini uniserial, avicular.

Hypsicomus phæotænia (Schmarda).

Sabella phæotænia, Schmarda, ii., 1861, p. 35.

Hypsicomus phæotænia, Marenzeller, 'Südjapan. Ann.,' ii., 1884, p. 16 of reprint, p. 212 of the 'Wiener Denkschr.'

Sabella pyrrhogaster, Grube, 'Ann. Semp.,' 1878, p. 250.

Localities :—Station V., off Chilaw, Gulf of Manaar, 11 fathoms, several specimens; and South-west Cheval Paar.

Marenzeller notes the resemblance between *Sabella pyrrhogaster* and *Hypsicomus phæotænia*, but adds that in the former only one kind of setæ was observed by Grube in the thoracic tori. According to Grube also the dorsal setigerous lobes of the thorax only contain paleæ, whereas in *phæotænia* there are a few lanceolate setæ in addition to the paleæ. The latter discrepancy is easily accounted for by the fact that the lanceolate setæ are frequently broken and hence cannot be observed. The former discrepancy with respect to the tori in which the armature is biserial and dimorphic in *phæotænia* and alleged to be uniserial and uniform in *pyrrhogaster*, is undoubtedly due to the circumstance that the row of cuspidate uncini was overlooked. Neither does Grube mention the branchial eyes, the pigment of which was perhaps dissolved out of his material. This species has also been described by Grube as *Sabella fuscotæniata* in 'P. Zool. Soc., London,' 1874, p. 328.

A small though complete specimen measures 25 millims. long without the branchiæ, which add another 8 millims. From the posterior end of the basal lamella to the anterior border of the interfilar membrane or web measures 3·5 millims. The eyes occur on each side of the distal portions of the gill-stems, 14 to 17 in number, not in pairs. The terminal filament of the gill-stem is long, somewhat flattened and tapering to a point.

* "Soies en pioche"; "Pickelborsten."

The macroscopic characters by which the species may be recognised are the occurrence of an arcuate oblique double row of modified setæ in the first segment and the rich dark-brown colour of the ventral shields of the abdominal region. The short collar still retains a band of violet below ; it is entire, its dorsal border being slightly concave, while its ventral border is produced forwards to a median point. The cuspidate uncini which accompany the avicular uncini are called "Pickelborsten" by von Marenzeller.

Accompanying the typical individuals described above there is another specimen in which the whole collar is violet except at the anterior border. It is in a state of protraction, and the modified setæ of the first segment are disposed in a slightly undulating longitudinal ridge which stands out pale upon the violet background. This specimen further shows violet vittæ and scattered spots on the gills, but no eyes are to be found; the terminal filaments into which the cartilaginoid axes extend are exceptionally long. The apparent absence of eyes is remarkable. The brown colour of the abdominal scutes is missing; only the anterior abdominal region is preserved.

Dasychone cingulata, Grube—Plate VII., figs. 170 to 173.

Two specimens in bottle with *Loimia variegata*, *Eupomatus*, &c. [? Cheval Paar].

Total length 26 millims., gills 9 millims. to 10 millims., thorax 4 millims., width 3 millims.; about 60 segments. Eight thoracic segments with eight fascicles and seven tori, the capillary limbate setæ of the first fascicle not different from the others. In each gill 19 to 21 radioles, each provided with about 14 pairs of dorsal stylodes and eyes; radioles subarticulate; terminal filaments of moderate length. In a thoracic fascicle there are 36 limbate setæ (Plate VII., fig. 170), and in an abdominal fascicle about half that number; the setæ issue in two bundles, upper and lower, those of the latter are shorter and (especially in the abdominal region) have a pronounced curvature, a broader limbus and a shorter flagellum (terminal filiform portion). It may be explained that the term "radiole," as applied to a single shaft or rhachis of the gills, is used here in the sense in which it has been employed by Professor McIntosh. It corresponds to Grube's filum branchiale. The actual branchial filaments which are borne upon a rhachis are the pinnæ, to which Grube applies the term radioli. Grube and McIntosh, therefore, use the term "radiole" in different senses. Grube ('Ann. Semp.,' 1878, p. 259) describes the radioles (*sensu* McIntosh) as longearticulate, which corresponds with the Ceylon specimen, and he remarks further that there are about ten pinnæ (branchial filaments) to each joint; this is also in accord with my observations (Plate VII., fig. 172). In the Ceylon specimen the articulation of the radioles is faintly indicated and best seen under low magnification.

Dasychone, like *Phyllodoce*, occurs singly in collections, and nearly every tropical specimen has proved to be a distinct species. Grube says that in *Dasychone decora*, Sars, the number of radioles in each gill varies from 20 to 36. The uncini of

Dasychone are striated parallel to the curvatures and are somewhat characteristic for the species. There are long-shafted and short-shafted forms and others, as in *D. bairdi*, McInt. ("Challenger") and *D. picta*, McInt., of special form. Examples of long-shafted uncini are those of *D. wyvillei*, McInt., and *D. orientalis*, McInt.; short-shafted uncini are in *D. cingulata*, Grube, *D. japonica*, McInt., *D. nigromaculata*, McInt., and *D. maculata*, Fischli ("Polychäten von Ternate," 'Abh. Senckenb. Ges.,' Band xxv., Frankfort, 1900, p. 125).

The radioles of the Ceylon specimen of *Dasychone cingulata* agree in arrangement and form of stylodes and eyes with the figures of *D. japonica*, McInt., and *D. maculata*, Fischli. The colour has vanished except for the minute dark pigment spots between the fascicles and the tori of the abdominal segments. The denticulations on the vertex of the uncinus occur in transverse rows (about three in a row) as in many of the Terebellacea; two appear above the main hook in side view (Plate VII., fig. 171).

Eurato porifera (Grube)—Plate VII., fig. 173.

Sabella porifera, Grube, 'Ann. Semp.,' 1878, p. 252.
Eurato, St. Joseph, 'Ann. Dinard,' part iii.; 'Ann. Sci. Nat.' (7 ser.), xvii., 1894, p. 249.

"Large Sabellid from centre of coral block, Muttuvaratu Paar; yellow-olive body, scarlet and yellow plumes." Total length about 90 millims., of which the gills occupy 30 millims. and the thorax 10 millims.; eight thoracic segments; width 8 millims.

The colour of the preserved specimen is sandy-yellow without any trace of pigment spots or markings. The only relief from the yellow ground colour is afforded by the characteristic spongy glandular tract which occurs on the anterior dorsal thoracic region. This has a brown colour and appears divided into right and left portions by the dorsal thoracic groove.

Limbate capillary setæ of different lengths throughout; uncini uniserial, avicular with multidenticulate (cross-hatched) vertex, not different from those figured by von Marenzeller for *Laonome japonica*.

Branchial stems in a single row, a few of them only occurring at a slightly deeper level than the rest, about 51 on each side. The length of the laciniæ tentaculares is about 7 millims.

The dorsal glandular tract by examination under a lens appears to consist of anterior and posterior portions, the former of a looser texture and thicker; but in the specimen under description both regions have the same brownish tint. Another smaller individual which accompanied the one described above shows the glandular area much more clearly. There is a posterior pale porous tract with a labyrinthine structure, the sulci running, in general, transversely; in front of this there are two dark-coloured convex porous cushions. In this specimen the general colour is duller and the gills rather olivaceous. In both cases the ventral fæcal groove bends up between the ninth and tenth ventral shields and passes round to the dorsum obliquely between the eighth and ninth capillary fascicles (Plate VII., fig. 173). The total length of the smaller worm is about 70 millims., of which nearly 7 millims. go to the thorax, 20 millims. to the gills.

Eurato notata (GRUBE)—Plate VII., figs. 174 to 176.

Sabella notata, GRUBE, 'Ann. Semp.,' 1878, p. 256.

A small worm in a finely encrusted closely investing tube was associated with *Phyllochætopterus ramosa* from Galle. The worm could only be removed from its tube with difficulty and not without damage, the gills adhering closely to it and to each other. The gills, with about 12 radioles in each, are banded with purplish colour, but the bands are all obscure in the preserved state with the exception of the basal band formed of a row of elongate dense purple spots, one on each radiole placed immediately in front of the level at which the radioles pass into the basal membrane which supports them. This is the first feature to meet the observer on removing the animal from its tube. The next distinction is afforded by the presence of a pair of subtriangular or pear-shaped pigment aggregates on the dorsal side of the first segment above the capillary fascicle, the apex directed forwards; this no doubt corresponds with the C-shaped mark which GRUBE noticed on his specimen. A pigment patch occurs on each side of the succeeding segments between the groups of setæ and the uncini, *i.e.*, between the fascicles and the tori.

In this specimen the thoracic segments were abnormal, fewer than normal and fewer on one side than on the other. Similar variations have been described in several Sabellidæ by the Baron DE ST. JOSEPH. On the left side there are three thoracic tori, on the right side four. In side view of the uncini three rows of teeth are to be seen on the vertex (Plate VII., fig. 174). The capillary setæ are all limbate, some long-limbate, others short-limbate and some rather wide-limbate (Plate VII., fig. 175). The limbus of these setæ is a kind of guard upon one surface embracing the setæ. From some points of view the seta appears bilimbate, but when the shaft is broken across, the limbus may be left projecting far beyond the broken edge (Plate VII., fig. 176).

The total length of the worm is about 12·5 millims., of which 2·5 millims. belong to the gills; width 1 millim., length of tube nearly 20 millims. The collar of this species is only conspicuous ventrally, where it is represented by a pair of ventro-lateral lobes, broad lappets subacute in front at the outer angles; these are what GRUBE called the laciniæ ventrales. GRUBE'S was a larger example and the proportion of the length of gills to body-length differs from that of the Ceylon representative. Another fragment of a larger individual was obtained on east side of Cheval Paar, and also showed clearly 4 thoracic tori on the right side, 3 on the left. The marks on the pronotum are C-shaped, with the concavity directed forwards and inwards.

Sabellastarte indica, Sav.—Plate VII., fig. 177a.

Cf. Quatrefages, 1865, 'Hist. nat. des. Ann.,' ii., p. 432.

A specimen from the pearl banks, upwards of 40 millims. long (without the gills) by 7 millims. wide, inhabited a tube nearly twice its own length encrusted with sand. The deciduous branchial crown together with the tentacular laciniæ was present, but thrown off. Projecting beyond the collar are two collapsible buccal lobes, evidently protruded by fluid pressure from within. At the ventral sides of the thoracic tori purple streaks occur, and similar streaks occur towards the dorsal border of the tori. In the abdominal region these streaks are replaced by minute spots. The gills are banded. The thorax is composed of eight segments with seven pairs of tori; the setæ, of all the fascicles alike, are limbate capillaries.

Another specimen labelled "No. 80, *Sabella fusca*, Grube, orange-bodied *Sabella*, on under side of boulder, Galle lagoon, off Breffit, 7th June, 1902," is larger and darker; 100 millims. long (without the gills), 10 millims. wide; body subcylindrical in front, more flattened behind. Gills very dark; inner surface of collar with black-purple band and a patch of the same colour on the outer surface of the dorsal portions of the collar.* In frontal view of the buccal crown the two buccal lobes described above are seen, though not protruding to the same extent (Plate VII., fig. 177*a*).

Sabellastarte indica, var. **quinquevalens**, nov.—Plate VII., fig. 177.

Another specimen, brought up by the divers from Muttuvaratu Paar, inhabited a membranous tube coated with fine mud. Total length 100 millims., of which 35 millims. belong to the branchiæ; more than 140 segments. The thorax is composed of six segments with five pairs of uncinigerous tori. The uncini are uniserial and show numerous denticles above the main tooth, presenting, in frontal view, a finely cross-hatched appearance, in side view a series of 8–10 minute rows on the vertex of the hook (Plate VII., fig. 177). Width of the thorax 8·5 millims., of the anterior abdominal region 7 millims. Branchiæ banded with purple, the radioles or stipes in two rows, but the bases of all show through the basal membrane. The radioles of the two rows are roughly alternate, though the outer row contains more than the inner. Terminal filaments of gill-stipes short; gill-filaments biserial. Collar with broad purple submarginal band on inner surface, as in the typical examples. It seems likely that *S. indica* is co-specific with Grube's *S. spectabilis* ('Ann. Semp.,' p. 253) and even with Marenzeller's *Laonome japonica* ('Südjapan. Ann.,' ii., 1884, p. 16). See also St. Joseph, "Ann. de Dinard," 'Ann. Sci. Nat.,' xvii., 1894, p. 249. The number of thoracic segments is known to be subject to individual variations. The collar is notched below by a median incisura ventralis.

* Similar colour-markings occur on the collar of the first example.

Jasmineira caducibranchiata, n. sp.—Plate VII., figs. 178 and 179.

Locality :—East side of Cheval Paar.

A small slender worm of nearly even diameter, gently tapering behind, 22 millims. long, 1·5 millims. wide; eight thoracic segments, 36 abdominal segments with anal groove passing obliquely across the first abdominal (9th body-segment) to the right side and on to the dorsal surface. The thoracic segments do not differ macroscopically from the anterior abdominal segments; there are 8 dorsal capillary fascicles, and 7 ventral tori carrying a single row of rostrate uncini with long manubrium (Plate VII., fig. 178). The abdominal uncini are avicular (Plate VII., fig. 179). The buccal segment carries the first capillary fascicle near its hinder border and towards the dorsal side; the collar is rounded and slightly projecting forwards below, with a median notch or incisura dividing the two low rounded lobes, and a shallow impression on each side of the notch. On the dorsal side the collar stands out at right angles to the body and is then inflected at an acute angle, to be inserted on either side of the anal groove in this region. The gill-radioles are lost, but their carriers are retained and show the scars of about a dozen radioles each. Inside the gill-crown there is a pair of broad, pinkish-white laciniæ, and below these there is a group of about six slender tentacular cirri attached to the lower ends of the gill-carriers.

FAMILY: SERPULIDÆ.

Eupomatus albiceps, EHRB., GRUBE—Plate VII., figs. 180, 180A, and 181.

GRUBE, 'Monatsber. Berlin. Akad.,' 1869, p. 520 (p. 40 of reprint).

One specimen inhabiting a quadrilateral tube winding round a tube of *Phyllochætopterus ramosus* from Galle.

The worm only measured 7 millims. in length including the branchiæ, and a fraction of a millimetre in diameter. GRUBE's example was rather larger. The operculum gives the character of the species. In this case there are eight nearly erect, slightly curved virgulæ and a laterally compressed ovate lamina dorsalis, the latter being a direct continuation of the columella and bearing a pair of broad dorso-lateral chitinous hamuli. The marginal teeth of the opercular disc are blunt. Thoracic uncini, as stated by GRUBE, show about nine teeth.

Another specimen, growing upon the tube of a larger species from South-east Cheval Paar, has length of about 20 millims. by width of 1·5 millims. There are seven virgulæ on the operculum, and the lamina dorsalis is quite flattened except at the back (Plate VII., figs. 180 and 180A). The uncini from the last thoracic torus show seven teeth. The bayonet setæ of the first thoracic fascicle show two clear spines at the base of the terminal process (Plate VII., fig. 181).

Eupomatus exaltatus, MARENZ.—Plate VII., fig. 182.

VON MARENZELLER, 'Südjap. Ann.,' ii., 1884, p. 217.

Station V., off Chilaw, Gulf of Manaar, 11 fathoms; one specimen without tube.

Differs from *E. heteroceros* in the structure of the operculum, other characters being approximately the same. The branchiæ are rather short, the stems stout and close together in a digitate manner, about 16 stems in each gill; terminal filaments slender, flagelliform. Thoracic uncini with six teeth, some with five only. The opercular style is stout, slightly flattened; the margin of the opercular cup carries 23 denticulations; from the centre of the cup a stout columella rises carrying a circle of eight large hooks, of which the dorsal one is larger than the rest and somewhat scythe-shaped, with a long hook directed ventrally and mesially; the seven smaller hooks have curved extremities directed outwards and are destitute of accessory processes (Plate VII., fig. 182). The operculum is associated with the right gill; no rudiment could be found on the left side. The first fascicle contains besides a few simple capillary setæ a bundle of strong unequally bifid setæ, the terminal process long and acuminate, the subterminal process very short and obtuse; these are called bayonet setæ (von Marenzeller).

The Ceylon specimen varies from the type, in which there is a crown of nine hooks instead of eight, and the thoracic uncini show seven or eight denticulations. In spite of these differences, which are not outside a possible range of variation,* the character of the crown of hooks is so distinctive as to leave no doubt as to the identification, notwithstanding the fact that von Marenzeller unfortunately omitted to state explicitly that the hooks of the crown, except the dorsal hook, are directed outwards; this is left to be inferred, and it is an important inference, since it decides the species.

Eupomatus heteroceros, Grube.

Grube, 'Verh. zool.-bot. Ges. Wien,' 1868, p. 639, Taf. 7, fig. 8.

Locality:—Several specimens from South-west Cheval and East Cheval, 8 fathoms.

Tube round, except flattened surface of attachment, doubled upon itself, U-shaped, or slightly convoluted and faintly ridged; it shows coarse growth rings and is overgrown with Bryozoa and pearl-oyster byssus. Thoracic uncini sexdentate. The opercular disc carries a crown of seven hooks turned inwards, of which one is larger and plain, the others equal among themselves and each provided with a pair of accessory lateral hamuli, and an inwardly directed basal process. The lateral hamuli are inserted lower down the shafts of the coronal hooks than in Grube's figures, and the basal hamules appear less upturned. The latter can hardly be seen without bisecting the operculum. The bayonet setæ of the first fascicle have bicuspidate processes as figured by Grube. The uniserial thoracic uncini, not observed by Grube, show five and six teeth, rarely seven. The marginal denticulations of the opercular disc end in rounded spatulate expansions.

The collection contains many examples of this species. In one series of seven individuals from the South-west Cheval, 13th November, 1902, one specimen has eight hamuliferous hooks on the operculum, in addition to the great hook instead of

* Compare *E. albiceps.*

the typical six. Two others have seven such hooks in addition to the simple hook. Meristic variations affecting a specialised organ composed of a limited number of parts are of considerable interest, especially in view of the analogy presented by *Eupomatus exaltatus* in this respect. Compare also the thoracic segments of *Sabellastarte indica.* Examples from East Cheval show six, seven and eight hamuliferous hooks respectively, in addition to the main hook.

The collar-margin is plain ventrally, not projecting forwards between the gills. The anterior free flap of the collar (seen from below) can be distinguished by a transverse groove from the posterior portion of the buccal segment, and at the sides of this groove there is a pair of thoracic organs analogous to those observed in *Pomatostegus actinoceros.* The orifice is guarded by a small triangular papilla which occurs at the level of the incisura lateralis of the collar.

Eupomatus minax (Grube).

Locality :—South-west Cheval Paar.

Small involved round tubes showing coarse growth-rings; pearl-oyster byssus sometimes attached to the tube. The marginal spines of the opercular disc vary between 19 and 21. The columellar spines are more erect than in Grube's figure ('Ann. Semp.,' 1878, p. 269); the large dorsal spine is vertical and has a strong recurved hook and two lateral accessory hooks.

Pomatostegus actinoceros, Morch—Plate VIII., figs. 3 and 4.

Morch, Otto A. L., 'Revisio critica Serpulidarum,' Copenhagen, 1863, p. 400, plate xi., fig. 16; Grube, 'Ann. Semp.,' 1878, p. 271.

This is an extremely variable species in regard to the structure of the operculum, and on the other hand it is the exact Indo-Pacific counterpart of the Antillean species *Pomatostegus stellatus*, Abildgaard (see Ehlers, 'Florida-Anneliden,' 1887, p. 296).

This species and *Eupomatus heterocerus* are the most abundant Serpulids in Professor Herdman's collection, and they must play an important part in consolidating the pearl banks as well as serving as a base for the attachment of the pearl oysters. This is proved by the byssi which still cling to many of the calcareous tubes secreted by these worms. The tube is massive, coarsely rounded or trigonal, rugged and overgrown. Sometimes the tube is provided with a high laciniate keel. The branchiæ are spirally rolled and banded. Their appearance varies according to the preservation. The transverse striation sometimes indicated is due to contraction, which causes wrinkling of the strong cuticle which covers the outer surface of the gills. The radioles have an internal septate structure, but the superficial wrinkles are not related to it, and the surface may be quite smooth. In one specimen from the Muttuvaratu Paar, brought up by the divers, I counted 36 radioles in one of the gills. The thoracic uncini showed as many as twelve teeth in addition to the basal, transversely expanded, scalprate process which VON MARENZELLER calls the "Meisselzahn." In the last thoracic torus the teeth of the uncini were not so numerous as in the preceding segments, not exceeding nine.

The collar is approximately as long as the rest of the thorax, entire below and at the sides, open above and continuous with the thoracic membrane on each side. The operculiferous style carries a broad wing-like membrane on each side which terminates above in a short free simple lobe. This membrane can embrace and protect the gills when retracted within the tube.

The disc of the operculum is covered with a chitinous cuticle and carries a long narrow columella arising excentrically near the dorsal side and furnished with circlets of spines at intervals (Plate VIII., fig. 4). The circlets of spines may be webbed or free. In the former case the chitinous membrane which they support projects beyond the spines and forms a stage or disc equal in diameter to the actual basal disc of the operculum. In the specimen before me the columella carries four stages above the opercular disc and two circlets of spines above the topmost stage. Another from the same locality shows two stages above the disc and three free circlets of spines above. A third has one stage above the disc and six circlets of free spines beyond. A fourth has three stages above the disc and two circlets beyond. A fifth has one stage above the disc, then two free circlets, then two more, narrower, stages followed by a terminal circlet. The abdominal setæ, as mentioned by GRUBE, have the apical portion slightly marked off. They closely resemble the abdominal setæ of *Omphalopoma langerhansii* figured by MARENZELLER ('Südjap. Ann.').

In another example taken from the Muttuvaratu Paar the opercular style retains a roseate flush in the preserved state. The tube has a low dorsal keel. The columella of the operculum carries two corneous stages over the disc, surmounted by five circlets of spines. The radioles of the gills are disposed in a simple spiral, about 27 in each gill; they are slender and the surface is smooth. Thoracic uncini from the sixth (last thoracic) torus show 7 to 9 teeth in addition to the scalprate process. A specimen from the South-west Cheval Paar shows three stages above the opercular disc followed by three circlets. Others were obtained from the East Cheval Paar in 8 fathoms.

The buccal setæ of this species are delicate, forming a small, frequently inconspicuous bundle of about a dozen setæ, among which may be found some slightly distinguished as bayonet setæ. On each side of the buccal segment, on its ventral aspect, there is a large orifice bounded by prominent lips (Plate VIII., fig. 3). The collar-margin projects forwards as a tongue between the gills ventrally as in *Spirobranchus cervicornis.*

An individual was taken off Panadure, Station XLV., 25 fathoms, measuring 20 millims. in side view from the free edge of the collar to the posterior extremity of the body; the collar and thorax 7 millims.; the operculum projects 7·5 millims. beyond the collar; width of thorax 4·5 millims. The brachysomatic condition of the abdomen may be due to regeneration. Between the whorls of the operculum a small Annelid was found by Mr. HORNELL (see *Haplosyllis spongicola*).

Protulopsis palliata, n. sp.—Plate VII., figs. 183 to 185.

Associated in the trawl with *Phyllochætopterus ramosus* from Galle, Station XXXIX., 16 to 30 fathoms.

A round, slightly curved calcareous tube, attenuated behind, widened in front. The body without the gills is 19 millims. long, 3 millims. maximum diameter. Gills with between 30 and 40 radioles on each side, rolled inwards in a single spiral turn; no operculum. Thorax consists of seven segments carrying seven pairs of capillary fascicles, but I do not find the uncini commencing before the fourth segment. The first fascicle contains numerous limbate capillary setæ of the usual form. In the fourth fascicle, in addition to the ordinary setæ, there is a group of salmacine setæ (Plate VII., fig. 183). There are about twelve of this kind of setæ in the fascicle, characterised by a short normally limbate tract followed by a clear striated border extending to the tip of the seta. The striated border is not limited by a refringent edge; the latter ceases suddenly at the upper end of the limbus. The uncini show about twenty equal denticulations; the last tooth at the base of the uncinus is followed by a long characteristic spur (Plate VII., fig. 184). The abdominal setæ occur to the number of five in a fascicle (Plate VII., fig. 185). The collar, in combination with the thoracic membrane, shows a remarkable development dorsally, where it is produced forwards on each side into a wide lappet, which is rolled upon itself and is probably able to follow the branchial spire to its termination; the ventral portion of the collar is marked off from the dorsal portion by an incisura lateralis, and its ventral border is slightly concave.

Serpula granulosa, MARENZ.—Plate VII., figs. 186 and 186A.

VON MARENZELLER, 'Südjapan. Ann.,' ii., 1884, p. 215 (p. 19 of reprint).

Locality: South-west Cheval Paar; several specimens.

Tube round, subcristate to cristate; fila branchialia (radioles) about 26 on each side*; operculum shallowly concave, with 46–52 rays which project as denticulations at the margin. The grooves which separate the rays do not all reach to the centre of the disc; they are the superficial indications of dissepiments which project vertically with a free inner border into the substance of the operculum (Plate VII., fig. 186A). Seven thoracic segments; modified setæ of the first segment unequally bifurcate; capillary setæ of the other thoracic segments simple, limbate; thoracic uncini 5-dentate. *Serpula granulosa* differs from *S. gervaisii*, QFG., by its cristate tube and the shallow cup of the operculum. The degree of concavity can be varied, sometimes the disc is nearly flat, sometimes slightly convex, but it does not seem likely that it could be deepened to the extent which characterises *S. gervaisii*.†

* VON MARENZELLER gives 35 for the type.

† *Cf.* GRUBE, 'Ann. Roth. Meer.' (Frauenfeld), 1868, p. 640.

In a typical example such as that figured on Plate VII., fig. 186, the total height of the tube in the region of the orifice is about 6 millims., of which the crest occupies 1 millim. The operculum is sometimes dextral. sometimes sinistral in position, and at the corresponding point on the other side, as noted by VON MARENZELLER, there is usually a rudimentary operculum. Minute tubercles are sparsely distributed on the concave opercular disc.

Serpula watsoni, n. sp.—Plate VII., fig. 187, and Plate VIII., fig. 6.

Locality :—Trincomalee, February, 1902.

I have much pleasure in dedicating this species to Mr. ARNOLD T. WATSON, whose drawing illustrates it (Plate VIII., fig. 6). It is characterised by the great length of the ampulla of the operculum, 3 millims., slightly exceeding the length of the style, the total length of the operculum being 5·5 millims. The ampulla is about twice the length of that portion of the style which rises above the collar. The disc of the ampulla is traversed by about 25 rays. There are about 30 radioles in each gill. The collar is entire below, divided on each side by an incisura lateralis. Uncini from the last thoracic torus with 5 and 6 teeth (Plate VII., fig. 187).

Spirobranchus cervicornis, n. sp.—Plate VII., figs. 188 to 192.

One specimen in bottle with *Loimia variegata*, *Dasychone cingulata*, &c. [? Cheval].

Total length 22 millims., made up as follows :—Gill-apparatus (including operculum) 7 millims., thorax 5 millims., abdomen 10 millims. Width of thorax 4·5 millims. The gills diverge outwards ; the gill-rays (radioles) are rolled inwards at the top and are disposed in a spiral of one turn and a half, about 30 in each gill. The thorax consists of seven setigerous segments with six pairs of uncinigerous tori. The first segment is produced into a capacious collar open above, its dorsal ends overlapping and covering the expanded style of the operculum, nearly reaching to the disc (Plate VII., fig. 188). Ventrally the collar-membrane is produced forwards as a tongue-like process between the gills (Plate VII., fig. 189). The buccal setæ (of the first fascicle) are of two kinds, long, slender, capillary setæ fringed with hair-like striæ though without a definite limbus ; towards the tips of the setæ the marginal hairs project ; secondly, stouter bayonet setæ with pilose extremities (Plate VII., fig. 191). The remaining thoracic setæ are of the common limbate type and call for no remark ; there are two groups of different sizes, more slender and stouter, in each fascicle. Thoracic uncini with fifteen teeth and a basal T-shaped mucro (Plate VII., fig. 192). The abdominal setæ are of the kind called "Dütenborsten" [geniculate setæ] by VON MARENZELLER ('Südjap. Ann.,' ii., Taf. iv., fig. 4*b*).

In *S. cervicornis* the horns of the operculum resemble a pair of antlers, of which the dorsal tine is half the length of the main tine (Plate VII., fig. 190). They only differ in proportion from the horns of *Spirobranchus giganteus* as figured by MORCH (1863) and EHLERS (1887).

It is not easy to define the limits of the genera *Pomatoceros*, PHILIPPI (1844) and *Spirobranchus*, BLAINVILLE (1818). GRUBE uses *Pomatoceros* in an extended sense and appears to disregard the prior claims of *Spirobranchus* ; the latter is retained by EHLERS (1887) and ST. JOSEPH (1894). The genus *Pomatoceros* s. str. comprises the species *crucigera*, GRUBE (Red Sea, 1869), *helicoides*, MARENZELLER (Japan, 1884), *triqueter*, L. (Europe, MORCH, 1863, ST. JOSEPH, 1894), and *bucephalus*, MORCH (Philippines, 1863). GRUBE'S *Serpula quadricornis* ('Ann. Semp.,' p. 275) appears to me to be probably co-specific with MORCH'S *Spirobranchus semperi* ('Revisio Serpulidarum,' 1863, p. 405). The species of *Pomatoceros* named above practically resolve themselves into two main groups represented respectively by the European *P. triqueter* and the Oriental *P. bucephalus.*

Spirobranchus semperi, MORCH.

MORCH, 'Revisio Serpulidarum,' Copenhagen, 1863, p. 405.
Serpula quadricornis, GRUBE, 'Ann. Semp.,' 1878, p. 275.

Opercular style with wing-like expansions as in the preceding species, opercular disc flat, carrying four distinct horns. Uncini from the last thoracic torus with 12 to 13 teeth.

Spirobranchus semperi, var. **acroceros**, nov.—Plate VII., fig. 193.

This variety is represented by several specimens apparently only differing from the typical form in the fact that the opercular disc is cone-shaped, carrying the horns at the top (Plate VII., fig. 193). Length 12·5 millims. (up to nearly 20 millims.) ; about 50 abdominal segments ; gill with 18 radioles.

Spirobranchus tricornigerus (GRUBE).

Serpula tricornigera, GRUBE, 'Ann. Semp.,' 1878, p. 273.

A small specimen from the pearl banks. The great feature of this species is the horizontal branching of the horns of the operculum, the main branches very slightly elevated and the ultimate ramifications lying approximately in one plane. The horns are very pale, calcareous, slightly chitinised. It is possible to distinguish three main branches proceeding from a common centre, but not so equilateral as in GRUBE'S figure. GRUBE assigns 20 teeth to the larger thoracic uncini. I only see the usual 12 teeth in the uncini of the last thoracic torus. The buccal setæ forming the first thoracic fascicle are of two kinds, simple capillary and bayonet setæ, both kinds with serrulate border. The gills are traversed by a strong, nearly black fascia a short distance in front of the basal membrane.

Vermilia pygidialis, n. sp.—Plate VII., figs. 194 to 196.

Locality :—South-west Cheval Paar.

Distinguished by the long, brown, horny, ringed, conoidal operculum, and by the obtuse posterior end of the body, which is furnished dorsally with an oval purplish-crimson cushion and long hair-like setæ (Plate VII., figs. 194 and 196). Ten radioles in the left gill; nine and the operculum in the right. Uncini from last thoracic torus with eleven teeth and a scalprate process (Plate VII., fig. 195). Capillary setæ of first thoracic segment not distinguished from the rest; simple limbate, accompanied by slender non-limbate setæ. Mid-abdominal region with dorsal uncini and ventral fascicles containing three geniculate setæ. Total length of operculum 5 millims., the style 2·5 millims., the ampulla and columella 2·5 millims. Length of gills 4 millims., of thorax 4 millims., of abdomen 11·5 millims. The terminal filaments of the gill-radioles are clubbed; in one specimen the clubs have a pinkish colour (Plate VII., fig. 194). The closeness of the intersegmental grooves gives the pygidium a foliate appearance. The tube is coiled horizontally upon itself, widens out in front, and presents 4 or 5 low longitudinal keels.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Chlœia flava.* Dorsal barbed bayonet seta. Zeiss 3 C.
,, 2. ,, Ventral furcate seta. Z. 3 C.
,, 3. *Hermione malleata.* Dorsal glochideal seta; the point is broken. Z. 3 C
,, 4. ,, Ventral furcate seta showing accessory tooth. Z. 3 C.
,, 5. *Pontogenia indica.* Anterior end.
,, 6. *Iphione muricata.* Anterior end.
,, 7. *Lepidonotus carinulatus.* Prostomium.
,, 8. ,, Carinulate papillæ of elytron arising from clear areoles.
,, 9. ,, Echinulate papilla.
,, 10. ,, Stellate papilla.
,, 11. ,, Ventral seta. Z. 3 C.
,, 12. *Halosydna zeylanica.* Parapodium.
,, 13. ,, Ventral seta. Z. 3 D.
,, 14. *Harmothoe dictyophora.* Elytron; the superficial filiform papillæ occurring on the larger shields are omitted.
,, 15. *Harmothoe dictyophora.* Head.
,, 16. ,, Ventral seta. Z. 3 C.
,, 17. *Hololepidella commensalis.* Dorsal seta. Z. 3 C.
,, 18. ,, Superior ventral seta. Z. 3 C.
,, 19. ,, Inferior ventral seta. Z. 3 C.
,, 20. ,, Head and proboscis.
,, 21. *Panthalis melanonotus.* Head and proboscis.
,, 22. ,, Fifty-fourth parapodium. *a*, geniculate appendix; *b*, dorsal cirrus; *c*, silken threads (tomentose setæ); *d*, notopodium; *e*, notopodial acicula; *f*, neuropodium; *g*, neuropodial acicula; *h*, ventral cirrus; *i*, coil of threads inside the body.

Fig. 23. *Panthalis melanonotus.* Lateral processes of four successive segments after the 28th, showing dorsal cirri with geniculate appendices, alternating with elytrophores and ovate processes; seen from above.
„ 24. *Panthalis melanonotus.* Superior ventral seta.
„ 25. „ Penicillate seta.
„ 26. „ Aristate seta.
„ 27. „ Inferior ventral seta.
„ 28. *Panthalis nigromaculata.* Anterior end.
„ 29. „ Head.
„ 30. „ Jaws.
„ 31. „ Third elytron.
„ 32. „ Parapodium.
„ 33. *Psammolyce zeylanica.* Two of the dorsal dermal papillæ.
„ 34. „ Head and portion of the anterior segments.

PLATE II.

Fig. 35. *Psammolyce zeylanica.* Dorsal cirrus of third segment. Z. 3 a.*
„ 36. „ Compound seta from second segment. Z. 3 C.
„ 37. „ Shaft of compound seta from third segment. Z. 3 C.
„ 38. „ Seta from central fascicle of neuropodium.
„ 39. „ Inferior ventral seta.
„ 40. „ Appendices of bidentate setæ.
„ 41. „ Lower border of parapodium with ventral cirrus.
„ 42. „ An elytron.
„ 43. „ Seta from central fascicle of 16th foot with cusp on shaft.
„ 44. *Psammolyce rigida.* Seta from central fascicle of 16th foot with plain shaft.
„ 45. „ Dorsal cirrus of third segment. Z. 3 a.*
„ 46. „ An elytron.
„ 47. „ Compound seta from second segment. Z. 3 C.
„ 48. *Sthenelais zeylanica.* Parapodium:—*v.c.*, ventral cirrus with its associated stylodes; 1, 1, 1, superior dorsal setæ (numerous, forming a dense tuft); 2, 2, inferior dorsal setæ, slender, striated; 3, superior ventral seta; 4, seta of the central group; 5, inferior ventral seta.
„ 49. *Sthenolepis japonica.* Parapodium.
„ 50. *Thalenessa digitata.* Superior ventral seta; the upper end of the shaft is faintly fringed. Z. 3 D.
„ 51. „ One of the digitate fimbriæ of an elytron.
„ 52. „ Anterior end:—*e.*, first elytrophore; *p.*, palp; *x.*, semilunar process of the second foot arching over the prostomium. The porrect cirrophores carry no visible setæ.

PLATE III.

Fig. 53. *Thalenessa stylolepis.* Head.
„ 54. „ Parapodium showing the ctenidium on the medial surface of the elytrophore and the cirriform branchia below the elytron; the marginal fimbriæ of the latter are concealed in this preparation.
„ 55. *Thalenessa stylolepis.* Compound seta from the 60th segment. Z. 3 C.
„ 56. „ Marginal plumose fimbria of an elytron. Z. 3 A.

Fig. 57. *Anaitis zeylanica.* Seta in side view.
„ 58. „ Articular portion of seta from above. Z. 3 D.
„ 59. „ Prostomium.
„ 60. „ Dorsal phyllode.
„ 61. *Notophyllum laciniatum.* Head, as seen after removal of the anterior phyllodes.
„ 62. „ End of shaft of seta showing the articular fossa.
„ 63. *Phyllodoce dissotyla.* Head.
„ 64. „ Parapodium.
„ 65. „ Portion of seta. Z. 3 D.
„ 66. „ The two kinds of papillæ on the proboscis.
„ 67. *Phyllodoce foliosopapillata.* Head and proboscis.
„ 68. „ Parapodium.
„ 69. „ Seta. Z. 3 D.
„ 70. *Phyllodoce macrolepidota.* Parapodium.
„ 71. „ Seta. Z. 3 D.
„ 72. *Phyllodoce sancti-josephi.* Head.
„ 73. „ Seta. Z. 3 D.
„ 74. *Irma limicola.* Parapodium; the bundle of fine dorsal setæ proceeding from the cirrophore is seen crossing the basal portions of the superior ventral setæ. Z. 3 a.*
„ 75. *Irma limicola.* Average compound seta.
„ 76. „ Inferior ventral seta.
„ 77. *Typosyllis taprobanensis.* Seta from posterior region of larger specimen. Z. 3 D.
„ 78. „ Posterior seta of smaller specimen. Z. 3 D.
„ 79. *Haplosyllis spongicola.* Head.
„ 80. „ Pharyngeal orifice and tooth.

PLATE IV.

Fig. 81. *Autolytus orientalis.* Magnified about 11 times.
„ 82. „ Fore-gut removed from body.
„ 83. „ Palps, mouth and tentacular cirri from below.
„ 84. „ Seta. Z. 3 J. water imm.
„ 85. *Nereis unifasciata.* Outline of 8th parapodium of right side seen from behind.
„ 86. „ Similar outline of 31st parapodium.
„ 87. „ Heterogomph spinigerous seta from 8th foot. Z. 3 D.
„ 88. „ Hemigomph seta from 18th foot. Z. 3 D.
„ 89. *Ceratonereis falcaria.* Dorsal seta from 27th foot. Z. 3 D.
„ 90. *Ceratonereis pectinifera.* Outline of 8th foot of right side.
„ 91. „ Outline of 32nd foot.
„ 92. *Platynereis bengalensis.* Dorsal falcigerous seta of 44th foot. Z. 3 D.
„ 93. „ Superior ventral falcigerous seta of same foot. Z. 3 D.
„ 94. „ Acervus of paragnaths of group IV., and maxilla.
„ 95. *Diopatra amboinensis.* Jaws protruding, seen from below. 1, 1, mandibles or forcipate jaws; 2, 2, serræ or saws; 3, impar; 4, 4, arcs; 5, 5, laminæ ventrales; *b.s.*, buccal segment.
„ 96. *Diopatra amboinensis.* First parapodium. Only a few setæ are indicated.
„ 97. „ Simple bidentate setæ from first foot. Z. 3 D.
„ 98. *Onuphis basipicta.* First right foot. Z. 3 A.
„ 99. „ Compound seta of first foot. Z. 3 D.

Fig. 100. *Onuphis dibranchiata.* Acicular seta from first foot. Z. 3 D.
,, 101. *Onuphis holobranchiata.* Tube about natural size.
,, 102. *Eunice martensi.* Right 46th foot.
,, 103. ,, Compound seta from 168th foot.
,, 104. ,, Acicular seta from same foot.
,, 105. *Paramarphysa orientalis.* Compound seta from anterior region.
,, 106. *Aglaurides fulgida.* Head removed, showing submedian eyes in groups, two large lateral eyes and three occipital antennæ.

PLATE V.

Fig. 107. *Aglaurides fulgida.* Right set of upper jaw-pieces from the side.
,, 108. *Aracoda obscura.* A jaw-piece of the first pair (left side).
,, 109. ,, Jaw-piece of the second pair (left side); fracture at the point marked *.
,, 110. ,, Right set of jaw-pieces.
,, 111. ,, Anterior end.
,, 112. ,, Ventral seta. Z. 3 C.
,, 113. *Glycera lancadivæ.* Articular ends of shafts of compound setæ, of form A. Z. 3 D.
,, 114. ,, Portion of a seta of form B. Z. 3 D.
,, 115. ,, Parapodial ligules of form A. Z. 3 A.
,, 116. ,, Parapodial ligules of form B. Z. 3 A.
,, 117. *Polydora hornelli.* One of the modified acicular setæ of the fifth segment. Z. 3 D.
,, 118. *Notomastus zeylanicus.* Anterior end in left side view showing the half-retracted prostomium, the "tongue" below it, the first and second achætous segments, and the first setigerous segment.
,, 119. *Notomastus zeylanicus.* Unciniform or acicular seta. Z. 3 J. water imm.
,, 120. *Armandia lanceolata.* Anterior end from above; 1, tentaculum impar; 2, nuchal organ; 3, rostrum; 4, anterior portion of metapleural fold.
,, 121. *Polyophthalmus australis.* Anterior end from above showing pigment tracks and nuchal organs.
,, 122. *Nicomache truncata.* Anterior fragment from the left side. Actual length 47 millims.; width 5 millims.
,, 123. *Nicomache truncata.* Frontal view of head.
,, 124. *Ammochares orientalis.* Anterior end from below.
,, 125. ,, From above (dorso-lateral), showing three capillary fascicles in front of the first pair of tori.
,, 126. *Chætopterus appendiculatus.* Modified seta from 4th foot. Z. 3 C.
,, 127. *Phyllochætopterus herdmani.* Anterior end from above. First pair of spirally coiled tentacles are lost.
,, 128. *Phyllochætopterus herdmani.* Modified seta from 4th foot. Z. 3 C.
,, 129. ,, Modified seta from 3rd foot of an aberrant individual. Z. 3 C.
,, 130. ,, Plan of one of the branchial segments.
,, 131. ,, Spatulate seta from first parapodium. Z. 3 C.
,, 132. ,, Abdominal uncinus. Z. 3 D.
,, 133. *Phyllochætopterus ramosus.* Branching tube.
,, 134. ,, Modified seta from 4th foot in side view. Z. 3 A.
,, 135. ,, Modified seta from 4th foot of another specimen in back view. Z. 3 A.
,, 136. ,, Lower portion of an uncinus from a branchial segment.
,, 137. *Pectinaria panava.* Uncinus from a posterior torus.
,, 138. *Heterocirrus typhlops.* Anterior region from above.

PLATE VI.

Fig. 139. *Cirratulus cylindricus.* Anterior region from above.
,, 140. ,, Head and mouth from below.
,, 141. *Leprea inversa.* Capillary seta from second setiger.
,, 142. ,, Geniculate seta from 45th setiger.
,, 143. *Polymnia labiata.* Anterior end from below; the bases of the tentacular cirri are indicated in front of the labium (= 1st and 2nd segments); the lateral lobes of the 3rd segment project beyond.
,, 144. *Polymnia labiata.* Thoracic uncinus in front view. Z. 3 D.
,, 145. ,, Uncinus from 9th torus in side view. Z. 3 D.
,, 146. *Polymnia socialis.* Anterior region from below; the epistome projects in front; tentacles omitted.
,, 147. ,, Front view of a thoracic uncinus.
,, 148. ,, Side view of thoracic uncinus. Z. 3 D.
,, 149. *Polymnia triplicata.* Anterior region from the right side; *ep.*, epistome; *lab.*, labium.
,, 150. ,, Epistome (*ep.*), labium (*lab.*), and mouth in frontal view.
,, 151. ,, Uncinus in three-quarter view. Z. 3 D.
,, 152. ,, Uncinus in side view. Z. 3 D.
,, 153. *Loimia annulifilis.* Uncinus from third torus. Z. 3 D.
,, 154. ,, Anterior region from below, tentacles omitted; in front is the epistome, then the labium, then the lateral lobes.
,, 155. *Loimia medusa.* Anterior region from below.
,, 156. ,, var. *angustescutata*, showing additional tori and capillary fascicles.
,, 157. ,, Uncinus from first torus. Z. 3 D.
,, 158. ,, Uncinus from fourth torus. Z. 3 D.
,, 159. ,, Abdominal uncinus. Z. 3 D.
,, 160. *Loimia montagui.* Anterior region from below.
,, 161. ,, Quinquedentate uncinus from first torus. Z. 3 D.
,, 162. ,, Sexdentate uncinus from first torus. Z. 3 D.
,, 163. ,, Uncinus from 13th torus. Z. 3 D.

PLATE VII.

Fig. 164. *Grymæa cespitosa.* Anterior end from the right side. The small circles in the first branchial acervus are the scars of branchial filaments.
,, 165. *Grymæa cespitosa.* Uncinus. Z. 3 D.
,, 166. *Branchiomma acrophthalmos.* Spatulate seta from thorax.
,, 167. ,, Anterior end from above. In front the gill-bases are shown on each side, the radioles being omitted.
,, 168. *Branchiomma quadrioculatum.* Buccal segment and cephalic complex from below.
,, 169. ,, Uncinus. Z. 3 D.
,, 170. *Dasychone cingulata.* Average superior thoracic capillary seta. Z. 3 C.
,, 171. ,, Thoracic uncinus. Z. 3 D.
,, 172. ,, Portion of a gill-radiole showing stylodes and eyes and the bases of the gill-filaments.
,, 173. *Eurato porifera.* Anterior thoracic region from above.

Fig. 174. *Eurato notata.* Thoracic uncinus. Z. 3 D.
,, 175. ,, Thoracic capillary, broadly limbate seta. Z. 3 D.
,, 176. ,, Thoracic capillary seta with the shaft broken and the limbus projecting.
,, 177. *Sabellastarte indica.* Thoracic uncinus. Z. 3 C.
,, 177*a*. ,, Frontal view of cephalic crown; *d.*, dorsal side; *t.*, antenna or tentacular lacinia.
,, 178. *Jasmineira caducibranchiata.* Thoracic rostrate uncinus. Z. 3 C.
,, 179. ,, Abdominal uncinus. Z. 3 D.
,, 180. *Eupomatus albiceps.* Operculum in side view.
,, 180*a*. ,, Dorsal view of operculum.
,, 181. ,, Bayonet seta from first thoracic fascicle.
,, 182. *Eupomatus exaltatus.* Oblique lateral view of operculum.
,, 183. *Protulopsis palliata.* Salmacine seta from fourth thoracic fascicle.
,, 184. ,, Base of uncinus.
,, 185. ,, Abdominal seta.
,, 186. *Serpula granulosa.* View of orifice of tube with operculum *in situ*.
,, 186*a*. ,, Operculum bisected.
,, 187 *Serpula watsoni.* Uncinus from last thoracic torus. Z. 3 D.
,, 188. *Spirobranchus cervicornis.* Cephalic crown in dorsal view; *c.*, collar flap turned aside.
,, 189. ,, Cephalic crown obliquely from below.
,, 190. ,, One of the opercular horns in side view.
,, 191. ,, Bayonet seta from buccal segment.
,, 192. ,, Base of uncinus in side view and in frontal view.
,, 193. *Spirobranchus semperi*, var. *acroceros.* Operculum from below.
,, 194. *Vermilia pygidialis.* Anterior region from dorsal side.
,, 195. ,, Uncinus from last thoracic torus.
,, 196. ,, Posterior end.
,, 197. *Leprea inversa.* Posterior abdominal uncinus. Z. 3 J. water imm. From one of the last three or four segments.

PLATE VIII.

The figures on this plate were drawn by Mr. Arnold T. Watson, to whom the identification of the "building organs" of *Pallasia pennata* is due.

Fig. 1. *Pallasia pennata.* Side view of anterior region. *t.*, retracted tentacles; *b*, white portion of peristome; *c*, brown portion; *d*, brown with white zebra-like stripes. × 19. *a*, internal bristles crossing when head contracts.
,, 2. *Pallasia pennata.* Ventral view of anterior region; *b.o.*, building organ. × 19.
,, 3. *Pomatostegus actinoceros.* Ventral view; *op.c.*, opercular cavity; *x.*, thoracic orifice. × 16.
,, 4. ,, Dorsal view. × 16.
,, 5. *Stylarioides parmatus.* Showing recurved abdomen; the fore-body is seen from below. × 17. *a*, uncini.
,, 6. *Serpula watsoni.* Operculum. × 18.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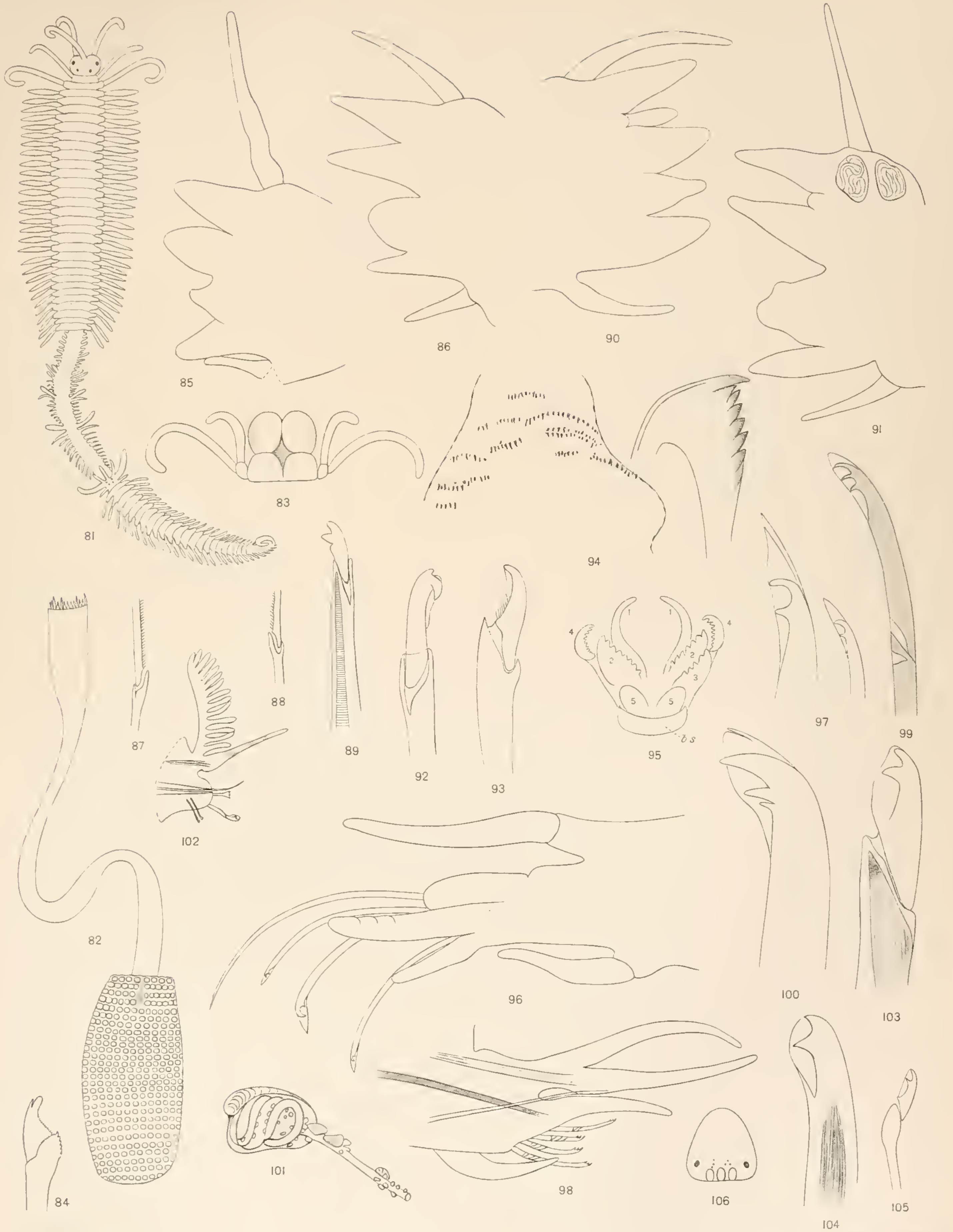
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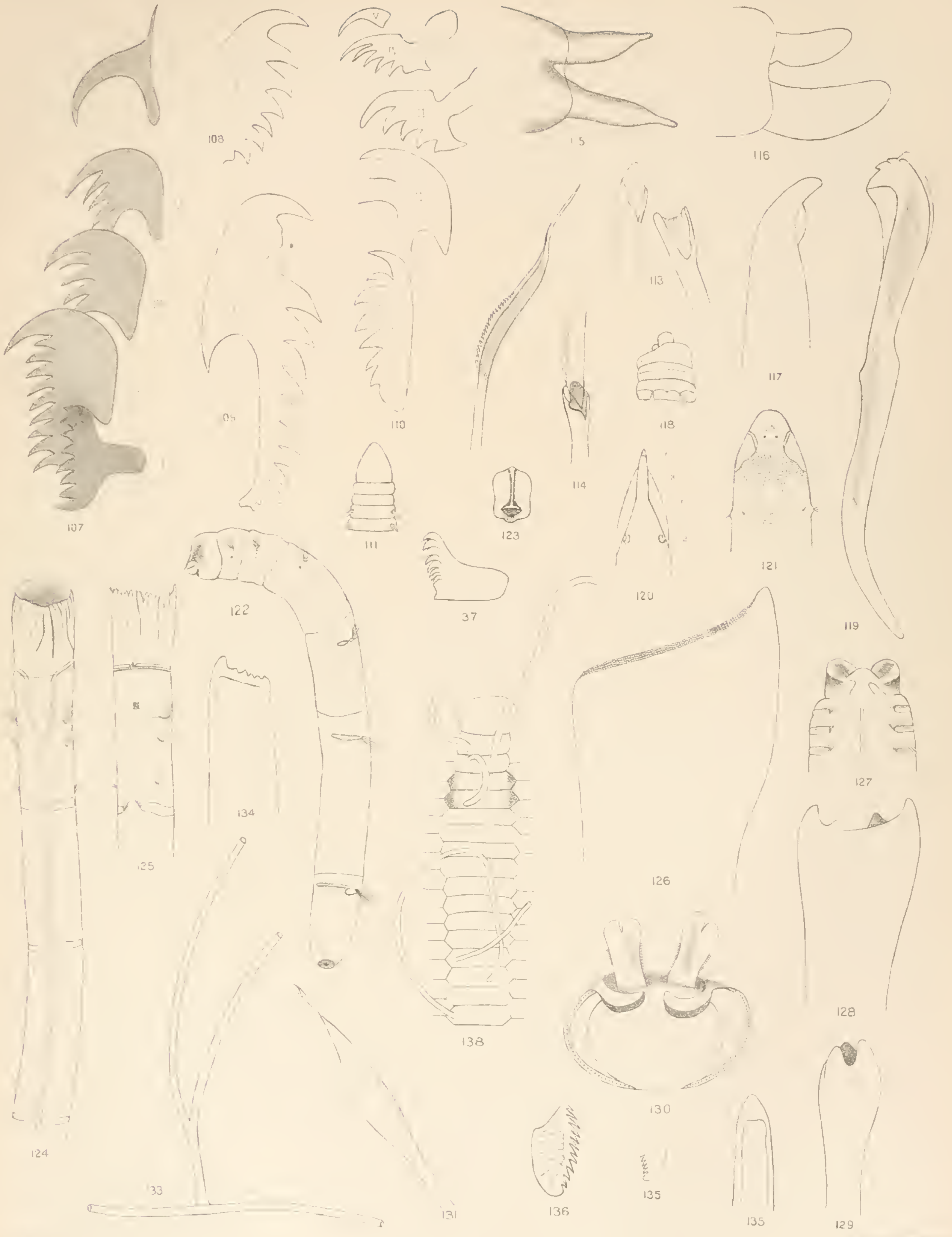
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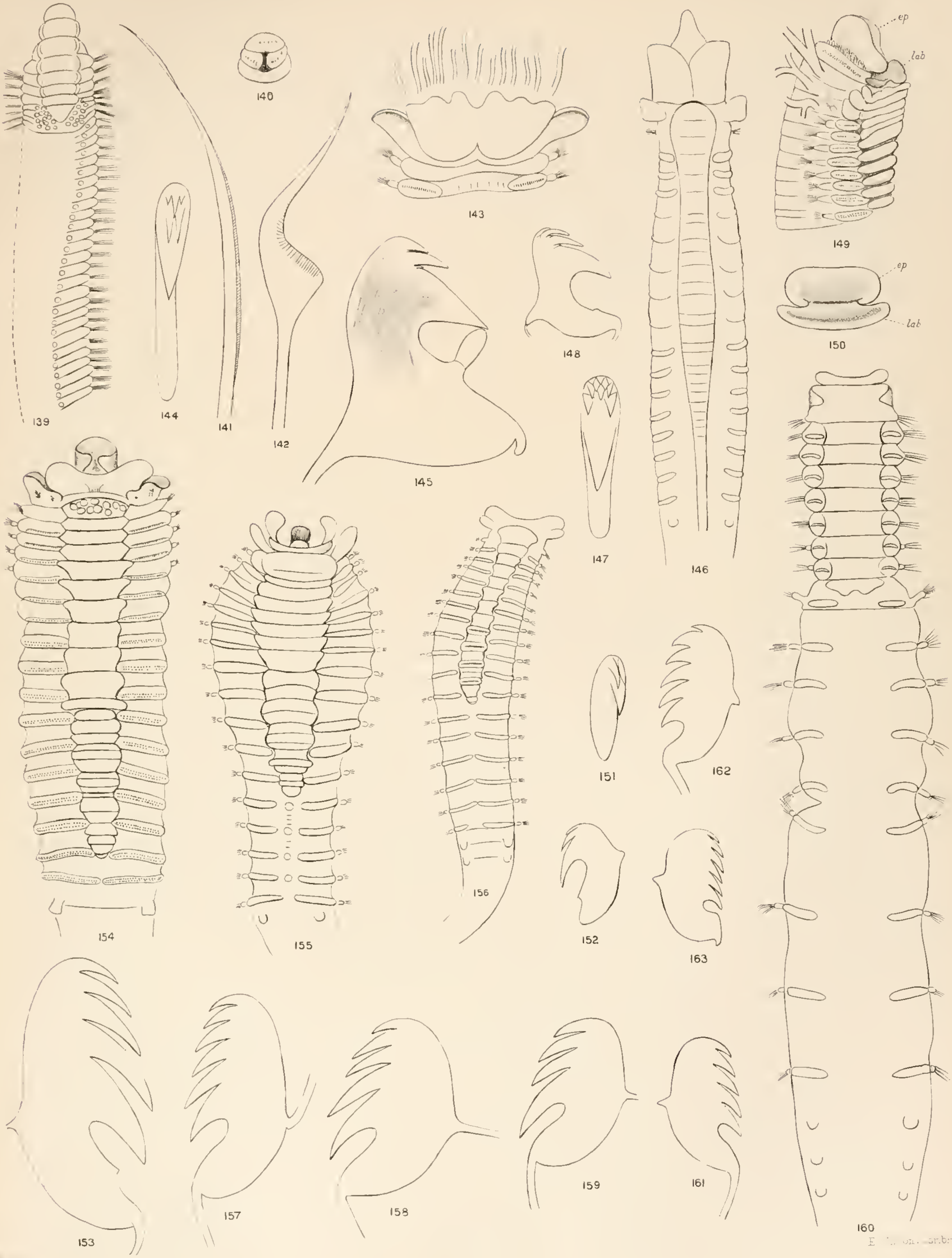
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NOTE ON POLYDORA ARMATA, Lnghs.*

BY

ARNOLD T. WATSON, F.L.S.

The specimens referred to in this note were found living commensally with a sponge, *Aulospongus tubulatus*, which is very common on the pearl banks, and is mentioned by Professor Dendy in his Report upon the Sponges in this series ('Ceylon Pearl Oyster Report,' Part III., p. 176).

A fuller description, with a figure showing the tubes piercing the sponge radially and the worms *in situ*, had previously been given by Dendy in his "Report on Sponges from the Gulf of Manaar" ('Ann. and Mag. Nat. Hist.' (6), iii., p. 73, 1889).

The general characteristics of the species are well described by Mesnil ('Bull. Sci. France et Belgique,' tome xxix., 1896, p. 203), and I have but few points of difference to note. Of these the most important, perhaps, relates to habitat.

The specimens described by Mesnil were obtained from *Lithothamnion*, through which they had pierced and in which they had formed tubes of calcareous sediment; while Carazzi and Lo Bianco report these worms as living in the shells of Venus and therein forming U-shaped tubes. A similar variation in habitat occurs in another closely allied species of this genus, *Polydora cæca*, which sometimes lives commensally with the sponge *Microciona plumosa*, as described by Hornell ('Nature,' vol. 47, 1892, p. 78).

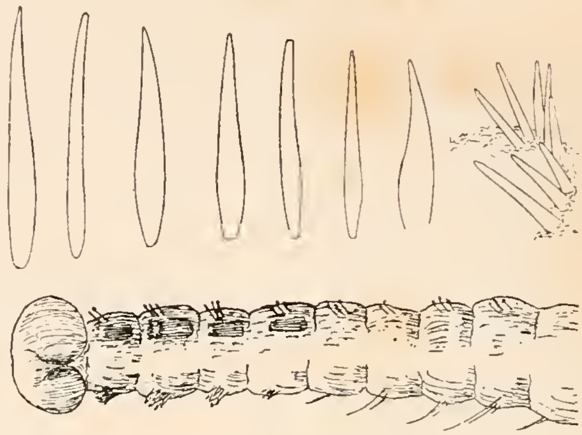
Owing to the difficulty of separating the worms uninjured from the sponge, it has only been possible to secure one or two fairly perfect specimens. The following notes, therefore, may be incomplete.

The Ceylon worm is apparently a smaller form of the species *Polydora armata*, Langerhans. The length varies from 2 to 3 millims. and the number of setigerous segments from 22 to 26. The branchiæ, of which I find four pairs, commence, as usual, on the 7th setigerous segment. They are comparatively broad and sometimes, but not always, of equal length. In one instance they gradually lengthen, the first being only half the length of the fourth. Eye-spots may or may not be present; most frequently they are invisible, but, after special treatment, in one case, I detected one pair. The tentacles are fairly long, reaching, in one specimen (though bent and twisted), to the 7th setigerous segment.

The setæ of the 5th segment, each with a characteristic hook, arising from an upright collar, which terminates on either side in a prominent pointed process projecting in the same direction as the hook (the whole having somewhat the appearance of an articulated seta), correspond well with Mesnil's figure. They number two, or sometimes three, in each parapodium.

* Langerhans, 'Zeitschr. f. Wiss. Zool.,' 34, 1880, p. 93.

Each parapodium of the 7th and following segments bears two or three hooded ventral uncinigerous setæ. The general outline of the worm is noticeable. The caruncle is slightly bilobed in front and extends backwards to about the 2nd setigerous segment; the anterior ten or eleven segments (except the 5th) are nearly equal to one another in length and breadth; they are followed by seven or eight segments, which are much larger, being nearly double the length and breadth of the former; in the hinder part of the worm the proportions of the segments become somewhat similar to those at the anterior end. The anal segment is broader than the preanal (see fig. in text). It is somewhat reniform in outline, the indent being dorsal. The segmental divisions in the anterior part, although fairly clear, are not deep, but commencing with about the 13th setigerous segment the separation becomes more and more distinct, until the last four or five preanal segments, in which it is very marked. This marked separation is further accentuated by the presence in the parapodia of these last segments of a fascicle of from 15 to 18 stout brown setæ, which vary greatly in form, size and proportion, a fact which was not shown by MESNIL. The forms comprised are acicular, lanceolate and scimitar-like (see fig. in text).



Polydora armata, LNGHS.—Posterior part in dorsal view, ×75; part of a dorsal posterior fascicle; and seven dorsal setæ from a posterior fascicle, ×375.

These setæ, which are more numerous than in MESNIL's examples, have usually their points drawn together in preserved specimens, forming a hollow, subspiral, truncate cone; but in several cases I have found the fascicle opened out, the points of the setæ being widely directed outwards, an arrangement extending over three parts of a circle, the central convexity of which is directed antero-laterally. By dissection the fascicle can be unrolled, when the setæ of which it is composed are seen to be arranged symmetrically side by side, the longest in the centre and the smallest at the outer edges. Probably in life the fascicle is expanded with a sweeping action. The forms of the setæ seem admirably adapted to the function described, the swollen parts, some distance from the base of the seta, doubtless acting as fulcra and rendering mutual support and aid in the action I have suggested.

The distribution of the species as noted by MESNIL is: Atlantic Ocean (Madeira), Mediterranean (Naples), British Channel (Manche: "Anse St. Martin"), to which we now add the Gulf of Manaar.

HARRISON AND SONS, PRINTERS IN ORDINARY TO HIS MAJESTY, ST. MARTIN'S LANE.

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REPORT

TO THE GOVERNMENT OF CEYLON

ON THE

PEARL OYSTER FISHERIES

OF THE

GULF OF MANAAR,

BY

W. A. HERDMAN, D.Sc., F.R.S., P.L.S.,

Derby Professor of Natural History in the University of Liverpool.

WITH SUPPLEMENTARY REPORTS

UPON THE

MARINE BIOLOGY OF CEYLON,

BY OTHER NATURALISTS.

PART V.

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CONTENTS OF PART V.

PEARL OYSTER REPORT.

SUPPLEMENTARY REPORTS.

PREFACE.

This Report on the Pearl Fisheries and Marine Biology of Ceylon has required a much greater expenditure of time and labour, and has extended to a greater length, than was contemplated at the outset. In the winter of 1901, it was supposed that about one year must elapse, after my return from Ceylon, before the Report could be completed, but the necessary work has occupied all my leisure for over four years, and I am painfully conscious that it is still unfinished—there are several matters I should like to have included, or to have followed up further, had time for investigation and funds for publication been less limited.

But this must be the final volume, and I wish now, in bringing the work to an end, to make use of this opportunity mainly for the purpose (1) of reiterating my thanks to many friends who have kindly helped me, (2) of correcting such errors and omissions* in the former volumes as have come to my notice, and (3) of saying my final word as to the present position and future prospects of the pearl fisheries.

I have reluctantly come to the conclusion that an index to the five volumes is impracticable. If it contained all specific names it would be largely an unjustifiable repetition of our lists, and every Zoologist who consults the work will be readily able to find any desired species from the classifications given in the reports. It may, however, be some aid to the reader if I give here a scheme indicating in which Part each section of the subject and each special report will be found. The sections of the pearl-oyster report proper are arranged in chronological order, as that corresponds with the natural development of the subject, from preliminaries to final conclusions, and the special, or "supplementary," reports are placed in zoological order from the lowest groups to the highest, so that the position of each in the volumes can be ascertained from this list at a glance.

PEARL OYSTER REPORT.

* See p. 449.

SUPPLEMENTARY REPORTS.*

* If I may be allowed to offer the suggestion, I believe the most convenient form of reference to a species in one of these Supplementary Reports would be as follows:—*Sphæroma walkeri*, Stebbing, in Herdman, 'Ceylon Pearl Fisheries,' Part IV., p. 31, Suppl. Rep. XXIII., "Isopoda," 1905.

It has been my desire, so far as possible, to deposit the types of new species in the British Museum. In the case of some of the smaller forms the type specimens have become more or less used up in the process of examination, or exist only in the form of fragments on microscope slides or as sections. In other cases, the authors are still actively working at the groups in question, and it has been represented to me that the best interests of science would be served by allowing all the specimens to remain in their hands for the present. I have, however, already sent to the British Museum the types of new species, and, in some cases, representatives of additional species, in the following groups:—Echinodermata, Pantopoda, Hemiptera, Polyzoa, Cumacea, Amphipoda, Leptostraca, Schizopoda, Stomatopoda, and, in the case of other groups, the specimens are now in process of being picked out for packing and transmission.

I am very much indebted to my Zoological friends who have so ably helped me by taking charge of separate groups. The Supplementary Reports which they have contributed form a valuable body of information on the marine fauna of Ceylon which is indispensable in discussing any biological problems in that part of the Indian Ocean. A few corrections and additions kindly supplied by the authors will be found at the end of this volume.

I desire once more to acknowledge the very efficient help which I have received from Mr. James Hornell, F.L.S., both in the initial investigation and also during the production of this Report. Even after Mr. Hornell ceased to be formally my assistant in the matter, and was appointed to a responsible post under the Ceylon Government, he continued to spare no pains to keep me fully informed of the changes in the condition of the pearl banks and to obtain any specimens or evidence that might be required to clear up points in doubt.

Since the last volume of this Report was issued, another very successful pearl fishery has been held at Ceylon. Over 67 millions of oysters were fished, and the total proceeds amounted to 1,385,000 rupees. This does not, of course, rival the great fishery of 1905 (when over eighty-one and a half millions of oysters were fished and the revenue brought in was upwards of two and a half millions of rupees), but it comes second on the list of recorded fisheries, and makes the fourth in successive years of a remarkable series—the most profitable pearl fisheries that, so far as is known, have ever been held.

As to the future, it seems probable that the remaining oysters on the Muttuvaratu Paar, along with the patches which are known to be on the Karativo Paar, on the Mid-west Cheval and on a new ground inspected by Mr. HORNELL, lying three to four miles N.N.E. of the Muttuvaratu, will suffice for a fishery of moderate dimensions in 1907. Then, in 1908, there should be a good fishery on the Mid-east Cheval, where there is now a healthy bed of two-year-old oysters, which was reinforced with 1000 tons of cultch last spring. After 1908 the prospects depend upon further careful scientific inspecting, transplanting and cultching, upon the lines which have been laid down in successive sections of this report.

It can scarcely be doubted that the aquicultural operations which have been commenced under the auspices of the Ceylon Government will be carried on vigorously by the Pearl Fishing Company to which the fisheries have now been leased. It must be a matter of congratulation to all concerned—to the Colonial Government, to the Company, and to men of science—that, in the terms of the lease, the necessity for a scientific treatment of the pearl banks during the next twenty years has been duly recognised and provided for.

After such treatment the property ought to be returned to the hands of the Government at the end of the period in a still more valuable condition than it is at present, and even if that were to be the only economic result of the present Report, those who have spent thought, time, and money in the investigation and the publication will be able to feel that their labour has not been in vain.

I cannot conclude without expressing my appreciation of the honour done me by the Royal Society in undertaking the publication of this Report, and I desire especially to thank those I have had to consult with at the Colonial Office, as well as the Officers and Staff at the Royal Society, for much kindly interest and consideration, for advice given and trouble taken during the progress of the work.

W. A. HERDMAN.

THE UNIVERSITY, LIVERPOOL.
September, 1906.

REPORT ON THE PEARL OYSTER FISHERIES OF THE GULF OF MANAAR.—PART V.

PEARL PRODUCTION.

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[WITH THREE PLATES AND SOME TEXT-FIGURES.]

THE investigation of a pearl fishery clearly falls into two parts—(1) the prosperity of the pearl-producing mollusc as part of the population of the pearl banks, and (2) the production of the pearls. It is the latter subject to which we now come. The preceding sections of this Report have dealt mainly with the pearl oyster as a healthy animal—with its distribution, structure and mode of life; while the Supplementary Reports have made known the many organisms which are associated with the pearl oyster on the banks, and which are inter-related with it in various ways and undoubtedly influence its life and prosperity.

The present section, on the other hand, treats of an abnormal process. Pearl-formation has often in the past been characterised, with substantial truth, as "a disease"; and whether the pearly material be deposited around a parasitic worm, or upon a particle of inorganic sand, or over an organically formed calculus, the resulting pearl is in each case a pathological product of the oyster's own tissues. It is always the shell-fish itself that makes the pearl. The pearl-inducing parasite does not produce the pearl any more than the grain of sand does, but either of them can apparently supply the stimulus which leads in the end to the formation of the gem. Many different kinds of shell-fish produce pearls, and these latter differ in quality in accordance with the animal that has deposited them rather than with the nucleus around which they have been formed. Still, even in the same shell-fish, pearls may differ much, and such differences are due to the nature of the nucleus, to the position in the body, and to the method of formation.

It is clear that pearls can be formed in several different ways, and recent discoveries show that some of the earlier suggestions are not altogether fanciful but contain an element of truth. The writings on pearl-production are numerous, and it is unnecessary to discuss all the views that have been held. But this report would have little claim to be regarded as even moderately complete if no mention were made of, at any rate, a few of the chief stages in the discovery of how pearls are formed.

HISTORICAL.

Our subject being the oriental pearl, it is only appropriate that we should mention first the early Hindu tradition, held even to the present day in the East, that at night or during heavy rain the pearl oyster ascends to the surface of the sea, opens its shell to the air and takes in drops of fresh water which become consolidated as pearls. PLINY and other classical writers record the similar belief that pearls are caused by drops of dew which enter the gaping shell at dawn and reflect the first rays of the sun, while still uncovered by the sea. Another poetical variant is that the pearls are due to the tears of the Nereids. These and other equally fanciful ideas are found scattered through the literature for centuries; and COLUMBUS, we are told, was convinced he had found the locality for orient pearls when he reached a spot, on the coast of Paria, in South America, where the trees grew down into the sea and had their roots covered with oysters gaping ready to receive the dewdrops from the leaves above.

As an example of an entirely different, but equally imaginative, idea, we have ÆLIAN'S statement that the pearls were formed by a lightning flash entering the opening shell. It must not, however, be supposed that all the views of the ancients on pearl-formation were wholly erroneous, for, as GIARD has recently pointed out, ATHENÆUS states that a certain ANDROSTHENES, who had travelled in the East, compared the developing pearls in the oyster to the Cestode larvæ in pork—a wonderfully close approximation to the truth.

Coming to more modern writers, we find many speculations as to more or less mysterious pathological effusions which may become solidified, as to displaced eggs which may form centres of deposition, as to possible similarity to calculi and to galls, and as to calcification of deposits formed around sand-grains, microscopic algæ, ova, embryos, and various kinds of minute parasites and other organic nuclei. We shall give here, in tabular form, some of the leading names (by no means a complete list) in the history of this inquiry, with, where known, the species of shell-fish on which the observations were made, and an indication of the view held, with more or less justification, as to the nature of the nucleus around which the pearl is formed.

Author.	Shell-fish investigated.	View as to origin of pearl or nature of nucleus.
Androsthenes	Oriental pearl oyster	(?) Cestodes.
Pliny	Oriental pearl oyster	Drops of dew.
Ælian	Oriental pearl oyster	Lightning-flash.
Rondeletius, 1554 . . .	. . . .	Parasites; also concretions.
Redi, 1671	. . . .	Grain of sand.
Réaumur, 1717	*Pinna, &c.*	Pathological effusion of shell-matter.
Bohadsch, 1761	*Aplysia*	Calculi.
Sir E. Home, 1826	*Anodonta*	Abortive ova.
Filippi, 1852–56	*Anodonta*	*Distomum* (Cercaria), &c.
Küchenmeister, 1856 . .	*Margaritana* and *Anodonta* . .	Mite (*Limnochares anodontæ*).
Von Hessling, 1856 . . .	*Margaritana* and *Anodonta* . .	Sand, algæ, ova, parasites.
Meckel, 1856	. . . .	Calculi.
Moebius, 1857	Both marine and fresh-water .	Entozoa.
Kelaart, 1857–59	Ceylon pearl oyster	Sand, diatoms, ova, parasites.
Pagenstecher, 1858 . . .	. . . .	Pathological concretions.
Garner, 1863, 1871 . . .	*Anodonta* and *Mytilus*	*Distomum.*
Harley, 1889	"British, Australian and Ceylonese" oysters	Calculi round inorganic or organic particles.
Comba, 1898	*Margaritifera vulgaris*	Parasites.
Diguet, 1899	*Meleagrina margaritifera* . . .	Pathological calcification of fluid formed around parasite.
Giard, 1897, 1901	*Donax, Tellina, &c.*	Distomids.
Dubois, 1901, 1903 . . .	*Mytilus* and *Margaritifera* . .	Distomid larvæ.
Jameson, 1902	*Mytilus edulis*	Distomid (Cercaria).
Herdman and Hornell, 1902, 1903, 1906	Ceylon pearl oyster (*Margaritifera vulgaris*)	Larval Cestodes.
Seurat and Giard, 1903, 1904, 1906	*Margaritifera margaritifera* . .	Larval Cestodes.
Shipley and Hornell, 1904	Ceylon pearl oyster	Larval Cestodes.
Crossland, 1905	Red Sea pearl oyster	Larval Cestodes.
Hornell, 1905	*Placuna placenta*	Larval Cestodes, rarely Distomids.

Omitting the more fanciful views, there are evidently three main methods which have been advanced as explaining the formation of pearls; and as is not infrequently the case when there are several competing theories, it cannot be said that one only is correct and of universal application and that the others are quite erroneous. The three methods referred to are:—(1) The grain-of-sand irritation; (2) the pathological secretion; and (3) the stimulation caused by the presence of a parasitic worm which acts as a nucleus, around which an epithelial sac deposits successive layers of pearly material. We shall briefly examine each of these views in turn.

Most of the attempts* at artificial "margarosis"—the production of pearls by stimulation of the Mollusc—have been based upon the belief that the nucleus of the

* There is, however, another artificial method which has been suggested—by infection with the parasites—which will be discussed below.

natural pearl is an inorganic particle. This "grain-of-sand" theory was supported by REDI and many other early and also more recent Naturalists, and it is the view which has been most generally adopted in the text books, and perhaps we may add in educated public opinion, as expressed, for example, in Sir EDWIN ARNOLD's lines :—

> "Know you, perchance, how that poor formless wretch—
> The Oyster—gems his shallow moon-lit chalice ?
> Where the shell irks him, or the sea-sand frets
> This lovely lustre on his grief."

Of late years, however, this view has been discredited by scientific investigators, and some recent writers seem to exclude altogether the grain of sand from participation in pearl causation. We cannot agree with that attitude. There is no doubt that occasionally a particle of sand or other inorganic material does form the nucleus of a free pearl. We have ourselves found three such, out of hundreds of pearls examined, in the course of our investigation. But, as a rule, any such foreign inorganic matter introduced between the mantle and the shell gives rise only to a pearly or nacreous excrescence, or blister, attached to the shell. Artificial pearls of an inferior sort are, however, sometimes produced in this way ; and the practice in China of forming rows of nacreous beads, or images of a Joss, or of Buddha, on the inner surface of the fresh-water mussel *Dipsas plicatus*, LEACH, depends simply upon the fact that foreign bodies placed outside the mantle will be cemented to the shell by a layer of nacre. The so-called "secret-process" of LINNÆUS, often referred to in the literature of pearl-formation, has been shown,* from manuscripts now in the library of the Linnean Society of London, to consist merely in piercing the shell and inserting a small fragment of calcareous matter kept in position by a piece of fine silver wire. LINNÆUS, on the evidence of contemporary manuscripts, seems to have obtained by the process certain pearls which the Swedish crown-jeweller declared to be in every way as good as those produced naturally. Probably they were compared not with the most precious pearls from the pearl oysters of Eastern seas, but with those of the Swedish fresh-water mussels (*Unio margaritifera*).

In 1898 BOUTAN experimented in artificial pearl-formation at Roscoff, and succeeded in obtaining pearls from the marine Gastropod *Haliotis;* and no doubt they might be obtained artificially from other shell-fish also.

The importance of all this, from our present point of view, is merely to show that the grain-of-sand method is occasionally found operative in the causation of true pearls, and it is possible that some of those that appear to have no nuclei may have been deposited around very minute inorganic particles.

The view that the pearl is produced as a calculus, or pathological deposit, was originated by RÉAUMUR in 1717, followed by BOHADSCH in 1761, was supported by MECKEL and by PAGENSTECHER nearly a century later, and again revived by

* 'Proc. Linn. Soc.,' 117th session, p. 18, 1905.

Dr. George Harley in 1889. Giard has recently pointed out that a considerable resemblance between the pearl and an animal calculus is compatible with the parasitic theory. Calculi commonly form around a nucleus, and many parasites are known to have calcified cysts deposited over them. Some pearls, as we shall show below, not of the finest quality, are probably formed as calculus-like growths independently of vermean parasites. Even when the parasite is present as a nucleus and causes the initial stimulation, it must be remembered that the pearl is produced by the molluscan host, not by the parasite, and so has been justly compared by more than one writer to an animal gall.

There are two papers by Harley in the 'Proceedings of the Royal Society.' The first (vol. 43, p. 461) dealt with the chemical composition of pearls, and the second (vol. 45, p. 612) with the structural arrangement of the mineral matters, and there Harley states two views, the one that they are "diseased concretions" comparable with "other morbid calculi," and the second that they are "misplaced pieces of organised shell." He recognises various kinds of nuclei, organic and inorganic, but also admits that pearls may sometimes begin "by the mere aggregation and coalescence of mineral molecules." (See our 'Calcospherules,' p. 27, below).

Composition of Pearl and Nacre.

In the paper on the "Composition of the Pearl and of Nacre," G. Harley and H. S. Harley ('Roy. Soc. Proc.,' 1888, p. 461) give the following as their analysis of "pure white pearls" (British, Australian and Ceylonese):—

Carbonate of lime	91·72
Organic matter (animal)	5·94
Water	2·23
Loss	0·11.

They also, for comparison, quote from Watts' 'Dictionary of Chemistry'* the following analysis of mother-of-pearl:—

Carbonate of lime	66·00
Water	31·50
Organic matter	2·50,

and express their surprise at the large amount of water found.

This difference between these two substances, produced in the same animal in a similar manner, and supposed to be so closely related to one another, is so very great that we felt that it was desirable to have another analysis made—especially since it is not stated in Watts' Dictionary who made the analysis quoted, nor what shell was

* Vol. iii., p. 1057, 1882.

used. A quantity of nacre was therefore detached from Ceylon pearl-oyster shells which had been lying dry in a box at the ordinary temperature of the Museum for about four years, and was handed to Dr. HERBERT E. ROAF, of the Bio-chemistry Department of the University of Liverpool, who has kindly supplied us with the following analysis :—

Calcium carbonate	88·79
,, sulphate	4·93
Organic matter	2·32
Water	2·28
Loss (no magnesium, no phosphates, faint trace of iron)	1·68.

From this it appears that the composition of the nacre is much more like that of the pearl than HARLEY supposed, and in fact the proportions of mineral matter and of water present in the two cases are practically the same if the "carbonate of lime" in the older analysis may be regarded as expressing the total salts of calcium present. The only notable difference remaining is the larger amount of organic matter in the free pearl than in nacre. In both, the calcareous part is in the form of aragonite.

The abnormal pearls which are formed not of nacre but of prismatic layers (calcite) or of horny material may very possibly have a composition widely different from that of the true orient or "cyst" pearl.

PEARLS AND PARASITES.

It is commonly thought that the Italian naturalist, PH. DE FILIPPI, originated in 1854 the view that the nucleus of the pearl is really organic, being an encapsuled parasite. But GIARD has recently reminded us that RONDELETIUS propounded the same view in 1558, and that ages before that ANDROSTHENES, who had travelled in the East, is reported by ATHENÆUS to have compared the developing pearls in the oyster to the Cestode larvæ in "measly" pork. This, in the absence of microscopic examination, can scarcely be regarded as a scientific demonstration ; but it was at least a very happy guess, for one of the first facts that we were able to determine in connection with the Ceylon pearl oyster, in the spring of 1902, was that the orient pearl in the Gulf of Manaar is deposited around the young larva of a Cestode.

Coming to actual identifications of the organic nucleus in comparatively recent times, we find that FILIPPI's pearl-parasite in *Anodonta cygnea* was the Trematode *Distomum duplicatum*, v. BAER ; ROBERT GARNER (in 1871) records "Distomes" from both fresh-water and marine mussels ; and GIARD attributes the origin of pearls in *Donax* and *Tellina* to a species of *Brachycœlium*—all these being cases of Trematoda. Other naturalists have since extended the discovery to other pearl-producing molluscs and to other worm parasites. To E. F. KELAART belongs the honour of having first connected the formation of pearls in the Ceylon oyster with the presence of vermean parasites. He and the Swiss zoologist, A. HUMBERT, who was with him at a pearl fishery off Aripu in 1857, found various parasitic worms infesting the viscera and other parts of the pearl oyster, and they agreed that these worms played an important part in the formation of pearls. KELAART moreover, in 1859, made the remarkable suggestion, in the case of the Ceylon pearl oyster, that it might be possible to increase the quantity of pearls by infecting the oysters in other beds with the larvæ of the pearl-producing parasites. This is exactly the idea that has lately been revived by DUBOIS in France.

OBSERVATIONS ON MYTILUS PEARLS.

Turning now to European shell-fish, we find that our countryman, ROBERT GARNER, in 1863 and again in 1871* associated the production of pearls in our common English mussel (*Mytilus edulis*), as well as in Anodon, with the presence of Distomid parasites.

Professor GIARD, in 1897, and other French biologists since, have made similar observations in the case of *Donax* and other Lamellibranchs—GIARD describing† the Distomid worm which he found as a species of *Brachycœlium* which he has identified since with *Distomum constrictum*, MEHLIS. LÉON DIGUET, in 1899, described the pearl-sac which secretes concentric layers of the nacreous deposit around the remains of parasites. We now come to quite recent years, during which there has been great activity. Professor RAPHAEL DUBOIS, in 1901, ascribed the production of pearls in mussels on the French coast to the presence of the larva of *Distomum margaritarum*. The next year (1902) Dr. H. L. JAMESON‡ followed with a more detailed account of the relations between the pearls in *Mytilus edulis* and the Distomid larvæ which he identified as belonging to *Distomum* (*Brachycœlium*) *somateriæ*§—the same sub-genus as GIARD had found some years previously in other Lamellibranchs. JAMESON's observations were made partly at Billiers (Morbihan), the same locality at which DUBOIS had also worked, and partly at the Lancashire Sea Fisheries Laboratory at Piel, in the Barrow Channel. DUBOIS published a further note‖ in January, 1903, in which he stated that JAMESON had come to Billiers after his departure and had confirmed the discovery made previously, first by GARNER and then by himself. But JAMESON had really done much more than that. He had shown that it is probable that the parasite causing the pearl formation in our

* 'British Association Report' for 1863, p. 114; and 'Journ. Linnean Soc., Zool.,' vol. xi., p. 426.

† 'Comptes Rendus Soc. Biol.,' November 13, 1897, p. 956.

‡ 'Proc. Zool. Soc. Lond.,' 1902, p. 140.

§ GIARD states ('Feuille des Jeunes Naturalistes,' January 1, 1904) that this species is the *Distomum constrictum* of MEHLIS, but there seems some reason to believe that JAMESON had more than one species under observation.

‖ 'Comptes Rendus Acad Sci.,' January 19, 1903.

common mussel (*Mytilus edulis**) is the larva of *Distomum somateriæ*, a Trematode worm, the adult of which† lives in the intestine of the eider duck and the scoter duck. He also stated that the larva inhabits Tapes or the cockle as a first host before getting into the mussel, and gave figures of the parasite in various conditions.

Two very important matters are, however, left in a somewhat unsatisfactory condition by JAMESON'S paper. The first of these is the mode of origin of the epithelial sac which encloses the larval parasite and which secretes from its cellular walls layer after layer of nacreous material so as to form a pearl. The presence of this sac was known before (VON HESSLING, 1858, and DIGUET, 1899), but no one had yet satisfactorily traced its origin. JAMESON several times compares it with the epithelium on the outer surface of the mantle, using such terms as "similar to" and "indistinguishable from," but he evidently considers that it has nothing to do with that epithelium, although it produces an identical pearly secretion. He describes the sac round the parasite as formed by the proliferation of a few cells which "are basally continuous with fibres of connective tissue." He also says of it, "This epithelium appears to arise quite independently of the outer epidermis." Now such a mode of origin as this is very unlikely, and from our own observations upon pearl-bearing mussels obtained from the same locality as JAMESON'S, we think there can be little or no doubt that the cells of the pearl sac are directly or indirectly, but at least genetically, connected with the exactly similiar cells on the outside of the mantle. It is very probable that the parasite in burrowing into the mantle carries in with it one or more epidermal cells which proliferate to form the sac. As the Distomid larvæ are found moving on the inner surface of the shell before coming to rest in the mantle, they must traverse the epidermis, and it is natural to suppose that in their migration they may push some epidermal cells in before them. Even in the absence of direct evidence of this, it will be admitted that it does not involve such a violent assumption as that the connective tissue in the centre of the mantle can produce an epithelial sac, the cells of which are indistinguishable both in structure and in function from the epidermis outside.

In giving a preliminary account of pearl-formation in the Ceylon pearl oyster to Section D of the British Association in September, 1903, we took up the position that the sacs enclosing the pearls were in all cases of ectodermal (epidermal) origin;

* JAMESON also states that he had found a Trematode in a sac in an example of the Ceylon pearl oyster ('Nature,' January 22, 1903, p. 281).

† ODHNER, however, has shown that JAMESON'S larval stages and his sexually mature form cannot belong to the same species, and that both belong to the genus *Gymnophallus*. The adult, according to ODHNER ('Fauna Arctica,' iv., 2, p. 291, 1905) is *Gymnophallus somateriæ* (LEVINSEN), and the larval form which causes the pearl-formation in *Mytilus* belongs to *Gymnophallus bursicola*, ODHNER. In a recent paper, "Über die Entstehung der Perlen," Dr. M. LÜHE also refers JAMESON'S stages to different species of *Gymnophallus*, and considers it probable that the parasite that causes pearl-formation in the mussel is a distinct species which must then be called *Gymnophallus margaritarum* (DUBOIS).

and it was gratifying to find that Professor A. GIARD in a note* on the subject shortly afterwards took the same view and considered that in the case of JAMESON'S mussel pearls there is a "passive immigration" of the epithelial cells caused by the migrating parasite.

Just as this section of the report was going to press I received a letter from Dr. JAMESON (now on the staff of the Transvaal Technical Institute, Johannesburg) in which he says: "I had never any doubt that it is a true epidermis, but I never got so far as to determine actually by observation whether it arose, as I think you have suggested, by the Trematode carrying in with it a fragment or pocket of epidermis; or, as I suspected, by means of epidermal or sub-epidermal replacement cells (Ersatzzellen)." From this it may be gathered that Dr. JAMESON would now agree with GIARD and BOUTAN and ourselves that the epithelium of the pearl-sac must be derived directly or indirectly from the epidermis of the mantle.

The second point in JAMESON'S account which, from the evidence presented, is not quite satisfactorily settled is the supposed infection of the mussel with parasites by other mollusca—*Tapes decussatus* in France and *Cardium edule* (the cockle) in the Barrow Channel. So far as regards this case, JAMESON'S conclusion is based upon the experiment of placing some mussels which he supposed to be free from parasites in a tank with French *Tapes* which were infected, and examining the mussels from time to time until he found they contained the parasites (Cercaria). Now in such an experiment it is necessary to be quite sure of the material used, to deal with sufficiently large numbers, and to have control experiments. JAMESON may have taken these precautions, but it does not appear from his paper. He says of the material: "These mussels, of which I examined a number, were practically without parasites. About one in every five of the largest examples contained a Cercaria, one had two Cercariæ, and one contained a small pearl." This can scarcely be described as free from parasites. He used 70 mussels, and if we take his own figures, one in five, as accurate, then about 14 of these specimens were infected at the beginning of the experiment. We find from his records that he only examined 13 of these mussels (2 after 11 days, 6 after 2 months, and 5 after $6\frac{1}{2}$ months), and found 12 of them infected. But it is obvious that that number may have been infected from the beginning, or may have become infected at any time from neighbouring mussels. The theory of transference of the parasite from one mollusc (such as cockle) to another (the mussel) may be true, but it is not proved by those experiments. It was not shown that the mussels were free from parasites at the start, the numbers in the recorded experiments are too small to yield definite conclusions, and the observations should clearly be repeated, using hundreds of cockles and of mussels with well-devised control experiments. In order to show the necessity for large numbers in this kind of work, it may be added that, Mr. ANDREW SCOTT having informed us of Dr. JAMESON'S observations at Piel, we had some samples of these same mussels and cockles sent to the Liverpool Laboratory,

* 'Comptes Rendus Soc. Biol. Paris,' December 19, 1903, lv., p. 1618.

where, with the assistance of Mr. WALTER TATTERSALL, B.Sc., and Mr. J. PEARSON, B.Sc. (in October, 1902), an independent examination of them was made, with results that do not altogether agree with Dr. JAMESON'S.

We may distinguish between four kinds of mussels examined by both of us, and described by JAMESON as follows:—

(A) From the beds opposite the Piel Hatchery—"where every specimen is abundantly infected . . . . and almost every specimen contains pearls."
(B) From the piles of the old pier at Piel—"practically without parasites."
(C) From Roosebeck Scar, outside Barrow Channel—"not infected."
(D) Roosebeck Scar mussels transplanted to foreshore at Piel two years ago—"all were infested" . . . . "each contained several small pearls."

Of (A) we examined a sample of 25 mussels which contained in all 151 pearls and 11 parasites, but 4 of the specimens had neither pearls nor parasites and no less than 18 out of 25 had no parasites. We cannot therefore agree that "every specimen is abundantly infected."

Of (B) we examined also 25 mussels, which showed in all 21 pearls and 22 parasites, 7 had neither pearls nor parasites, and 13 had no parasites. These, then, showed far fewer pearls than (A), but twice as many parasites, and fewer of them were free from infection. They can scarcely be called "practically without parasites."

Of (C) we examined 28 mussels, which contained 73 pearls and 37 parasites, 4 had neither pearls nor parasites and only 9 (out of 28) had no parasites. These, then, are evidently just as much infected as the mussels on the Piel foreshore (A).

Of (D) we examined 24 mussels, and they contained 65 pearls and 26 parasites, 3 had neither pearls nor parasites and 12 out of 24 had no parasites. So in place of these transplanted "Roosebecks" having become more infected on the Piel shore, they on the whole showed rather less infection than the mussels taken direct from the parent bed.

Finally, we examined a sample of 25 cockles from Piel, and found in them 8 pearls, but no parasites at all of the right kind. This does not support the view that the cockle contains the earlier stage of the parasite and passes it on to the mussel.

At the end of October, 1902, Mr. ANDREW SCOTT, A.L.S., and Mr. JAMES JOHNSTONE, B.Sc., examined some further samples at Piel with the following results:—

(A)	Examined	61,	got	390	pearls and	191	parasites.
(B)	,,	103,	,,	100	,,	61	,, *
(D)	,,	53,	,,	161	,,	66	,,

(Roosebeck Scar mussels could not be got at the time.)

* Mr. JOHNSTONE, however, informed me that before he made this examination a gale had washed away some of the piles of the old pier, and that, consequently, his sample of (B) was obtained from rather a lower level than JAMESON'S and so may have contained more parasites.

The most noteworthy difference between these results and those given above are in the case of the parasites in (A), where Mr. Scott found about 7 times as many as we did. The sample of (B) in this case also, it will be noticed, is by no means free from infection. Since that time Mr. Scott has examined a few more samples from these same beds with slightly different results, and also a number of batches of mussels from other parts of the coast of the Irish Sea. As these may be interesting for comparison with other localities and other molluscs, we give Mr. Scott's notes, with which he has kindly supplied us, in summarised form, as follows :—

Beds on the estuary of the Wyre :—			
"Wardleys"	72 mussels had	30 pearls	and 3 parasites.
"Hambleton"	11 ,,	1 pearl	,, 0 ,,
"Skear"	12 ,,	1 ,,	,, 0 ,,
"Knott End"	10 ,,	0 pearls	,, 3 ,,
"Fleetwood Lighthouse" .	13 ,,	23 ,,	,, 6 ,,
On the Lune :—			
"Crook Skear"	10 ,,	2 ,,	,, 1 parasite.
"Abbey Skear"	10 ,,	0 ,,	,, 0 parasites.
On the Ribble :—			
"St. Anne's"	9 ,,	2 ,,	,, 0 ,,
"North Training Wall" .	27 ,,	1 pearl	,, 0 ,,
At Morecambe :—			
"Ringhole"	42 ,,	27 pearls	,, 27 ,,
"Knott End"	32 ,,	0 ,,	,, 5 ,,
"Bailing Knott"	34 ,,	3 ,,	,, 12 ,,
"Reap Skear"	5 ,,	0 ,,	,, 0 ,,
Cheshire :—			
"Wallasey"	68 ,,	0 ,,	,, 0 ,,
North Wales :—			
"Conway"	12 ,,	33 ,,	,, 8 ,,
"Ogwen River"	15 ,,	77 ,,	,, 14 ,,
"Llanfairfechan"	20 ,,	18 ,,	,, 1 parasite.
"Carnarvon"	18 ,,	9 ,,	,, 8 parasites.
"Aberdovey"	21 ,,	2 ,,	,, 0 ,,
"Barmouth"	26 ,,	6 ,,	,, 4 ,,
Barrow Channel :—			
"Roa Island"	53 ,,	231 ,,	,, 77 ,,
	520	466	244

The totals show nearly as many pearls as mussels, and nearly twice as many pearls* as parasites, but that must not be considered as a conclusion that can be generally applied. The last item on the list shows how much more abundant the pearls and parasites may be in one locality than in others.† In fact, we do not wish to attach much weight to any of these figures given above. The point we desire to make is rather that in working with these comparatively small samples each fresh examination gives a somewhat different result, and that, consequently, it is necessary that some one living on the spot, with abundance of material at hand and with tanks for experiments under constant observation, should make a comprehensive investigation of some hundreds or thousands of each kind of mussel and cockle in order to clear up the distribution of pearls and parasites, and settle this question of infection.

It must not be supposed that we are disputing Dr. LYSTER JAMESON's theory of pearl-formation. We recognise the excellence of his work and appreciate the energy he displayed in prosecuting the research, both at Billiers and at Piel. His paper marks a distinct advance in our knowledge of the subject. But there remain the two points on which it seems to us the evidence in JAMESON's paper is not completely satisfying. These are (1) the origin of the epithelial sac that secretes the pearl, and (2) the infection of the mussel from a previous molluscan host, the *Tapes* or the cockle. There may be such a host, but JAMESON's observations and our own later ones leave the matter still doubtful.

Finally we desire to emphasise the point that JAMESON's observations and conclusions refer to pearl-formation in the common marine mussel of North-west Europe, *Mytilus edulis*, and cannot, without further evidence, be extended to other pearl-bearing molluscs. It is becoming clear that several parasitic worms and several distinct processes are at work in bringing about the production of pearls in shell-fish.

ARTIFICIAL INFECTION.

To continue our historical survey, Professor M'INTOSH‡ has described the examination of 700 mussels from near St. Andrews, where he found that 300 in all, or nearly 43 per cent., were pearl-bearers—a small proportion, however, com-

* In comparing these statistics with those of the Ceylon pearl oyster, one is struck by the wholly different ratio borne by pearls to parasites in the two cases. In the mussels, pearls are far more numerous than the living parasites. In our Ceylon oyster, parasites may be exceedingly abundant; while pearls (cyst-pearls) are relatively very rare, probably not more than one to a hundred parasites.

† Mussels that grow rapidly and regularly have few pearls. It is the old "blue-nebs" of uncertain age and battered appearance that have the most pearls. We may add that the same general principle holds good in the case of the Ceylon pearl oyster. The most prolific pearl-bearers are those of stunted appearance and somewhat rounded form the "Koddapakku" or Areca-nut oysters, as the divers call them.

‡ 'Ann. Mag. Nat. Hist.,' June, 1903, p. 549. W. NICOLL has a recent note ('Ann. and Mag.,' January, 1906) on Trematode parasites in the cockle and mussel at St. Andrews. He finds the adult in the oyster-catcher, but it is evidently not the form described by JAMESON, since NICOLL refers to it as probably a new species of *Echinostomum*.

pared with our results from Piel. He associates the occurrence of pearl-bearing mussels in St. Andrews Bay with the presence of large numbers of parasites in the wild ducks that feed upon these mussels; and suggests that possibly other birds, such as the oyster-catcher, may be found to harbour the same parasites.

Professor R. DUBOIS, whose former observations had been made in Morbihan, has since turned his attention to the Mediterranean coast. He found that the southern French mussel (*Mytilus gallo-provincialis*) forms pearls caused by another Distomid, distinct from that of Brittany. He then worked at the acclimatisation of a true oriental pearl oyster ("pintadine") in French waters and the artificial production of pearls.* He brought the pearl oysters from the Gulf of Gabes, in South Tunis, to the marine laboratory at Sfax, and caused them to multiply and increase in size. The pearls produced in Tunis are small and very rare—it is necessary to open 1,200 to 1,500 oysters to find one pearl; but DUBOIS tells us† that by placing them on ground where *Mytilus gallo-provincialis* becomes infested with pearls and parasites, he very easily provoked the production of fine pearls in the "pintadine" to such an extent that three successive individuals opened contained each two little pearls. This, if corroborated, is a remarkable circumstance from several points of view. First, it will, if it proves a success, be a striking verification of what KELAART in Ceylon, fifty years ago, declared might be done. Secondly, if the "pintadine" in question is really the same species as the Ceylon pearl oyster (GIARD considers that it is not), it is curious that a Distomid parasite should prove to be so efficacious in setting up pearl-formation, since we have found that in the Gulf of Manaar the pearl-parasite is a Cestode larva. Thirdly, it is remarkable that the parasite of the *Mytilus* should transfer itself so readily to a new host belonging to a distinct family.

It is this last paper by DUBOIS that has given rise to various more or less exaggerated or even erroneous statements in the public Press, such as that the pearl-oyster must be infected with a microscopic germ in order to render it pearl-producing; or even that inoculation with a serum causes the oyster to produce artificial pearls. The parasite that causes the irritation is, as has been known for many years, not a "germ," and still less a "serum," but a worm which is visible to the eye—a worm which in *Mytilus* seems to be usually a Trematode, and in the Ceylon pearl oyster (*Margaritifera vulgaris*), according to our observations, is certainly a Cestode.

According to an interesting note by Professor GIARD,‡ the discovery of Cestode larvæ as nuclei of pearls, which we had made upon the Ceylon pearl oyster in 1902, was shortly afterwards corroborated by Dr. L. G. SEURAT, working independently in his laboratory at Rikitea in the Island of Mangareva (Gambier Archipelago). The oyster on which SEURAT worked was *Margaritifera margaritifera*, var. *cumingi*,

* COMBA had, however, in 1899, introduced the same mollusc on the South Coast of Italy, and experimented there in artificial pearl-formation.

† 'Comptes Rendus Acad. Sci.,' October 19, 1903, p. 611.

‡ 'Comptes Rendus Soc. Biol. Paris,' November 6, 1903, lv., p. 1222.

REEVE, and the Cestode parasite found, is, according to GIARD, an *Acrobothrium* (= *Cyathocephalus*) or some allied form. Some of our Ceylon pearl-oyster parasites very closely resemble the figures given by GIARD, and possibly may also belong to the genus *Cyathocephalus*, although most of them are certainly Tetrarhynchids.

GIARD, in a further note in the same Journal (p. 1225), discusses the statements that have been made in regard to "margarose artificielle," and evidently considers that DUBOIS' claim to have established the artificial production of pearls is not yet justified by the facts. About the same time, M. L. BOUTAN* wrote showing that "fine pearls" do not really differ from "nacre-pearls," since both are secreted from open or closed epithelial sacs derived from the epidermis; and GIARD very properly replied, a few days later,† that this fact is quite in accord with general principles, and was previously known. M. BOUTAN then published a more detailed account‡ giving figures illustrating his point that in all cases the pearl-sac is formed by an invagination of the surface of the mantle, and that it is of ectodermal origin, not mesodermal as he supposed JAMESON to have indicated. Finally, in a letter (January 20, 1904) to one of us, he states that he is on the point of departure for the East in order to investigate the matter further. The results have not yet appeared.

CEYLON PEARLS AND PARASITES.

Turning now to the investigations on the Ceylon pearl oyster in the Gulf of Manaar, let us first recall the work of our predecessor, Dr. E. F. KELAART, in the same field and on the same animal nearly half a century ago. KELAART, in 1857, in his "Introductory Report on the Natural History of the Pearl Oyster of Ceylon," after describing the secretion of nacre by the mantle, said:—"It will be thus clearly understood, that when a grain of sand or the larva of an insect is introduced between the mantle and shell, it will become covered over with the pearly secretion; which, always going on, is augmented at the part where the foreign matter lies. This phenomenon I have detected with the aid of the microscope, in its very earliest stage." The probability is that by "larva of an insect" in this passage KELAART meant such an organism as the Cestode larva which we now find is the determining cause of such pearl-formation.

In another passage, in his "Report on the Pearl Banks of Arripo for Season 1858," he says:—"The presence of a worm (a species of *Filaria*) found in the oysters has, I am positive, much to do with the formation of pearls. I would rather reserve this part of my investigation for longer experience. But this much I can say at present, with perfect safety: that whenever I found good pearls in a batch of oysters, I found this worm and its eggs in large numbers in the liver, ovary, mantle, and other parts

* 'Comptes Rendus Acad. Sci.,' December 14, 1903, p. 1073.

† 'Comptes Rendus Soc. Biol. Paris,' December 19, 1903, p. 1618.

‡ "Les Perles Fines: leur Origine réelle," 'Arch. Zool. Expér.,' sér. 4, t. ii., p. 47, 1904.

of the oyster." This "Filaria" may possibly be either the *Ascaris* or the *Cheiracanthus* which we have found, and which are described as new species by SHIPLEY and HORNELL; or it may possibly be the elongated, later stage of the *Tetrarhynchus* larva which also occurs.

Finally, at the end of KELAART's last Report (1859) occurs the remarkable passage where, in speaking of the corroborative observations of Mons. A. HUMBERT, he said :—"We both agree that these worms play an important part in the formation of pearls; and it may yet be found possible to infect oysters in other beds with these worms, and thus increase the quantity of these gems." As we stated in the Introduction to this work (Part I., p. 7, 1903), "Dr. KELAART's short reports show that he was tackling the problems in a scientific manner, and his researches were incomplete at the time of his sudden death."* We may take these observations as our point of departure. THURSTON, in 1894, however, confirmed KELAART, finding in the tissues and also in the alimentary canal of the oyster "larvæ of some platyhelminthian (flat worm)"; but he was able to add little beyond figuring ("Madras Museum Bulletin," I., Plate ii., fig. 1) a section showing two of the parasites encysted between the alimentary canal and the gonads. Here the matter practically rested so far as actual investigation of the Ceylon pearl oyster was concerned, until we found the Cestode larvæ in association with pearls in the tissues during our cruises in the "Lady Havelock" in the Gulf of Manaar, in February and March, 1902. It was about March 6th (see "Narrative," p. 70, in Part I.), when cutting up oysters from the western part of the Cheval Paar, that we first became convinced that the opaque white globular larvæ we were finding encysted in the liver belonged to Cestode worms. Subsequent work showed us that some of them at least were referable to the genus *Tetrarhynchus*, and the various stages that we were able to find up to the spring of 1904 were described by SHIPLEY and HORNELL in Part II., p. 79.

Since then large numbers of pearl oysters from various paars in the Gulf of Manaar have been examined by us in the field and in the laboratory, and although many small pearls and many parasites have been found, it is apparently very difficult indeed to hit upon a stage showing the commencement of the pearl-formation, or any evidence bearing on the entrance of the parasite into the mollusc.

The youngest stages in the life-history of *Tetrarhynchus* are still unknown, and it is still uncertain whether the free-swimming larvæ found on Muttuvaratu Paar really belong to this life-history. They have calcareous corpuscles and an indication of an invaginated head, and are almost certainly young Cestodes. We reproduce here (fig. 1) four of the figures of this presumed youngest stage, given by SHIPLEY and HORNELL, and are unable to add anything to their statement (*loc. cit.*, p. 86) :—"On the whole we think it probable that this larva is the first stage in the life-history of the pearl-forming organism," &c.

* When in medical attendance on General LOCKYER. Both the General and the Doctor died in the Red Sea, in 1859.

Many of the pearl oysters which we examined in the Gulf of Manaar in February and March, 1902, and also those we have examined since, both in Liverpool and at Ceylon, show numerous encysted parasites in various parts of the body. We have

Fig. 1. Free-swimming larvæ caught in the tow-net on Muttuvaratu Paar.

found these cysts on the branchiæ, in the mantle, in the liver and gonads, and elsewhere amongst the viscera. Fig. 2, giving a transverse section (A) and a lateral view (B) of a pearl oyster, shows a number of pearls and a few encysted parasites in the positions where we most commonly find them.

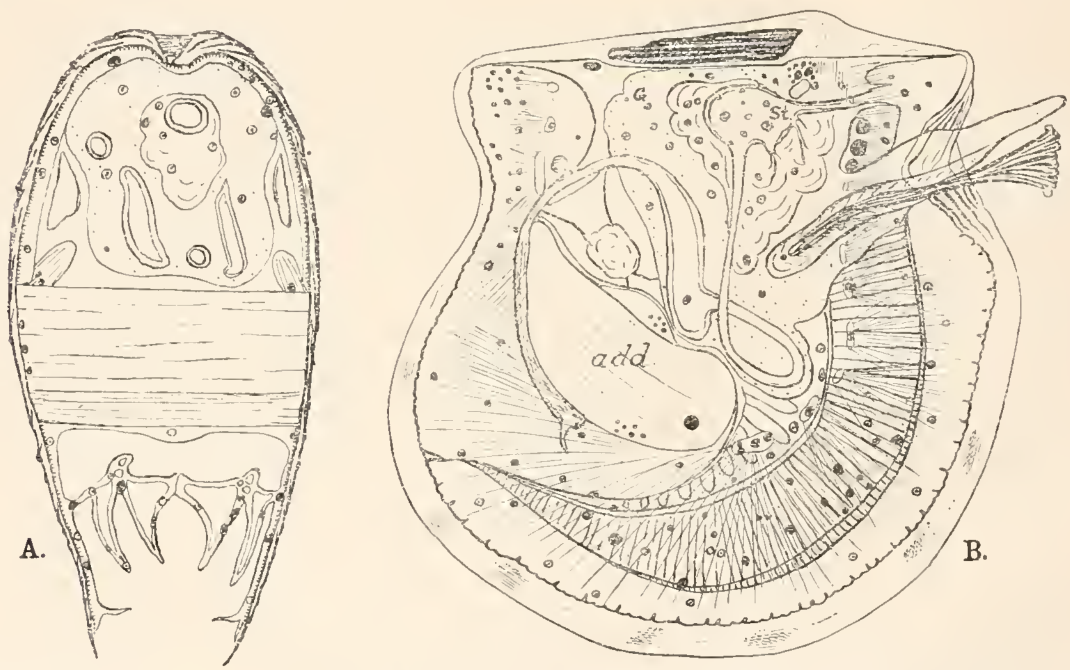


Fig. 2. **A**, transverse section of *Margaritifera vulgaris*, and **B**, dissection from the right side, to show the usual positions occupied by pearls and parasites.

These cysts, though small, are usually visible to the eye, and measure from 0·13 millim. to 1·3 millims. in diameter. The contained parasite is not always in the same stage of development, but is always, so far as our observations go, a young Cestode worm. It is possible, however, that more than one species of Cestode is represented—one is certainly a species of *Tetrarhynchus* (*Rhynchobothrius*), and another is probably the same genus or may possibly belong to *Cyathocephalus*, Kessler (= *Acrobothrium*, Olsson), characterised by the unarmed head and the terminal circular bothrium.

Seurat, writing in 1906,* states that in the case of the pearl oysters (*Margaritifera margaritifera*, var. *cumingi*, Reeve) of the Gambier Archipelago the numerous encysted parasites scattered through various parts of the body—branchiæ, mantle, heart, liver, &c.—are the scolices of Cestodes "appartenant aux genres *Cyathophyllus* [*Cyathocephalus*†] ou *Acrobothrium*."

In a letter received on February 28th, M. Seurat gives as his latest opinion "L'adulte du Cestode qui produit les perles à Mangareva vit dans la raie-aigle ; je me propose de l'appeler *Aphanobothrium*, n.g., *margaritiferæ*, genre voisin des *Cyathocephalus*, Kessler." Finally, in a further letter (March 8th), he says :—"Je crois pouvoir ranger le Cestode margaritifera dans le genre *Tylocephalum*, Linton, et ne pas avoir à créer de nouveau genre. Ce sera donc le *Tylocephalum margaritiferæ*. Hab. scolex—*Margaritifera cumingi*, Reeve. Hab. adulte—Intestin spiral de *Ætobatis narinari*, Euphr."‡

We agree at least with Seurat that the parasites are Cestodes, and that is clearly the first point to establish.

In order to be able to co-relate our work with that of Dr. Jameson and make a comparison between the Ceylon specimens and those from European seas where the parasite is a Trematode, we obtained material from the pearl-bearing mussels (*Mytilus edulis*) at Piel,§ on the Lancashire coast, the same locality where Dr. Jameson worked. Figs. 1 to 12 on Plate I. show the condition of affairs in this material ; and the chief points of contrast with the Ceylon pearls are :—

(1) The distinctness of the pearl-sac (figs. 8, 10, 11).
(2) The large size of the nucleus in the pearl (where a nucleus is present) and its characters, which are quite different from those of the encysted parasites in the Ceylon pearl oyster.

We agree entirely with Jameson, of course, that the organism in the *Mytilus* pearls is a Distomid, and the marked difference that we find in our own preparations of the two cases (*Mytilus* and *Margaritifera*) confirms us in our belief that the Ceylon parasite cannot be a Trematode.

* "La Nacre et les Perles en Océanie Française," par M. L. G. Seurat, Chargé de mission à Tahiti, in 'Compte Rendu des Trav. Première réunion internat. d'Agronomie Coloniale' : Alcan, Paris, p. 308.

† Seurat writes "*Cyathophyllus*," but surely that must be intended for *Cyathocephalus*.

‡ Since published in 'C.R. Acad. des Sci.,' 26 Mars, 1906, p. 801.

§ We are indebted to our friend Mr. Andrew Scott, A.L.S., Resident Naturalist at the Piel Marine Laboratory, for the help he has kindly given us in this matter ; and to Mr. T. Southwell, in the Liverpool Laboratory, for assistance in the preparation of many specimens.

Before leaving the *Mytilus* material, we may add two further points of interest. The first is that some pearls have no trace of a nucleus. Plate I., fig. 5, shows a case where a careful search through all the sections (serial) showed no internal cavity and no imbedded foreign structures We have similar cases also in our Ceylon material. The second point is that in some places the pearl sac shows a mass of enlarged and proliferating epithelial cells which are generally adherent to the pearl at points where there is a depression and a marked irregularity in the deposition of the layers (Plate I., figs. 10 and 11). Some of the *Mytilus* pearls are exceedingly irregular in form, projections being given off which appear like separate pearls in some of the sections (fig. 11). In addition to such cases, there are sometimes two or more pearls in the same sac (fig. 2), and in figs. 6 and 7 we find a pearl and a parasite enclosed together by the one layer of epithelium. In some places small blood sinuses adjoin the pearl-sac for portions of its extent, but these are not larger than those seen elsewhere in the mantle of *Mytilus*. We do not find that the pearl-sac is surrounded by a blood sinus, as BOUTAN states is the case.

ENCYSTED CESTODES.

The smallest and simplest cysts we have seen in the Ceylon pearl oyster are in the mantle (Plate II., fig. 1). They have no pearl and no pearl-secreting epithelial sac, and the connective-tissue cyst contains an embryo which shows only an outer wall and some irregularly scattered internal cells. It is presumably an onchosphere or pro-scolex stage in which the hooks have been lost and invagination to form the scolex has not yet taken place.

Similar early stages are found also in the gills, either in the principal gill filaments (see Plate II., fig. 3), or, more usually, alongside the great blood-vessels in the axis of the gills where they adjoin the body.

The majority of the cysts, however, contain later stages (text-fig. 3) where more or less invagination to produce the scolex has taken place. These measure from 0·07 millim. to 0·16 millim. in longest diameter, most of them are about 0·14 millim. A number may be present in the same host; we have frequently seen two close together in the same section, under the microscope. Figs. 17 to 22 on Plate II. show several of these stages, from the liver, the gonads, and the mantle. One end of the globular or ovate parasite forms a cup-like invagination with a central boss or papilla rising from the bottom of the cup. In some cases the margin of the cup is turned in so as almost to close the aperture. Round the outside of the invagination there may be more or less of a projecting pad in the form of a collar or annular thickening. This form (seen typically in Plate II., fig. 17) agrees very closely with the figures given by SEURAT for the pearl-causing Cestode parasite of the Gambier Islands,* and with the figures given by SHIPLEY and HORNELL of the nuclei of pearls in Part II. of this Report

* See GIARD, "L'Origine Parasitaire des Perles," 'Comptes Rendus Soc. Biol.,' lv., p. 1222.

(p. 79, 1904). Although most of those which we have examined are not surrounded by any pearl, there can be no reasonable doubt that these are the parasites that form the nuclei of the orient pearls. When we compare SHIPLEY and HORNELL'S figures

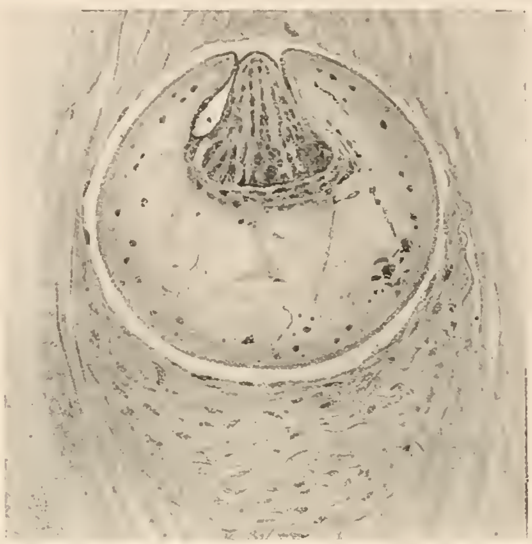


Fig. 3. Young larval Cestode (*Tetrarhynchus*, sp.) encysted in connective tissue of pearl oyster.

(Part II., Parasites, Plate I., figs. 4 to 6 and 13) with SEURAT'S figures (GIARD, *loc. cit.*, figs. 1, 2 and 3) and our present figures (Plate II., figs. 17 to 22 and Plate III., figs. 1 to 8) there can be little or no doubt that these all represent similar stages in the same kind of organism. We do not mean that our larvæ necessarily belong to the same species as SEURAT'S. In fact, differences in size and details of structure convince us that they are not identical, but the resemblance is sufficiently close to indicate that they all belong to allied organisms.

Moreover, it is clear that these are all larval Cestodes in the blastocyst condition containing young scolices. It was the possession of calcareous corpuscles noticed in the fresh condition in 1902 in the Gulf of Manaar that caused us first to identify these larvæ as Cestodes. We now enumerate as Cestode characters :—

1. The invagination to form the head of the adult worm ;
2. The hooks upon portions of the invaginated surface ;
3. The calcareous corpuscles in the walls of the vesicle ;
4. The division of the (? muscular) tissue on the floor of the invagination into several masses (probably four, as either two or three can usually be seen in different views).

The invagination (Plate II., figs. 17, 20) agrees very closely with the "figures idéales" of early stages of the genus *Tetrarhynchus* given by P. J. VAN BENEDEN ("Vers Cestoïdes," pl. xxiii.), and with the sections of the larvæ of *Rhynchobothrius adenoplusius*. PINT., from *Lophius*, showing receptaculum and developing scolex, published in the third part of his 'Studien über Tetrarhynchen' (Taf. ii., fig. 11), by PINTNER, in 1903, and is quite consistent with the section of a Cysticercus of *Tetrarhynchus* given by MONIEZ in his 'Essai Monographique sur les Cysticerques,' at plate iii., fig. 1, and with PINTNER's figure of *Tetrarhynchus smaridum* ('Sitzb. Akad. Wiss., Wien.,' Jahrg. 1893, Abth. I.).

The hooks (Plate III, figs. 2 and 9) are similar to those shown by various authors as belonging to different larval Cestodes. The spines upon the projecting annular pad or collar are, for example, rather like those of *Tænia* (*Devainea*) *frontina*, DUJARDIN; and PINTNER shows a very similar arrangement to what we figure, in his 'Studien über Tetrarhynchen,' III., Taf. i., fig. 6.

The calcareous corpuscles are not seen so well in the preserved specimens from which the sections have been made in Liverpool as they were in the fresh material we examined in Ceylon, but there can be little doubt that it is the remains of these bodies that we show along with the loose network of connective tissue in the vesicle behind the invagination in figs. 6, 7 and 8 on Plate III.

The division of the more opaque (? muscular) tissue in the scolex at the bottom of the cup cannot be seen distinctly in all specimens, but the appearance shown in Plate II., figs. 19 and 20, can scarcely be interpreted otherwise than as the beginning of the segregation to form four discs (or bothridia) with their proboscides.

The possession of all these characters together, in our opinion, definitely stamps the organisms as larval Cestodes. It is no easy matter, however, to refer these larvæ to their proper genus. We find later stages in the tissues of the pearl oyster which clearly belong to *Tetrarhynchus*, in a wide sense, but it is difficult to find conclusive evidence that these younger larvæ belong to the same organism as the later forms with four proboscides. GIARD is of opinion that SEURAT's similar figures represent a member of the group Monobothria in the order Pseudophyllidea. SEURAT gives as his later opinion, as we have shown above, that they belong to a new species of LINTON's genus *Tylocephalum*. In either case the terminal invagination would represent a sucker with a papilla on its floor. We are inclined to regard it rather as the opening in a hood or depression formed by the sinking of the scolex into the front of its vesicle. The changes of shape which we observed in this larva in the living state, the protrusion and retraction of the papilla-like part which we regard as the anterior end of the scolex, agree with this interpretation. Consequently, we are of opinion that this larval Cestode is not one of the Monobothria—that it belongs to neither the Pseudophyllidea nor the Tetraphyllidea, but is a young Tetrarhynchid belonging to the Trypanorhyncha, and we give here (fig. 4) a series of diagrams in order to show the positions that we suppose our stages to occupy in the development of such a form.

In regard to the life-history of the pearl-inducing parasite, we have little to add to what has already been published in the preceding parts of this Report. In the Introduction (Part I., p. 12) an outline of the history was sketched which still holds true in the main. SHIPLEY and HORNELL in Part II. (p. 77) described and figured various stages of the Cestode larvæ both from the centre of decalcified pearls and also free in the tissues of the pearl oyster, but left it an open question whether the subglobular younger larvæ belong to the same life-history as the elongated older forms

A. B. C. D. E. F.

Fig. 4. Series illustrating the connection between the Cestode larvæ found in the pearl oyster. A, B, C, and D represent stages that commonly occur, E is the hypothetical connecting link, and F is a young *Tetrarhynchus*, copied from fig. 31, of Plate II., in the "Report on the Parasites of the Pearl Oyster" (Part II.). Since this figure was made, a still younger *Tetrarhynchus*, very slightly more advanced than is shown in E here, has been found in the liver of the pearl oyster (see text, p. 22, and Plate III., fig. 10).

which are young Tetrarhynchids. If our arrangement of the stages observed in the tissues of the pearl oyster is correct, and if all these larvæ belong to the same species, then the interpretation we have given above brings us to the conclusion that the larger of our two globular larvæ belongs to the worm which Shipley and Hornell described as *Tetrarhynchus unionifactor* in 1904. Figs. 1 to 8 on Plate III. show most of the common stages we have found, and in regard to which there can scarcely be any doubt (1) that they all belong to the same life-history, and (2) that they are young Tetrarhynchids leading on to the stages shown in figs. 10 and 11.

If we distinguish the genus *Rhynchobothrius* from *Tetrarhynchus* by the possession of only two bothridia, then the correct name of the species becomes *Rhynchobothrius unionifactor* (Shipley and Hornell). The adult condition of this species is found in the large ray *Rhinoptera javanica*, M. and H. (see this vol., p. 65). In addition to these larger larvæ there is, however, a smaller form of globular larva (Plate II., fig. 19, &c.) which we meet with in the tissues of the pearl oyster, and which probably belongs to a distinct species of Cestode. The two forms of larvæ are seen side by side in fig. 17 on Plate II., and, as shown there, the larger (B) is about six times the diameter of the other (A). The two are, however, closely related forms and in similar stages. In both there is the same anterior invagination with the central papilla—various stages in the formation of which are shown in figs. 20, 21, 22 on Plate II. and figs. 1, 2, 6 and 8 on Plate III. There are the same cuticular spines round the margin of the invagination in both, and the same histological structure in the body wall of the vesicle and the future scolex. In size, Seurat's larvæ approach more nearly to our smaller form; but differ from both in proportions and details of structure.

Although we have examined sections of several hundred of these parasites from various parts of the pearl oyster, we have been unable to find any stage intermediate between that shown in figs. 6 and 8, on Plate III., and the young *Tetrarhynchus* with four proboscides. It is probably therefore a rare occurence for the larva to advance further in its development in this molluscan host; but that it does occasionally happen is shown by our finding a few young Tetrarhynchids in cysts on the wall of the pearl oyster's intestine (see Plate III., fig. 11, for a section of this stage, and fig. 16 on Plate II. for the general appearance of what is probably the same species). We have found, in all, about six such Tetrarhynchids in company with over 200 of the globular parasites. If the parasite normally does not go beyond the globular stage in the body of the pearl oyster, but only occasionally advances a stage further and acquires the four proboscides, and then again remains quiescent in a cyst, it follows that the transition form which we have looked for in vain may be passed over very rapidly. In that case we should find the greater number of the parasites in the younger globular stage, a very few in the more advanced Tetrarhynchid condition, and practically none in an intermediate state.

Since the above was printed, and the diagrams shown in text-fig. 4 (p. 21) were drawn, we have found, encysted in the liver of the pearl oyster, a very young Tetrarhynchid larva which possesses the characteristic four proboscides, but has not yet become elongated. It is of ovate form (Plate III., fig. 10) and measures 0·53 millim. in length. It shows at the anterior end the lateral projections bounding the central depression just as in earlier stages (see fig. 6), but the central papilla is traversed by several openings which are clearly the tubular proboscides (fig. 10). In fact it agrees so well in all other respects except the proboscides with the larger form of globular larva that we can scarcely fail to recognise it as the later stage of the same animal—*Rhynchobothrius unionifactor* (SHIPLEY and HORNELL).

SHIPLEY and HORNELL have described (this vol., p. 43, *et seq.*) several other species of *Tetrarhynchus* from Ceylon, but none of them from the pearl oyster; so we are as yet unable to refer to its species the smaller globular larvæ which we find commonly encysted, and which may occasionally form the nuclei of pearls.

Both our larval Tetrarhynchids we believe to be pearl-inducing parasites in the Ceylon pearl oyster. The figures on Plate II. show for the most part the appearances presented by the smaller globular parasite in our specimens. Though small, they are visible to the eye (figs. 1 and 2). Fig. 17 shows the relation in size between the two kinds of larvæ—the larger (0·9 millim. in length) being about six times the size of the smaller (0·14 millim. in length). SEURAT'S larvæ are 0·25 millim.

We give on Plate II. (figs. 3 to 16) some of the drawings made by one of us (J. H.) in Ceylon, and which were used in SHIPLEY and HORNELL'S article upon the parasites of the pearl oyster (this work, Part II, 1904). They show mode of occurrence in the tissues (figs. 1, 2, 3, 17, 18, 19), relation to pearls (figs. 4, 5, 6, 7), stages in the structure of the larva (figs. 8, 9, 10, 17, 20, 21, 22), differences in the amount of the connective-tissue cyst (figs. 17, 18, 19, 21, 22), and finally some later stages of

Tetrarhynchids which we have met with either in the pearl oyster or in fishes which we know to feed upon that mollusc (figs. 11, 12, 13, 14, 15, and 16).

It is quite evident from the examination of a large series of sections, such as we have worked through, that the majority of these encysted parasites do not become encased in pearls. Probably none of those in thick connective-tissue cysts are destined to form nuclei. They are awaiting their legitimate further development in the next host, after their sheltering mollusc has been devoured by a fish. In such cysts and around such parasites we find no epithelial sac, and as a consequence there can be no pearl. Whether or not it is the case that only dead parasites supply the stimulus necessary to induce pearl-formation, and whether, as GIARD has suggested, the parasites may be infested and killed by a species of *Glugea*, so that that Sporozoon comes to be eventually responsible for the pearl, we are not prepared to say—we have found no fresh evidence in the Ceylon material bearing upon that point. It seems clear to us, however, that the epithelium is always associated with pearl-formation, and that in the absence of the epithelium only a thick-walled connective-tissue cyst is produced. If we adopt the view (see below) that this epithelium is genetically related to the ectoderm, then a possible explanation of the difference in behaviour in the encysted condition would be that those larvæ that carried in ectodermal cells became covered (when dead or while still alive) by a pearl sac and embedded in a pearl, while those that were free from ectoderm become surrounded by the connective-tissue cyst.

The larger globular larva (*Tetrarhynchus unionifactor*) is illustrated in Plate III. Figs. 5 and 6 show common stages; fig. 8 is more highly magnified, giving histological details, and the spines at the anterior end are shown enlarged in fig. 9. The sections represented by figs. 3 and 4 are probably oblique. Fig. 11 shows a section of a young *Tetrarhynchus*, such as we find in the wall of the intestine and occasionally elsewhere in the tissues of the pearl oyster; and after the finding of the intermediate form shown in fig. 10, it can scarcely be doubted that these Tetrarhynchids are a later stage of the pearl-inducing globular larvæ.

In our first account of these parasites we suggested that the next stage after that found in the pearl oyster, occurred in a species of *Balistes*, which we showed was sometimes found feeding on oysters, and that the adult worm inhabited one of the large Elasmobranch fishes (Rays), which in their turn devour the *Balistes*. SHIPLEY and HORNELL have now identified as the adult *Tetrarhynchus unionifactor* a parasite that we found in *Rhinoptera javanica*,* the "Walwadi tirikkai" of

* SEURAT considers that the sting-ray *Aetobatis narinari*, EUPHRASEN, is the host of the pearl-inducing Cestode which he investigated in the Pacific. He does not state what evidence he has of this, but it is quite probable. We find the same species in Ceylon, where it is known as "Kuruvi tirikkai" by the natives, and it has an evil reputation on the pearl banks and many Entozoa in its interior. Its main food in Ceylon, as shown by the stomach contents, consists of sand-living Lamellibranchs, such as species of *Cardium* and *Venus*.

the Tamils (see this vol., p. 60, and Part III., Preface, p. viii). No fresh light has been thrown upon the possible occurrence of an immature stage in *Balistes* (which is eaten by the large rays), and although that intermediate host may not be necessary to the life-history, since the rays also feed upon pearl oysters, still there is nothing in the observed facts to forbid the existence of such a stage, and it is not unusual in Tetrarhynchids to have two fish-hosts, an intermediate Teleostean which is devoured by a final Elasmobranch.

Cyst and Pearl-Sac.

We now turn from the larvæ to the cysts which enclose them. In the youngest stages of both species these are merely thickenings of the connective tissue of the mantle (Plate II., figs. 17 and 18), or the mesoderm around the tubules of the liver, gonads, and other viscera. The thickening is laminated (Plate II., fig. 21), and the fibres, when fibres are visible in the lamellæ, run concentrically around the more or less spherical body of the larva. In the thicker cysts the outer layers may contain many blood spaces (lacunæ), and sometimes the thickening becomes quite spongy or œdematous (fig. 19). In some cases a considerable increase in the number of connective-tissue corpuscles or leucocytes is evident, and in later stages (Plate III., figs. 7 and 10) cells are sometimes seen to accumulate, and probably proliferate, along the inner surface of the fibrous cyst. It is just remotely possible that it is in this way that the pearl-producing epithelial sac is formed, from apparent mesoblast cells, inside the connective-tissue cyst. The other and more probable view that may be held is that these cells proliferating on the inner surface of the connective-tissue cyst are ectodermal in origin, and produce the pearl-sac.

As our specimens do not give conclusive evidence as to the stages in the formation of the epithelial sac, and as previous observers seem to have left this matter in some doubt, we think it advisable to state here fully the two possible alternative views that have been and may be held.

The first of these views is that the epithelial sac which surrounds the parasite and secretes the pearl is derived directly or indirectly from the ectoderm on the outer surface of the mantle—the layer which normally secretes the nacreous layer of the shell. By "directly" we mean where the sac as a continuous layer is formed by a pouching inwards of the ectoderm, the pouch being then cut off from the surface to form a closed sac. We should call "indirect" such cases as those where isolated ectoderm cells wandered into the mesoderm or were carried in by a moving parasite (the "processus cœnogénétique" of Giard); these ectoderm cells proliferating, it may be supposed, around the parasite to form the sac which then secretes the pearl.

In favour of this ectodermal origin may be stated :—

1. The very close resemblance between the epithelium of the pearl-sac and that of the outer surface of the mantle, amounting to identity in staining reaction.

Figs. 8 and 10, on Plate I., show examples of this from *Mytilus edulis*, where the sections were stained with eosine and methyl blue, and in both ectoderm and pearl-sac the cells and nuclei are of the same size and shape, and the nuclei are stained red with eosine and the cytoplasm blue to the same extent, so as to have a precisely similar appearance. In looking at a small part of the section under a high power, one receives the impression that the two adjacent epithelia are folds of the same layer (see Plate I., fig. 12). We show the same point in the case of the Ceylon pearl in fig. 16. Here the section is stained with gentian violet and light green, and in both ectoderm and pearl-sac the nuclei have taken up the violet, and the cytoplasm the green, to a quite similar degree.

2. The fact that pearls formed in different parts of the mantle have the character of the layers of the shell formed by the ectoderm in their neighbourhood—"horny" pearls, resembling the periostracum, have been found at the mantle edge; in the zone above that, pearls have been found having the characters of the prismatic layer of the shell; and finally, the great majority of pearls, both in the mantle and in the deeper tissues, show the structure of nacre, the layer produced by the greater part ot the surface of the ectoderm on the mantle. It is difficult to account for these facts if the epithelium of the pearl-sac has no genetic connection with the layer of ectoderm lying outside it. The ordinary nacreous pearl is clearly produced in a similar manner to the inner part of the shell. The nacre is formed from epithelium on the outer surface of the mantle; the pearl from epithelium lining a closed sac. The most natural working hypothesis to hold until it is disproved, is that the epithelium of the closed sac is derived in some manner from the outer surface of the mantle.

Against this view, however, there is the notable fact that most recent investigators* have been unable to find any evidence of the pushing in of the ectoderm to form the pearl-sac. We may feel fairly certain, then, that the majority of pearls are not formed in actual pouches of ectoderm closed off from the mantle, as, if such structures were formed in any numbers, we could scarcely fail to obtain some evidence of their presence.

* The one definite exception to this statement is the case of M. L. BOUTAN, who, in his paper in 1904 ("Les Perles fines: leur origine réelle," 'Arch. Zool. Expér.,' 4 sér., tome ii., p. 47), describes and figures the actual pouching in of the ectoderm around the Distomid parasite to form cyst pearls in the case of *Mytilus edulis*. In this paper BOUTAN criticises adversely GIARD'S comments on our short note read at the Southport Meeting of the British Association in 1903; but our intention in that paper certainly was to express our belief in the ectodermal origin of the cyst pearls. When we stated "In all cases, whatever its nucleus may be, the pearl, like the nacre, is deposited by an epithelial layer," we intended to imply the ectoderm; and where, further on, we speak of "closed sacs," we meant to indicate that the ectodermal pouches alluded to in the previous sentence have become closed off. Professor GIARD interpreted our words correctly; and although in the present report we have discussed both possible views, still we have from the time of our first observations in Ceylon believed, as BOUTAN does, in the ectodermal origin of the cyst or "fine" pearls.

There still remains, however, the indirect connection, the possibility that, as the result of stimulation, cells from the outside of the mantle have migrated inwards to surround the parasite, or that the larva destined to form the nucleus of a pearl has in its wanderings carried in a few ectoderm cells which have eventually proliferated around it to form the pearl-sac. These would naturally be very difficult matters to prove, and the fact that no undoubted evidence of the migration, active or passive, of ectoderm cells in the case of the Ceylon pearl oyster has yet been found is not sufficient to disprove the possibility that the process takes place.

As a matter of fact there are some appearances in our sections that might be interpreted as indicating a migration of ectoderm cells (Plate I., figs. 18, 19, 20). When the pearl is in the mantle there is no great thickness of connective tissue between the ectoderm cells and the very similar epithelium forming the pearl-sac, and in some cases we have observed cells giving the same appearance and staining reactions in intermediate positions, and a few of these sub-epithelial cells are undoubtedly undergoing division (fig. 18). These may be regarded as wandering and proliferating ectoderm cells; we think they can scarcely be interpreted in terms of the other alternative—to which we now pass.

The second view that may be held is that the epithelium of the pearl-sac is formed from the neighbouring mesodermal connective-tissue cells modified *in situ* in response to the stimulation caused by the parasite. In favour of this view there is the absence of any direct evidence of the derivation of the cells from elsewhere, so that, so far as appearances go, the cells, although so very similar to those of the ectoderm, seem to arise from the tissue in which the parasite and pearl are placed—and in the present state of opinion amongst pathologists no one is likely to deny that indifferent mesodermal cells might become aggregated around a foreign body to produce an epithelial sac. Whether, however, we should be justified in imagining that such an epithelium might, under the stimulation of the parasite, produce layers of pearly material similar to the ectodermal nacre of the shell, is not so clear.

It is a distinct difficulty in the acceptance of this view that so many parasites in all parts of the body are merely surrounded by connective-tissue cysts, have no epithelial sac, and are apparently not being encased in pearls. If the pearl-producing epithelium can be formed *in situ* from connective-tissue elements, one would expect that every quiescent parasite which was becoming encysted would eventually be the centre of a pearl; but that does not appear to be the case. For one cyst pearl in our Ceylon material we find something like 100 encysted parasites, and these are surrounded by laminated connective tissue which may extend for several times the diameter of the parasite (Plate II., fig. 19).

Another strong reason against accepting this view is the point mentioned above, that pearls in different parts of the mantle present the characters of the ectodermal exoskeleton of their own neighbourhood. It would be difficult to understand that indifferent mesodermal cells could simulate specialised ectodermal cells to that extent.

In conclusion, then, we still adhere to the view we expressed in 1903, that in cyst pearls containing an organic nucleus the pearl-secreting epithelium is of ectodermal origin.

Muscle Pearls.

There are some pearls, however, that show no nucleus whatever, either organic or inorganic, and it seems probable that these have been formed by the deposition of calcareous matter around a minute calculus in the tissues. These are the pearls that we have distinguished ('Brit. Assoc. Report, Southport,' p. 695) as "Muscle pearls," since we find them most abundantly in the muscular tissue near the insertions of the levator and pallial muscles. Figs. 5A and 5B, illustrate the distribution of cyst pearls

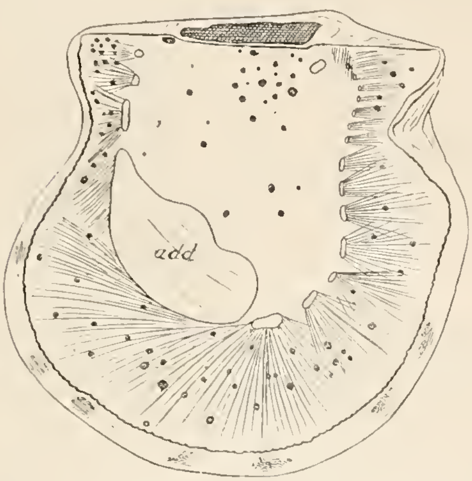


Fig. 5A. Diagram showing the comparative frequency of position of cyst pearls in the various parts of the mantle.

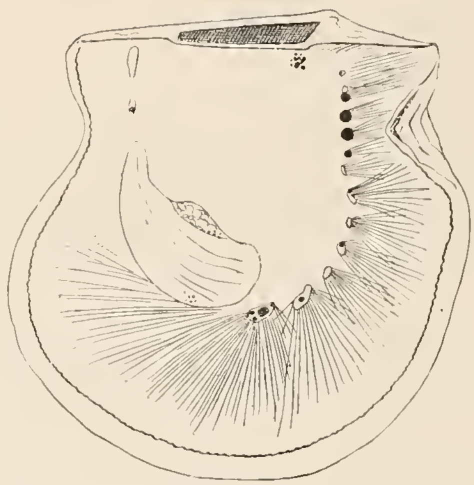


Fig. 5B. Diagram showing the positions most frequently occupied by muscle pearls.

and muscle pearls respectively, the localities most commonly occupied by the pearls being indicated by spots. Figs. 13 and 14 on Plate III. show also the mode of occurrence of the muscle pearls near the insertion scars.

The muscle pearls when present are usually abundant,* and when examining under the microscope a young pearl of this kind, *in situ*, it is common to find a large number of minute calcareous depositions, or calcospherules (Plate III., fig. 12), scattered in the neighbouring tissue. It is probable that the muscle pearls are formed around these microscopic calcospherules as centres of irritation, and as these positions are invariably in our experience close to the surface of the muscle or the mantle, there is no difficulty in understanding that there, if anywhere, ectoderm cells might migrate to the source of irritation and thus be responsible for the deposition of a pearl.

* At the insertion of one levator muscle, 23 small pearls were counted with the eye, while under the microscope 170 additional tiny spherules were found to be present.

CONCLUSIONS ON PEARL-FORMATION.

We may now sum up our views as to pearl-formation in the Ceylon pearl oyster as follows (using with but slight changes and additions the wording of our 1903 note* on the subject) :—

1. The majority of pearly excrescences on the interior of the shell are due to the irritation caused by *Clione*, *Leucodore*, and other boring animals. In exceptional cases a free pearl may be formed in this way.

2. Minute grains of sand and other inorganic particles only form the nuclei of pearls under exceptional circumstances. Probably it is only when the shell is injured, *e.g.*, by the breaking of the "ears," thus enabling sand to get into the interior, that such particles supply the irritation that gives rise to pearl-formation. The ectoderm, in such cases, would probably also be damaged, and cells may be carried in with the inorganic particles.

3. Many pearls are found in the muscles close to the surface, especially at the levator and pallial insertions, and these are formed around minute calcareous concretions, the "calcospherules," which are produced in the tissues and form centres of irritation. These are, in all cases, close to the surface of the mantle, or even in contact with the ectoderm.

4. Most of the fine pearls found free in the body of the Ceylon oyster contain the remains of Cestode parasites, so that the stimulation which leads to the formation of an "orient" pearl is, as has been suggested by various writers in the past, due to the presence of a minute parasitic worm. Probably in all cases, whatever its nucleus may be, the pearl, like the nacre, is deposited by an epithelial layer derived from the ectoderm.

These four categories are separated according to the cause of the stimulation. The first set, however, can scarcely be considered as "pearls," and the others may be conveniently classified under the following three names :—

I. *Ampullar-pearls*, where the nucleus and resulting pearl lie between the shell and the body, or in a pouch (the ampulla) of the ectoderm projecting into the mantle. The others lie in closed (ectodermal) sacs.

II. *Muscle pearls*, formed around calcospherules near the insertions of muscles.

III. *Cyst pearls*, formed around encysted parasites. The parasite in the case of the majority of the cyst pearls of Ceylon is the larva of one or more species of Cestodes, belonging to the genus *Tetrarhynchus*.

It seems possible that in *Placuna placenta*, the "vitre chinoise" or window oyster of Tampalakam Lake near Trincomalee, a Distomid parasite which we find in the tissues both free and encysted, may also occasionally be a cause of pearl-formation.

* 'British Association Report, Southport,' p. 695.

The encysted Cestode larvæ found in the pearl-oyster are, however, also present in *Placuna*—sometimes in great numbers, so as to be densely crowded together in the superficial layer of the mantle, as shown in fig. 6. Compound cysts, where one larva occurs within the vesicle of another, are sometimes seen. Similar larvæ, both alive and as nuclei of pearls, are also found in specimens of *Placuna placenta* from the Gulf of Kutch.* In fact, a fuller experience is causing us to incline to the view that various parasites may act as pearl nuclei even in the same mollusc. Some pearls are certainly formed round intrusive Nematodes. We have a complete cyst pearl, free and unattached, of which the nucleus is a coiled *Cheiracanthus uncinatus*, on which the pearl deposit is not sufficiently thick and opaque to obscure the coils so as to render identification difficult.

Fig. 6. Aggregation of encysted Cestode larvæ in the mantle of *Placuna placenta*; magnified.

But although Kelaart's statement, half a century old, that various kinds of worms are concerned in pearl-formation may be correct, still we hold that our investigation has shown that in *Margaritifera vulgaris*, at Ceylon, the production of the orient pearl is dependent upon Cestode infection and that the species mainly concerned is *Tetrarhynchus unionifactor*.

The next question that naturally arises is—Can we profitably follow up Kelaart's suggestion that it might be possible to increase the number of pearls by infecting the molluscs with the appropriate parasites? This "margarose artificielle" has been tried, as we have shown above, by Dubois in a case where the parasite was supposed to migrate from one mollusc (a *Mytilus*) to another of a different genus (*Margaritifera*). Giard and others have pointed out the difficulties in the way of accepting this case, and the doubts that naturally arise; and we are probably correct in concluding that the method has not as yet resulted in a marked success on the southern coast of France; although it is quite possible that similar methods with other shell-fish elsewhere may give good results.

On the Ceylon pearl banks, however, it is probably quite unnecessary to take any steps to ensure infection with the appropriate parasite. Oysters, wherever they appear, when they are old enough contain pearls, and encysted parasites are even more abundant. Even when new beds are formed artificially by transplanting to unoccupied ground, as we do not doubt will be the case in the future, that operation may be carried out with perfect confidence that when the four-year-old oyster is fished it will contain the normal† supply of pearls. The parasites are probably so widely spread that every pearl oyster in the Gulf of Manaar, or, for that matter, around the coast of Ceylon, runs a fair chance of becoming infected. Cyst pearls are found in the

* See Hornell's Reports from the Ceylon Marine Biological Laboratory, Part II., 1906.

† Of course some beds are richer in pearls than others and some years are better than others.

oysters at Trincomalee; the fishes that are, in all probability, the hosts of the parasite in its more advanced stages abound at various points. It is the molluscan host and not the parasite that stands in need of artificial aid in Ceylon. If we can increase the number of beds, and can prevent catastrophes from devastating the oyster populations, so that the divers can collect them annually in their tens of millions, we need not fear any scarcity of pearls.

As BOUTAN, who thinks favourably of artificial methods, points out*:—" Mais il ne faut pas oublier que l'infection d'un animal par un parasite ne favorise pas précisément le développement normal du sujet infesté." He advocates as an alternative method experimental trepanning of the shell, but that or any other mode of individual treatment is clearly impracticable in dealing with the millions of the Ceylon pearl banks. Our own opinion is that, although all pearl-production is a departure from the normal, the pearl-inducing parasites are not sufficiently abundant to affect seriously the health of the oyster; and that, to reverse the popular saying, if we attend to the prosperity of the bed as a whole, the individual oysters may be left to take care of themselves, both in regard to health and pearl-production.

DISTRIBUTION OF PEARLS.

Figs. 5A and 5B, on p. 27 show the usual distribution of cyst and muscle pearls respectively in the Ceylon pearl oyster. The following table will show the numerical proportion between the two kinds in various parts of the body. It is the summary of a number of observations made by us in 1902 and 1903:—

Locality.	Number of oysters dissected.	Cyst pearls—		Muscle pearls at insertion of —				Total pearls.
		In mantle lobe outside the pallial line.	Within the pallial line.	Levator muscles.	Palpar pallial muscles.	Other pallial muscles.	Adductor and retractor.	
South-east Cheval . .	378	7	10	48	9	4	6	84
Mid-east Cheval . .	450	19	10	13	4	1	—	47
North-east Cheval . .	266	7	2	11	3	—	—	23
Periya Paar Karai .	168	6	3	10	1	1	—	21
West Cheval . . .	83	2	1	—	1	—	—	4
Dutch Modragam . .	17	—	—	—	—	—	—	0
Muttuvaratu . . .	38	2	—	—	—	—	—	2
Totals	1400	43	26	82	18	6	6	181

* 'Arch. de Zool. expér.,' 1904, p. 89.

As these two classes of pearl differ not only in value but in mode of occurrence, it is worth while to contrast their distribution more definitely. If we unite the subdivisions of the pearl-classes, we find the proportions to be :—

Locality.	Number of oysters dissected.	Number of cyst pearl-bearers.	Number of muscle pearl-bearers.	Total number of pearl-bearers.	Percentage of cyst pearls.	Percentage of pearl-bearers of both classes.
South-east Cheval . .	378	17	67	84	4·5	22·2
Mid-east Cheval . . .	450	29	18	47	6·4	10·4
North-east Cheval . .	266	9	14	23	3·4	8·6
Periya Paar Karai . .	168	9	12	21	5·4	12·5
Western Cheval . . .	83	3	1	4	3·6	4·8
Dutch Modragam . .	17	—	—	—	—	0·0
Muttuvaratu	38	2	—	2	5·3	5·3
Total	1,400	69	112	181	—	—

From this it is seen that of the 1,400 oysters, aged from 3 to $3\frac{3}{4}$ years, which were individually dissected with the greatest care, only 181 proved to be pearl-bearers, equal to a percentage of 13.

A remarkable feature of these and other observations we have on record is the relatively great abundance of individuals upon the South-east Cheval containing muscle pearls. On the other hand, as the value of the oysters is chiefly dependent upon the proportion of cyst pearls present, these oysters appeared to be commercially inferior to those of the Mid-east Cheval—a conclusion subsequently proved correct by the actual returns obtained from these two banks during the course of the Fishery of 1903. The proportion of muscle pearls for the South-east Cheval at that fishery was over 90 per cent. Of 94 pearls dissected out, only 9 were cyst pearls.

Whatever may be the cause of certain pearl oysters containing exceptionally large numbers of muscle pearls, it is worthy of note that the vigorous and healthy oysters of the Eastern Cheval and Periya Paar Karai produced practically all the examples of this class of pearls, there being 111 muscle pearl-bearers from these banks out of 1,262 oysters, whereas the 138 oysters from the beds characterised by stunted growth—the Western Cheval, Dutch Modragam, and Muttuvaratu paars—gave but a solitary instance of this class.

The variation in the number of cyst pearls is due, ultimately, to the relative abundance of the pearl oysters on different grounds and of the *Tetrarhynchus* larvæ that cause pearl-production, and that ratio must be affected amongst other factors by the abundance of the fish-host of the sexually mature Cestode.

We give now another tabular statement obtained more recently :—

Pearl-yield of Representative Samples of Oysters (over $3\frac{1}{2}$ Years Old) Examined in November, 1905.

Name of bank.	Number of oysters examined.	Cyst pearls.			Muscle pearls.			Pearl bearers, both cyst and muscle.	Percentage of total pearl-bearers to total examined.
		Number of cyst pearls.	Individuals containing cyst pearls.	Percentage of cyst pearl-bearers.	Muscle pearls found.	Individuals containing muscle pearls.	Percentage of muscle pearl-bearers.		
South-east Cheval .	180	44	34	18·888	171	54	30	88	48·333
,, ,, .	180	22	16	8·888	49	18	10	34	18·888
North Modragam .	225	13	13	5·777	90	31	13·777	44	19·554
South ,, .	67	8	6	8·955	29	10	14·925	16	23·880
Kutiramalai . . .	28	7	5	17·857	26	5	17·857	10	35·714
Mid-west Cheval .	21	4	3	14·285	2	1	4·762	4	19·047
,, ,, .	200	13	11	5·500	63	22	11·000	33	16·500
Muttuvaratu . . .	30	Nil	Nil	Nil	16	5	16·666	5	16·666
,, . . .	140	9	9	6·428	40	18	12·857	27	19·285
,, . . .	420	10	9	2·143	106	41	9·762	50	11·905
Total . . .	1491	130	106	7·109	592	205	13·749	311	20·858

The following table shows the positions in the body and the weights of certain of the above pearls :—

Location and Weight of Pearls from the same Representative Samples.

Name of bank.	Location of cyst pearls.		Weight of the larger cyst pearls in grammes.	Weight of small cyst pearls plus all the muscle pearls in grammes.
	Peripheral region of mantle.	Central region of mantle.		
South-east Cheval	12	32	22 largest = 1·050 (South-east Cheval, both rows)	44 cyst and all muscle pearls (264 in all) weighed 1·480 (South-east Cheval, both rows)
,, ,,	10	12		
North Modragam	1	12	4 ,, = 0·250	9 cyst and 90 muscle pearls, 0·510
South ,,	5	3	3 ,, = 0·045	5 ,, 29 ,, 0·105
Kutiramalai . .	1	6	3 ,, = 0·300	4 ,, 26 ,, 0·170
Mid-west Cheval .	1	2	Insignificant	Insignificant
,, ,, .	4	9	6 largest = 0·120	7 cyst and 63 ,, 0·380
Muttuvaratu . .	Nil	Nil	Nil	16 ,, 0·100
,, . .	8	1	5 cyst pearls = 0·290	3 cyst and 40 ,, 0·220
,, . .	5	5	Not taken	Not taken
Total . .	47	82	43 cyst pearls = 2·055	72 cyst plus 484 muscle pearls, 2·965

NATIVE CLASSIFICATION OF PEARLS.

It may be useful if we place on record here the native system of classification of pearls, which is supposed to be of extreme antiquity and is still made use of in Government reports, at the fisheries and by the pearl merchants.

We may conveniently give the procedure of the native in classifying his pearls in the words of CORDINER*—one of the earliest English writers on the subject, as his observations were made on the fisheries which took place at the beginning of last century, under the Government of Lord GUILDFORD.

"After the pearls are separated from the sand, washed with salt water, dried, and rendered perfectly clean, they are sorted into classes according to their sizes, by being passed through ten brass sieves or saucers full of round holes. The saucers are apparently all of one size, but made so as to go in within one another. They are distinguished into numbers, 20, 30, 50, 80, 100, 200, 400, 600, 800, and 1000. This is a kind of ratio to estimate the value of the different sizes of pearls; and probably the distinguishing numbers, in some measure, correspond with the quantity of holes in each basin. These completely occupy the bottom of the vessel; and as they increase in number, necessarily decrease in size. The pearls are thrown in a promiscuous heap into the uppermost sieve, which being raised a little and shaken, the greater part of them pass through into the second sieve, and only those remain which exceed a large pea in size. The second sieve is shaken in the same manner; the pearls that remain in it are of the size of a small pea, or grain of black pepper. The quantity of pearls gradually increases as the size diminishes. Those which fall through the tenth saucer (No. 1000) belong to the class of Tool, or seed pearls, so called from the smallness of their size.

"I saw this operation of sorting the pearls performed with the produce of seventeen thousand oysters, which only weighed three-quarters of a pound, and was contained in a vessel smaller than a common soup-plate. Out of that quantity there were not found two perfect pearls, either of the first or second order. About twenty or thirty pearls remained in these saucers, but almost all of them were slightly deformed, rugged, and uneven. Of the smaller sizes many were round and perfect.

"The pearls contained in the sieves from No. 20 to 80, inclusive, are distinguished by the general name of Mell, or the first order. Those of the sieves from No. 100 to 1000 are denominated Vadivoo, or the second order. Both these orders are divided into various sorts, according to their shape, lustre, and other qualities; amongst which are Annees, Annadaree, Kayerel, Samadiem, Kallipoo, Koorwel, Pesul, and Tool. The Annees are the first sort, perfectly round, and of the most brilliant lustre. Annadaree is a sub-division of them, possessing the same qualities in an inferior degree. Kayerel is the next in beauty, but not so completely round, and of a duller

* 'Description of Ceylon,' London, 1807, vol. ii., p. 62.

colour. To this class belongs the Samadiem, which is nearly of the form of a pear, and the Kallipoo, which has flat sides. The Koorwel, or third class, is a double pearl, ill-shaped, and of a dull water; to it may be added the Pesul, the most deformed of all the pearls; and the Tool, the most diminutive."

From the above it will be seen that CORDINER could get no definite information as to the numbering of the ten sieves, viz., 20, 30, 50, 80, 100, 200, 400, 600, 800, and 1000. Sir WILLIAM TWYNAM informs us that these numbers indicate that so many pearls from such sieves stand to a "Kalanchu." We show here in fig. 7, A and B, the impression, natural size, of the bottoms of the two extreme sieves of the series, 20 and 1000, kindly supplied to us by Sir W. TWYNAM.

As regards sieve No. 1 (the 20 sieve, fig. 7, A), it is, of course, only the pearls which just escape going through the sieve that can be taken into account in making the estimate. Large pearls of more than ordinary value are regarded as exceptional, and are not taken into account in valuing samples. It is said that the native merchants judge the value of samples chiefly by what remains in the No. 4 (80 sieve).

This account of the methods in use a hundred years ago applies perfectly at the present day (as may be seen from the modern valuation form we print below, p. 38) except for some slight changes in the spelling of the names. We give now a list of the classes of pearls distinguished by the native valuers and merchants, with some indication of the meaning of the name and any other information* we have as to the kind of pearl. The list begins with the finest class of pearls and ends with the poorest. In each case we give first the Tamil name written in English, according to the Government spelling, then the literal meaning of the word, to which may be added the more extended meanings in present usage, the size, shape and other characters, followed by any peculiarity in use or native estimation. It will be noticed that some of the terms, such as "Mel" and "Tul," indicate relative size, while others, such as "Ani," apply to quality, or, such as "Kuruval" and "Kodai," to shape and colour.

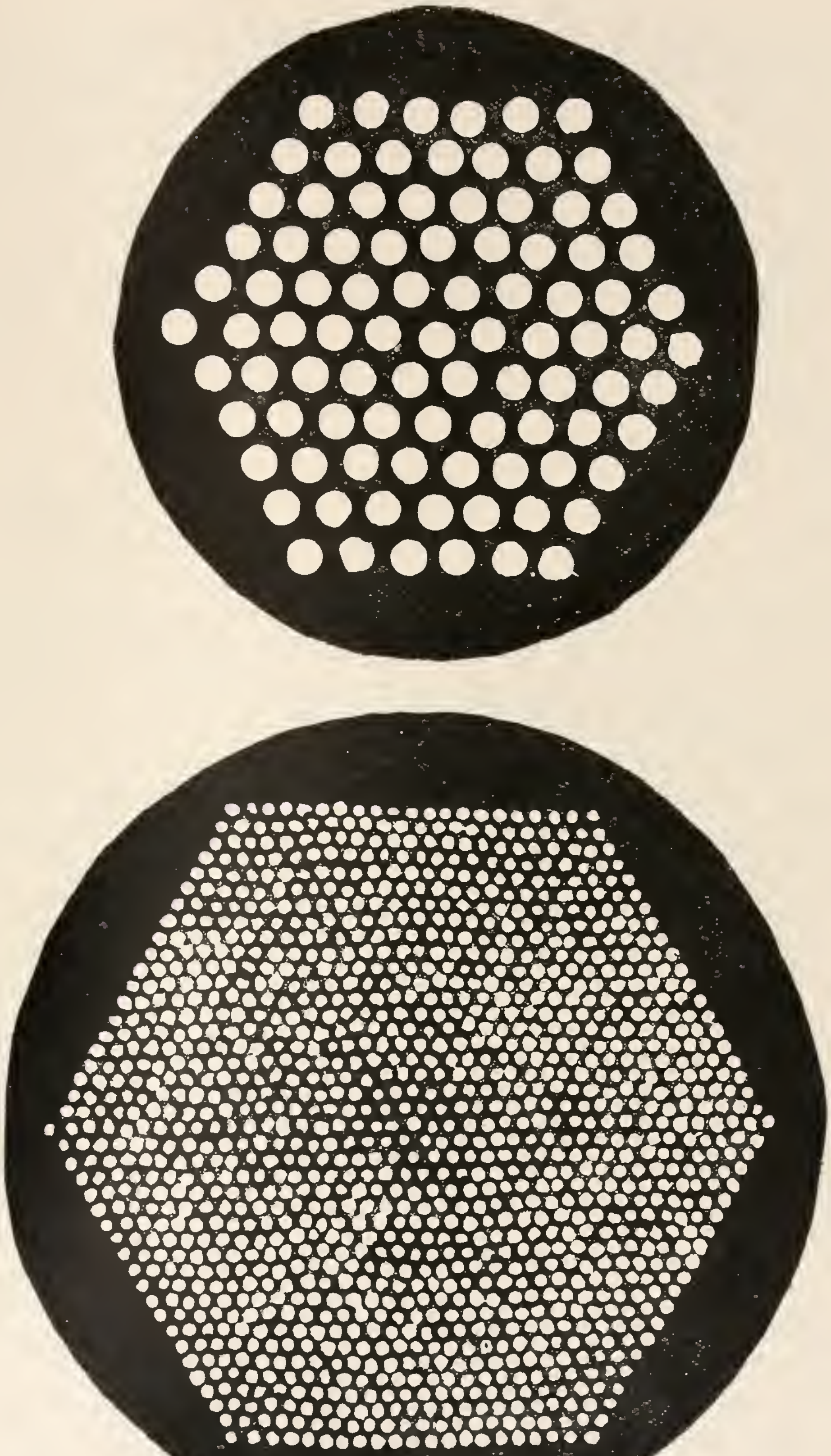
"MEL" or "MEL-MUTTU," meaning "upper," or superior pearl. This is a term of size, not of quality, and applies to pearls retained in the 20 to 80 sieves.

"ANI," meaning "best"; excellent—a fine, superior pearl both as regards quality and perfectly spherical shape, of the best lustre and colour, the true "orient" pearl.

"ANATARI," meaning "follower" or "second"; a pearl closely approximating to the Ani, but with some slight departure from perfection, such as a speck or a flattening on one side.

"KALIPPU," meaning "rejected," or inferior to Anatari; a good pearl, more or less symmetric, may be lens-shaped or oblong, usually flattened.

* We are indebted for some of this information to Sir WILLIAM TWYNAM, of Jaffna, who has been most kind in supplying us with details as to former fisheries and native methods, both during our expedition in 1902 and also on occasions since.



A.

B.

Fig. 7. Impressions of the largest and the smallest of the pearl merchants' ten sieves. **A**, the 20 sieve or basket ; **B**, the 1000 sieve or basket.

"KURUVAL," meaning "short"; deformed and double pearls, but not necessarily inferior in quality, may be of excellent lustre but of irregular form. "Ani-Kuruval" is where two Ani are partially fused together, whether the pearls be of equal size or not; but each must be so formed that if not fused it would be spherical. "Pisal-Kuruval" is where several pearls of good lustre and colour are partially and irregularly fused together. "Pampara-Kuruval" is a pearl grooved regularly, like a top.

"KAYARAL," meaning "the clasp of a necklace"; a dark-coloured treble pearl, not completely round, and of a dull colour.

"SAMADIAM," a pearl with a reddish tint, pear-shaped, but of a dull colour.

"NIMELAI," a nose-pearl, a perfect-skinned, pear or egg-shaped pearl.

"SIRIPPU," a pearl grooved with irregular wrinkle-like furrows.

"MASAKU," badly coloured pearls; usually grey, but symmetrical and with lustre.

"PISAL," meaning "torn"; a deformed pearl or cluster of small misshapen pearls of little or no value, of bad colour, usually slag-like in appearance.

"KODAI," meaning "brown"; like a nut, with no nacreous lustre, formed of prismatic shell, may be large and is usually spherical and includes pearls of different colours, and those white ones that have black or brown marks. "Van-Kodai" is a Kodai pearl with one side nacreous. "Karunk-Kodai," a black or blue-black slag-like pearl.

"VADIVU," meaning "beauty"; also "decreasing"; that which is strained or sifted, an intermediate pearl, found in the 100, 200 and 400 sieves. These small pearls of regular form, good colour, and lustre, are what are held in most general esteem in the East.

"MADANKU," meaning "folded or bent"; all pearls of Vadivu size that are imperfect in form or colour.

"TUL," meaning "powder"; the seed-pearls, smallest size, those that are retained by the 600, 800 and 1000 sieves.

"MASI-TUL," meaning "ink-dust" or chalk powder; smaller than the 1000 sieve. These are generally used for medicinal purposes or burnt and used as chunam to be eaten with areca nut and betel by the natives.

"ODDU" or "OTTUMUTTU," meaning "shell-pearl"; an attached pearl or nacreous excrescence on the inside of the shell.

If we consider only the size of the pearls as separated out by the sieves, we find :—

"Mel-muttu" in the 20 to 80 sieves;

"Vadivu" and "Madanku" in the 100, 200 and 400 sieves;

"Tul" in the 600, 800 and 1000 sieves; while

"Masi-Tul" are those that pass through the finest sieve.

Considered from the point of view of perfection in lustre and quality generally, the "Mel-muttu" or large pearls are grouped as "Ani," "Anatari," "Kalippu," "Kuruval," &c.; while some of the remaining terms refer to special abnormalities or unusual shapes and colours.

As may be seen from the valuation form printed below, "Kalippu," "Kuruval," "Pisal," "Kodai" and other inferior classes may be of large size and so occur along with "Ani" and "Anatari" amongst the "Mel" in the 20, 30, 50 and 80 sieves.

As showing the relative abundance of the three grades of good pearls comprised under the head of "Vadivu," those obtained from the washing of 11,000 four-and-a-half year old oysters from the South-east Cheval Paar in November, 1905, were found to be as follows:—

	108	pearls of the	100	basket size	(weight	$11\frac{8}{32}$ Manchadi)
	154	,,	200	,,	(,,	$9\frac{11}{32}$,,)
	253	,,	400	,,	(,,	$9\frac{10}{32}$,,)
Total	515					

Finally we print here a sample of the official valuation given in the 'Ceylon Government Gazette,' previous to a fishery, as the result of the examination (by the Inspector, the local Adigar, and three native pearl merchants) of the samples of oysters lifted from the banks during an inspection (see p. 38).

Kalanchu (corruptly Kalangi) and Manchadi are weights, there being 20 Manchadi (originally the scarlet seed of a plant) of 0·546 gramme each in the Kalanchu, which thus weighs 10·920 grammes. Now the Manchadi has been standardised and is a tabular brass weight of square form. The fractions and multiples represented by the little brass weights commonly employed by the Tamil pearl merchants range from the $\frac{1}{32}$ of a Manchadi to 10 Kalanchu.

The Chevoe, used in the valuation of the finest pearls, is an imaginary criterion depending partly upon weight and partly upon quality, and the valuers have to estimate how many such chevoe there are in each of the Ani and Anatari grades of pearl in the sample.

Bombay and Surat merchants as a rule do not employ the brass weights favoured by the Tamil merchants. They prefer beautifully modelled, pear-shaped weights of agate—sometimes red, sometimes greyish-white in colour. A rupee weighs approximately $1\frac{1}{16}$ Kalanchu.

The monetary basis employed in the calculation of values is the Star pagoda, a small plano-convex gold coin that was the standard gold currency in South India less than one hundred years ago. Its nominal value in the calculations made is Rs. $3\frac{1}{2}$. So if Masi-tul be valued at two star pagodas a Kalanchu, this indicates the market value to be Rs. 7 per Kalanchu. It should be noted that although the nominal value of the star pagoda is taken for the purpose of calculation at but Rs. $3\frac{1}{2}$, its intrinsic value as a gold coin at the present rate of exchange is considerably greater, being worth fully Rs. 6 as gold.

STATEMENT of the Valuation and Produce of 12,000 Oysters taken from the South-west Cheval Paar in February, 1904.

Description.	Size in basket.	Number.	Quantity in Chevoe.	Kalanchu.	Manchadi.	Total. Kalanchu.	Total. Manchadi.	Value.	Total value.	Per Chevoe.	Per Kalanchu.
								Rs. c.	Rs. c.		
Ani	20	1	$\frac{25}{320}$	—	$\frac{5}{16}$			12 58		50 pagodas	—
Anatari	20	1	$\frac{60}{320}$	—	$\frac{1}{2}$			19 68		30 "	—
Kalippu. . . .	20	2	—	—	1			5 25		—	30 pagodas
Kuruval . . .	20	2	—	—	$\frac{3}{4}$			1 31		—	10 "
Pisal	20	7	—	—	$3\frac{1}{2}$			1 83		—	3 "
Kodai	20	3	—	—	$1\frac{1}{4}$		$7\frac{5}{16}$	0 21	40 86	—	1 pagoda
Ani	30	5	$\frac{106}{320}$	—	$1\frac{1}{2}$			42 $87\frac{1}{2}$		40 pagodas	—
Kalippu. . . .	30	7	—	—	$2\frac{1}{8}$			7 44		—	20 pagodas
Kuruval. . . .	30	5	—	—	$1\frac{3}{4}$			3 6		—	10 "
Kodai	30	4	—	—	1		$6\frac{6}{16}$	0 $17\frac{1}{2}$	53 55	—	1 pagoda
Anatari	50	3	$\frac{25}{320}$	—	$\frac{9}{16}$			8 $22\frac{1}{2}$		30 pagodas	—
Kalippu. . . .	50	7	—	—	$1\frac{1}{2}$			5 25		—	20 pagodas
Kuruval. . . .	50	10	—	—	$2\frac{1}{2}$			5 25		—	12 "
Pisal	50	3	—	—	$\frac{3}{4}$			0 39		—	3 "
Kodai	50	4	—	—	$\frac{1}{4}$		$6\frac{1}{16}$	0 13	19 $24\frac{1}{2}$	—	1 pagoda
Ani	80	9	$\frac{40}{320}$	—	$1\frac{1}{4}$			21 $87\frac{1}{2}$		50 pagodas	—
Anatari	80	6	$\frac{40}{320}$	—	1			13 $12\frac{1}{2}$		30 "	—
Kalippu. . . .	80	17	—	—	$2\frac{1}{2}$			8 75		—	20 pagodas
Kuruval. . . .	80	21	—	—	$4\frac{1}{4}$			8 $92\frac{1}{2}$		—	12 "
Pisal	80	6	—	—	1			0 $52\frac{1}{2}$		—	3 "
Kodai	80	3	—	—	$\frac{1}{2}$		$10\frac{5}{16}$	0 $8\frac{1}{2}$	53 $28\frac{1}{2}$	—	1 pagoda
Vadivu	100	—	—	—	18					—	—
Vadivu	200	—	—	—	19					—	—
Vadivu	400	—	—	—	18	2	15	192 50	192 50	—	20 pagodas
Tul	600	—	—	1	5					—	—
Tul	800	—	—	—	17					—	—
Tul	1,000	—	—	—	10	2	12	63 70	63 70	—	7 pagodas
Masi-tul. . . .	—	—	—	—	16		16	7 0	7 0	—	$2\frac{1}{2}$ "
Shell-pearls . .	—	—	—	—	—			2 0	2 0	—	—
					Totals .	7	$13\frac{4}{16}$		432 14		

Equal to Rs. 36·01 per 1,000 oysters.

JAMES HORNELL, Inspector of Pearl Banks.
V. VRASPILLAI, Adigar, Musali.
.................., Valuer.
.................., Valuer.
.................., Valuer.

Marichchikaddi,
March 9, 1904.

South Indian pearl merchants make constant use, in working out their valuations, of a useful Pearl Merchants' "Ready Reckoner," published in 1890 at Tondimundalam, Madras, under the name of "Pearl-calculating Tables." It is printed wholly in Tamil, and gives the number of chevoe for a certain weight in Kalanchu and Manchadi of special classes of pearl. That obtained, the valuers fix the estimate according to what they agree shall be considered the market price of the day per chevoe of this quality. It may be accepted that this figure given in the official valuation is always considerably under the true ruling price of the day, and at the auctions during the fishery that follows, the oysters always sell at far above the estimate given in this valuation.

It is possible that with the advent of the London syndicate, to which the Ceylon pearl fisheries have been leased for the next twenty years, these picturesque old-time native methods, which have survived through the Portuguese, Dutch and British administrations, may now give place to more exact modern financial requirements. We are glad to have had this opportunity of putting on record a system which, existing, it is said, at the time of the "Periplus of the Erythræan Sea," has come down to our own day, practically unaffected by European civilisation, and may before long be doomed to disappear.

Pearl merchants.—From a photograph by J. Hornell.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. Part of a gill lamella of *Mytilus edulis*, showing a larger pearl occupying the whole thickness of the lamella and a smaller one in an enlarged gill filament. × 40.

,, 2. Group of four pearls in the mantle of *Mytilus edulis*—two of the pearls being in one sac. × 40.

,, 3. Pearl from the mantle of *Mytilus edulis*, showing a small, but quite simple nucleus, evidently, from its staining, an organic particle, but having no visible structure. × 40.

,, 4. Pearl from the mantle of *Mytilus edulis*, showing a relatively very large, deeply stained, but disorganised nucleus. × 40.

,, 5. Pearl from the mantle of *Mytilus edulis*, showing no nucleus, no cavities, and no foreign structure. × 100.

,, 6. Pearl and Trematode lying together in the mantle of *Mytilus edulis*. × 40.

,, 7. Pearl (with several centres) and Trematode lying together, enclosed in the same sac, in the mantle of *Mytilus edulis*. × 40.

,, 8. Pearl in a gill lamella of *Mytilus edulis*, showing a very large, disorganised nucleus, and a distinct sac, with epithelium closely resembling that of the adjacent ectoderm. × 300.

,, 9. Pearl from *Mytilus edulis*, decalcified to show the layers of conchiolin. × 40.

,, 10. Portion of a pearl and its sac (*p.s.*) from the mantle of *Mytilus edulis*, to show the similarity between the epithelium and the ectoderm (*Ect.*). × 300.

,, 11. Another portion of a pearl and its epithelial sac from the mantle of *Mytilus edulis*, to show irregularly projecting parts of the pearl cut separately. × 300.

,, 12. Adjacent portions of pearl sac and ectoderm from fig. 10, to show similarity. × 1000.

,, 13. Section through a Ceylon pearl in the natural condition. × 40.

,, 14. A partially decalcified pearl in the mantle of the Ceylon pearl oyster. × 100.

,, 15. Section through a partially decalcified Ceylon pearl. × 100.

,, 16. Portion of pearl sac and adjacent ectoderm of Ceylon pearl, to show similarity. × 1000.

,, 17. Portion of a Ceylon pearl and its epithelial sac. × 200.

,, 18 Portion of Ceylon pearl and its epithelial sac and mantle, to show large clear cells. × 900.

,, 19. Ceylon pearl and mantle, to show the large clear cells in the ectoderm (B) and in the pearl sac (A). × 900.

,, 20. Mantle of Ceylon pearl oyster over a pearl, to show the distribution of the large clear cells. × 900.

PLATE II.

Fig. 1. Margin of mantle of a highly infected Ceylon pearl oyster from Muttuvaratu Paar, showing nine encysted Cestode larvæ. Natural size.

,, 2. Transverse section through viscera of Ceylon pearl oyster, showing four Cestode cysts in the liver. Slightly enlarged.

,, 3. Gill filaments of Ceylon pearl oyster, showing encysted Cestode larva. × 12.

,, 4. A. Outline of a cyst pearl for comparison with B. Outline of the Cestode larva that forms the pearl-nucleus. × 20.

Fig. 5. Nucleus of a decalcified cyst pearl from the posterior ear-region of a Cheval Paar oyster, showing the characters of the Cestode larva. × 20.

,, 6. Partially calcified cyst around a dead Cestode larva, from the mantle of a 3-year-old Muttuvaratu Paar oyster. × 20.

,, 7. Nucleus of a decalcified cyst pearl from the mantle of a Cheval Paar oyster, showing a Cestode larva with a spherical calcification in its interior. × 20.

,, 8. Young Cestode larva (*Tetrarhynchus unionifactor*), extracted from thick-walled cyst in mantle of pearl oyster. × 40.

,, 9. Young *Tetrarhynchus* larva, extracted from a cyst in the mantle, showing the spines upon the "collar." × 40.

,, 10. The same, seen after slight pressure has caused the evagination of the "head." × 40.

,, 11. Another slightly later stage, seen under slight pressure. × 60.

,, 12. Rather later stage of the larva, showing elongation of body; from a cyst in viscero-pedal part of pearl oyster. × 30.

,, 13. Encysted later larva of *Tetrarhynchus pinnæ*. × 10.

,, 14. Later larva of *Tetrarhynchus pinnæ*, freed from the cyst-membrane. × 10.

,, 15. Late larva of *Tetrarhynchus balistidis*, from the liver of the File-fish, which eats pearl oysters. Natural size, and "head" × 16.

,, 16. The latest larval stage of *Tetrarhynchus unionifactor* met with in the pearl oyster. × 30.

,, 17. Part of the liver of the pearl oyster, showing one of the smaller (A) and one of the larger (B) Cestode larvæ encysted in the connective tissue. × 50.

,, 18. Globular larval Cestode encysted in the connective tissue of the liver. × 300.

,, 19. One of the smaller larvæ (*Tetrarhynchus* sp.) surrounded by a very thick connective-tissue cyst, showing a laminated structure. × 50.

,, 20. Larva in the same stage, showing the division of the muscle masses into incipient bothridia, or proboscides. × 300.

,, 21. Another larval stage, surrounded by a dense connective-tissue cyst. × 300.

,, 22. Another similar larva, slightly younger, showing a very slight cyst. × 450.

PLATE III.

Fig. 1. Section of larva of *Tetrarhynchus unionifactor*, showing an unusually depressed head. × 300.

,, 2. Section of another larva, showing the usual protruding papilla. × 960.

,, 3. An oblique section, × 40—showing the developing muscular tissue at *a* enlarged.

,, 4. Another oblique section, showing lateral muscular thickenings. × 40.

,, 5. Section through a larva, showing infoldings on the head. × 40.

,, 6. Section of the usual form, with large muscular protruding head. × 40.

,, 7. Posterior end of the last section, showing details. × 300.

,, 7A. Details of the fibres and spines on the cuticle of the last, more highly magnified.

,, 8. Typical longitudinal section through the larva of *T. unionifactor* as seen commonly encysted in the pearl oyster. × 960.

,, 9. Group of hooks *in situ* from the cuticle on the anterior invagination of the larger Cestode larva (*T. unionifactor*); with enlarged outlines of two isolated hooks. × 1000.

,, 10. Section through a very young *Tetrarhynchus*, with the four proboscides; from cyst between stomach and liver in pearl oyster. × 50.

,, 11. Section through more elongated *Tetrarhynchus*, also from a cyst *in situ* in the viscera of the pearl oyster. × 50.

Fig. 12. Three calcospherules from the insertion of anterior levator muscle; a, simple; b, compound; c, optical section showing pearl layers (*a*) being deposited round calcospherule.

„ 13. Diagram showing position of two irregular compound muscle pearls in 2nd and 3rd pallial muscle insertions; *a* and *b* show the two pearls, slightly enlarged.

„ 14. Diagram showing two rows of muscle-scars, the outer being the present functional ones; *a* marks the position of a muscle-pearl on the site of a former muscle-insertion (palpar region).

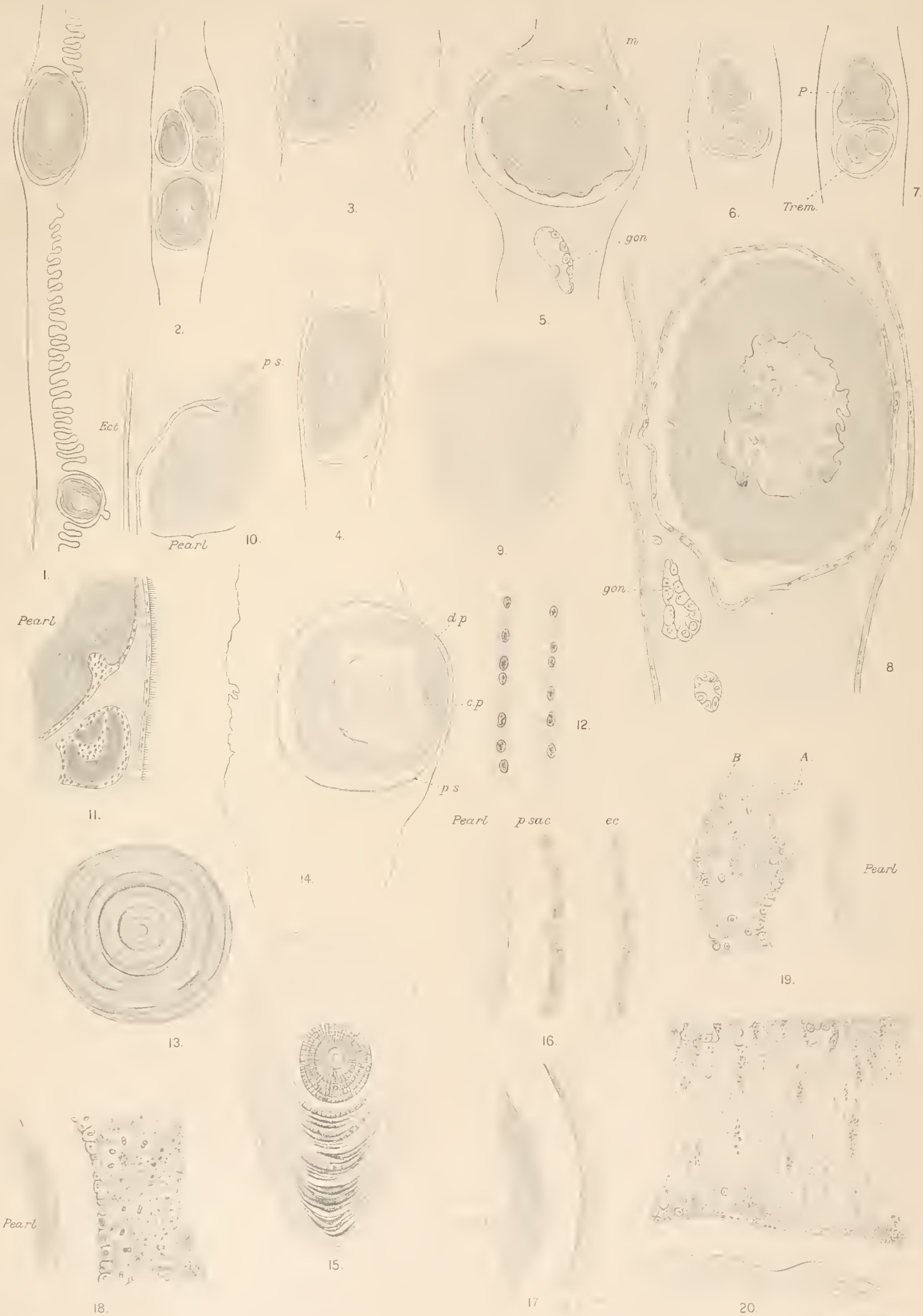
„ 15. Six cyst pearls in the mantle of the posterior ear, left side; four others lay in a corresponding position on right side.

„ 16. Two cyst pearls in mantle, posterior to dorsal end of adductor muscle.

„ 17. Six cyst pearls, misshapen through mutual pressure, in the mantle of the posterior ear.

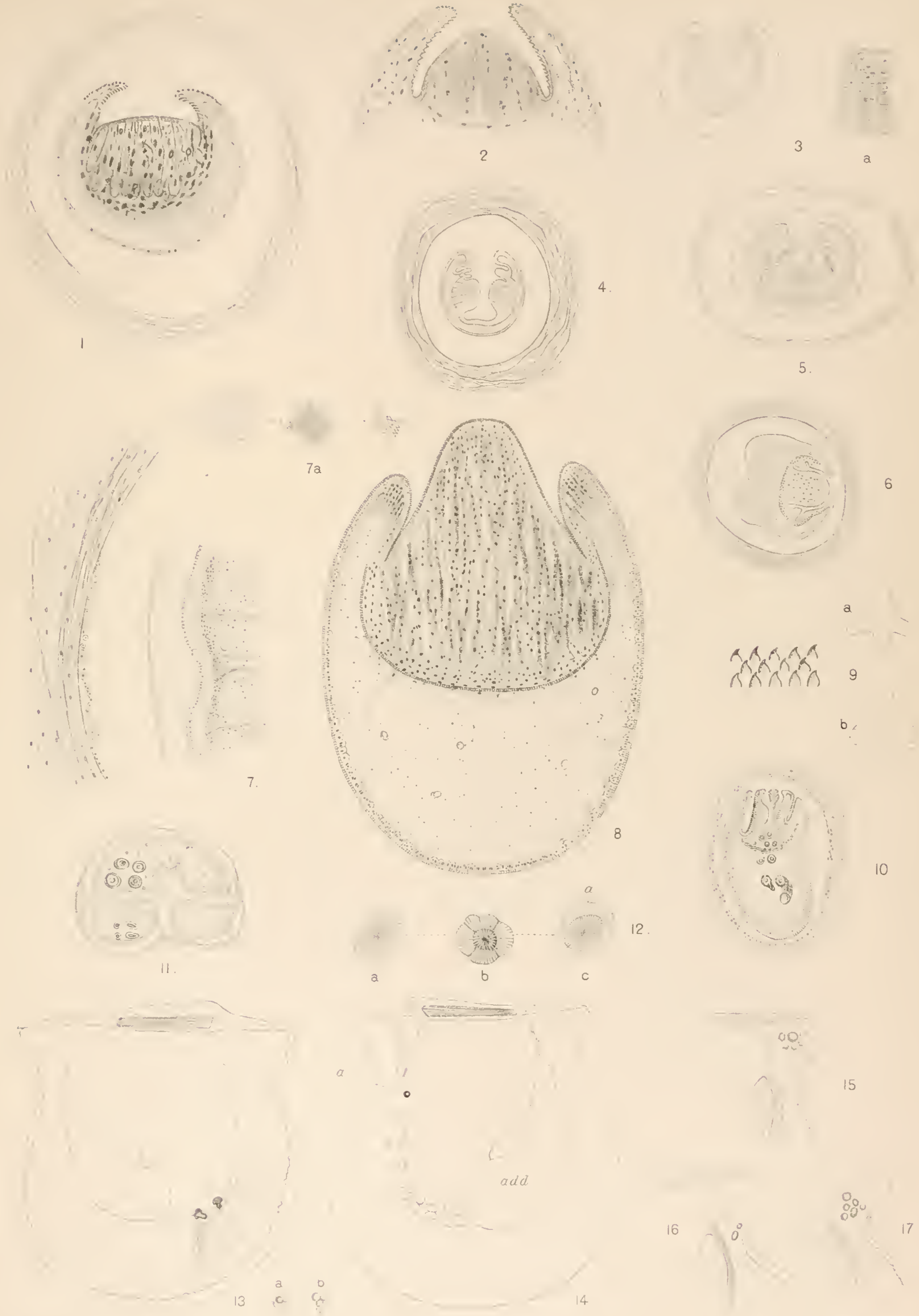
Figs. 13 to 17 are about natural size.

Section of a Tay pearl in the natural condition—magnified. (After M'Intosh, from 'The Zoologist,' for February, 1904—lent by the courtesy of the Publishers.)



PEARLS AND PEARL CYSTS

CESTODE LARVÆ



CESTODE LARVÆ AND PEARLS

REPORT

ON THE

CESTODE AND NEMATODE PARASITES

FROM THE

MARINE FISHES OF CEYLON.

BY

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[With SIX PLATES.]

In this Report the Cestodes and Nematodes collected from fishes taken off the Coast of Ceylon, and especially in the Gulf of Manaar, mainly in the first half of 1905, are described alphabetically under their several hosts, which in their turn again are arranged alphabetically. The Trematodes follow in a separate article which Dr. Lühe, of the University of Königsberg, has been good enough to write.

Owing to the necessity of bringing to a conclusion this "Report to the Government of Ceylon," the time allowed for the investigation of the large number of Cestodes in the collection was very limited, and it has not, except in very few cases, been found possible to "sectionize" the tape-worms. The following descriptions are based on observations made on the living animals and on those that had been killed, stained, and mounted. Many genera and species were represented by but two or three specimens, and in some cases even one was all that was available for study. We are greatly indebted to Mr. E. Wilson, of Mill Lane, Cambridge, for the care he has taken in drawing many of the figures which illustrate this Paper.

I. CESTODA.

We shall print the names of the fish-hosts in small capitals in the centre of the line, the names of the Cestode parasites will be in Clarendon type, the genera in the centre of the line, and the species at the left-hand margin.

AETOBATIS NARINARI (EUPHRASEN).

The Tamil name is "Pua tirikkai." Occasionally it is also termed "Kuruvi tirikkai," the "bird-ray"; but this latter is a somewhat general term applied to several of the bird-like rays and analogous to our use of the term "eagle-ray." *Pua tirikkai* is the true distinctive Tamil term. In Sinhalese it is "Pulli-maduwa." Very characteristic features of this fish are the *blue-black* tint of the flesh, and the manner in which the inner surface of the stomach is raised into a multitude of stout fleshy papillæ.

The specimens dissected were :—

A. A small individual from Puttalam Lake, opposite Kalpitiya. Width of disc, $14\frac{1}{2}$ inches; $6\frac{3}{4}$ inches between mouth and anus; length of tail, 32 inches. December 30, 1904.

B. A larger one from the open sea off Dutch Bay Spit. January 2, 1905.

C. A third individual from same locality as B. January 6, 1905. Dimensions :—Width of disc, $27\frac{1}{2}$ inches; length of disc, 27 inches; length of tail, 34 inches. From the root of the tail to the root of the tail spine was 11 inches.

Food :—Specimen A. The stomach contents consisted entirely of the remains of Lamellibranch shells and visceral masses. There were fully two hundred recognizable pedal fragments, belonging apparently to a small *Mactra* and allied forms.

B had been feeding principally upon the feet and siphons of Gastropods. A single small Hermit-crab (*Eupagurus* sp.) was also present. The stomach of C was empty.

Cephalobothrium, n. gen.

A large, median, circular sucker takes up most of the head; it is controlled by longitudinal muscles. Four small spherical suckers are placed equidistant from each other in the rim of the circular sucker. The proglottides are wider than broad, with the exception of the last six or seven. The reproductive pores are lateral and very irregularly alternate.

Cephalobothrium aetobatidis, n. sp.—Plate I., figs. 1, 2, 3 and 4.

This curious Cestode was drawn from life by Mr. HORNELL in Ceylon, the enormous terminal sucker being, in that state, much more conspicuous than in the preserved material. This sucker is round, with thickened edges, and from its underside run longitudinal bands of muscles which apparently control it.

The whole head is rounded, shaped like a turban, and bears four minute spherical suckers on the edge of the great median terminal sucker. There is no neck. The proglottides begin immediately after the sucker.

The whole length of the single worm we had at our disposal is 10 millims., but the posterior proglottides seemed ripe; the breadth of the head and of the posterior proglottides is 0·5 millim., the rest of the body is very fine and slender. The proglottides remain broader than they are long until within the last six; here they become square, and the last of all is almost twice as long as it is broad. The posterior angles of each proglottis overlap the anterior rim of the succeeding one, but not to a very pronounced degree. The reproductive openings are very irregularly alternate and lateral.

Habitat:—The spiral valve of *Aetobatis narinari*, taken off Dutch Bay, Ceylon. The specimens came from the fish described above as B.

Hornellobothrium, n. gen.

Very minute, 2 millims. in length. Head with rostellum and four suckers. No neck, but the body behind the head expands into a flattened region, something like the hood of a cobra; some twenty segments make this; the breadth then contracts and the proglottides become cylindrical. Cuticle finely striated. Reproductive pores alternate, slightly irregular.

Hornellobothrium cobraformis, n. sp.—Plate I., figs. 5 to 10.

Great numbers of this curious and very minute species were found in the spiral intestine of *Aetobatis narinari*; five of these were sent to England. They are so small as not to be much more than visible to the naked eye, for although they are—or at any rate the two larger are—2 millims. in length, they are of an extreme tenuity in breadth, looking like little bits of very fine white silk.

When alive, these Cestodes have a head with knob-like rostellum, on a constricted stalk; this emerges from a broader squarish base, whose angles bear four deep suckers. The whole is capable of considerable expansion and contraction; and constitutes the head. There is no neck, the proglottides beginning immediately after the head. The first twenty proglottides widen out to form a broad flattened part of the body, in outline like the inflated hood of a cobra. These proglottides are all many times as broad as they are long, and the ratio of these diameters is greatest about the tenth or eleventh segment. About the twenty-first or twenty-second segment the proglottides become, perhaps, twice as broad as long and by the twenty-fourth they are square; the remaining four or five proglottides are longer than broad, but the longest is never more than twice as long as broad. The posterior edges of the proglottides overhang the succeeding segments, but the extent to which this is done varies with the state of the contraction or expansion of the body. The cuticle is finely striated. The reproductive pores are alternate, but rather irregularly so, two consecutively left or right sometimes appearing.

Habitat :—*Aetobatis narinari*, in the spiral intestine.

Kystocephalus, n. gen.

Head bladder-like, with four small suckers and a myzorhynchus which is partially covered by a membrane. Proglottides with very salient posterior borders, most of them much broader than long. Lips of reproductive pores, which are irregularly alternate, very prominent.

Kystocephalus translucens, n. sp.—Plate I., figs. 11 and 12.

The two specimens of this worm at our disposal measured, respectively, 10 millims. and 35 millims., yet each appeared to end in ripe proglottides.

The head and the thicker part of the body measured 0·4 millim. in breadth. The head is a curiously bladder-like concern, which takes little stain and bears four very small spherical suckers. There seems to be a myzorhynchus, surrounded and half enclosed in a circular membrane. The membrane, however, has a central circular aperture through which the myzorhynchus protrudes. Immediately behind the head the proglottides appear, and for about one half the body-length they are considerably broader than long; they then become square, and the last five or six are longer than broad. The posterior end of each proglottis widens out like the walls of a funnel and overlaps the anterior end of the succeeding proglottis to a much greater extent than is usual, so as to sometimes cover a third of the hinder proglottis. At least this is the case in one of our specimens; in the other this salient edge was curled back like the brim of a top-hat. The genital orifices are lateral and in the posterior proglottides have very prominent lips; they are irregularly alternate, usually two or three on one side and then three or four on the other.

This form seems to be not far removed from the genera *Tylocephalum* and *Cephalobothrium*, but it is marked off by quite definite features.

Habitat :—*Aetobatis narinari*, in the intestine.

Myzocephalus, n. gen.

"Head" with four slipper-shaped bothridia each divided by a horizontal partition into two areolas. "Head" surrounded and smothered in four most voluminous and crumpled folds like the bothridia of *Anthobothrium*. Proglottides barrel-shaped. Reproductive pores irregularly alternate. Cuticle finely ringed.

Myzocephalus narinari, n. sp.—Plate I., figs. 13, 13*a*, 14, 15, 16*a*, *b*, *c*.

This remarkable form reminds one of an *Anthobothrium* which has enormously developed and crumpled up its bothridia, as in *Phyllobothrium*, and which retains a myzorhynchus or "head." The largest of our specimens measured 25 millims. in length. The head with its ruff-like bothridia measures 2 millims. across and the posterior ripe proglottides measure 1 millim. transversely. The anterior end consists of a head which bears four slipper-shaped bothridia each divided by a horizontal ridge into two areolas. They are very mobile. In life the head is very contractile and readily alters its shape (figs. 16*a*, *b*, *c*). Its anterior end is rounded. The water vascular canals penetrate the head and anastomose there, branches are also given off into the "ruff." During life the puckered bothridia were continually undergoing changes of form and the whole mass was in constant motion and transformation. The ruff is formed of four immensely crumpled lateral extensions which branch all together and completely hide the head and give the anterior end of the body the appearance of a cauliflower. These four extensions are borne on four stalks which are equally immersed in their voluminous folds. It needs but an extension of the so-called bothridia of *Anthobothrium* to produce this ruff, but if the extensions are morphologically bothridia, then in this worm we have a double set of bothridia, one in the head, the other forming the ruff. The excretory tubes on each side extend to the end of the myzorhynchus, and then double back.

There is no neck, the transverse divisions beginning immediately after the insertions of the ruff. The line between the proglottides is straight, and except faintly at the anterior end of the body there is no trace of overlapping. The cuticle is finely ringed. The proglottides are barrel-shaped, arching out at each side. The first differentiation which arises in the growing proglottides is the appearance of the scattered testes, and almost at the same time the primordium of the uterus and genital ducts arise. The uterus even in our ripest specimens remains unbranched. The complex of the ovary and shell gland lies posteriorly. The openings of the genital duct are irregularly alternate, perhaps 4 on the right side, 1 on the left; 5 on the right, 3 on the left, and so on.

Habitat:—The spiral intestine of *Aetobatis narinari* taken off Dutch Bay, Ceylon. These Cestodes came from the specimen B mentioned on page 44.

Myzophyllobothrium, n. gen.

Long worms, some 80 millims. in extent. Head with myzorhynchus with four suckers, four bothridia, sessile, with smooth edges and a thickening (? small sucker) at the apex. No neck. Proglottides never overhanging, with anteriorly straight sides. Red pigment at base of head apparently associated with water vascular system.

Myzophyllobothrium rubrum, n. sp.—Plate I., figs. 17 and 18, and Plate II., figs. 19 to 21.

This curious worm, taken from the intestine of *Aetobatis narinari*, belongs to the order Tetraphyllidea,* Carus, and to the family Phyllobothriidæ, but it seems to us to

* Bronn's 'Thierreich.' "Cestoda," by M. Braun.

form a new genus which we have called *Myzophyllobothrium*. This form obviously comes near *Phyllobothrium*, but there is no neck and there is a distinct "myzorhynchus." It is a much larger form than *Hornellobothrium cobraformis* found in the same specimen.

The worm is a long one for a Selachian parasite, measuring some 8 centims. in our longest specimen, and about 0·4 millim. broad. The head is 1 millim. across. It consists of a terminal myzorhynchus which bears four almost terminal suckers; the whole is very delicate, transparent, mobile and capable when alive of great extension. The myzorhynchus is flanked by four bothria or sessile, leaf-like extensions; these also bear at their apex a small thickening which may represent a sucker. The edges are not crumpled and wrinkled as in *Ph. lactuca*, but are smooth and entire.

There is practically no neck. The proglottides are cut off from one another by perfectly flat partitions at right angles to the surface. The two sides of each proglottis in the anterior half of the body are flat and, as nearly as possible, parallel; behind this the sides become somewhat bowed outward, and thus there is a constriction at the "joint." There is no trace of overlapping of the posterior end of a proglottis over the anterior end of the next succeeding. The centre of the body consists of proglottides, which are about square; the most posterior proglottides may reach a length of three times the breadth.

The testes appear early, and are always accompanied by an L-shaped structure (Plate I., fig. 17*a*), which has a limb passing from the genital aperture to the centre of the proglottis and then another limb running straight back; this probably represents the vas deferens and vagina. The posterior proglottides nearly always have their penes protruding.

When alive, the posterior proglottides readily detached themselves from the worm, and then showed very active movements, crawling about rapidly.

There is a deposit of granular red pigment just behind the head which seems to accompany the excretory canals; at any rate, it runs back along the main longitudinal ducts. It contrasts strongly with the general milk-white colour of the worm.

Habitat:—In the spiral intestine of *Aetobatis narinari*, the individual A from Puttalam Lake.

Tylocephalum trygonis (SHIPLEY and HORNELL).*

Tetragonocephalum trygonis, SHIPL. and HORN.

This species, which has hitherto been recorded only from the intestine of *Trygon walga*, was found associated with *Tetragonocephalum aetobatidis* and with *Myzocephalus narinari* in the intestine of *Aetobatis narinari*.

* This Report, Part III., p. 51. Since writing this article we have come to the conclusion that the genus we described as *Tetragonocephalum* is identical with LINTON'S *Tylocephalum*, 'U.S. Commission of Fish and Fisheries,' Commissioner's Report for 1887, Part xv., 1891, p. 805.

Tetrarhynchus aetobatidis, n. sp.—Plate II., figs. 22 to 24.

This species, of which we had but two specimens, measures 12 millims. in length. The head is squarish, with two well-marked suckers on each side and the proboscides emerging at the four angles of the anterior surface. These proboscides are perhaps a little stouter and thicker than usual. They bear the hooks in oblique rows. The hooks at the anterior end of the extended proboscides are strongly curved backward and have a very characteristic haft. There is a prominent projection anteriorly, just where the hook is inserted into the skin. Posteriorly the hooks become more sabre-like.

One characteristic feature of this species is the swelling which takes place at the posterior half of the head, caused by the presence of the stout muscular bulbs of the proboscis. Just before the junction of the proboscis tubes with the proboscis bulbs are two aggregations of red pigment spots. This region is at least twice the diameter of the succeeding body. There is a short neck, or, at least, a region where no divisions are visible. The number of the proglottides in our two specimens hardly surpassed thirty-five, but the posterior ones were not mature. The proglottides are barrel-shaped. The reproductive pores are irregularly alternate, but, as a rule, there are not more than two consecutively on the same side. The cuticle is roughly ringed.

The diagnosis of *Tetrarhynchus aetobatidis* is as follows :—

Head squarish ; proboscides rather stout ; hooks with tubercle at their base, the anterior strongly recurved, the posterior more sabre-like. The part of the head in which the proboscis bulbs lie is much thicker than the body. Short neck. Proglottides barrel-shaped. Reproductive pores irregularly alternate. Red pigment at posterior end of proboscis tubes.

Habitat :—The intestinal spiral valve of *Aetobatis narinari*. It is also said to occur in *Trygon walga*, and to be common in both Elasmobranchs in Dutch Bay and on the pearl banks.

BALISTES MITIS, Bennett.

The Tamil for this File- or Trigger-fish is "Kilati."

These fishes were abundant on the South-west Cheval Paar pearl banks, Ceylon, on February 5, 1905 ; eight specimens were caught within a short time. The stomach contents were worms, small Crustaceans, small Lamellibranchs, but no pearl oysters in these particular individuals, due to the absence from this locality of any young pearl oysters at the date in question.

Free in the abdominal cavity of one was a strangely coloured Trematode, $\frac{1}{4}$ inch long. It was light brownish-yellow in ground tint, blotched prettily with chestnut-brown splashes.

From the same individual several encapsuled larvæ of Tetrarhynchids were obtained belonging to several species. Two species are quite distinct from either of the two described in our first report. The teeth in both more or less graded from large to small in each row, and are not all similar as in those already described.

Tetrarhynchus sp.—Larvæ.

At least two young forms were taken together with some Trematodes from *Balistes mitis*. Some of these belonged to the species *T. balistidis*,* others were in the form of cysts with the head protruded, others again had their heads enveloped in a bladder. A fourth form is shown in Plate II., fig. 25. It is like *T. balistidis*, and consists of a head which has not yet begun to bud off proglottides. The anterior part of the head bearing the lappets is just about as long as the part bearing the proboscis sacs, whilst the median portion traversed by the proboscis sheaths is two to three times as long as either. The proboscis teeth are graded in each row from long narrow, sabre-like outlines to short beaked forms (Plate II., fig. 26). From the account drawn up at the time of capture from the living material this form had evidently only just escaped from a cyst of the *T. erinaceus* type.

A very different form of *Tetrarhynchus* larva was also taken from the tissues of *Balistes mitis*, and is shown in fig. 27. Here there is no enveloping bladder, but the Tetrarhynchid head is attached and protrudes from a vesicle which shows signs of an excretory pore posteriorly. This larva is evidently one of VAULLEGEARD'S first division, of which *T. lingualis* is the type. The larva differs from the form we described, under the name of *Tetrarhynchus balistidis*, in Part II. of these reports inasmuch as there is the large vesicle present. The whole length of the larva and head is just under a millimetre. The teeth, as drawn from living specimens, are shown in Plate II., fig. 27*a*. The wall of the vesicle, seen under a high power, seems to contain a large number of globules, possibly calcareous bodies.

CARCHARIAS GANGETICUS, MÜLL. and HENLE.

A specimen, measuring 5 feet 6 inches in length and 32 inches in breadth behind the pectoral fins, was taken on January 3, 1905, in Dutch Bay, Ceylon. The contents of its stomach were many fish-bones, but in the small intestine a number of Tetrarhynchids which fall into two species were found. No Entozoa were found in the spiral valve, usually a favourite haunt of parasites.

Tetrarhynchus gangeticus, n. sp.—Plate II., figs. 28 and 28*a*.

Two forms of *Tetrarhynchus*† were taken in the intestine of *Carcharias gangeticus*, one with a stout smooth head, which we have named *T. gangeticus*, and the other smaller with a rumpled head. The former was found in very few numbers, and the three specimens sent to England were short, 10 millims. long, but at least 2 millims.

* See this work, Part II., p. 89.

† Neither agree in many particulars with the *T. carchariæ rondeletii* of WAGENER, *v.* 'Acta Ac. German.,' xxiv., supplement, 1854.

broad, and the head is 3 millims. at least in width. *T. gangeticus* has a smooth, white head, two very clearly defined and large lappets, somewhat heart-shaped, the apex pointing forward and the four proboscides issuing near the two apices, two on each side (Plate II., fig. 28). The proboscides are stout and bear teeth of many sizes. On the concave side of the extruded proboscis are large, strongly recurved teeth ; these are flanked by teeth of lesser size, and they gradually diminish until upon the convex side there are a multitude of fine toothlets. Although it is rather masked, these teeth are really arranged in very obliquely placed rings.

The edges of the lappets are outstanding and sharply separated from the head, and they have clear-cut edges.

The proboscis-tubes leading to the proboscis-bulbs are not spirally twisted so much as bent in and out. The head narrows posteriorly, anteriorly it is 2 millims. in width, and the whole is 3 millims. in length.

There is no neck, the proglottides appear immediately after the head. As there were but three specimens, one only was mounted, and this, which is drawn on Plate II., fig. 28, shows only just the anterior five or so proglottides.

The diagnosis of *Tetrarhynchus gangeticus* is as follows :—

Short (10 millims.), stout (2 millims., and head 3 millims. in breadth) forms. Head with two very clearly cut lappets standing out from general surface. Proboscides stout, with large hooks on one side, diminishing regularly to small hooks on the other. Hooks arranged in oblique rings. Proboscis-tubes bent in and out.

Habitat :—Small intestine of *Carcharias gangeticus*.

Tetrarhynchus perideræus, n. sp.—Plate II., figs. 29, 30, 30*a*, 31*a*, *b*, *c*.

This species was present in large numbers in the small intestine of *Carcharias gangeticus*. The head, and a peculiar extension of the head in this species, is a well-marked shade of dark grey, which contrasts vividly with the matt-white of the rest of the body. Even in the stained and mounted specimens, peculiar coloured granules can be recognized, which doubtless give rise to this colour in the live animals.

This is a big species, some specimens attaining a length of 70 millims., possibly more, as the bottle in which they travelled was full of fragments. The width varies, but is never great, and even the head never exceeds about 1·3 millims. The head bears two lappets, but they are so divided in the centre as to appear like four. They are very compressed into the head and do not stand out. They appear rather puckered at their edges. The proboscides are slender, and bear oblique rows of very minute teeth, all of uniform size (Plate II., fig. 30*a*). The proboscis-tubes and proboscis-sheath are alike short. The head is produced backwards into a very characteristic collar which overhangs and embraces the anterior part of the body. This is a very marked feature (Plate II., fig. 30).

There is a fairly long neck, the first trace of segmentation occurring some way behind the posterior limit of the collar. The proglottides have straight sides, and except at the posterior end there is no sign of the cuticle being indented between them. One peculiarity is that the body, usually about the middle of its length, is thrown into coils and twists of a very characteristic form. In the anterior proglottides one sees a central stained part, possibly the uterus; posteriorly, however, the scattered testes are visible, and the vas deferens and penis, represented sometimes by a clear area, runs from about the centre of the anterior border of each proglottis to the middle of either side, right or left, irregularly alternating.

The diagnosis of *Tetrarhynchus perideræus* may run :—

Head with well-marked backwardly directed collar which, together with the head, is dark grey; the body is white. Some 70 millims. long. The two lappets are almost split into four and lie adpressed and crumpled in the head. Teeth all of the same size. Neck rather long. No constrictions between the proglottides except posteriorly. Penis runs from centre of anterior edge of proglottis to the centre of either side.

Habitat :—The small intestine of *Carcharias gangeticus.*

CARCHARIAS MELANOPTERUS, Quoy and Gaimard.

This fish is in Sinhalese called "Kunda mora." The specimen we examined contained in its stomach a large specimen of the genus *Caranx.* It was caught at Dutch Bay Spit on January 5, 1905, and contained in its intestine the three species of Cestodes described immediately below.

Phyllobothrium minutum, n. sp.—Plate III., figs. 32 and 33.

One or two examples of two forms of *Phyllobothrium* were found in the intestine of *Carcharias melanopterus.* They are a great deal smaller than, for instance, *Phyllobothrium thridax* described by Zschokke, but their head and general structure coincides with that of the genus.

Phyllobothrium minutum measures 8 millims. in length and at the widest 0·3 millim. in width. The neck is very fine and whip-like; it terminates in a small head. The head bears four bothridia with on each an accessory sucker or areola (Plate III., fig. 33). The edges of the bothridia are crumpled, at least slightly so. The round areola was near the centre of each bothridium. The neck is long .and very transparent. The number of proglottides some 80 to 100; each slightly overlaps the one behind it. The central proglottides are still a little broader than they are long, but the posterior are at least one and a half times longer than broad (Plate III., fig. 32).

The reproductive pores are lateral and all on the same side.

The diagnosis of *Phyllobothrium minutum* may run :—

Length 8 millims., greatest breadth 0·03 millim. Head with four sessile bothridia, each bearing a single, large, round areola near the centre. Proglottides 80 to 100, neck fine and transparent.

Habitat :—*Carcharias melanopterus*, in the intestine.

Phyllobothrium pammicrum, n. sp.—Plate III., figs. 34 and 35.

This is the second small *Phyllobothrium* found in the intestine of *Carcharias melanopterus.*

Two specimens which were mounted measured 13 millims. and 11 millims. respectively. The greatest width was 0·5 millim. The head and neck are very transparent. The head carries four sessile, rather crumpled bothridia, in which there are no areolas. The edges of the bothridia are decidedly crumpled. Many muscles run down from the head through the neck, which is long (Plate III., fig. 35).

The strobilization is peculiar. There is no sign of the gradual differentiation of the proglottis first as a narrow band, which broadens as it passes backward, but the most anterior segment is almost as large as those which succeed it—perhaps one ought to say, those which precede it (Plate III., fig. 34). The proglottides have straight parallel sides and straight parallel ends, and their hinder edges do not overhang the front edges of the next behind. The reproductive pores are lateral and confined to one side. The posterior segments are three times as long as they are broad, sometimes even a little longer.

The diagnosis of *Phyllobothrium pammicrum* may run :—

Length 11 millims. to 13 millims. Greatest breadth 0·5 millim. Head with four sessile bothridia crumpled, with no areola. Neck long. Proglottides when they first appear are almost of full size, with straight sides and ends, and no overlapping. Reproductive pores lateral and on one side only.

Habitat :—In the intestine of *Carcharias melanopterus.*

Tetrarhynchus carcharidis, n. sp.—Plate III., figs. 36 and 37.

A minute form of *Tetrarhynchus* was found in the intestine of a *Carcharias melanopterus* taken in Dutch Bay on January 5, 1905. The length usually 9 millims. The anterior end of the body is extremely thin and whip-like; the body, however, thickens posteriorly until the two last proglottides are 0·5 millim. in thickness. These proglottides are very long, 1·5 millims. and 2 millims. respectively.

The head is minute, and in stained specimens takes little stain. The two lappets are smooth at their edges, not wrinkled, and with no indentation or sign of division into two. The proboscides are very fine, and bear a number of spines, not hooks. These spines are thicker at the base than at their free end; they all point backwards. They are very minute, and seem to be arranged in slightly oblique rings. The proboscis-tubes are very closely coiled, and end in the four muscular bulbs, which hardly occupy one fifth of the total head length. The whole head seems to be dusted through with granules (Plate III., fig. 37).

There is no neck. The narrow, band-like proglottides appear immediately behind the head, and they and even the hinder proglottides are separated by quite clear transparent divisions. There are only some eighteen or nineteen proglottides, and we were unable to make out the anatomy of these, as it seemed the material was not very well preserved.

The diagnosis of *Tetrarhynchus carcharidis* is as follows :—

Minute, some 9 millims. Anterior end of body very fine and whip-like. Head small, proboscides very fine, with backwardly directed spines, not hooks; lappets with simple edges, not wrinkled; proboscis-tubes very coiled, proboscis-bulb one-fifth the length of head. Eighteen or nineteen proglottides, separated by clear, transparent partitions, at first very narrow from front to back. The last two attain a length of 1·5 millims. and of 2 millims., and a width of 0·5 millim.

Habitat :—*Carcharias melanopterus*, in the intestine.

CHILOSCYLLIUM INDICUM (GMEL.).

This fish is termed "Kurakan sūra" in Tamil.

A female, sexually mature, and having an egg capsule in each uterus, was caught on the North Modragam Paar, Ceylon pearl banks, on February 3, 1905. The stomach contents consisted of small fishes.

Carpobothrium, n. gen.

A minute form, belonging to the Phyllobothriidæ. The head consists of four stalked bothridia, each ending in a circular, flat area, from which project two processes, which are opposed to one another. One of these is obcordate in outline. The body is coiled, with little or no neck, the cuticle very crinkled.

Carpobothrium chiloscyllii, n. sp.—Plate III., figs. 38 and 39.

These peculiar and minute little tape-worms were taken from the intestine of a *Chiloscyllium indicum*, the common "dog-fish" of the Indian Ocean, on the North Modragam Paar, Ceylon. They are short and in all cases coiled forms, the whole animal being twisted up into a bunch not more than 1 millim. by 0·5 millim.

The head is remarkable for four long arms which end in four remarkable suckers. The arms stand out at right angles to one another and to the neck; they consist of a stalk terminating in a very peculiar bothrium. The stalk is capable of considerable extension. In a sketch made from a living specimen each of the four stalks are extended till they attain a length of about one-sixth the total body length and have parallel sides. In the preserved specimens the stalk is contracted and conical. Each stalk ends in a circular, slightly concave area, from the centre of which emerge two processes, slightly flattened and opposed to one another. The process which is nearer to the centre of the head is obcordate like a violet leaf, the second process is rounded. Around the base of these is a ring of muscle fibres, which is, however, broken into two halves, as is shown in Plate III., fig. 39. The bothridia are very mobile, and take up different outlines in different specimens.

There is practically no neck; the sharp, unstained clear lines which represent the division between one proglottis and the next begin close behind the head. At first the proglottides are much broader than long, but they very soon become square and then much longer than broad, till at the hind end the length is six or seven times the breadth. There are only seventeen or eighteen proglottides in all. Unfortunately the details of the inner anatomy refused to reveal themselves by staining. Two peculiarities of the body are the way it is coiled up, as is characteristically shown in Plate III., fig. 38, and the rapid rate at which the proboscides lengthen.

Habitat:—The intestine of *Chiloscyllium indicum.*

CHIROCENTRUS DORAB (Forsk.).

This fish, the only representative of the family to which it belongs, inhabits the Indian Ocean and the seas of China and Japan. It is known as "Vālai" or "Wālai" in Tamil, and as "Katuwalla," Sinhalese, literally a "bunch of thorns," a reference to the multitude of needle-like bones that are present in this fish. Our specimen was caught at Kalpitiya, Ceylon, on December 29, 1904, and contained Trematodes in the anterior end of the intestine and Tetrarhynchid cysts.

Tetrarhynchus, sp.—Cysts (α).—Plate III., figs. 40, 40*a* and 41.

A number of small cysts containing *Tetrarhynchus* heads were found in the body of *Chirocentrus dorab*, taken at Kalpitiya. They were all taken from the peritoneum.

The cysts are 8 to 12 millims. long, and consist of an oval head 0·7 millim. in breadth and 1 millim. in length, and a long flaccid tail about 0·3 millim. to 0·4 millim. in width. The larval *Tetrarhynchus* lies entirely in the head (Plate III., figs. 40 and 41). It consists of a head and a small unsegmented body piece. The head shows well the four proboscides with their teeth, the proboscis-tubes and the proboscis-bulbs.

The whole cyst is contained in an outer sheath, which is probably a portion of the host. The Cestode part resembles a cysticercus which has been drawn out into a long tail. The head of the *Tetrarhynchus* is invaginated into the sac, but the outer wall of the invaginated portion seems to fuse with the inner wall (which is, of course, the actual outer wall of the *Tetrarhynchus* head) near, but not quite at the posterior end.

The whole cavity of the cyst, into which the end of the larva sticks, is full of cells sparsely distributed with apparently many vacuoles containing fluid between the cells. The nuclei are large. The same tissue occupies the lumen of the tail.

Judging from the number collected, these cysts must have been common in the fish. Unfortunately, it was impossible to make out any detail of the teeth in the retracted proboscis, and as the head alone was present, all characteristics of the proglottides were equally hidden. Hence nothing could be done to determine the species.

Tetrarhynchus, sp.—Cysts (β).

Two different kinds of cysts were found in a second specimen of *Chirocentrus dorab* taken at Marichchukaddi. One closely resembled *T. balistidis*, the other was enclosed in a cyst of peculiar form. The head of the animal lay in a little golden cyst, 2 millims. long by 1 millim. broad, which is continued posteriorly into a long, thin tail some 8 millims. or 9 millims. long.

CYBIUM GUTTATUM, Cuv. and Val.

This fish, one of the "Mackerels" or Scombridæ, harboured two kinds of Tetrarhynchid cysts. The "Seer," as it is called, is one of the most esteemed food-fishes of the Europeans in Ceylon.

Tetrarhynchus, sp.—Cysts.—Plate III., figs. 42 and 43.

A number of Tetrarhynchid larvæ were taken from the peritoneum of a *Cybium guttatum* captured off Trincomalee. Like those described in Part II. of this work as *T. balistidis*, they exist in two stages, one in a cyst, the other without a cyst. Whether one of these is, as we assumed in our description of *T. balistidis*, an older form of the other, or whether they represent separate species, is uncertain. That they are both larval is shown by the entire absence of any proglottides. The form without the cyst is somewhat egg-shaped, 4 millims. long and at its widest 2 millims. broad (Plate III., fig. 42). The most interesting feature in it is that the tail or posterior end is ensheathed in a circular fold like a petticoat, and from it runs up a number of ribs or ridges which fade out in the head. The teeth on the proboscides are large and stout and comparatively sparse (Plate III., fig. 42).

The other larvæ, which on the whole we are inclined to regard as a different species, are enclosed in a voluminous cyst which may attain a length of some 14 millims. and a breadth of 2·5 millims. They were dissected out from the peritoneum of *C. guttatum*. The larval head is very much smaller than that just described; it is invaginated, and the walls of the cavity in which it lies meet and all but fuse (Plate III., fig. 43). They are then continued backward as the wall of the cyst, which is constricted here and there. Posteriorly the exit of the excretory system is visible. The cyst is enclosed in a secondary cyst pathologically formed from the tissues of the host in which it lives. They evidently belong to the second group into which VAULLEGEARD divides the Tetrarhynchidæ, the type of which is *T. erinaceus*.

In another specimen of *Cybium guttatum*, taken at Marichchukaddi, there were several cysts very like those described above, and two very different species of Trematode.

DIAGRAMMA, sp.

Tetrarhynchus, sp.—Cysts.—Plate III., fig. 44.

A number of Tetrarhynchid cysts were taken from an undetermined species of *Diagramma*, a sea-perch common in the hotter parts of the Indian and the Pacific

Oceans. They belonged to the form enclosed in a bladder, *e.g.*, *T. erinaceus*. They are small, measuring 2 millims. by 1 millim., and the head is extremely minute and rather coiled. We figure the cyst on Plate III., fig. 44.

LUTJANUS ANNULARIS, Bloch and Schn.

Tetrarhynchus, sp.—Cysts.

A few small cysts of *Tetrarhynchus* were found in the tissues of this fish, one of the Serranidæ, but little could be made out of them. The same tissue contains a number of oval, brown, glistening, granular-looking bodies, which may have been a species of *Sarcocystis*.

MYLIOBATIS MACULATA, Gray and Hardw.

This common Eagle-ray is known in Tamil as "Panjadi" or "Panchadi tirikkai," also "Neduvali tirrikai," or the long-tailed Ray, and in Sinhalese as "Panjadiya maduwa."

The food of this fish consists of Crustaceans (hermit crabs) and the feet of Molluscs, chiefly *Turbinella* and *Murex*, also *Strombus*, whose opercula were found in the stomach.

Anthobothrium crispum, n. sp.—Plate III., figs. 45 and 46.

A few specimens of this species were taken from the intestine of *Myliobatis maculata*. For Elasmobranch Cestodes they are large tapeworms, reaching a length of 8 centims. or 9 centims. The head is 3·5 millims. in diameter. It is produced into bothridia whose edges are much crumpled, frilled, fringed and subdivided. In some cases the subdivision extends a good way towards the pedicel, and gives the head the appearance of consisting of six or eight bothridia. The pedicels are very short and the bothridia seem to be almost sessile. No myzorhynchus was visible.

The neck is very long, and even quite posteriorly the proglottides show very little demarcation. There is no indentation of any sort. The line which separates one proglottis from its neighbour is usually clear and sharp in the centre, but it hardly reaches the sides of the tapeworm. These latter are quite smooth, and, except that the body slightly increases in thickness, they would be quite parallel. The neck is about 0·7 millim. in width, the posterior part of the body 1 millim. in width.

The specimens did not stain well, and all that could be made out was an L-shaped structure, of which one arm represents the reproductive ducts running to the pore and the other arm the uterus. The reproductive pores are irregularly alternate.

This form is much more slender than the *A. rugosum* of *Trygon walga* and the bothridia are less stalked.

The diagnosis of *Anthobothrium crispum* is as follows:—

Length, 8 or 9 centims. Head with four fringed bothridia, somewhat sub-divided and with practically no pedicels. Neck long. Division between proglottides feebly marked, no constriction or overlapping, and the dividing line does not reach the edges. Sides smooth and almost parallel. Reproductive pores irregularly alternate.

Habitat :—Intestine of *Myliobatis maculata.*

Diagonobothrium, n. gen.

Head 2·3 millims. in length, about 1 millim. in breadth. There is a large terminal muscular sucker and two ear-like bothridia which run down right and left of the head. One edge of each of these bothridia runs forward obliquely, and loses itself in the crinkled membrane which surrounds the terminal sucker. There is only one edge on each side thus prolonged, and the two prolongations cross one another at about a right angle. The head is thus asymmetrical. The neck is long and shows hardly any structure.

Diagonobothrium asymmetrum, n. sp.—Plate III., fig. 47.

A single specimen of a curious tapeworm was found, with *Anthobothrium crispum,* in the intestine of *Myliobatis maculata* taken in Dutch Bay. Unfortunately the head and neck, which showed no strobilization and no structure, were alone taken. The head consists of a very large and muscular sucker, centrally placed and terminal. The sucker is surrounded by a rather wrinkled membrane. The head is 2·3 millims. long and anteriorly 1·2 millims. wider ; its average width is about 1 millim.

Each side of the head are two somewhat ear-shaped lateral, hollow bothridia, and the peculiar feature of the head is that one edge of the bothridia is continued up on to the membrane which surrounds the terminal sucker in an oblique manner (Plate III., fig. 47). The other edge of each bothridia is not so prolonged. Thus it comes about that these prolonged edges cross one another, one being on one side, and the other being on the other side of the head. Hence the head is not symmetrical about any plane, and it would be impossible to cut it into two symmetrical " looking-glass " halves. This feature is very unusual in a Cestode, and one could not put from one's mind that it might be an abnormality, especially as only one specimen was taken, and that without any proglottides.

The neck was long and showed little structure, and it was broken across before it began to segment.

Habitat :—The intestine of *Myliobatis maculata.*

Rhoptrobothrium, n. gen.

Minute forms. Head with four bothridia surrounding a myzorhynchus which carries four suckers. Bothridia stalked and leaf-like, with the terminal end cut off and forming an areola. Head extends behind the insertions of the stalk of the bothridia and is followed by a neck,

Rhoptrobothrium myliobatidis, n. sp —Plate III., fig. 48.

Of this minute Cestode, one only was available, and that included little more than the head, and was in a poor state of preservation, showing very little histological detail. The length of the worm, which was obviously imperfect, was 1·8 millims., and the arms of the head when stretched measured 1 millim. from tip to tip.

The head somewhat resembles the head of *Anthobothrium* or *Echeneibothrium*, that is to say there are four arm-like bothridia, but in *Rhoptrobothrium* the bothridia surround a myzorhynchus which projects forward from their common base. Anteriorly, this ends in a bluntly-pointed knob. It bears at equal distances four rather leaf-like suckers whose edges are curled inwards, and bear half-way along their edge a pair of inwardly directed projections.

The bothridia are stalked and in general outline much resemble an ovate leaf. The stalk arises not opposite the suckers in the myzorhynchus, but opposite the space between each pair of neighbouring suckers. The tip or terminal fifth of each bothridium is cut off from the rest by a ridge, and forms a shallow sucker or areola. The edges of the remaining four-fifths are incurved.

Behind the insertion of these bothridia there is a region which may be called the head; this does not stain deeply. It contracts and is succeeded by a neck which stains well. In the single specimen from which this description is taken the rest of the body was absent.

Habitat :—*Myliobatis maculata*, in the spiral intestine.

Tylocephalum dierama, n. sp.—Plate III., figs. 49 and 50.

Along with *Rhoptrobothrium myliobatidis*, a specimen or two of what we take to belong to LINTON's genus *Tylocephalum** were found.

The worms measured between 20 millims. and 35 millims. They were very slender anteriorly, but the posterior proglottides attain a width of 0·5 millim., and the head is about 0·6 millim. in breadth, and is rather longer than broad.

The head consists of an anterior cushion, called a myzorhynchus by LINTON; it is obviously to some extent retractile, and in one of our specimens was slightly "pulled in" in the middle, so that the whole head resembled a cottage loaf. This myzorhynchus is separated from the second part of the head or "bothrial disk," as LINTON has it, by a narrow band, not only by a constriction, but by a band. The "bothrial disk" is spherical and bears four equidistant, simple suckers. There is a short neck. The proglottides are, at the posterior end, not more than twice as long as they are broad. They are flattened. Anteriorly they have salient posterior borders, and these, as they approach the hinder end, become much more conspicuous and overhang an eighth or a sixth of the length of the succeeding proglottis. These funnel-like extensions are very characteristic of this species; they are much less marked in

* 'U.S. Commission of Fish and Fisheries,' Commissioner's Report for 1887, Part xv., 1891, p. 805.

LINTON's species, *T. pingue*. The last proglottides were equally rounded, and contained a uterus full of ova.

The diagnosis of *Tylocephalum dierama* is as follows :—

Length between 20 millims. and 30 millims. Proglottides with very overhanging posterior borders. The body is flattened.

Habitat :—*Myliobatis maculata*, in the intestine.

RHINOPTERA JAVANICA (MÜLLER and HENLE).

"Of the two species of *Rhinoptera* recorded from Indian waters, *R. javanica* is the fish known as 'Valvadi tirikkai' to Tamil fishermen. From the accounts received of a very closely allied but much larger species which goes by the name of 'Mundeikanni tirikkai,' and which I have not yet seen, I have no doubt that it is the second Indian species of *Rhinoptera*, *R. adspersa* (MÜLLER and HENLE).

"Prior to the present, 'Valvadi tirikkai' has been wrongly identified with *Trygon uarnak*. Mr. H. SULLIVAN THOMAS ("Report on Pearl Fisheries and Chank Fisheries, 1884," Madras, 1884, p. 17) was the first in this error, and until the present his identification has been followed. During my recent stay of several weeks' duration at the fishing station of Dutch Bay I had exceptional opportunity to examine large numbers of Rays, and to learn the native names. Before I had seen any specimen of 'Valvadi,' by enquiry from many different sources I learned that its characteristics were entirely those of a *Rhinoptera*. All the men I cross-examined concerning 'Valvadi' laid stress on the snout being truncate; the skin smooth, without tubercles; and the teeth 'stony.' I showed them sketches of Rays, and in each case they recognised a woodcut of the dental armature of *R. javanica* as identical with that of their 'Valvadi.' They all agreed that this is an oyster-eating species, and SULLIVAN THOMAS' statement that the 'Valvadi' devours pearl oysters is correct, but not his linking of it with the name *Trygon uarnak*.

"Later I had the opportunity to dissect both *R. javanica* and *T. uarnak*. The former agreed in every particular with the description of the oyster-eating 'Valvadi,' whereas the latter had the median region of the dorsum tuberculated, a pointed snout, and a dental apparatus wholly unfitted for devouring oysters of large size. The teeth were comparatively weak and closely approximated in form and arrangement with those of the Crustacean-eating *Trygon walga*. The stomach contents in *T. uarnak* were also Crustaceans, consisting of some scores of the young of a small swimming crab. It goes by the distinctive Tamil name of 'Pullian tirikkai,' *i.e.*, 'spotted Ray.' *T. uarnak* is thus the 'Pullian tirikkai' of the natives.

"Reverting to *R. javanica*, the dissection of three specimens showed the food, as evidenced by the stomach contents, to be exclusively molluscan. They consisted almost wholly of Lamellibranch fragments.*

* The shells from the stomach of this specimen were kindly examined by Mr. E. A. SMITH and Mr. B. B. WOODWARD, of the British Museum, but the fragments were too small to be identified.

"The first individual came from Puttalam Lake, opposite to Kalpitiya.

"Samples from the stomach of the second specimen, taken from the open sea off Dutch Bay, contained nothing but the broken shells and visceral masses of a small thin-shelled *Mactra*, rayed with brown.

"These fishes appear to be gregarious, going about in shoals of great numbers. A reliable fish-curer has informed me that during the Pearl Fishery of 1889 a single net, operated on the adjacent coast, took in a single haul 7,000 individuals. My informant was certain as regards the number stated, as it was he himself who purchased the entire catch. His men, even with additional help, took eight days to complete the cutting up. To keep the fish till ready to cut up, the whole lot was buried in trenches in the sand after being roughly eviscerated. Afterwards the men started at one end and worked methodically through the trenches, one after the other. The same year cholera broke out in the Pearl Fishery Camp in the vicinity (Dutch Bay), and many of the ignorant natives traced the source of the epidemic to this vast heap of fish, which no doubt gave off a strong fishy odour during curing operations."*

Echeneibothrium javanicum, n. sp.—Plate IV., figs. 51, 52, 53, 54, 55, 56.

A collection of seven or eight of these Cestodes was taken from the spiral intestine of a *Rhinoptera javanica* captured off Dutch Bay on January 21, 1905.

The specimens are from 9 millims. to 12 millims. in length and about 0·5 millim. in breadth at the broadest part, but the head, when the bothridia are bent out, is at least 1 millim. across.

The head is followed by a long neck which occupies from about one-third to near one-half of the whole body length. It is in this particular alone that our specimens depart from the diagnosis of the genus given by Braun in Bronn's 'Thierreich.' His description includes the words "Hals kurz oder fehlend." In our specimens the neck is very long, very thin, and most clearly marked off both from the head and from the body (Plate IV., fig. 52).

The head consists of four pedunculated pad-like bothridia, somewhat triangular in shape. Each is traversed by two longitudinal and a number of transverse ridges, separating the surface into a number of areolas (Plate IV., fig. 54). One of these is apical. At the base of each bothridium there are seven areolas, and these are followed by three rows of seven, the central row being ended by the apical areola (Plate IV., fig. 54); the disposition of the areolas is easily understood by a reference to the figures. The bases of the four bothridia fuse together and so form the head, but there is no extension forward of any central portion. There is no myzorhynchus, and the bothridia can be widely divaricated, as fig. 52, drawn from the life, shows. Internally the head contains the nervous system, which consists of a transverse ganglion, runs at each side into the lateral nerve-cord, a plexus of water vascular

* This quotation is from Mr. Hornell's notes.

canals which unravel themselves into two dorsal and two ventral canals which run down the neck (Plate IV., figs. 55 and 56), and a series of muscle-fibres which pass to the base of the bothridia. These muscle-fibres gather themselves up into stout strands which run down the neck, and these, together with the nerve-cords and the lateral pairs of water vascular canals, make up all there is in the neck. The neck and the proglottides are alike striated, the cuticle being very clearly ridged. The striation of the neck is more apparent than that of the body, possibly because the proglottides to some extent break it up. The longitudinal muscles can be seen running down the neck. The proglottides begin at the base of the neck, and their appearance can be judged by Plate IV., fig. 51. In the ripe proglottides the central uterus and the lateral yolk-glands take the form of a coil with three limbs. The coil starts from a point in the posterior middle line, passes forward and turns either to the right or left and returns again posteriorly, then passes across the proglottis and runs forward again. One curious feature is that the turning to the right or left goes in pairs. A pair of proglottides with the turning to the left is followed by a pair with the turning to the right, and so on. These markings, which somewhat resemble the Greek key pattern, give a characteristic appearance to the proglottides. The transverse bar which seems to connect the uterus with either the right or left row of vitellaria is formed of the genital duct and penis. The genital pores are lateral and alternate in pairs, first a pair on the left side, then a pair on the right. The penis is covered with minute spines.

The diagnosis of *Echeneibothrium javanicum* is as follows :—

Length from 9 millims. to 12 millims. Head with no myzorhynchus; the four bothria divided by two longitudinal ridges into three rows of areolas, one of these being terminal; then come three longitudinal rows of seven areolas, and at the base is a transverse row of seven large areolas. A long narrow neck occupies one-third to one-half the body-length. Cuticle very definitely striated.

Habitat :—*Rhinoptera javanica*, in the intestine.

Echinobothrium rhinoptera, n. sp.—Plate IV., figs. 57, 58 and 59.

Along with the *Eniochobothrium gracile* a few specimens of a curious Cestode which we place with the genus *Echinobothrium* were found. The specimens measured about 3 millims. in length, the head slightly over 0·2 millim. As a rule in the genus *Echinobothrium* the head is succeeded by a portion called the "Kopfstiel" by German writers. This bears eight rows of very characteristically shaped spines. In our specimen, however, the head is borne by a long "neck," devoid of spines. This "neck" is 0·3 millim. in length, and in the fresh condition it seemed strobilized, but in the stained and mounted preparations this seems not to be so much a real strobilization as a more or less regular wrinkling of the cuticle. Unfortunately, the number of specimens was so small that we could not settle this point by an appeal to the knife.

The "neck" is followed by an armed region 0·2 millim. long. This has eight longitudinal rows of characteristic *Echinobothrium* teeth, with their basal process, their long fine point and the two side rods at right angles to the rest. The number of teeth in each row was either twelve or thirteen. The armed region was greater in circumference than the neck. Behind it the body soon broke up into proglottides, and of these seven or eight could be recognized as distinct. They increase very rapidly in size, and in our mounted specimen the seventh proglottis is 0·75 millim. in length and 0·2 in breadth, and occupies a bulk of about one half to one third the rest of the body. The only internal organs visible are the testes, arranged much as those of *E. musteli*, as figured by PINTNER,* the cirrus bulb and the cirrus. When the latter was exserted, it was seen to bear very numerous minute recurved hooks (fig. 57). The two points in which this Cestode differs from the other members of the genus, *e.g.*, *E. affine*, *E. typus*, *E. brachysoma* and *E. musteli* are the complete absence of any spines on the head,† and the presence of the naked region or "neck" between the head and the armed region of the body. On the other hand, the shape of the head with its four projecting lappets and its intervening two spoon-like depressions, the armed region, the shape of the teeth, the number of the rows of teeth, the number of the proglottides, the arrangement of the testes, all resemble what we know of the genus, and justify us in including this amongst the species of *Echinobothrium*.

The diagnosis of *Echinobothrium rhinoptera* is as follows:—

No spines on the head. An unarmed region, the "neck," separates the head from the toothed region. Teeth in eight longitudinal rows, about twelve to thirteen in each row.

Habitat:—The intestine of *Rhinoptera javanica*, MÜLL. and HENLE, taken in Dutch Bay, Ceylon, on January 10, 1905.

Eniochobothrium, n. gen.

Small Cestode, ranging from 6 millims. to 12 millims. in length. Head unarmed, with four suckers, rostellum conspicuous. Body divided into several regions, first a narrow neck of three or four segments; secondly, an oval region of eighteen segments, which get broader until about the tenth proglottis and then narrow again —the segments of this region overlap like a many-caped cloak; thirdly, a second very narrow region of eighteen segments, all about the same size; fourthly, the reproductively ripe region of six to eight segments rapidly maturing and becoming very large, the last, and in some cases the last two, being as large as the rest of the body. The reproductive pores are lateral and alternating; the cirrus bulb and cirrus are very large, and the latter has a broad band of chitinous spicules.

* 'Arb. Inst. Wien,' viii., 1888.

† These may have fallen off, but no trace of them was observed in the fresh state.

Eniochobothrium gracile, n. sp.—Plate IV., figs. 60 to 62.

Along with certain specimens of *E. javanicum* from the intestine of the *Rhinoptera javanica* captured off Dutch Bay on January 10, 1905, were some small but very remarkable Cestodes which we have named *Eniochobothrium gracile.* Unfortunately but few specimens of each were taken.

Eniochobothrium gracile measures, according to Mr. Hornell's drawing, natural size, 12 millims., but in the few specimens put into spirit none surpassed 5 millims., and the only one mounted attained a length of 3·5 millims. These specimens, it is true, had all lost their heads, but, as the sketches show, this takes up but a small proportion of the total body length. Possibly they may have shrunk in spirit.

The head is pyramidal in form, the apex pointing forward (Plate IV., fig. 62). This part, which represents the rostrum, is circular in outline, but at the base of the pyramid the circumference becomes quadrangular and bears at each angle a small but conspicuous sucker ; behind these the head rapidly narrows towards its insertion into the neck. The rostrum is unarmed.

The drawings made from the fresh specimens show behind the head a short neck of three segments. This is followed by a remarkably expanded portion of the body forming an oval somewhat pointed at both ends (Plate IV., figs. 60 and 62). This expansion consists of some eighteen segments which, beginning behind the neck, gradually increase in width until the ninth or tenth segment and then diminish again until they reach their narrowest at about the eighteenth segment. The posterior edges of these segments are very salient and overlap the succeeding segments, except in the middle line, where there is a break just as there is in front between the right and left sides of an Inverness cape. In fact this portion of the body looks somewhat like the elderly coachmen who figured in the early half and middle of the nineteeth century, encased as they were in innumerable capes, each a little longer than the other, as one penetrated inwards from without.

Behind this oval portion comes another isthmus, consisting again of about eighteen segments, very much narrower than any in the expanded oval region and very much shorter from before backwards. They are perhaps a little wider than the segments of the neck, but they are very small.

We can easily imagine how segments can become larger as they are pushed backward by the intercalation of new segments behind the head, but it is not so easy to see how they shrink. The wide large tenth segment of the oval expanded area must gradually dwindle as it becomes in turn the eleventh, twelfth, thirteenth, and finally the eighteenth. There must be an almost sudden shrinkage as the eighteenth passes into the nineteenth segment, and then the bulk of the segments remain about constant and very minute until the thirty-sixth segment is reached (Plate IV., figs. 60 and 61). After this come some six or eight segments which very rapidly increase in size ; so quickly do they grow that each of the last two may equal or even surpass the whole of the rest of the tape-worm

The most conspicuous feature of these large proglottides is the cirrus bulb and the cirrus. The former is conspicuous and median, the latter is in all cases we have examined protruded in the last two proglottides, but most fully in the last. The cirrus is a pleurecbolic introvert, and for one portion, and one portion only, it is covered by a broad band of bristles or minute chitinous teeth or rods. Traces of vitellaria and testes can also be made out. The genital openings are lateral and alternating.

Unfortunately we had only two or three specimens at our disposal, and it was not advisable to cut any of them into sections, so that our knowledge of the minute anatomy is still to seek.

The peculiarities of this Cestode are so marked that it deserves to be recognised as at least a new genus, if not as a representative of a new family. Until we know more of its anatomy it is probably wiser to confine ourselves to the establishment of a new genus, and we suggest the name *Eniochobothrium*, in view of the Cestode's many-caped-coachman-like appearance.

Habitat:—From the intestine of a *Rhinoptera javanica*, Müller and Henle, taken off Dutch Bay, Ceylon, on January 10, 1905.

Tetrarhynchus unionifactor, Shipley and Hornell.—Plate IV., figs. 63 and 64.

These specimens were taken from the intestine of *Rhinoptera javanica*, Müll. and Henle, captured in Dutch Bay. They are described as existing in swarms in the stomach, especially at the pyloric end. Very few were found in the spiral intestine. They occurred in all the specimens of *Rhinoptera javanica* captured. The longest was 3 centims., the other two were about half that length; but Mr. Hornell states that when alive they can extend themselves to 4 or 5 inches. The head and body are stout, averaging a little under a millimetre in diameter; the proboscides are very small and fine, and are invisible to the naked eye. They arise apically, close together at the anterior surface of the head, and are supported by two shallow cephalic suckers or bothridia on each side which meet anteriorly. The neck extends for 1·5 millims. to 2 millims., and contains the four clearly-marked proboscis sheaths and four tubules proceeding from them enclosing the retractor muscles of the proboscides; these are very convoluted. The proglottides are at first broad and shallow, but they soon lengthen, and in the middle of the body they are cylindrical, three times as long as broad and circular in transverse section; their posterior border just overlaps the succeeding segments, but only just. Posteriorly the proglottides lose their shape, become baggy, and develop a purplish-brown colour, and here they are 2 millims. in length and rather over 1 millim. in breadth.

The genital openings are irregularly alternate, there being perhaps two pores on the right side, succeeded by two on the left, then one on the right, and so on.

The anterior proglottides are very shallow, and lie one upon another like a series of saucers or a pile of developing ephyræ; when they deepen a little, they have one, rarely two, transverse creases in their cuticle, but as they get to be as deep as they are broad, the number of these creases has very much increased, and the posterior end of the body is quite crinkled.

The proboscides are armed with hooks which are spirally arranged; the hooks are not very hooked, and the angle is slight; further, the hooks are all shaped alike and are all about the same size. They are very small.

The two bothridia are comparatively shallow, but during life their edges are obviously very mobile, and they may deepen or become shallower as occasion arises. Their outline is roughly triangular, one angle being anterior. The angles are very rounded, and the deepest part of the bothridium lies in the posterior angles.

We have in these forms, undoubtedly, the mature generation of the larval form we described and named *T. unionifactor* in the tissues of the pearl-forming oyster, *Margaritifera vulgaris*, SCHUM. In the structure of the head, the lappets with bothridia, the arrangement, shape and size of the hooks on the young and the old animals closely resemble one another. There is no doubt that the immature *T. unionifactor* is swallowed by *Rhinoptera javanica* when it eats the oysters, as it undoubtedly does, and that the tapeworm becomes mature in the intestine of the fish, that it lays eggs, and that these, somehow or other, make their way into the pearl oyster. Whether some of these become the little Cestode larvæ around which the pearls are deposited is still largely a matter of conjecture; if they do, they perish in a costly coffin. It is certain, however, that many of the young of *T. unionifactor* escape entombment and grow into the larval forms described in Part II. of these Reports. If we could find quite young larval forms of this *T. unionifactor*, and if on comparison with the forms which make the pearl they appeared to us to be identical, we should have solved the problem of pearl-formation, at any rate in the Ceylon seas. It seems increasingly probable that the pearl-forming Cestode is a *T. unionifactor*, but this has not yet been *proved*.

We described the species from the larva as we had no adults at our disposal; we now add a few more features taken from the adult.

The diagnosis of *Tetrarhynchus unionifactor* is:—

Head and proboscides as in the larva (see Part II. of these Reports, p. 88). Length, 1·5 millims. to 3 millims. Head and body stout. Neck containing the much-coiled proboscis sheaths, and the proboscis bulbs 1·5 millims. to 2 millims. in length. Genital pores irregularly right and left. Anterior proglottides shallow and saucer-like, with projecting edges, but about the middle of the body the proglottides hardly overlap at all, and the right and left sides form a straight line. There is, however, especially anteriorly, a tendency to be crinkled.

The larval form is found in the tissues of the pearl oyster, *Margaritifera vulgaris*, SCHUM., and possibly encysted in the pearls. The adult lives in the stomach of *Rhinoptera javanica*, MÜLLER and HENLE, a great Ray which feeds on oysters.

Tiarabothrium, n. gen.

About 11 millims. to 12 millims. long. Head with four sessile bothridia, each divided into twelve transverse areolas; the bothridia can be raised off the head anteriorly. Two stout muscles enter the head laterally and split up into four muscles on each side, two of which are inserted into each bothridium. Definite neck present, provided with an extensile collar. Proglottides with slightly concave sides, divided from each other by perfectly flat partitions. Genital pores alternate. Penis with numerous spines.

Tiarabothrium javanicum, n. sp.—Plate IV., figs. 65, 66, 67 and 68.

Length of the worm 11 millims. to 12 millims. Breadth of head 1 millim., average breadth of body 0·5 millim.

The head bears four bothridia, each divided by transverse ridges into twelve areolas, which, since each bothridium is oval in shape and rather pointed at each end, are very diverse in size, the anterior and posterior areolas being much smaller than the median. The bothridia are sessile upon the head, and judging from the preserved specimens were closely attached to the head by their whole inner surface. However, the drawing made by one of us of a living specimen shows that they are capable of standing out from the head anteriorly for about one-quarter to one-third of their length. The remainder of the bothridium remains, however, always in continuity with the head, and there is never any question of a stalk. The presence of the bothridia with the areolas gives the head something the appearance of a spherical Chinese lantern (Plate IV., figs. 66 and 67).

Longitudinal sections show that the head is a rather more flattened globe than is our earth. The interior of this globe consists of dense connective tissue, but between this and the inner faces of the bothridia is a layer of very loose tissue, and it is by the play this loose tissue allows that the bothridia can be in the anterior half raised a little away from the surface of the head (Plate IV., figs. 67 and 68).

Two very stout lateral muscles enter the head from the neck. They soon split up into eight separate muscles, of which two are dorsal, two are ventral, and two are right and two are left laterals. There is a lateral and a dorsal behind each of the dorsal bothria, and a lateral and a ventral behind each ventral bothria. As these muscles pass forward the laterals die out, but the two dorsals and the two ventrals are continued forward and break up into a number of small strands, which ultimately disappear in the connective-tissue mass which occupies the centre of the head. The water vascular system lies laterally, but there are at one or two levels cross communications between the right and left vessels, and the vessels on each side are very convoluted and coiled; as they pass down the neck they take up the position of dorsal and ventral vessels on each side of each segment.

The head is followed by a definite neck, and this is clothed by a very turn-down collar, such as a lower-form Eton boy wears. The free edge of this collar projects backwards for a variable distance. In the living form drawn by one of us the collar is far more extensive than it appears to be in the preserved specimens; it may have shrunk in the preserving fluids. In the one which was cut longitudinally there is evidence of such shrinking, especially at the base of the head.

The proglottides are at first extremely narrow, but lengthen out until about the centre of the body they are as long as they are broad. Posteriorly they may be three times as long as they are broad, and here they have the somewhat melon-seed outline of the *D. cucumerina*. In front of the last three or four proglottides, each has slightly convex sides, and the posterior edge is slightly broader than the anterior, so that the posterior edge of each proglottis extends a little beyond the anterior edge of the next behind it, but it does not overlap. The junction of two proglottides is always in one plane. The transverse section is almost circular, the dorso-ventral axis being but little shorter than the ventral.

The genital pore is lateral. The penis is armed with innumerable minute recurved spines. The yolk glands are very definitely arranged in a layer external to the other reproductive organs. As they stain deeply they form a conspicuous ring just inside the muscular layer, which is thin. Posteriorly they converge to a spot near which the ovary probably lies. The uterus is thick walled. The testes occupy a large part of the body within the vitellaria, and there is a conspicuous vesicula seminalis, crowded with spermatozoa. There were only two specimens available for study; one of these was mounted whole, the other was partially sectionized, but in none of the proglottides cut were there eggs in the uterus.

Other specimens of the species *Tiarabothrium javanicum* came from the intestine of the *Trygon walga*. The bothridia were not very distinct, and the number of areolas could not be made out. In one specimen, which was mounted, the breaking up of the longitudinal muscles as they entered the head was very clearly shown. The proglottides are broadest in the middle and narrow towards each end, and the posterior end is no wider than, and does not overlap, the anterior end of the next succeeding proglottis. There is no unsegmented neck, the first proglottis coming immediately behind the head, and the anterior half of the body is broadest at about the region between the eighth and the sixteenth proglottis. The cirrus is armed with spines. The collar is small.

Habitat :—Intestine of *Rhinoptera javanica*.

RHYNCHOBATUS DJEDDENSIS, Forsk.

A ray common throughout the Indian Ocean, from the Red Sea to Sumatra.

Tetrarhynchus rhynchobatidis, n. sp.—Plate IV., figs. 69, 70, and 71.

The Tamil name for *R. djeddensis* is "Pal-ulluvi," the Sinhalese "Kiri-uluwa," or "Uluwa mora." Both "pal" and "kiri" signify milk and refer to the milk-white spots on the body of the species. Two individuals were dissected; in one the remains of a number of fish, including a young *Pristis* sp., were found, in the other only crustacean fragments. The parasites were few in number and all belonged to one species of *Tetrarhynchus*.

The largest specimen of this *Tetrarhynchus* attained a length of 5 centims.—but since some loose proglottides measured 4 millims. each, probably the full length is greater—and its posterior end a width of 1 millim. The length of the head is 4 millims. The lappets are short and widely separated; anteriorly they occupy 1 millim., and the remaining 4 millims. are equally divided between the part of the head which contains the proboscis tubes and the part which contains the proboscis bulbs. The part of the head which bears the lappets is 1·2 millims. broad, but behind this the head tapers. The colour of the living specimens is an opaque milk-white.

The hooks in the proboscides are arranged in longitudinal rows and also in rings; the latter are almost horizontal, there being only a very slight trace of obliquity as they surround the stem. One peculiarity which we have not noticed in other species is that on each proboscis there is a longitudinal row of hooks, whose points are reversed and look towards the tip of the proboscis and not to the base, as do all the others. The shape of the hooks is shown in fig. 71; some of them are not nearly so hooked as others and pass into sabre-like forms.

Another peculiarity is that the outer muscles of the proboscis bulb are very oblique, very clear, and cross one another at right angles, giving a "Malvolio, cross-gartered" appearance to these structures.

There is a short neck, and then a number of proglottides, five or six times as broad as long, separated one from another by perfectly straight lines and with at first parallel straight sides. They soon, however, begin to lengthen, and at the end of the first quarter they are square. The sides also begin to bow outwards, but the ends are always flat, and there is absolutely no overlapping.

The reproductive pores are lateral and at the juncture of the anterior two-thirds with the posterior third. Their circular lips are prominent and everted. The pores are irregularly alternate; for instance, starting at the last of one specimen, they run as follows:—1 right, 3 left, 2 right, 1 left, 1 right, 2 left, and so on.

The diagnosis of *Tetrarhynchus rhynchobatidis* is:—

Five centims. long, posteriorly 1 millim. broad. Head with small lappets. Milk-white when alive. Proboscides with longitudinal rows of hooks, one row being turned the wrong way, hooks also arranged in nearly horizontal rings. Proboscis bulb chequered by external, obliquely-placed muscles, crossing each other at right angles. Proglottides not overlapping. Genital pores with everted lips, lateral, irregularly alternate, situated at anterior border of last third of the proglottis.

Habitat:—Intestine of *Rhynchobatus djeddensis*.

In another specimen of *Rhynchobatus djeddensis* were a couple of single proglottides

15 millims. in length by about 0·5 millim. in breadth, but in the absence of the head they could not be identified. Specimens of *T. herdmani* described under *Trygon walga* were also taken from this fish.

SPHYRÆNA COMMERSONI, Cuv. and Val.

This is the sole genus in the family Sphyrænidæ. The species are often called "Barracudas"; they are large voracious fishes living in the tropical and sub-tropical seas.

Tetrarhynchus, sp.—Cysts :—

A considerable number of large Tetrarhynchid cysts were taken from the abdominal cavity of a *Sphyræna commersoni.*

The cysts are large forms varying in length between 8 millims. and 30 millims., with a breadth of about 3 millims. They belong to Vaullegeard's *T. erinaceus* series, being enclosed in a vesicle as well as in a cyst, which latter is apparently formed by the tissues of the host. The teeth were very crowded, and the excretory opening was visible, but little else could be made out.

TRYGON KUHLI, Müller and Henle.

This large ray is called in Tamil, "*Kătti tirikkai.*"

Two individuals were dissected ; the first captured off Dutch Bay, the second caught on the pearl bank known as South Modragam Paar.

From the stomach contents of these two it would appear that the food consists almost exclusively of small annelids and small crustaceans. In the first named the stomach was distended with a large mass of *Lumbriconereids*, mingled with which were a few thin-shelled small crustaceans. In the second specimen the material was wholly annelidan—*Terebella*, *Lumbriconereis*, *Eunice*, &c.

Phyllobothrium blakei,* n. sp.—Plate V., figs. 72 and 73.

Some half a dozen specimens of this minute worm were taken from a *Trygon kuhli* captured in the pearl banks. Half of these were without heads. They are very delicate, thin, fragile creatures, measuring 10 millims. in length of the body, and at their greatest width some 0·25 millim. to 0·33 millim.

The head measures something over 0·5 millim. It consists of four crumpled bothridia with thickened edges, which are so twisted that they show numerous little bays and rounded recesses which at first sight might easily be taken for small circular suckers. These bothridia spring with practically no stalk from the edge of a hollow which shows some circular markings as if there were here two rings of circular muscles. There is no kind of armature.

The proglottides immediately following the head are broader than the subsequent

* Named in honour of H.E. Sir Henry Blake, K.C.M.G., the present Governor of Ceylon.

ones; they soon, however, narrow, and only very slowly widen again. The sides of the proglottides are straight and almost parallel, and although they project very slightly at their hinder end they do not overlap the succeeding segment. The posterior proglottides are almost three times as long as they are broad, and instead of having square ends they have rounded ones and are swollen in the middle. Their contents seems to be a roomy uterus with numerous large ova. In the stained specimens the central region of each proglottis stains deeply, making a deep line along the centre of the body. The reproductive pores are alternate.

The diagnosis of *Phyllobothrium blakei* is :—

Small delicate forms, 1 centim. long. Head with four frilled bothridia, practically sessile. No neck; the proglottides which come after the head are broader than those that follow. No overlapping at the posterior end of each proglottis. Ends of posterior proglottides rounded. Genital pores alternate.

Habitat :—Intestine of *Trygon kuhli*.

Rhinebothrium ceylonicum, n. sp.—Plate V., figs. 74 and 75.

Although the stalks or pedicels of the bothridia (if indeed they exist at all) must be very short, the specimens about to be described seem to us to belong to LINTON's genus *Rhinebothrium*.* The head bears four fleshy bothridia at the four angles, back to back. Each bothridium is divided into two halves, as in *Rh. flexile*, LINTON, by a longitudinal groove, and each half bears a number of horizontal slit-like areolas placed transversely. The number of these areolas was not exactly made out, but it is somewhere about twenty. The whole recalls a rasp (ῥίνη), after which the creature takes its name. In the preserved specimens, of which only two were taken, the head was rather broader than it was long, its greatest breadth being 4 millims. Judging from the figure taken of the head whilst alive, the length about equalled the breadth. In the living form also the bothridia seem more clearly distinct from one another and from the head; in the preserved form they have all shrunk together.

The length of the body of our longer preserved specimen is 5 centims., but, as in both, the tail is curved up in the lateral plane, and perhaps, if uncoiled, the length would be 5·8 centims. or 6 centims. When alive, it measured 9 inches. The body is stout and wide. Our second specimen—also giving off mature proglottides—was a little more than half this size. In the middle, which is the widest portion, it is 3 millims. broad, and it tapers away slightly both in front and behind. It is 2 millims. thick and is very stiff and firm in the preserved condition.

The neck is short, and the proglottides are at first very narrow from front to back. There seems to be a curious false strobilization whereby five or six segments are grouped together, but this may have been an individual character. The posterior angle of each proglottis was salient and projected slightly over the

* 'United States Commission of Fish and Fisheries,' Report of the Commissioner for 1887, part xv.; p. 768. Washington, 1891.

succeeding proglottis. Only at the hinder end are the proglottides as long as they are broad, and only the last three or four are longer than they are broad. The incurved tail seemed characteristic, at any rate it occurred in both our specimens.

The body was too thick and too opaque for us to make out any details of the internal anatomy.

The diagnosis of *Rhinebothrium ceylonicum* is as follows :—

Head with sessile or almost sessile bothridia, each with two rows of some twenty transverse areolas. Body very stout, 3 millims. in its widest part ; very thick, 2 millims. ; and varying from 3 centims. to about 5·8 centims. in length. Proglottides with salient posterior edges, mostly much broader than long, but the last few longer than broad and a few squarish. Tail incurved.

Habitat :—*Trygon kuhli*, spiral intestine. According to the collector, the same species occurs both in *Myliobatis maculata* and in *Trygon walga*.

In the same bottle with these two worms was another of a different kind, but whose head was so damaged that it is impossible to accurately diagnose it.

Tylocephalum kuhli, n. sp.—Plate V., figs. 76 and 77.

A single specimen was taken from the intestine of *Trygon kuhli*. It measured 12 millims. in length, and its greatest width, which lies a little before the posterior end, is 0·6 millim. The head consists of two portions, something like a cottage loaf, and in general resembling those of *T. uarnak* and *T. trygonis*. The anterior part or myzorhynchus is, however, somewhat smaller than in those species. The larger and posterior part bears four small spherical suckers. The muscles which enter the head from the body spread out in this portion in a button-like manner. Immediately behind the head is a constriction, and then the proglottides begin.

At first the proglottides are very shallow, with projecting rims like a pile of saucers upside down, then about half-way along the body each proglottis is seen to have a groove in it dividing it into approximately equal halves. If we trace the proglottides still further back, we see that these two halves have very different fates ; the anterior becomes the proglottis full of reproductive organs, etc. (Plate V., fig. 76), the posterior becomes the pronounced, everted, and almost recurved, salient edge.

The hindermost proglottis is square, and in no case is the longitudinal diameter greater than the transverse. The last two or three proglottides had the penis protruded, and these were all on the same side.

The diagnosis of *Tylocephalum kuhli* is as follows :—

This form measured 12 millims. in length by 0·6 millim. in width at the widest point. Head separated from body by a sharp constriction. Proglottides at first very shallow, and never longer than broad. About the middle of the body each proglottis is divided into two halves, the posterior does not develop so quickly as the anterior and forms the very marked, recurved, salient, posterior angle.

Habitat :—Intestine of *Trygon kuhli*.

TRYGON SEPHEN (Forsk.).

This fish is known as "Ada tirikkai" in Tamil, and as "Polkolla maduwa" in Sinhalese. A large individual of this species was obtained from the fishermen on Dutch Bay Spit, on January 3, 1905. The breadth of the disc was 47½ inches, and the length from the snout to the butt of the tail was 34 inches.

The stomach itself was empty, but the large intestine was choked with sand, intermixed with which were a large number of partially digested skins of worms, apparently Gephyreans. A few limbs of crabs were also present. It would seem that this *Trygon* feeds principally upon worms, with such small crustaceans as may be associated with them in sand.

Anthemobothrium, n. gen.

Fourteen millims. long when preserved. Head about 1 millim. in diameter, almost spherical, with four small suckers in the hinder half, and fourteen feathered bothridia radiating over the anterior half. Neck narrow and short. Proglottides slightly overlapping their successors. The skin is faintly striped. The uterus in the posterior proglottides occupies almost all the space and is crowded with ova.

Anthemobothrium pulchrum, n. sp.—Plate V., figs. 78, 78*a*, 78*b* and 79.

A single example of this beautiful and remarkable Cestode was found amongst the crowd of *Tetrarhynchus leucomelanus* and *Prosthecobothrium walga* taken from the intestine of a *Trygon sephen* captured in Dutch Bay.

It measures 14 millims. in length when preserved in formaline, and as the posterior segments are crowded with eggs, it is apparently a full grown worm. The head, which is almost spherical and as broad as it is long, measures just under 1 millim. across (Plate V., fig. 79). The neck is very slender and short, and the body gradually, but slowly, broadens until the last segments are about 0·6 millim. broad by 0·9 millim. or 1 millim. long.

The head consists of a basal hemisphere bearing four equidistant, small, rounded suckers. From the distal end of this basal part emerge fourteen radiating bothridia, which are flattened down and look like so many neatly arranged ostrich feathers or frilled petals of a flower.

The neck is narrow and short. The proglottides soon appear, at first much wider than long, but by the middle of the body they are square, and behind are twice as long as they are broad. The genital pore is not clearly visible, but some proglottides seemed to show an aperture on the flat surface near the anterior end. The uterus arises also at this end and is soon evident as a clear coiled tube. The divisions between neighbouring coils soon break down, and in the last proglottis the uterus, crammed with eggs, occupies almost all the space in the segment.

Each segment has a very short lip posteriorly, which slightly overlaps the succeeding one. There is also a curious arrangement, probably of glands, in the skin, which gives the Cestode a longitudinally striped appearance, darker bands where the glands are present alternating with lighter areas where they are not.

Habitat :—Intestine of *Trygon sephen.*

Prosthecobothrium trygonis, n. sp.—Plate V., figs. 80, 81, 82 (*a* and *b*).

One specimen of this Cestode was taken from the intestine of *Trygon walga* and three from *Trygon sephen.* The longest measured when preserved 120 millims. in length. The worm is very slender and soft and anteriorly very narrow, 0·5 millim. only in breadth, though posteriorly it broadens out to a couple of millimetres.

The head is 1 millim. in width. It is square, something like a cushion which is indented in the centre and along the lateral and dorso-ventral axes. The head is thus divided into four squares of equal area, and each of these squares bears at its external angle anteriorly a large hollow or bothridium, on the anterior edge of which lie the hooks mentioned below. Behind each is a single, round, rather small but quite conspicuous sucker. This sucker is a simple sucker and has no sub-divivions or areolas. On its surface each of the four squares bears two hooks more or less connected at their base ; each hook is forked and consists of two unequal-sized prongs ; of these, that which is next the diagonal lines or lines joining the bases of the suckers is the larger and bears a tubercle at its base. The hooks are dark brown, chitinous-looking structures.

The neck is very long, 2 centims. or 3 centims. at least. It is smooth and traversed by a number of longitudinal muscle bands which are conspicuous through the epidermis. They split up in a symmetrical way in the head.

The proglottides are extremely numerous, they have salient posterior angles. They always remain somewhat broader than they are long, even at the posterior end, except perhaps the very last. This species obviously differs considerably from that described by VAN BENEDEN in his "Recherches sur les Vers Cestoïdes"* under the name *Acanthobothrium dujardini*, especially in the relative proportions of the head ; in our worm this is broader than long, in VAN BENEDEN'S it is longer than broad.

The diagnosis of *Prosthecobothrium trygonis* is :—

Slender Cestode some 12 centims. in length. Head square and divided by depressions into four equal squares. Each of these bears a sucker at its free corner and on the surface a pair of unequally two-pronged hooks. Neck very long. Proglottides very numerous, with very salient edges, never longer than broad, except perhaps the last.

Habitat :—*Trygon walga*, MÜLL. and HENLE, and *Trygon sephen* (FORSK.), in the spiral intestine.

Tetrarhynchus leucomelanus, n. sp.—Plate V., figs. 83, 83*a* and 84.

This large species of *Tetrarhynchus* was found in the intestine of *Trygon sephen.*

* 'Mem. Ac. Belgique,' xxv., 1850, p. 133.

Many specimens were taken which measured in length 5 centims. to 8 centims. The anterior end of the body is slender, scarcely 1 millim. broad, though the lappets are quite that. The body, however, slowly widens, and the posterior third is about 3 millims. wide, and here the proglottides are almost square and in the centre 1·5 millims. thick, though they thin off towards all four edges.

One of the most characteristic features of this species is that, when preserved, it is half white and half black. This is perhaps not strictly accurate, it is about the posterior third that is black, and there is no sharp transition, the pigment appearing about, or soon after, the middle and gradually deepening until it reaches a deep slatey black. The living specimens are described as milky white with a rosy pink smudge, fading away behind, at the base of the proboscis sheaths.

The head is 7 millims. long, at the level of the lappets it is 2 millims. broad, behind this 1·5 millims. and it narrows down to less than 1 millim. at the posterior end. The lappets are but very slightly hollowed, their length is about one fifth the length of the head and they are very symmetrically placed (Plate V., fig. 84). The four proboscides are covered with an immense number of very minute hooks; these are regularly arranged in rings and in numerous longitudinal rows, though the arrangement may be upset near the tip, owing to a bit on one side being more evaginated than on the other. The hooks are all the same size. The proboscis tubules are short and coiled, the arrangement is very symmetrical, the two tubes on each side being coiled parallel to one another. The proboscis sheaths are very long and occupy seven-tenths of the total length. There seemed a certain difficulty in withdrawing the proboscides, at any rate they are seldom completely withdrawn. They are fine and narrow and converge near the posterior end. There is a short neck, and at first the segments are six or seven times as broad as they are long; by the middle of the body they are almost square and the last two or three are longer than broad. A row of well separated but clearly marked longitudinal muscles is conspicuous, especially in the larger segments. The posterior edge of each proglottis is salient and at first a little overlapping, in the posterior proglottides it sticks out like a frill, and forms a quite distinct rim round the posterior end of the proglottis. The generative pores are alternate and rather irregular.

The diagnosis of *Tetrarhynchus leucomelanus* is as follows :—

Five centims. to eight centims. long, with posteriorly thick, stout proglottides, 3 millims. broad. Anterior half or two-thirds of the preserved body white, the remainder slaty black, deepening into a dense black. When alive, milky white, with a pink patch behind the proboscis sheath. Head with two shallow lappets, well defined. Proboscides with an enormous number of very minute teeth, all uniform in size and shape, arranged in rings and longitudinal rows. The proboscis sacs are very long, occupying seven-tenths of the length of the head. There is a short neck, the posterior edge of each proglottis is salient. Generative pores irregularly alternate.

Habitat :—Intestine of *Trygon sephen.*

TRYGON UARNAK (Forsk.).

This fish is called "Pullian tirikkai" in Tamil, which signifies "spotted ray," and well describes its appearance.

One specimen was obtained at Dutch Bay on January 6, 1905. The length of the disc was 28 inches, the breadth 33 inches, and the tail was 56 inches long.

Food.—The stomach contents consisted exclusively of some score of small, swimming crabs.

Tylocephalum uarnak, n. sp.—Plate V., figs. 85 and 86.

A few examples were taken from the intestine of *Trygon uarnak.* The longest measured some 35 millims. The number of segments is, however, small, varying from 30 to 40. The head, which is a little exaggerated in our figure (Plate V., fig. 86), stands out like a button or knob at the end of the fine neck. The body is thickest in the middle, some 0·7 millim. in breadth, the posterior extremely elongated proglottides have a somewhat attenuated look.

The head consists of an anterior lobe, resting on a squarish cushion; the anterior lobe or myzorhynchus seems to be fixed on to an extension borne by the cushion as though on to a peg. This extension seems to be a thickened tissue, into which the longitudinal muscles are inserted. The cushion is square, with suckers at each angle; the anterior lobe is separated from it by a simple contraction, not by a band as in *Tylocephalum pingue.* There is a short neck. The proglottides show very early traces of reproductive organs. The excretory pore is immense, a great round opening, more or less median; posteriorly it loses its firm outline, becomes crinkled, and is pushed a little aside by the development of the uterus. The testes are scattered mostly at the anterior end of each proglottis, and as the uterus develops the testes are pushed towards the periphery and tend to disappear. The uterus is a long sac, constricted in the middle by the reproductive pore like an old-fashioned "ring" purse. The posterior proglottides are extremely long, at least 5 millims. in length, some ten times as long as they are broad. None of the proglottides overlap. Their ends are flat and their sides very nearly straight, or at most slightly bowed.

The diagnosis of *Tylocephalum uarnak* is as follows:—

Length some 35 millims. Greatest breadth in middle region of body. Genital pore very large, round and median. Testes scattered in anterior end of proglottis, pressed outward by the growing uterus. The latter forms an anterior and posterior swollen part united by a thinner portion. Number of segments 30 to 40.

Habitat:—The intestine of *Trygon uarnak.* This species also occurs in *T. walga.*

Tetrarhynchus macroporus, n. sp.—Plate V., figs. 87, 87*a* and 87*b*.

These are fair-sized Tetrarhynchids, averaging about 25 millims. in length and 1 millim. in breadth.

The lateral lappets are small, each divided into two, each half corresponding with one of the four hooked proboscides. The head is 6 millims. long, and swells out a little behind where the muscular sheaths of the proboscides lie. When alive, there is a patch of pink anterior to these sheaths. Each proboscis bears on its concave side when unrolled a number of strongly recurved teeth, which gradually pass into a much straighter, sabre-like tooth on the convex side (Plate V., fig. 87*b*). The recurved teeth have a marked anterior process something like a sword-guard, where the tooth passes into the haft, which is embedded in the tissue. This is absent in the more sabre-like teeth. The teeth are in rings, which are not obliquely placed.

There is practically no neck, and the number of the proglottides is small, some 30 to 35. Until the last three or four, the sides of the proglottides are parallel, straight at their ends, and with no sign of overlapping. The whole body is marked by a curious longitudinal striation, which is due to the presence of minute pigment spots, and to the fact that these little brownish particles are arranged along certain longitudinal lines; also these pigment spots seem broken up into other areas, which give a mottled appearance to the skin.

The last four or five proglottides are remarkable for the enormous development of the genital pore, which sometimes occupies one quarter to one third of the length of the proglottis. From this gaping cavity a minute penis protrudes. These same four or five proglottides lose their uniform shape, and become very irregular in outline. The pores are in all cases lateral and irregularly alternate.

The diagnosis of *Tetrarhynchus macroporus* is :—

These Cestodes are about 25 millims. in length and 1 millim. in breadth. They have small lappets, turned forward, hooks recurved sabre-like, in straight lines; no oblique rows. Proglottides number about thirty, and the last four or five are distorted by the enormous development of the genital pore.

Habitat :—The intestine of *Trygon uarnak*.

Thysanobothrium, n. gen.

Length 7 centims. ; posterior proglottides being 1·5 millims. to 2 millims. long. Head squarish, with a sheath bearing four minute suckers at the angles ; within the sheath a rounded knob, and between the sheath and the knob a ring of some twenty finger-like tentacles stretched forward. Neck long. Genital pores very irregularly alternate.

Thysanobothrium uarnakense, n. sp.—Plate V., figs. 88 to 91.

This remarkable form attains, for a tapeworm parasitic in Elasmobranchs, considerable proportions. Our largest specimen measured 7 centims., and in this animal the posterior proglottides reached a length of 1·5 millims. to 2 millims., and a breadth of 1 millim. The anterior end of the body is, however, very slender, 0·3 millim. to 0·25 millim. in width, but the head, though small, is somewhat wider than this, and attains a breadth of at least 0·5 millim.

The head is squarish, and yet sub-globular, with four minute suckers equidistant from one another at the angles. The suckers are borne on a kind of cup-like external bowl, which surrounds a central portion, and between this cup-like shield and the central portion a number of simple tentacles protrude.

These tentacles are very curious, and, as far as we know, are unique amongst the Cestoda. They are finger-like processes, with no branching, and they hang over the central portion of the head. They seem to be about sixteen to twenty in number, but in the preserved specimens it was impossible to count them accurately.

In the living specimens a number of concretions, apparently of a calcareous nature, occurred at the base of the head, just where it joins the neck. The neck is long, no trace of strobilization appearing for at least a distance of half a centimetre behind the head. The proglottides, when they do appear, are shown by lines in the centre of the body, which do not at first reach the side, so that for a time the sides of the worm are unindented, straight, and almost parallel; then the dividing lines reach the edge and the sides of each proglottis bow out, and by the time the proglottides are about as long as they are broad the body has a somewhat moniliform appearance. The proglottis is symmetrical about a line which passes across it midway between its anterior and posterior edge; there is no overlapping and no trace of it. The posterior proglottides are flask-shaped, and seem to be little more than bags of eggs. The reproductive pores are very irregularly alternate, some six or seven being to the right, then one or two to the left, then seven or eight to the right, and so on. The penis was often protruded.

Habitat:—The intestine of *Trygon uarnak*.

TRYGON WALGA, Müller and Henle.

The Tamil name is "Manal tirikkai," signifying "Sand Ray." This species is perhaps the commonest Ray taken by fishermen in the neighbourhood of the pearl banks. A considerable number were examined, as follows:—

A. Caught on the N.W. Cheval Paar, April 4, 1904.

B, C, D, E, and F. Caught in fishermen's nets in the open sea, January, 1905, off Dutch Bay Spit, N.W. Province, Ceylon.

G. Taken on a line on the North Modragam Paar pearl banks, February 2, 1905.

Food.—As shown by stomach contents, this Ray lives chiefly upon small crustaceans, supplemented frequently by octopods, gephyreans, polychætes, and occasionally thin-shelled small molluscs.

Anthobothrium rugosum, n. sp.—Plate V., fig. 92.

Two specimens of the worm were taken from the intestine of a *Trygon walga*. One measured 65 millims. when preserved, but it had stretched to 12 inches when alive, the other 20 millims. in length. The greatest breadth of the body is about 2 millims.

The head consists of four bothridia, each borne on a short stout stalk. Each bothridium consists of a simple bag-like sucker or depression, the walls of which are rather crinkled and marked with lines, and the edges which surround the opening of the depression are distinctly puckered. All these four bothridia are in both our specimens very much flattened, and all lie in the same flat plain; the head, in fact, looks like a pressed flower. As far as we know, the animals had never been compressed in any way, and this flatness may be natural to the species. Each sucker measures 3 millims. across at its broadest, and the whole head measures 6 millims. from side to side.

It is followed by a neck which extends some 5 millims. or 6 millims., and then the body becomes segmented. The proglottides are always broader than long, and the body is broad throughout, differing in that respect from *A. cornucopia*, VAN BEN.,* whose body "est extraordinairement fin et effilé en avant." Anteriorly there is a curious wrinkling at the edges, and the exact correspondence of this with the limits of the proglottides was not made out. The strands of muscles which run down the body in this region are also very conspicuous and easy to see.

Diagnosis of *Anthobothrium rugosum*:—

This species is distinguished from the *A. cornucopia*, VAN BEN., and the *A. musteli*, VAN BEN., by the wrinkling of the bothridium and the shape of the body, and from the *A. elegantissimum* of LÖNNBERG,† by the absence of a myzorhynchus. Its most striking characteristics are the crumpled suckers, the stout neck, and the longitudinal muscles. Length, when alive, 1 foot.

Habitat:—The intestine of *Trygon walga*.

Echeneibothrium minimum, VAN BENEDEN.‡—Plate V., figs. 93 and 94.

This species is in all probability the *Echeneibothrium minimum* of VAN BENEDEN, although instead of the bothridia fading at their lower end into a stalk like the leaflet of a rose, they are borne on the stalk in a peltate manner. As in *E. variabile*, and unlike *E. gracile*, where there is a terminal areola at each end of the bothridia, the areolas in this species are paired throughout. There is no myzorhynchus. There are thirteen pairs of areolas in each sucker. The bothridium is fringed by a transparent, extensible membranous edge. An excretory tubule runs underneath it. The stalks are very muscular and very mobile.

The worms are slender but long, larger than those which as a rule live in Elasmobranchs, and are intermediate in length between *E. variabile*, with its 100 millims., and *E. minimum*, with its 15 millims. to 17 millims. Our species ranged from about 60 millims. to 30 millims. It attains at the maximum a breadth of 1 millim., and this maximum is not necessarily at the posterior end of the animal.

* 'Mem. Ac. Belgique,' xxv., 1850.

† 'Bih. Svenska Ak.,' xiv., 1888–9.

‡ 'Mem. Soc. Belgique,' xxv., 1850, p. 114.

The body has, in fact, a somewhat lumpy, untidy appearance, and is thrown in irregular wrinkles and sometimes knots. There is no neck, as in *E. gracile*.* The posterior segments are not very long, at most twice or three times as long as wide. The genital pore is lateral.

This species came from the intestine of *Trygon walga*, the same specimen which contained *T. herdmani*.

Echeneibothrium simplex, n. sp.—Plate VI., figs. 95, 96 and 97.

The species is one of the simplest of the genus to which it belongs. Its head consists of four stalked bothridia, each shaped like a violet leaf. The edge of each is divided by horizontal ridges into areolas, some twenty-two in number. It was difficult to make out the exact number. There is no myzorhynchus. The body measured 2 centims. in length. There is also no neck, the transverse divisions beginning immediately behind the head. The number of segments is about 100. They are nearly all broader than long, except the last six or seven; the anterior three of these are about square, the others are longer than broad, the last being perhaps twice as long as broad. The reproductive pores are lateral and alternate; there are often two on the same side, followed by two on the other.

The diagnosis of *Echeneibothrium simplex* is :—

Very simple leaf-like bothridia, with areolas, some twenty-two stretching right round the edge of each bothridium. No neck. Genital pores rather irregularly alternate.

Habitat :—Intestine of *Trygon walga*.

Echeneibothrium trifidum, n. sp.—Plate VI., figs. 98 and 99.

This beautiful little Cestode was taken from the spiral intestine of *Trygon walga*, where it lived with a *Tylocephalum uarnak*. There were only three examples, which differed a little in length, but averaged 6 millims. or 7 millims. The head bears four leaf-like bothridia, stalked and very mobile. The basal or posterior half of each bothridium is single, and carries nine transversely elongated areolas. The proximal end of each bothridium is, however, split into two halves, and each half bears nine areolas, of a somewhat rounded form. There are thus altogether twenty-seven areolas, nine large and eighteen small, in each bothridium. A fine, delicate, extensile membrane edges the bothridium. These bothridia are borne on stalks which can be readily elongated and contracted, as the sketch indicates. The unsplit part is usually curled with the split part into a C. There is no myzorhynchus. The proglottides at an early stage show traces of the testes, but only the posterior half show any genital pores. These are lateral, and very irregularly alternate.

Diagnosis of *Echeneibothrium trifidum* :—

This species is characterised by its trifid bothridia with twenty-seven areolas.

Habitat :—The intestine of *Trygon walga*.

* ZSCHOKKE, 'Mem. Instit. Nat. Genev.,' xvii., 1889.

Echeneibothrium trygonis, n. sp.—Plate VI., fig. 100.

This species is much more delicate and slender than *E. minimum*. It measures from 8 millims. to 15 millims., and its greatest breadth is about 0·3 millim., if we leave out of account the head, which, when the bothridia are turned out, may attain the width of nearly 1 millim.

The head does not bear the bothridia on stalks, but the neck passes into the head like the stem of a goblet into the bowl. The head is, in fact, rather like the seat of those three-legged camp-stools upon which artists sometimes sit, only there are four instead of three legs. The bothridia face inwards, are deeply hollowed, and acting together must form a very effective sucker.

On the inner face of each bothridium are seven or eight areolas which stretch across the bothridium, and thus there is no median longitudinal line.

The head is carried on a stout unsegmented neck, which is a good deal broader than the succeeding segmented part. The proglottides, in fact, do not become thicker as they become posterior; the anterior and posterior edges of each proglottis are of the same width, and the ripe posterior proglottides are loosely attached to one another, like so many sausages, the medium which keeps them together being apparently the cuticle. In this region they are some five times as long as they are broad. The stained specimens showed no detail of structure and the specimens were too few to cut into sections.

Diagnosis of *Echeneibothrium trygonis* :—

Delicate slender form. The four bothridia spring from the neck with no stalk, and bear a single row of seven or eight transverse areolas. The posterior proglottides get thinner as they get older.

Habitat :—The intestine of *Trygon walga.*

Echeneibothrium walga, n. sp.—Plate VI., fig. 101.

This very delicate little tapeworm was found amongst a collection of *Tylocephalum trygonis* and *Echeneibothrium minimum*. Unfortunately but one specimen was taken. This measures 7 millims. in length and about 0·2 millim. in breadth. The posterior proglottides are ripe and the animal is probably full grown.

The head breaks up into four long stalks, each bearing two bothridia or rather two halves of a bothridium. The stalks appear to be permanently about 1 millim. long, though doubtless they may expand and contract within narrow limits. Each of the half bothridia faces the other and they somewhat resemble the clasping appearance of a Gecko's toes. They each contain a double row of some twelve areolas which are not rounded off towards the longitudinal median partition. Numerous muscle strands pass into each stalk after they have made a cruciform plexus in the head.

There is scarcely any neck, the narrow, straight-sided proglottides appear close behind the head. About half way along the body the proglottides are square, whilst the mature ones at the posterior end are perhaps twice as long as broad. Here the remains of the penis are visible, and it seems to bear spicules. In the few proglottides where it is visible, the reproductive pores appear to be regularly alternate. In appearance this somewhat resembles VAN BENEDEN'S figure of one phase of *E. minimum*.* It is however, we believe, a distinct species.

The diagnosis of *Echeneibothrium walga* is as follows :—

Head provided with four long stalks, each bearing a pair of opposed half bothridia, each composed of twenty-four areolas. Body minute, neck hardly present, reproductive pores regularly alternate.

Habitat :—Intestine of *Trygon walga.*

Echeneibothrium ceylonicum, n. sp.—Plate VI., figs. 102 and 103.

Four specimens varying in length from 8 millims. to 25 millims. were taken from the intestine of *Trygon walga.* The head is comparatively small and resembles in general architecture the head of *Echeneibothrium trygonis,* but it differs considerably in details. The head itself is longer and takes up a greater proportion of the whole body. It splits into four short arms, and each of these bears a bothridium. The bothridia are built up of fourteen areolas, of which one is terminal at each end and twelve are paired, as in the figure (Plate VI., fig. 103). Special muscles run from each arm down the neck, and the several arms are very mobile and contractile and take on different shapes in different states of contraction.

The body is stouter than in the case of *Echeneibothrium trygonis* ; the neck is of fair length ; the proglottides bulge out a good deal at the sides, so that the outline is like a thread of beads. The reproductive pore is median. The mature proglottides are never more than twice as long as they are broad, and their sides are curved, not straight and parallel. Mixed with the adults were a number of young forms, with tapering bodies, but not yet divided into proglottides.

The diagnosis of *Echeneibothrium ceylonicum* may run :—

Length up to 25 millims. Head with four inwardly directed bothridia, bearing fourteen areolas ; of these, two are terminal and twelve are paired. Proglottides rounded at the side, the oldest, ready to break off, never more than twice the length of the breadth. Reproductive pore median.

Habitat :—Intestine of *Trygon walga.*

Phyllobothrium lactuca, VAN BENEDEN.—Plate VI., figs. 104 (*a* and *b*) and 105.

This is by far the longest Cestode found in *Trygon walga.* It attained in one preserved specimen the length of 33 centims. In this particular specimen the width hardly exceeded 2 millims., and the texture was flimsy and soft, but in another specimen, which was in pieces, the consistency of the worm is stiff and almost brittle, and the width had swollen out to 4·5 millims. and, although broken up, its length could have

* 'Mem. Ac. Belgique,' xxv., 1850, Plate ii., fig. 3.

exceeded 150 millims. The width gradually increased as we passed backwards until the last half dozen proglottides, which narrowed a little (Plate VI., fig. 104). When alive the worm was in all probability much longer; they contract when being killed.

The head resembles the figs. 2 and 3 of VAN BENEDEN's pl. iv. of his "Recherches sur les vers cestoïdes,"* which represent *Phyllobothrium lactuca*, but the bothria are more definitely arranged in four, and the edge, which is crinkled and ruched, has not such a square section (Plate VI., fig. 105). The neck is very long. The proglottides all through the body are broader than they are long, except the posterior six or seven, which are slightly longer than they are broad. Each proglottis overhangs the ones which follow it, and thus its posterior border is wider than its anterior. The sides are oblique and, as the figures show, slightly wrinkled.

Habitat:—Intestine of *Trygon walga.*

Tylocephalum trygonis (SHIPLEY and HORNELL).

Tetragonocephalum trygonis, SHIPLEY and HORNELL.

Several specimens of this species were found in the intestine of *Trygon walga.* They permitted one to observe what was not recorded in the original description,† that the genital pores are very irregularly alternate. Thus in one specimen, using R for right and L for left, the genital pores were arranged as follows:—R 6, L 2, R 1, L 2, R 1, L 1, R 1, L 1, R 3, L 1, R 2, L 2, R 3, L 2, and so on. In the posterior segments the pore is very large and stands out from the proglottis just as the portion which bears the leaf stands out from a bare twig of a chestnut tree in winter.

Tetrarhynchus equidentatus, n. sp.—Plate VI., figs. 106 and 107.

This is, I think, the largest *Tetrarhynchus* I have seen, and it is certainly very large to come from the alimentary canal of an Elasmobranch. Unfortunately but one specimen was taken, and this measured 4·7 centims. in length, not a very great length; but it is the breadth which gives the magnitude to this animal. It is almost uniformly 3 millims. broad from one end to the other, though it increases very slightly as we pass backward, but the last proglottis is narrowed. It is perhaps 0·3 millim. thick.

Compared with the size of the body, the head is very small, and the muscular sheaths come right up to the anterior end of it, and thus there are no more or less coiled tubes between them and the base of the exserted proboscides. The proboscides bear spiral or rather obliquely placed rings of hooks; the hooks are all of precisely equal size and most regularly arranged. They are 0·049 millim. in length. The head bears laterally well-marked lappets or bothridia. It is succeeded by an unsegmented region

* 'Mem. Ac. Belgique,' xxv., 1850.

† This Report, Part III., p. 51.

which is about 2 to 2·5 times the length of the head. This region terminates, as in *Tetrarhynchus herdmani*, in a well-marked collar with somewhat scalloped edge. The collar hangs back and overlaps the body region.

The divisions between the proglottides are anteriorly very insignificant, but they soon become distinct and the proglottides become a little longer. The total number is between one and two hundred. But they are never very long, never even square. The posterior proglottides are always some six or seven times as long as they are broad, and the anterior perhaps twice as much again. Their edges are rounded, there is no trace of overlapping, and in the latter half of the body the reproductive organs cause an opaque patch in each segment.

The diagnosis of *Tetrarhynchus equidentatus* is :—

Very small head, muscular proboscis sheaths reach anterior end of head ; unsegmented region, terminating in a well-marked collar, follows head ; proglottides, 100 to 200 in number, always much broader than long, rounded edges, no overlapping. Proboscis hooks same size throughout, arranged in regular obliquely placed rows.

Habitat :—Intestine of *Trygon walga*, MÜLL. and HENLE.

Tetrarhynchus herdmani, n. sp.—Plate VI., figs. 108 and 109.

The second species to *Tetrarhynchus*, found in the alimentary canal of *Trygon walga*, and later in the same position in *Rhynchobatus djeddensis*, is a long and comparatively slender one. We had only three or four specimens, which averaged about 30 millims. in length. The head is small, about 1 millim. in length. It has two well-developed lappets which, as usual, are very contractile and extensile. The four proboscides emerge from very short muscular sheaths, which lie near the posterior limit of the head. Instead of being half as long as the head, as is often the case in the Tetrarhynchidæ, they are perhaps one-twelfth to one-tenth the head length. The proboscides which emerge from them are slender and covered with minute teeth, all of the same size, arranged in spiral rows. The teeth are about 0·01 millim. in length.

The most characteristic feature of this Cestode, but one which it shares with *T. equidentatus*, to be described is a peculiar fold or collar which hangs back from the head and covers the anterior part of the neck. This collar seems to be very extensile. In the figure drawn from the live specimen, its border of free edge is scalloped, but in the specimens in spirit the collar seems more retracted and the free edge is smooth and undivided.

The neck is very short. Almost immediately after the head the proglottides are indicated by sharp lines. There are some 80 to 100 proglottides present, all separated from one another by clear, horizontal, and in no case concave, lines. Till the proglottides become packed with eggs, the lateral contours are also straight and parallel ; there is no overlapping. Thus the Cestode does not increase in width until we get to the posterior proglottides, and in these the presence of the eggs entails a slight lateral swelling, so that this end is almost moniliform. The eggs are about 0·07 millim. in length.

In the centre of each of the last half dozen proglottides is a large clear place. This may possibly be the remains of the genital atrium, and if it is so, this is median.

Tetrarhynchus herdmani is characterised by having a small head with well-developed bothridia, short muscular proboscis sheaths, one-tenth to one-twelfth the length of head, teeth on proboscis, uniform in spiral lines, 0·01 millim. in length, well-developed collar, 60 to 100 proglottides, most with parallel sides.

Habitat :—Stomach of *Trygon walga* and *Rhynchobatus djeddensis,* MÜLL. and HENLE.

Tetrarhynchus macrocephalus, n. sp.—Plate VI., figs. 110, 111 and 112.

At least six different species of *Tetrarhynchus* are found in the intestine of *Trygon walga.* This species is a short, stout, thick-set form, with large bothridia or lappets, which, however, when the proboscides are extended, are far less conspicuous than when they are retracted (Plate VI., fig. 110).

The total body length averages 7 millims. or 8 millims., and the body is stiff and straight. The relative length of the different parts of the body in one specimen, whose total length was 8 millims., was 3 millims. for the part of the head traversed by the coiling ducts of the proboscis sheath, 3 millims. for the part of the head which contains the muscular proboscis sheath, and 2 millims. for the rest of the body. The second portion, that which contains the muscular sheath, is the thickest, and its walls are smooth ; the anterior half of the head is wrinkled.

The four proboscides were in some specimens extended, but not fully ; they attained a length of some 2 millims. Each bears a longitudinal double row of minute, almost straight spines, diverging from one another (Plate VI., fig. 111), the whole producing the effect of a stitch known, I believe, to housewives as "herring-boning." This lies the whole length of the proboscis. There are also very numerous sharply hooked spines, which lie in transverse rows some hundred or more in number. Each of these rows consists of some ten or twelve hooks, grading in size from the largest, which is just opposite the "herring-boning," to the smallest, which flank the "herring-boning."

When the whole is retracted it passes first into the very coiled ducts of the muscular sheaths, which are very apparent in the specimen.

The strobila is smaller than either half of the head ; the piece immediately succeeding the head is anteriorly concave, and receives into its concavity the convex end of the head (Plate VI., fig. 110). It soon begins to "segment," and the proglottides grow rapidly. They are few in number, and the most posterior, which is about the tenth or twelfth, is almost as large as all the others put together. It shows clearly the exit of the water vascular system. The specimens were probably young ones.

Diagnosis of *Tetrarhynchus macrocephalus* :—

The characteristic features of this species are the relatively enormous head, the few —some ten or twelve—proglottides, the "herring-bone" spicules on the proboscides, and the arrangement and grading of the hooks on the same.

Habitat :—The stomach and intestine of *Trygon walga*.

Tetrarhynchus platycephalus, n. sp.—Plate VI., figs. 113 and 114.

This is a moderate-sized form, measuring 10 millims. or 12 millims. in length. The head and neck occupy about one-sixth of the whole body length. The head is compressed from front to back and spreads out laterally, having something the appearance of a Toreador's hat. The four-hooked proboscides bend out towards the edge of the hat, and finally emerge at the angles (Plate VI., fig. 114). The hooks are large, sabre-like, and of uniform size.

The body consists of ten or eleven segments, the last two of which are as big as the rest of the body altogether. The proglottides are at first some six times as broad as they are long, but the fourth or fifth proglottis is already square, and the last is perhaps four or five times as long as broad. They are rounded and plump, stouter half way along than at either end, and stouter in front than behind. The most characteristic feature is the genital pore. This is a great cleft which runs almost half across the proglottis and seems to half cut it in two. This appears already in the fourth or fifth proglottis, and gives the appearance of an irregular and abnormal segmentation. The pores are lateral and alternate as a rule, though now and then two will consecutively follow each other on the same side.

The diagnosis of *Tetrarhynchus platycephalus* is as follows :—

Head much flattened, proboscides coming out of the edges of the flattened head. Hooks uniform in size, sabre-like. Proglottides ten or eleven in number, broader in the middle than at either end. Reproductive pore resembles a huge cleft, which seems to half cut the proglottis in two; alternate, but slightly irregular.

Habitat :—The intestine of *Trygon walga*.

Tetrarhynchus rubromaculatus (Diesing).—Plate VI., figs. 115 and 115*a*.

This is by far the smallest of the Tetrarhynchids found in *Trygon walga*. Only two specimens were taken, one measuring 4 millims., the other 7 millims. in length. The head occupies nearly half this length, and the proboscis sheaths, which vary a little in the two specimens, are nearly half the length of the head (Plate VI., fig. 115).

The bothridia are distinct even when the proboscides are protracted. The latter are four in number and bear sickle-shaped spines, not arranged in very definite rows; between some of them are short rows of minute straight spines.

Behind the head the body consists of six or seven proglottides: the first two of these are band-like, the third longer, the fourth about square, the fifth twice as long as broad, the sixth and seventh four to five times as long as broad. In one specimen the posterior proglottis bore a lateral eminence, presumably the genital pore, which much resembled the similar process figured by WAGENER* in a *Tetrarhynchus* taken from a *Trygon pastinaca.*

In some notes which Mr. HORNELL sent with the material, he states that in the bottle which contained the *E. trygonis* were two species of Tetrarhynchid, one with collar and the other with red pigment anterior to the muscle sacs. Now, as a matter of fact, there were four species of Tetrarhynchids in the bottle, and two of these were collared forms. Thus there is a reasonable degree of probability that the species we are describing, although colourless in spirit specimens, had a reddish patch in front of the muscular proboscis sheaths. In his figure of the *Tetrarhynchus* taken from a *Trygon pastinaca,* WAGENER paints a bright red splash just in this place. Neither WAGENER'S figure nor DIESING'S† diagnosis, given under the name *Rhynchobothrium rubromaculatum,* descend into any details, which might not apply to many Tetrarhynchids, yet there is nothing in the figure or in the diagnosis which differs materially from what we find in our specimens, and on the whole we seem justified in regarding these as belonging to the species *T. rubromaculatus* (DIESING).

Habitat :—The intestine of *Trygon walga.*

Tetrarhynchus ruficollis (EYSENH.)—Plate VI., figs. 116, 117.

Several specimens of this worm were taken from the intestine of *Trygon walga.* They measure 40 millims. to 50 millims. and had the characteristic criss-crossing of the proboscis sheaths. The teeth are not quite so regular as in VAN BENEDEN'S specimens, and he does not figure any of the posterior proglottides; these are cylindrical and smooth, the same diameter throughout and eight to ten times as long as they are broad. They are so cylindrical that it is impossible to say if the genital pore is on the edge or median. There are besides the larger teeth, arranged in more or less oblique rows, two longitudinal chains of very minute tubercles.

VAN BENEDEN'S specimens came from *Mustelus vulgaris,* MÜLL. and HENLE, ours came from the intestine of *Trygon walga,* MÜLL. and HENLE.

MARGARITIFERA VULGARIS, SCHUM.

Finally, we insert the pearl oyster as a host to complete the series.

Tetrarhynchus unionifactor, SHIPLEY and HORNELL—Plate VI., fig. 118.

A few specimens in the same stage as those described and figured in Part II. of this work, p. 88 and Plate II. But what is of greater interest was the discovery of a number of still younger forms of the same species in the stomach and alimentary canal of the oyster. These are quite small forms 1 millim. in length; and they

* 'Acta Ac. German,' xxiv., 'Supl. Taf.,' xxi., 253.

† 'S.B. Ak. Wien.,' xlviii., 1863, 1st Abth., p. 292.

consist of hardly anything more than the head, but the little piece of body shows some slight traces of the markings at the hinder end of the large larval form (see Part II., Plate II., fig. 20). The arrangement of the lappets, the proboscides, the proboscis sheath and the proboscis tubes are similar to those of the older larvæ, and so, as far as it could be made out, and that was by no means completely, was the shape and arrangement of the teeth in the proboscides.

Assuming—for we have as yet no absolute proof—that the youngest form of *T. unionifactor* forms the nucleus around which the pearls are deposited, we have in this lately found larval form an explanation of how the species is preserved. Of the given number of larvæ which enter at a very early stage into the body of the Oyster a certain number arrive in the mantle and other tissues, acquire an ectodermic sac and there encyst, and find a costly grave in the developing pearl. The remainder, however, reach the alimentary canal and grow and flourish there. When they attain the dimensions of the stages described in Part II., they leave the alimentary canal and encyst usually upon the outer surface of the intestine. Now they are too big for enclosure in a pearl, and they can wait without anxiety for the advent of their second host (*Rhinoptera javanica*) within whose intestine they rapidly become sexually mature. It is not entirely impossible that these Tetrarhynchids are different species, though at present the evidence is in favour of the two being different stages of the same species. If they are different species, the smaller probably corresponds with the smaller pearl-forming larvæ described in the previous paper (this vol., p. 22).

Further specimens of the Trematode *Aspidogaster margaritiferæ* were also collected.

II. NEMATODA.

Professor M. Stossich, of Trieste, whose untimely death has deprived us of a most helpful friend, has supplied us with the names and in some cases with short descriptions of the few Nematodes collected on this occasion.

AETOBATIS NARINARI (Euphrasen).

Spiropterina scillicola, v. Ben.

Aetobatis narinari is a new host for this species.

CARCHARIAS MÜLLERI, Müll. and Henle.

Ascaris, sp.

An embryonic form too young to be identified.

MARGARITIFERA VULGARIS AND PLATAX TEIRA.

Ascaris meleagrinæ, Linstow.

Part II. of this work, p. 99.

Platax teira is a new host for this species. The stomach of *Platax teira*, one of the "sea-bats," contained numbers of Octopuses entangled with Lumbriconereids and Eunicidæ. This Nematode also lives in *Balistes mitis* and *B. stellatus*.

Echinocephalus gracilis, n. sp.

The following account of this new species is due to the late Professor M. Stossich: "In the pearl oyster, *Margaritifera vulgaris*, there lives the larva of a Nematode, which Linstow recently ascribed to the species, *Echinocephalus uncinatus*, a species created by Molin for the form living in the Adriatic *Trygon*, but in comparing these with some of the examples of *E. uncinatus* from the Adriatic, it is evident that they are entirely different, and neither belong to the species of Linstow or of Molin. I therefore create a new species, *Echinocephalus gracilis*, with the following diagnosis :—

"Body about 12 millims. long, caudal end hooked and twisted; the head is surrounded with a spherical swelling of the cutis, covered with six transverse rings of hooks, each containing some 40 to 50 hooks; these hooks resemble closely those of certain *Echinorhynchus*, and consist of a large half imbedded in the skin and of a free blade; they gradually increase in size from the first to the sixth row. The mouth is surrounded by six lips, the dorsal and ventral are the largest and are truncated at their outer end, the four lateral have their free end distinctly crenated.

"Habitat :—*Margaritifera vulgaris*, in the adductor muscle."

STEGOSTOMA TIGRINUM, Günther.

The stomach of this fish contained the feet of Gastropods and remains of Pleurobranchi.

Acanthocheilus nidifex, Linton.

Allied species occur in *Mustelus vulgaris*, *M. laevis*, *Scyllium catulus*, *S. stellare*, *S. canicula*, and other Elasmobranchs.

INDEX TO PARASITES AND HOSTS IN THIS AND THE TWO PREVIOUS REPORTS (PART II., p. 77, AND PART III., p. 49).

* I. Refers to the first report on Parasites, in Part II.
II. Refers to the second report on Parasites, in Part III.
III. Refers to the present report on Parasites, in Part V.

Parasite.	Host.	Page
Spiropterina scillicola	*Aetobatis narinari*	III. 88
Staurobothrium aetobatidis	*Aetobatis narinari*	II. 49
Tetrarhynchid cysts	*Balistes mitis*	III. 50
Tetrarhynchid cysts	*Chirocentrus dorab*	III. 55
Tetrarhynchid cysts	*Cybium guttatum*	III. 56
Tetrarhynchid cysts	*Diagramma* sp.	III. 56
Tetrarhynchid cysts	*Lutjanus annularis*	III. 57
Tetrarhynchid cysts	*Sphyræna commersoni*	III. 70
Tetrarhynchus aetobatidis	*Aetobatis narinari*	III. 49
Tetrarhynchus balistidis	*Balistes mitis, undulatus, stellatus*	I. 89
Tetrarhynchus carcharidis	*Carcharias melanopterus*	III. 53
Tetrarhynchus equidentatus	*Trygon walga*	III. 83
Tetrarhynchus gangeticus	*Carcharias gangeticus*	III. 50
Tetrarhynchus herdmani	*Trygon walga*	III. 84
Tetrarhynchus leucomelanus	*Trygon sephen*	III. 74
Tetrarhynchus macroporus	*Trygon uarnak*	III. 76
Tetrarhynchus macrocephalus	*Trygon walga*	III. 85
Tetrarhynchus minimus	*Tæniura melanospilus*	I. 89
Tetrarhynchus perideræus	*Carcharias gangeticus*	III. 51
Tetrarhynchus pinnæ	*Balistes mitis, undulatus, stellatus*	I. 89
Tetrarhynchus platycephalus	*Trygon walga*	III. 86
Tetrarhynchus rhynchobatidis also *Tetrarhynchus herdmani*	*Rhynchobatus djeddensis*	III. 68
Tetrarhynchus rubromaculatus	*Trygon walga*	III. 86
Tetrarhynchus ruficollis	*Trygon walga*	III. 87
Tetrarhynchus unionifactor	*Margaritifera vulgaris*	III. 87, I. 88
Tetrarhynchus unionifactor	*Rhinoptera javanica*	III. 65
Thysanobothrium uarnakense	*Trygon uarnak*	III. 77
Tiarabothrium javanicum	*Rhinoptera javanica*	III. 67
**Tylocephalum aetobatis*	*Aetobatis narinari*	III. 48
Tylocephalum dierama	*Myliobatis maculata*	III. 59
Tylocephalum kuhli	*Trygon kuhli*	III. 72
†*Tylocephalum trygonis*	*Trygon walga*	III. 83
Tylocephalum trygonis	*Trygon walga*	III. 48
Tylocephalum uarnak	*Trygon uarnak*	III 76
* v. *Tetragonocephalum aetiobatidis*	*Aetobatis narinari*	II. 52
† v. *Tetragonocephalum trygonis*	*Aetobatis narinari*	II. 51

NATIVE NAMES OF ELASMOBRANCH FISHES.

We add a list of such native names of Elasmobranchs in use in the North of Ceylon as we have so far been able to ascertain, together with the scientific designation. Where possible the signification of the native names is given.

We are well aware that the list is far from complete. It is offered in lieu of anything fuller being in existence, and in the hope that it may prove of assistance to anyone who may pursue investigation in Ceylon touching the Elasmobranchs.

Preliminary List of the Native Names of Elasmobranchs in Use in the North of Ceylon.

Species.	Native name.	Signification.
Aetobatis narinari (Euphrasen)	Pua tirikkai, Tamil. Pulli-maduwa, Sinhalese.	Spotted Ray.
Carcharias melanopterus, Quoy and Gaim.	Kunda mōra, Sinh.	
Chiloscyllium indicum (Gmel.)	Kurakan sura, Tam.	Kurakan-shark (Kurukan = *Eleusine coracana*).
Chirocentrus dorab (Forsk.)	Valai or Walai, Tam. Katuwalla, Sinh.	Bunch of thorns.
Dicerobatis eregoodoo (Russell)	Koppu tirikkai, Tam. Kombu tirikkai, Tam. Añga maduwa, Sinh.	Horned Ray.
Mustelus manazo, Bleeker	Pāl sura, Tam.	Milk-shark.
Myliobatis maculata, Gray and Hardw.	Panjadi tirikkai, Tam. Panjadiya maduwa, Sinh.	
Narcine timlei (Bl. Schn.)	Hiri maduwa, Sinh. Timilī, Tam.	Numbing ray-fish. Numbing fish.
Pristis cuspidatus, Latham	Vēlā-mīn, Tam. Dētī m̆ōra, Sinh.	Sawfish. Saw-shark.
Pristis zyson, Bleeker	Illīpā, Tam.	
Pteroplatea micrura (Bl. Schn.)	Attavănnai tirikkai, Tam.	
Rhinobatus sp.	Gāl uluwa, Sinh. Kāl uluvi, Tam.	Rock uluwa. Rock plough-fish.
Rhinoptera adspersa, Müll. and Henle	Sankkudi tirikkai, Tam. Mundeikanni tirikkăi, Tam.	Chank-eating Ray (Madura coast). Goggle-eyed Ray (North of Ceylon).
Rhinoptera javanica, Müll. and Henle	Valvadi tirikkai	Gregarious Ray.*
Rhynchobatus djeddensis (Forsk.)	Kiri-uluwa, Sinh. Uluwa mōra, Sinh. Pāl-ūlŭvĭ. Tam.	Milk-uluwa. Uluwa-shark. Milk plough-fish.
Stegostoma tigrinum (Gmel.)	Komorin sura, Tam. and Pullian sura, Tam.	Comorin-shark. Spotted-shark.
Trygon kuhli, Müller and Henle	Kāttī tirikkai, Tam.	Ray with boils.†
Trygon sephen (Forsk.)	Adā tirikkai, Tam. Polkolla maduwa, Sinh.	Coconut-leaflet Ray.‡
Trygon narnak (Forsk.)	Pullian tirikkai, Tam.	Spotted Ray.
Trygon walga, Müll. and Henle	Mānāl tirikkai, Tam.	Sand Ray.
Urogymnus asperrimus (Bl. Schn.)	Kālli tirikkai, Tam. Erabadu maduwa, Sinh.	Prickly-pear Ray. Erabadu§ Ray.
Zygæna blochi, Cuvier	Udalŭ mōra, Sinh. Komban sūra, Tam.	Pickaxe-shark. Horned-shark.

* From its habit of going about in great shoals.

† A reference to the boil-like appearance of the large blue spots upon the disc.

‡ This name has reference to the resemblance borne to the pinna of a coconut leaf by the tail and its cutaneous fold.

§ Erabadu, the tree *Erythrina indica*, L., which has the trunk and branches studded with strong prickles.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. *Cephalobothrium aetobatidis.* × 10. Entire worm, drawn from preserved specimen.
,, 2. The head of the same. × about 35.
,, 3. The head of the same, drawn from life. × about 40.
,, 4. The head of the same, drawn from life. × about 40.
,, 5. Anterior end of *Hornellobothrium cobraformis*, with the suckers expanded. × about 100.
,, 6. The same, with suckers retracted. × about 100.
,, 7. Outline of edge of body in anterior broad region.
,, 8. The same, in the narrower posterior region.
,, 9. Body of *H. cobraformis*, × 45, drawn from stained specimen.
,, 10. Enlarged view of head, × about 450, showing button-like myzorhynchus and the extended suckers.
,, 11. *Kystocephalus translucens.* × 16. The head in this specimen is rather diagrammatic.
,, 12. Head of *Kystocephalus translucens*, × about 50, showing the terminal myzorhynchus.
,, 13. *Myzocephalus narinari.* × 10.
,, 13*a*. Posterior proglottis. × about 40.
,, 14. Head of *Myzocephalus narinari.* × about 40.
,, 15. The same simplified and opened out to show myzorhynchus. × about 40. Semi-diagrammatic.
,, 16. *a*, *b*, *c*. Bothridia on myzorhynchus, showing outline of shapes assumed.
,, 17. *Myzophyllobothrium rubrum.* × 6. (17.)
,, 17*a*. ,, proglottis from the middle of the body. × 25.
,, 17*b*. ,, last proglottis. × 25.
,, 18. ,, head. × 25.

PLATE II.

Figs. 19, 20, 21. *Myzophyllobothrium rubrum*, drawn from living specimens, showing various views of the head. The red pigment spots are represented by black dots.
Fig. 22. *Tetrarhynchus aetobatidis.* × 12.
,, 23. ,, extremity of a proboscis. × about 100.
,, 24. ,, showing the more sabre-like teeth at the base of the proboscis, and the position of the red granules.
,, 25. *Tetrarhynchus*, sp. Young form with no proglottides formed. × 40.
,, 25*a*. ,, Tip of proboscis. × about 150.
,, 26. A series of teeth of the above, showing the gradations of a single ring.
,, 27. *Tetrarhynchus*, sp. Young form with cyst still present. × about 75.
,, 27*a*. Proboscis and teeth of the same.
,, 28. *Tetrarhynchus gangeticus*, head. × 20.
,, 28*a*. ,, Still further enlarged view of proboscis.
,, 29. *Tetrarhynchus perideraeus.* × 12. Showing the coiled portion of the body.
,, 30. ,, the head. × 36.
,, 30*a*. More highly magnified view of the proboscis of the same.
Figs. 31*a*, *b*, *c*. Three views of proglottides of *T. perideraeus*, showing the modification in the pattern as one passes backward.

PLATE III.

Fig. 32. *Phyllobothrium minutum.* × 20.
„ 33. „ head. × 80.
„ 34. *Phyllobothrium pammicrum.* × 10.
„ 35. „ head. × 70.
„ 36. *Tetrarhynchus carcharidis.* × 20.
„ 37. „ head. × about 40.
„ 38. *Carpobothrium chiloscyllii.* × 100.
„ 39. „ single bothridium. × 150.
„ 40. Anterior end of a *Tetrarhynchus* cyst from *Chirocentrus dorab*, enclosed in a secondary cyst formed from the tissues of the host. × 20.
„ 40*a*. The whole cyst. × 2.
„ 41. View of the *Tetrarhynchus* when the cyst has been ruptured.
„ 42. Very young *Tetrarhynchus* from *Cybium guttatum*, × 25, showing also shape and arrangement of teeth.
„ 43. Cyst of *Tetrarhynchus* from *Cybium guttatum*, highly magnified.
„ 44. Tetrarhynchid cyst, × 30, from *Diagramma*, sp.
„ 45. Head of *Anthobothrium crispum.* × 10.
„ 46. A few segments of *Anthobothrium crispum*, × about 12, showing the characteristic L markings.
„ 47. Head of *Diagonobothrium asymmetrum.* × about 30.
„ 48. Head of *Rhoptrobothrium myliobatidis.* × about 66.
„ 49. *Tylocephalum dierama*, the entire animal × 6, and two more highly magnified sketches of proglottides to show the extent of the overlap.
„ 50. Head of *Tylocephalum dierama.* × about 60.

PLATE IV.

Fig. 51. *Echeneibothrium javanicum.* × 22. An enlarged view of the striated cuticle is shown to the left.
„ 52. A sketch of the same from life, showing the bothridia divaricated.
„ 53. Another sketch from life, showing the bothridia concentrated.
„ 54. A single bothridium, showing the areolas.
„ 55. A transverse section through the neck of the same, showing the fine excretory canal, the two nerve-cords, and bundles of muscles.
„ 56. A transverse section through the head, showing the hollows of the four bothridia and their areolas.
„ 57. *Echinobothrium rhinoptera*, magnified. *p.* penis; *p.h.*, enlarged view, the hooks of the penis; *s.r.*, spinous region.
„ 58. Head of the same, more highly magnified.
„ 59. Spine from the spinous region, very highly magnified.
„ 60. *Eniochobothrium gracile.* × 30. Rather diagrammatic sketch from life.
„ 61. The body of the same. × 30. Drawn from a preserved specimen.
„ 62. More highly magnified view of head and anterior end of body of *Eniochocephalum gracile.*
„ 63. *Tetrarhynchus unionifactor.* × 8. *a.*, enlarged view of a proboscis, showing arrangement of teeth; *b.*, a tooth still more enlarged.
„ 64. The same, drawn when alive, showing the anterior meeting of the two bothridia and the apical emergence of the proboscides.
„ 65. *Tiarabothrium javanicum.* × 16. Drawn from a spirit specimen.

Fig. 66. Head of the same, × about 50, drawn from life. *c.*, collar. *w.v.*, excretory canals.
,, 67. Longitudinal median section through the head of *Tiarabothrium javanicum*. *a.*, areola of bothridium. *c.*, collar contracted.
,, 68. Transverse section through the collar region of the same. *c.*, collar. *n.*, neck.
,, 69. *Tetrarhynchus rhynchobatidis.* × 4.
,, 70. The head of the same. × about 18.
,, 71. End of a proboscis of the same, × about 100, showing the curiously reversed teeth.

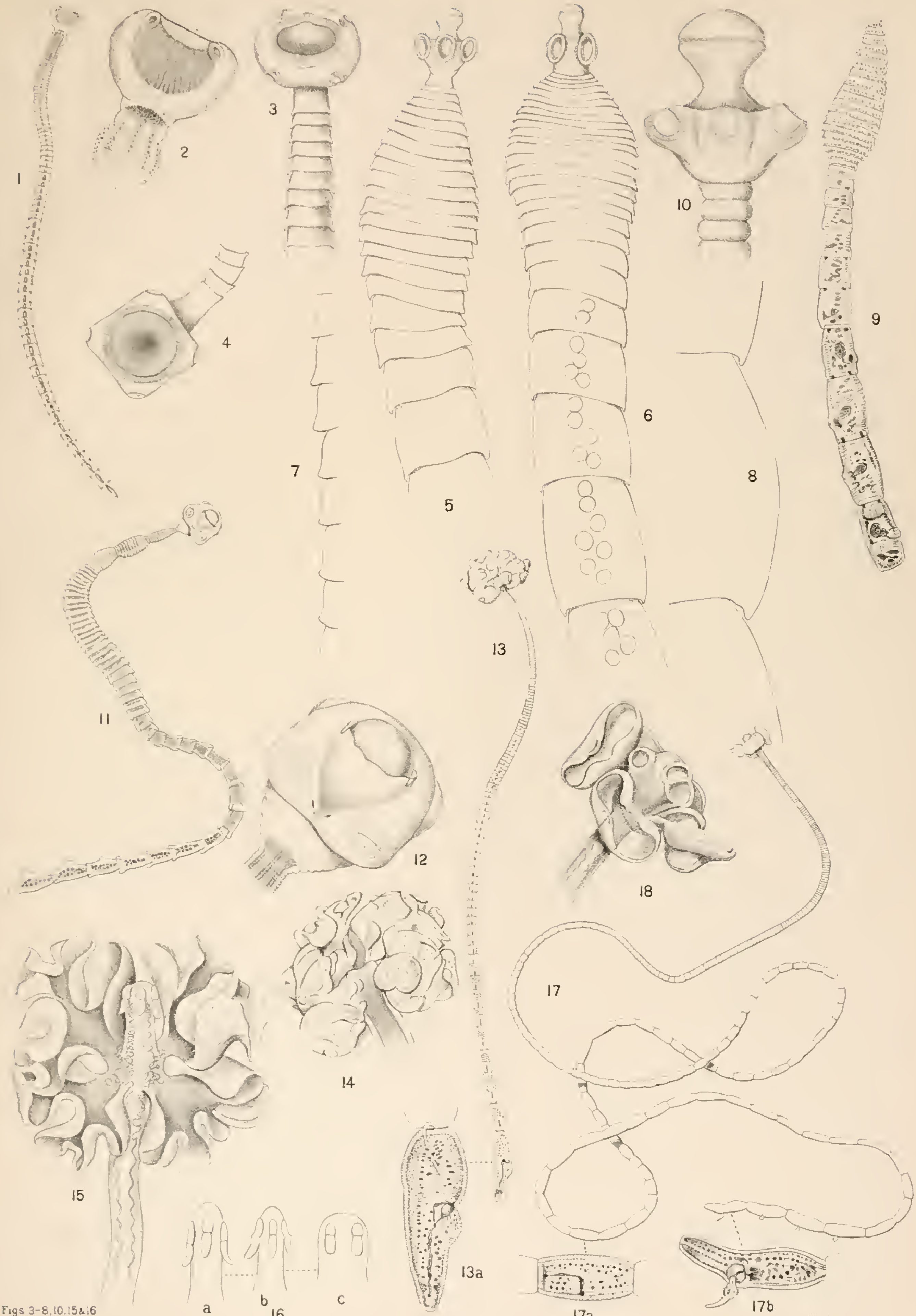
PLATE V.

Fig. 72. *Phyllobothrium blakei.* × 20
,, 73. The head of the same. × about 50.
,, 74. *Rhinebothrium ceylonicum.* × 2, drawn from the contracted preserved specimen.
,, 75. Head of the same, × about 5, drawn from the living specimen.
,, 76. *Tylocephalum kuhli.* × 20.
,, 77. The head of the same. × 60.
,, 78. *Anthemobothrium pulchrum.* × 8. *a.*, proglottis from middle; *b.*, from end of body.
,, 79. Head of the same. × 40.
,, 80. *Prosthecobothrium trygonis.* × 1·5.
,, 81. Head of the same. × 36.
Figs. 82*a* and *b*. Hooks from the head of *Prosthecobothrium trygonis*, highly magnified.
Fig. 83. *Tetrarhynchus leucomelanus.* × 2.
,, 83*a*. Proglottis from middle of the body, showing longitudinal striations.
,, 84. Head of the same, × about 30, with tip of proboscis highly magnified.
,, 85. *Tylocephalum uarnak.* × 10.
,, 86. Head of the same. × 40.
,, 87. *Tetrarhynchus macroporus.* × 10. *a.*, posterior segment, × about 30; *b.*, portion of the proboscis highly magnified.
,, 88. *Thysanobothrium uarnakense.* × 2.
,, 89. Head of the same. × about 20.
,, 90. Posterior view of head of the same. × about 20.
,, 91. Another view of head of the same. × about 20.
,, 92. *Anthobothrium rugosum.* × 7.
,, 93. *Echeneibothrium minimum*, highly magnified, with the bothridia expanded.
,, 94. The same, less highly magnified, with the bothridia contracted.

PLATE VI.

Fig. 95. *Echeneibothrium simplex.* × 6.
,, 96 Head of the same, from a spirit specimen. × 35.
,, 97. The same, from life. × 35.
,, 98. *Echeneibothrium trifidum*, magnified.
,, 99. Head of the same, more highly magnified.
,, 100. *Echeneibothrium trygonis.* × 20.
,, 101. *Echeneibothrium walga.* × 26.
,, 102. Anterior end of *Echeneibothrium ceylonicum*, magnified.
,, 103. Head of the same, more highly magnified.

Fig. 104. *Phyllobothrium lactuca*, VAN BEN. × 2. *a.*, outline of proglottides about middle of body; *b.*, the same from posterior part of body.
,, 105. Head of *Phyllobothrium lactuca*. × 6.
,, 106. *Tetrarhynchus equidentatus*. × 4.
,, 107. Proboscis of the same. × 50.
,, 108. *Tetrarhynchus herdmani*. × 6.
,, 109. The head of the same. × 60.
,, 110. *Tetrarhynchus macrocephalus*. × 10.
,, 111. View of the concave side of a proboscis of the same.
,, 112. View of the convex side of a proboscis of the same.
,, 113. *Tetrarhynchus platycephalus*. × 10.
,, 114. Head of the same. × 45.
,, 115. *Tetrarhynchus rubromaculatus* (DIESING). × 40. *a.*, a further enlarged view of the end of a proboscis.
,, 116. *Tetrarhynchus ruficollis* (EYSENH.). × 6.
,, 117. Head of the same. × 12. *a.*, further enlarged view of the end of a proboscis.
,, 118. *Tetrarhynchus unionifactor*, × about 100, from alimentary canal of pearl oyster.



Figs 3-8, 10, 15 & 16
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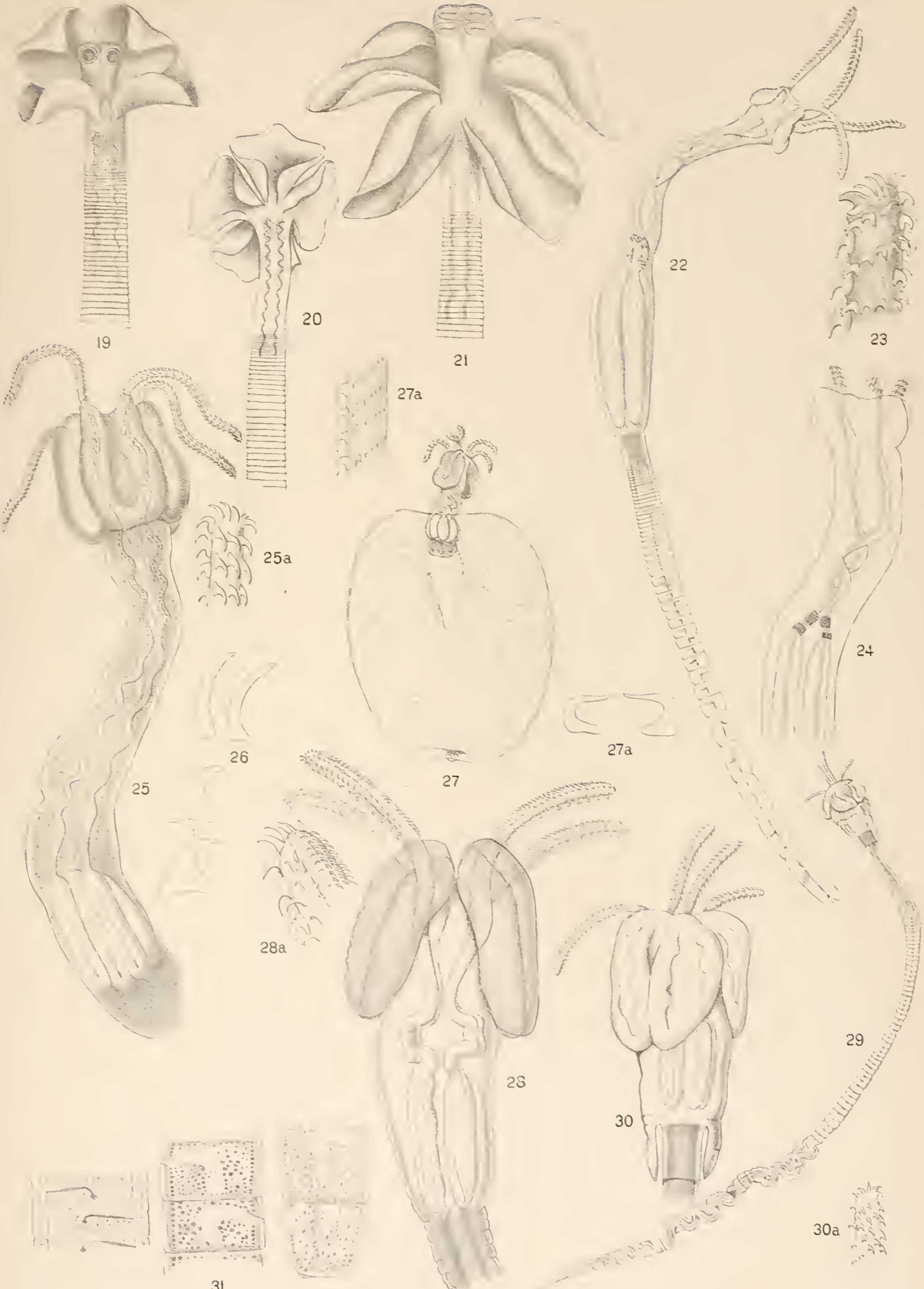
PARASITES



Figs 19-21, 24, 26, 27a, J Hornell, del

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PARASITES.

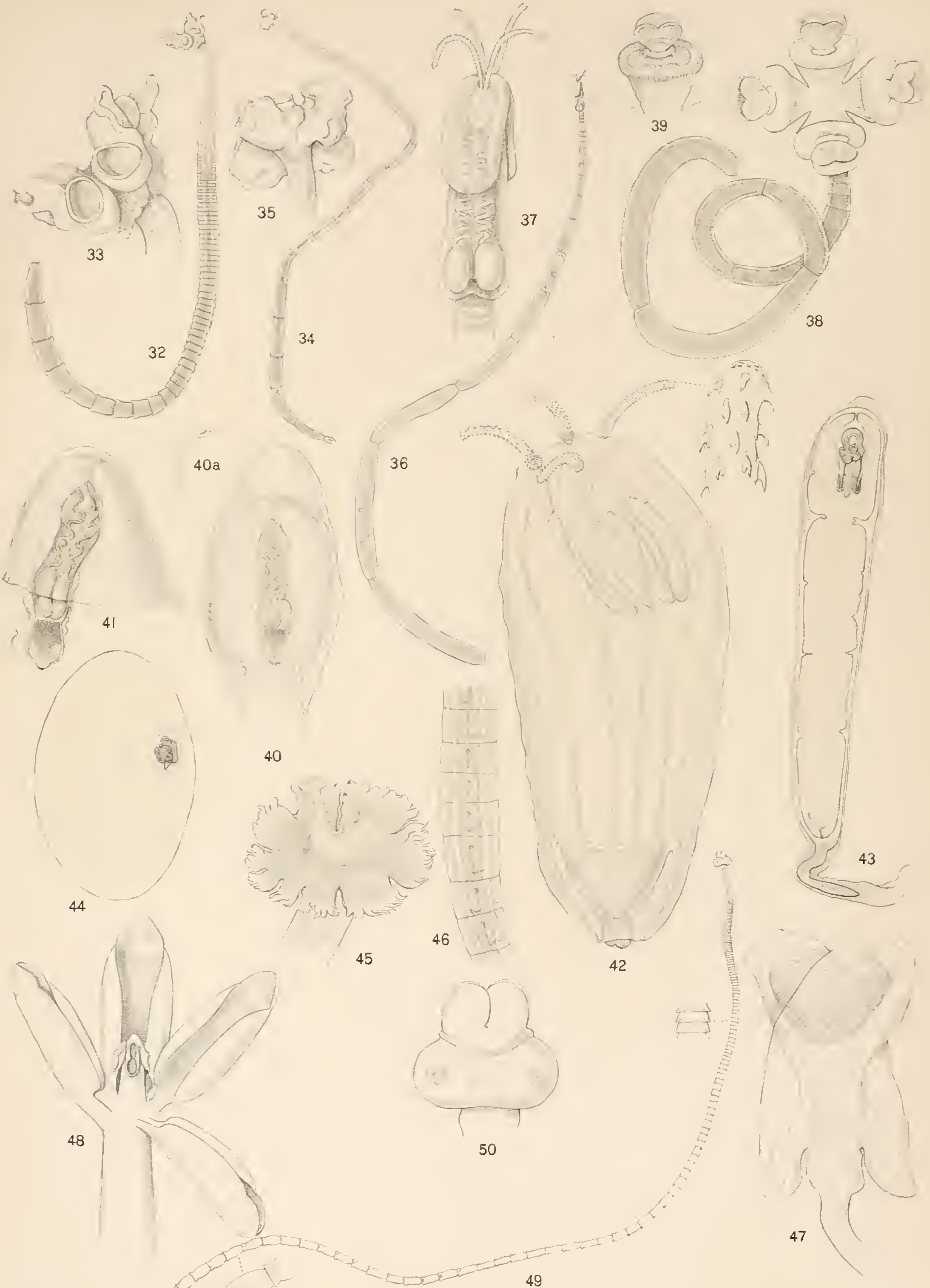

Fig 48, J Hornell, del

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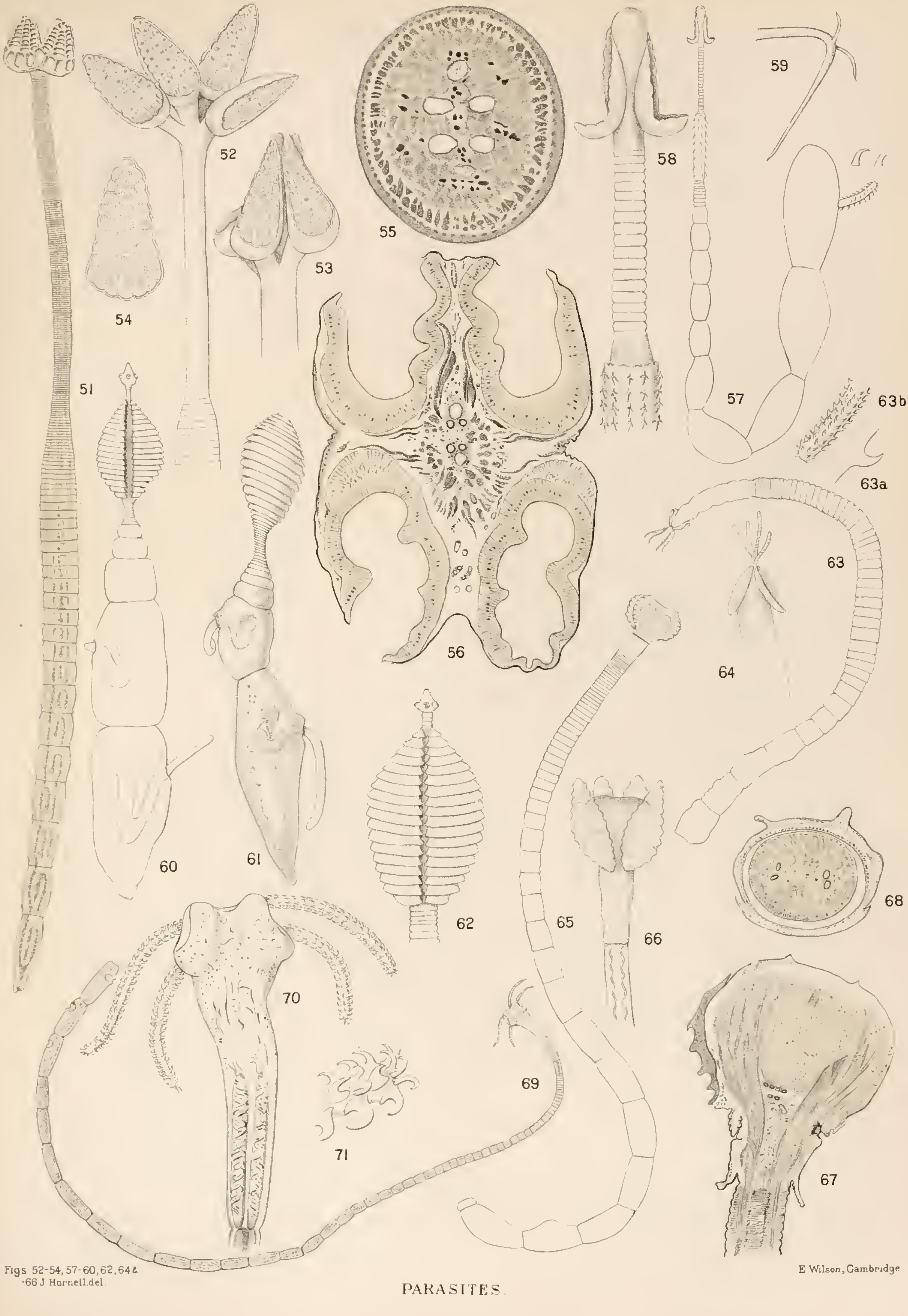
PARASITES



Figs 52-54, 57-60, 62, 64 & -66 J Hornell, del.

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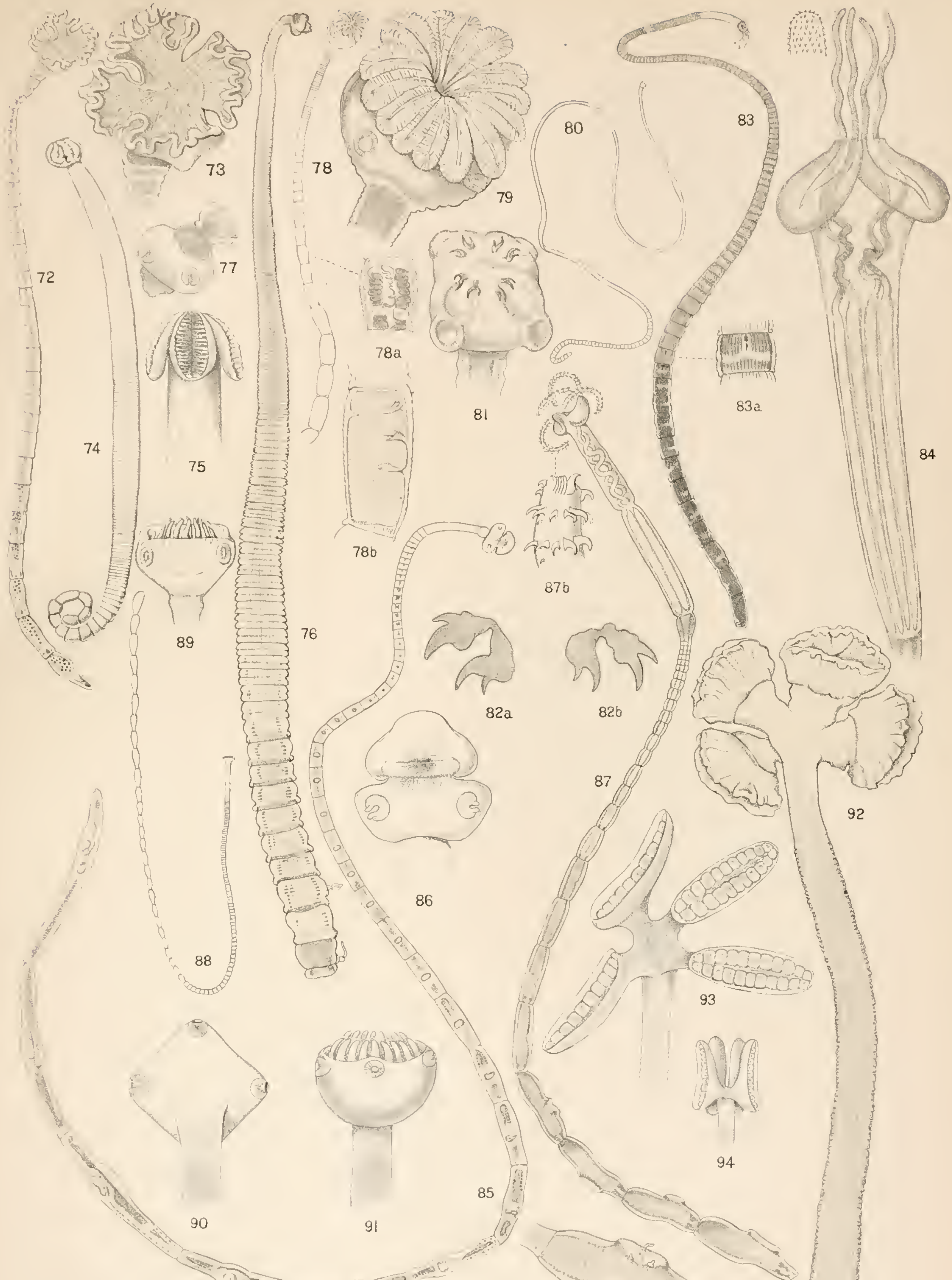
PARASITES.



Figs 75,82,90,91 & 93 J Hornell del

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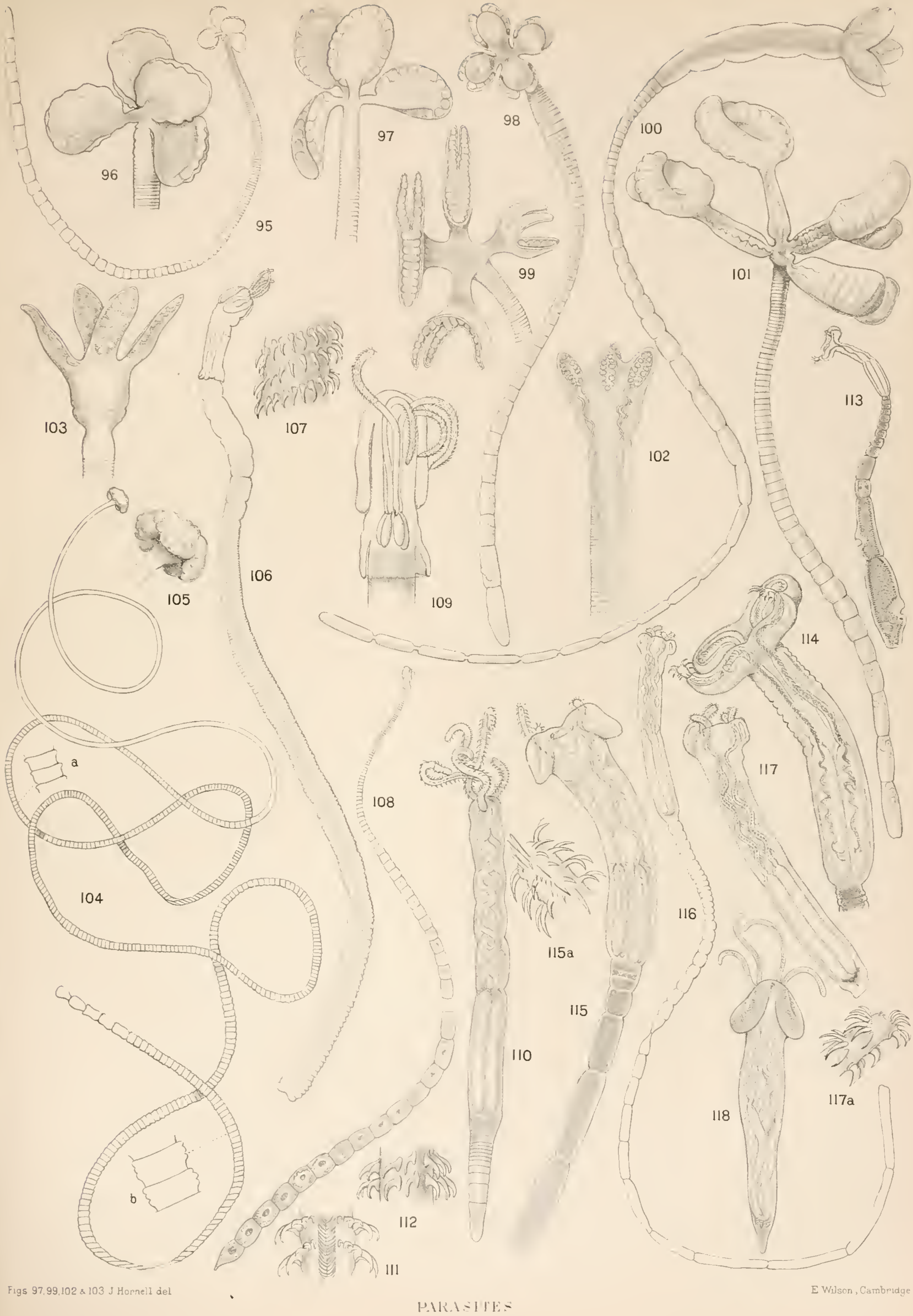

Figs 97, 99, 102 & 103 J Hornell del

E Wilson, Cambridge

PARASITES

REPORT

ON THE

TREMATODE PARASITES

FROM THE

MARINE FISHES OF CEYLON.

BY

MAX LÜHE, Ph.D.,

KÖNIGSBERG IN PREUSSEN.

[With TWO PLATES.]

By the kindness of Mr. A. E. Shipley,* to whom I wish to express here my warmest thanks, I have had the opportunity of studying a very interesting collection of Trematodes, mostly parasites of fishes, obtained from Ceylon by Professor Herdman and Mr. Hornell. The collection contained seven different species, all of which are new to science. They are described below.

One of the seven species belongs to the ectoparasitic Trematoda or Heterocotylea. Two are larval forms of Distomids, one of which, however, is a well-distinguished species of the genus *Stephanochasmus*, Looss, the systematic position of the other larva being still doubtful. Of the four adult Distomids contained in the collection, three belong to new genera.

Epibdella (Benedenia) macrocolpa, n. sp.—Plate I., figs. 1 to 3.

From the skin of *Rhinoptera javanica*, Müll. and Henle.

1. Kalpitiya.—Three specimens in bottle No. 36 (the type specimens).
2. Dutch Bay.—Two specimens in bottle No. 2.

Body oval, flattened; length 9 millims. to 10 millims., breadth 5 millims. to 7 millims. The two anterior suckers well developed, circular, with a diameter of about 1 millim., connected together by a thin membranous continuation of the

* These Trematodes were sent to Mr. Shipley with the other parasites (see preceding Report) and were by him sent on to Dr. Lühe for description.—W. A. Herdman.

anterior end of the body. Posterior sucker oval, with a longitudinal diameter of 2·3 millims. to 2·6 millims. and a broadest transverse diameter (a little before the middle of the sucker) of 2·1 millims. to 2·4 millims., with three pairs of hooks very similar in form and arrangement to those of *Benedenia hendorffi* (v. LINST.), and with four pairs of notches on the hinder half of its margin, due to the insertion of muscular fibres, the third of these notches just behind the third pair of hooks.

Mouth behind the plane of the hinder margin of the anterior suckers; œsophagus wanting. On the cerebral ganglion are two pairs of eyes; the posterior eyes a little larger than the anterior ones and directed forwards and outwards, the anterior eyes directed backwards and inwards.

Genital openings on the left lateral edge of the body, near the anterior end, by the side of the anterior sucker; the opening of the vagina just behind the common genital pore. Testes large, two in number, paired, irregularly round. Ovary large, elliptical, with its longer axis at a right angle to the longer axis of the body, situated in the median line, just in front of the testes and midway between the anterior end of the body and the centre of the posterior sucker. Vitellarium extending from the anterior end of the body, between the two suckers, to about the front end of the posterior sucker, that of the two sides intermingling with each other both in front of the cerebral ganglion and behind the testes. Paired yolk ducts directed transversely to the long axis of the body, uniting together near the median line just in front of the ovary. Unpaired yolk duct dilated to form a capacious yolk reservoir, situated in front of the left half of the ovary. The thinner end of the unpaired yolk duct unites soon with the oviduct, which arises from the middle of the anterior border of the ovary and proceeds forward. The canal arising from the united oviduct and yolk duct runs from about the median line to the left, undergoing several convolutions and opening into the ootype, which lies in the same line with the left border of the ovary. It has a characteristic rhomboid shape and is continued into the short uterus. The vagina is exceedingly long (hence the specific name *macrocolpa*); it arises from the yolk reservoir at its left border, and running on the left side of the body, outside the ovary and the testes, turns in a varying level between the hinder border of the testes and the front margin of the posterior sucker lateral and oral, and then proceeds orally, almost in a straight line, to reach the left margin of the body, at about the level of the hinder margin of the anterior suckers. Vasa efferentia relatively long, uniting with each other on the left side of the ovary; the vas deferens runs in an almost regularly curved line round the left side of the ovary and yolk-reservoir, and forms a large, close pack of numerous complicated convolutions between the ootype and the yolk-reservoir, then turning tailwards in a curved line and entering the penis in about the median line, a little in front of the ovary. Penis long, running in a curved line round the shell glands, ventral from the curved end of the vas deferens, and oral from the right half of the ovary, and entering into the very long genital atrium, which reaches the median line just before the ootype.

Stephanochasmus ceylonicus, n. sp.—Plate I., figs. 4 to 6.

From the subcutaneous tissue of *Narcine timlei*, Henle, taken off Dutch Bay, Ceylon. Several specimens.

Of this species only the encysted larval form was found, but there can be no doubt that the species is a new one, although closely allied to *Stephanochasmus pristis* (Deslongch.).

The specimens are about 2·0 millims. to 2·6 millims. in length, and 0·25 millim. broad. Margins of oral sucker projecting laterally over the thinner neck. Diameter of oral sucker 0·18 millim. to 0·2 millim., of ventral sucker 0·18 millim. Distance between the two suckers 0·6 millim. Length of præpharynx 0·4 millim. Pharynx 0·126 millim. in length, and 0·056 millim. broad. Round the mouth a double wreath of 36 large spines, which is not interrupted ventrally, as it is in *Stephanochasmus cesticillus* (Molin). The larger spines of the first row are 0·059 millim. and the somewhat smaller spines of the second row are 0·056 millim. in length. The small spines of the general body surface are best developed close behind the oral sucker, and become gradually smaller posteriorly, though more numerous. Behind the level of the ventral sucker the skin acquires the finely spinous structure described by Looss for *Hæmatolœchus asper*, Lss., and the posterior half of the body is smooth. Of the genital organs only the two testes, situated near the posterior end, are visible. The excretory vesicle is Y-shaped, with a short but ample median trunk, and two long branches reaching almost to the oral sucker.

The worms were encysted in round cysts, with a diameter of the outer wall of about 0·5 millim. to 0·8 millim., and of the inner wall of about 0·36 millim. to 0·47 millim. According to Mr. James Hornell, who collected the worms and has made drawings from the living objects, the fluid filling the space in the cyst around the larva was granular. In an uninjured cyst which I examined this fluid seemed quite clear.

Sub-family: ACANTHOCOLPINÆ, nov.

Provisional diagnosis.—Distomids with a very elongate and but slightly muscular body, whose cross-section is round or oval. Ventral sucker near the anterior end of the body. Oral sucker terminal or subterminal, but always cup-shaped, never funnel-shaped, followed mostly by a very distinct tubular præpharynx. Pharynx well developed, œsophagus short, intestinal cœca long, reaching almost to the posterior end of the body.

The two testes situated in the posterior part of the body, one behind the other, their axial diameter longer, more or less, than their transverse diameters. Cirrus-pouch long and slender, cirrus with spines. Ovary in front of the testes, median or sub-median. Vitellarium formed by numerous little follicles, situated on the sides of the body and behind the testes (in *Stephanochasmus* and *Acanthocolpus*) or only on the sides of the body (in *Deropristis* and in *Distomum semiarmatum*). Uterus running directly oral (in *Stephanochasmus* and *Acanthocolpus*), or at first tailwards and then turning in front of the testes (in *Deropristis*), or reaching the posterior end of the body (in *Distomum semiarmatum*). Vagina always very distinct and provided with similar spines to the cirrus. Genital atrium tubular, almost without spines, but sometimes (in *Acanthocolpus*) in its posterior part with similar spines to the vagina and cirrus. Genital opening in front of the ventral sucker in the median line.

From the generic differences mentioned in this diagnosis it results that *Acanthocolpus* is much more closely related to *Stephanochasmus* than to *Deropristis* and to *Distomum semiarmatum*.

Acanthocolpus, n. gen.

Provisional Generic Diagnosis :—Distomids of small size, with a thin, slender, very elongated body, round or oval in cross-section, without spines in the skin and around the mouth, with a transverse section of oval shape, rounded behind, somewhat pointed in front. Neck not enlarged Ventral sucker near the anterior end of the body somewhat pediculated. Oral sucker subterminal, followed by a very distinct præpharynx. Pharynx well developed, not far in front of the ventral sucker. Œsophagus short. Intestinal cœca long, ending not very far in front of the posterior end of the body.

Genital opening just before the short stalk of the ventral sucker in the median line. The two testes are oval shaped, with the longest diameter in about the long axis of the body, situated near the posterior end of the body in the median line, just behind each other. Ovary just in front of the testes. Very numerous follicles of yolk glands on the sides of the body and behind the testes, reaching the posterior end of the body.

Uterus developed in the same manner as in *Stephanochasmus*, opening into a very distinct long vagina, which bears on its inner side numerous spines ; cirrus-pouch very long, vesicula seminalis and pars prostatica lying on the dorsal side of the uterus ; cirrus of about the same length and with similar spines to the vagina. Cirrus and vagina opening into a long, tubular, genital atrium, the posterior half of which bears likewise similar spines to the cirrus and vagina. The spines are of a very characteristic shape, much broadened, and excavated at their bases. Eggs yellow-tinted.

This new genus, the type, and till now only species, of which is *Acanthocolpus liodorus*, is allied to the genera *Stephanochasmus*, Lss., and *Deropristis*, Odhn., and to another genus hitherto still unnamed, the type species of which is *Distomum semiarmatum*, Mol., a parasite of the sturgeon, found by me several years ago at Trieste, but the description of which I have not yet published, since another helminthologist, to whom I have sent my drawings, intended to write a special report upon the Trematode parasites of the sturgeon.

The above-named genera form together a separate sub-family, which I have named Acanthocolpinæ, the spines in the vagina being one of the striking characters.

Acanthocolpus liodorus, n. sp.—Plate I., figs. 7 and 8.

Specific diagnosis.—Length 2 millims. to 4 millims., breadth 0·36 millim. to 0·6 millim. Diameter of the oral sucker 0·12 millim. to 0·16 millim. Ventral sucker oval, with the largest diameter transverse to the long axis of the body; length 0·18 millim. to 0·24 millim. and breadth 0·24 millim. to 0·3 millim. Distance between the two suckers 0·24 millim. to 0·36 millim.

Præpharynx 0·21 millim. to 0·24 millim. long. Pharynx 0·13 millim. to 0·17 millim. long, 0·08 millim. to 0·10 millim. broad. Genital atrium 0·4 millim. to 0·7 millim. long, dividing behind the ventral sucker. Vagina about 0·25 millim. to 0·5 millim. long. Cirrus-pouch about 0·5 millim. to 1·05 millims. long, 0·07 millim. to 0·10 millim. broad. The long axis of the testes not quite in the long axis of the body, but somewhat oblique, the posterior end directed ventrally and the anterior end directed dorsally, and the two testes overlapping each other a little in this way. Ovary near the ventral surface of the body, partially still ventral from the anterior end of the anterior testes. The testes 0·35 millim. to 0·60 millim. long, 0·20 millim. to 0·24 millim. broad. Diameter of the ovary 0·14 millim. to 0·22 millim. Eggs 0·075 millim. long, 0·045 millim. broad.

From the intestine of *Chirocentrus dorab*, Cuv.; from Kalpitiya. About two dozen specimens.

Schistorchis, n. gen.

Provisional generic diagnosis.—Distomids of large size, with a very muscular, thick and wrinkled body, without spines. Shape almost rectangular, with rounded anterior and posterior ends. Mouth terminal, small, opening into the globular oral sucker. Pharynx well developed; præpharynx as well as œsophagus wanting; intestinal cœca long. Excretory vesicle **Y**-shaped, with long median trunk and long paired branches, crossing the intestinal cœca ventrally and finishing near the anterior end of body by the sides of the oral sucker.

Genital opening just in front of the ventral sucker. Cirrus-pouch well developed.

Testes in about the middle of the body, divided into several small separated pieces (in the same manner as in *Gorgodera*), five on the one side, and six on the other, lying for the most part behind each other in two lateral folds, which are separated from each other by the anterior end of the median trunk of the excretory vesicle. As in *Gorgodera*, the greater number of testes is on the ovarian side.

Ovary just in front of the testes and between the paired branches of the excretory vesicle, near the median line. Seminal receptacle present. Very numerous follicles of yolk glands on the sides of the body and behind the testes. Uterus very small, corkscrew-like, almost only by the side of the ventral sucker. Eggs clear yellow-tinted.

Type, and so far the only species of the genus: *Schistorchis carneus*, n. sp.

Schistorchis carneus, n. sp.—Plates I. and II., figs. 9 to 12.

Specific diagnosis.—Blood red tinted during lifetime, about 10 millims. to 15 millims. long, and about 4 millims. to 6 millims broad. Diameter of the oral sucker about 2 millims. to 2·5 millims., of the ventral sucker about 0·8 millim. to 1·0 millim. The oral sucker, in all the specimens examined, somewhat retracted, not reaching the outer surface of the body. Distance between the two suckers at the most 0·9 millim.

Pharynx much broader than long, 0·8 millim. by 0·3 millim. in the largest specimen, 0·6 millim. by 0·3 millim. in a smaller one. The intestinal cœca run in the beginning transversely outwards, then, after turning in almost a right angle, slightly convergent to the posterior end of the body. In several specimens they are filled with a dark matter. The paired branches of the excretory vesicle cross the transversely running beginnings of the intestinal cœca, and finish at the level of the greatest diameter of the oral sucker.

Diameter of the single testes reach 0·6 millim. to 1·0 millim. in the largest specimen. Cirrus-pouch with a large vesicula seminalis, which lies in the median line just behind the ventral sucker and opens in the pars-prostatica, turning round the left side of the sucker. Ovary near the median line, just behind the cirrus-pouch, and of about the same size as the single testes. Receptaculum seminis behind the ovary or at the left of it. Both ovary and receptaculum seminis in the triangle between the paired branches of the excretory vesicle, which unite just behind them. Vitellarium beginning at the level of the ovarium or of the vesicula seminis.

From the stomach of *Tetrodon stellatus*, Günther; from South Modragam Paar, Ceylon Pearl Banks. Eleven specimens.

General Remarks on Distomids with Numerous Testes.

Already several genera of Distomids with an increased number of testes are known. With some of these, *Syncœlium*, Lss., *Otiotrema*, Setti, *Hapalotrema*, Lss., this new genus has no affinity at all. Also with the above-named *Gorgodera*, Lss., it has no close resemblance beyond the number and arrangement of the testes. However, the resemblance is far greater with the genus *Pleorchis*, Raill., the anatomy of which, it is true, is but little known as yet; but the general arrangement of the genital organs is the same in *Pleorchis* as in *Sinistorchis*. The two species of *Pleorchis* also being intestinal parasites of marine fishes, it seems quite possible that the new genus is allied to *Pleorchis*, which differs, however, from it in several important points, justifying the creation of a new genus for the Ceylonese species described above. For *Pleorchis* is provided with spines in the cuticula, with a greater number of testes (24 to 30), with a long præpharynx, and with anterior branches of the intestinal cœca, similar to, though smaller than, the anterior branches of the H-shaped intestine of *Accacœlium*.

Referring to the species of *Pleorchis*, I must justify the mention of two species, although only one is quoted in the literature since the establishment of the genus *Gorgodera* for *Distomum cygnoides*, ZED. = *Pleorchis cygnoides*, STOSS. This only species is *Pleorchis polyorchis* (STOSS.), an intestinal parasite of the Mediterranean *Corvina nigra*. To the same species LINTON has referred an intestinal parasite of the North-American *Cynoscion regalis*, which I regard as a different species and which I will name *Pleorchis americanus*, n. sp. Besides the different habitat, the two species differ from each other in several important points of their anatomy; a distinct œsophagus is wanting in *Pl. polyorchis*, but present in *Pl. americanus*, and the anterior branches of the intestine are short and run parallel to the main branches in *Pl. polyorchis*, but are somewhat longer and form an angle with the larger intestinal cœca in *Pl. americanus*. In the latter species, moreover, the size of the two suckers seems to be smaller than in *Pl. polyorchis* (according to the figures given by STOSSICH and LINTON), and the number of testes somewhat larger than in *Pl. polyorchis*, which, according to STOSSICH, is provided constantly with 24 testes, whilst LINTON has counted 26 to 30 in *Pleorchis americanus*. It is of interest, that in this species also, as in *Gorgodera* and in *Sinistorchis*, the number of the testes is different on the two sides. In one specimen only LINTON found 15 testes on each side, and in another 15 on the right and 12 on the left, while of nine specimens with 14 testes on the right, two were provided with 16, three with 15, two with 13, and two with 12 testes on the left.

Gastris, n. gen.

Provisional generic diagnosis.—Distomids of large size, with a very muscular body, without spines. Anterior part of the body, between the two suckers, ventrally excavated; posterior part of the body, behind the ventral sucker, broadened, oval-shaped.

Oral sucker subterminal; pharynx well developed; œsophagus short; intestinal cœca long, and finishing not very far in front of the posterior end of the body.

Excretory system U-shaped, with long branches, situated between the intestinal cœca. Genital opening about midway between the two suckers, in the median line. Cirrus-pouch large, oval-shaped, situated in the angle between the two intestinal cœca.

The two testes globular, situated nearly symmetrically side by side, touching laterally the intestinal cœca and separated from each other by the uterus. Ovary in front of the testes near the median line. Yolk glands in the posterior half of the body, laterally to the intestinal cœca, arranged in several (6 to 7) groups, which lie behind each other and are separated from each other by a small interspace, in the same manner as in the genus *Opisthorchis*, R. BL. Uterus running at first to a little extent forwards, but turning very soon, proceeding then posteriorly and reaching the level of the blind ends of the intestinal cœca, not extending laterally beyond the branches of the excretory vesicle, but filling the whole space between these branches and behind the testes in numerous loops very densely pressed together. Eggs very dark, almost black.

At first view the arrangement of the genital organs of specimens somewhat compressed exhibits a superficial resemblance with *Dicrocœlium*, but closer examination exhibits no intimate affinity between this and the new genus.

Gastris consors, n. sp.—Plate II., figs. 13–16.

Specific diagnosis.—Length up to 16 millims.; just behind the ventral sucker 1·5 millims. to 1·7 millims. broad; greatest breadth about midway between the ventral sucker and the posterior end of the body up to 5½ millims.

Oral sucker circular, with a diameter of 1·0 millim. to 1·1 millims. Ventral sucker oval, with a greater diameter transverse to the long axis of the body of 2·6 millims. to 2·8 millims., and a smaller diameter parallel to the long axis of the body of 2·0 millims. to 2·2 millims. The opening of the ventral sucker is a transverse slit. Distance between the two suckers 1·6 millims.

Pharynx 0·6 millim. long, 0·84 millim. broad. Intestinal cœca end 1·8 millims. in front of the posterior end of the body, in several specimens filled with a dark matter.

Cirrus-pouch about 0·8 millim. long, about 0·5 millim. broad. Testes in about the middle of the body; vitellarium beginning at the level just behind the testes and not reaching the level of the blind ends of the intestinal cœca.

From *Tetrodon stellatus*, GÜNTHER.—Four specimens along with *Schistorchis carneus*, found apparently also on South Modragam Paar and also in the stomach of the host.

Anaporrhutum largum, n. sp.—Plate II., fig. 17.

From the body cavity of *Rhinoptera javanica*; Kalpitiya. A single specimen.

Body very flat, membranous, smooth, oval, 9 millims. long, 8 millims. broad; the greatest breadth just behind the ventral sucker.

Oral sucker subterminal, oval, with a longitudinal diameter of 0·65 millim. and a transverse diameter of 0·8 millim. Ventral sucker very large, but little excavated, slightly oval, with a longitudinal diameter of 2 millims., and a transverse diameter of 2·2 millims. Distance of the two suckers from each other 1·5 millims. Distance of the posterior margin of the ventral sucker from the posterior end of the body 4·8 millims.

Pharynx 0·42 millim. long and 0·48 millim. broad, not projecting into the oral sucker (as it does in *A. albidum*, OFENH.). Œsophagus short, about 0·6 millim. long. Intestinal cœca large and long, end about 1 millim. in front of the posterior end of the body, embracing a space smaller than that between their outer edge and the lateral margins of body. This broadening of the parts outside the intestinal cœca, together with the excessive diameter of the ventral sucker and the extreme thinness of the whole body, gives to the species a characteristic appearance, different from that of the other Anaporrhutinæ.

Excretory vesicle Y-shaped, with long median trunk, dividing a little behind the level of the posterior end of the yolk glands, and with shorter paired branches not crossing the intestinal cœca, but ending at the sides of the posterior edge of the ventral sucker.

Genital openings ventral from pharynx, somewhat at the right of the median line. Cirrus-pouch wanting.

Testes outside the intestinal cœca, but still within a distance of almost 2 millims. from the lateral margins of the body, extending from 0·5 millim. behind the posterior margin of the ventral sucker to 1·8 millim. behind the same. Their number is 14 at the right side of the body and 17 at the left side, pressed closely together in two rows which unite behind; the inner edge of these rows has but about half the length of the outer. Each testis is mulberry-shaped. The vasa efferentia from the single testes arise between the two rows and unite soon to form the vas deferens of each side. The two vasa deferentia do not anastomose with each other, as they are said to do in *A. albidum*, but only unite at about the level of the division of the intestinal cœca to form a very convoluted vesicula seminalis.

Ovary globular, with a diameter of 0·4 millim. It is situated just behind the ventral sucker, at the right side of the body. Receptaculum seminis of about the same size, situated at the side of the ovary in the median line. Yolk glands between the intestinal cœca and the paired branches of the excretory vesicle, the left just behind the ovary, and the right symmetrically on the other side of the body, each of them consisting of several tubules, which do not anastomose with each other, as they are said to do in *Anaporrhutum albidum*, Ofenh., and *Probolitrema capense*, Looss.*

Uterus similar to that of *Probolitrema richiardi* (Lop.) Lss., but ending about 0·7 millim. in front of the blind end of the intestinal cœca, and passing at the right side of the ventral sucker.

The new species *Anaporrhutum largum* differs from both *Anaporrhutum albidum*, Ofenh., and the two species of the genus *Probolitrema*, Lss. (*P. richiardi* and *P. capense*), in several points of its anatomy, especially in the position of the testes and the yolk glands, to which Looss has ascribed generic value. Accepting *Probolitrema* as a separate genus, it would be necessary therefore to create a third genus for the new species. But doubtless all these Anaporrhutinæ living in the body cavity of Selachians are more closely related to each other than to *Plesiochorus cymbiformis* (Rud.), placed by Looss in the same sub-family. It seems to me, therefore, that *Probolitrema* is to be regarded only as a sub-genus of *Anaporrhutum*, or

* In addition to *Anaporrhutum largum* I have also examined a species of *Probolitrema* very similar to *P. richiardi* (Lopez), if not identical with this, which is found in an undetermined shark from the Ulle Sea (Dutch India), and belongs to the Natural History Museum of Hamburg (No. 17705). In this species also the tubules of the yolk glands do not anastomose with each other.

that *Plesiochorus* is to be regarded not as a member of the Anaporrhutinæ themselves, but as the representative of a separate sub-family of the Gorgoderidæ allied to the Anaporrhutinæ.

Distomum, sp. (larva).—Plate II., fig. 18.

From *Pinna*, sp. One specimen.

A small larva of a Distomid, about 1 millim. long, and about 0·36 millim. broad, without spines. Ventral sucker very large, projecting, situated in the posterior half of the body, its distance from the posterior end of the body 0·20 millim., its diameter 0·33 millim. Diameter of the oral sucker 0·18 millim., of the pharynx 0·12 millim. Œsophagus wanting. Intestinal cœca ending at about the middle of the body. Excretory vesicle V-shaped, ending at about the same level as the posterior end of the intestinal cœca.

From the genus *Gymnophallus*, larval forms of which are found in some marine Lamellibranchs (*Mytilus edulis*, *Saxicava rugosa*), this parasite of *Pinna* differs in the absence of spines in the skin, of a distinct œsophagus, of an unpaired median trunk of the excretory vesicle, and by the smaller length of the excretory vesicle.

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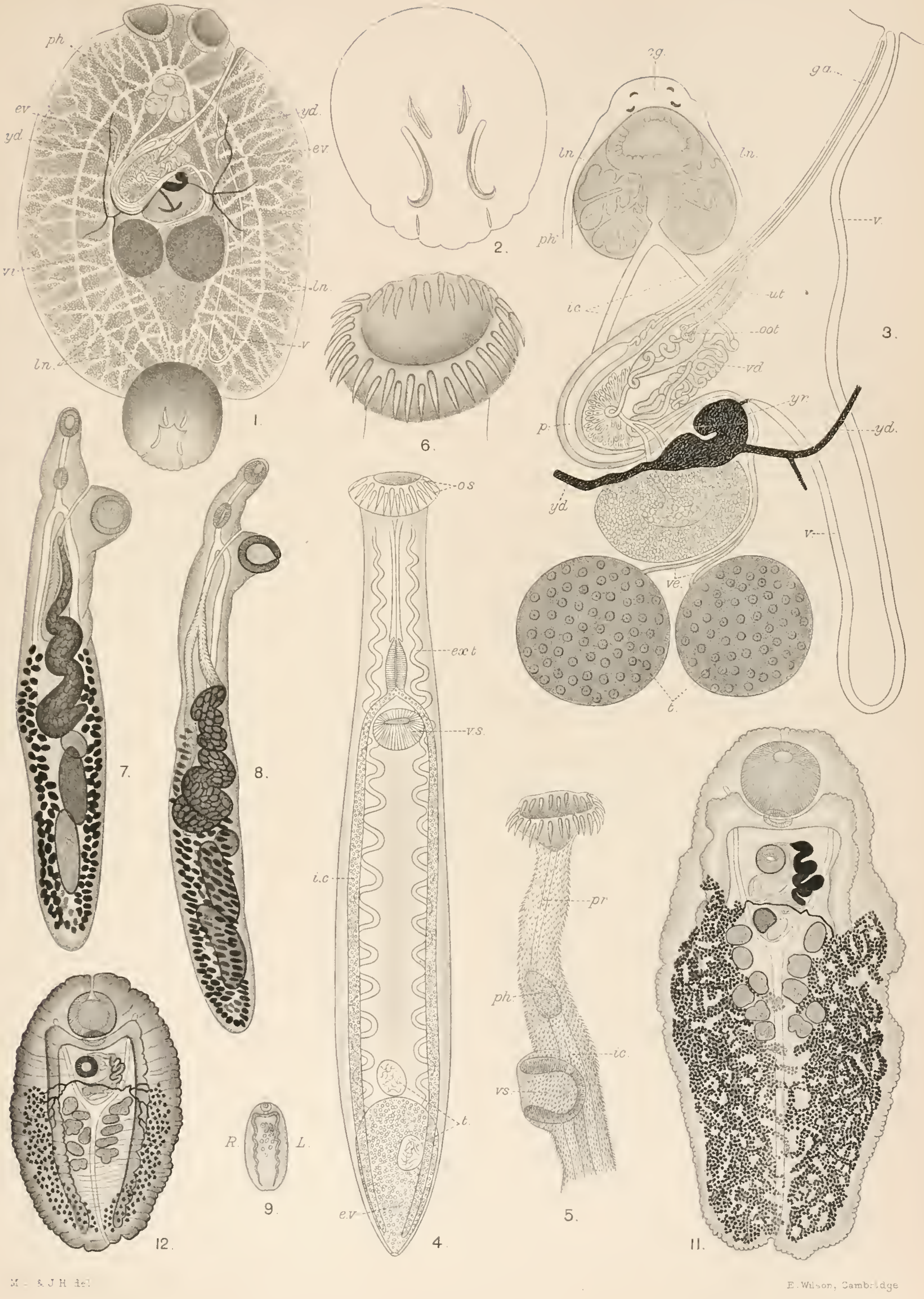
EXPLANATION OF PLATES.

PLATE I.

Fig. 1. *Epibdella* (*Benedenia*) *macrocolpa*, n. sp. Ventral view. × 10. (For letters, see fig. 3.)
,, 2. Posterior sucker of the same species, with the three pairs of hooks. × 20.
,, 3. Genital organs of the same species. × 30.
cg., cerebral ganglion with the two pairs of eyes; *ev. ev.* (only in fig. 1), excretory vesicles; *ga.*, genital atrium; *ic. ic.*, intestinal cœca; *ln. ln.*, longitudinal nerve; *oot.*, ootype; *ov.*, ovary; *p.* penis; *ph.*, pharynx; *t.*, testes; *ut.*, uterus; *v.* vagina; *ve.*, vasa efferentia; *vi.* (only in fig. 1), vitellarium; *yd. yd.*, yolk ducts; *yr.*, yolk reservoir.
,, 4. *Stephanochasmus ceylonicus*, n. sp. Ventral view of the living larva after liberation from cyst. (Drawn by JAMES HORNELL.) × 24.
ic., intestinal cœca; *ev.*, excretory vesicle; *ex. t.*, paired diverticula of the excretory vesicle; *os.*, oral sucker; *t.*, testes; *v.s.*, ventral sucker.
,, 5. Same. Lateral view of the anterior end. Leitz. Obj. 3, Oc. 3.
ic., intestinal cœca; *ph.*, pharynx; *pr.*, præpharynx; *vs.*, ventral sucker.
,, 6. Same. Ventral view of the oral sucker. Leitz. Obj. 5, Oc. 3.
,, 7. *Acanthocolpus liodorus*, n. gen., n. sp. Ventral view. × 30.
,, 8. Same. Lateral view. × 30.
,, 9. *Schistorchis carneus*, n. gen., n. sp. Ventral view of the living worm. Natural size. (Drawn by JAMES HORNELL.)
,, 11. Ventral view of another specimen somewhat squeezed and lying in creosote. × 6.
,, 12. Ventral view of a young specimen containing but a single egg in its uterus. × 10.

PLATE II.

Fig. 10. *Schistorchis carneus*. Ventral view of a specimen lying in alcohol. × 8.
,, 13. *Gastris consors*, n. gen., n. sp. Ventral view of an adult specimen lying in alcohol. × 8.
,, 14. Ventral view of another specimen somewhat squeezed and lying in creosote. × 10.
,, 15. Dorsal view of a third specimen squeezed in a similar manner. × 10.
,, 16. Ventral view of the fourth (young) specimen. × 20.
,, 17. *Anaporrhutum largum*, n. sp. Ventral view. × 12.
,, 18. *Distomum*, sp., from *Pinna*. Lateral view. × 38.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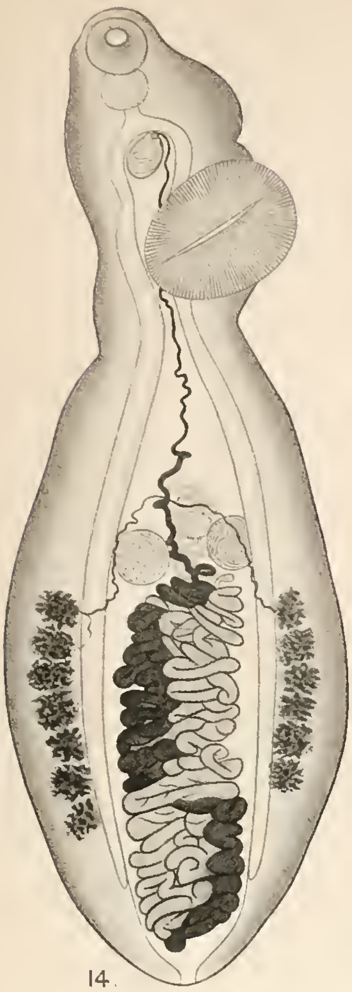

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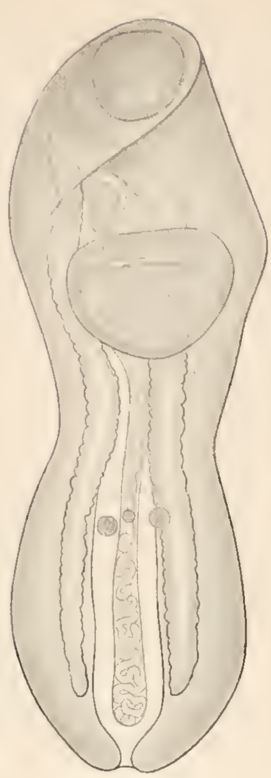

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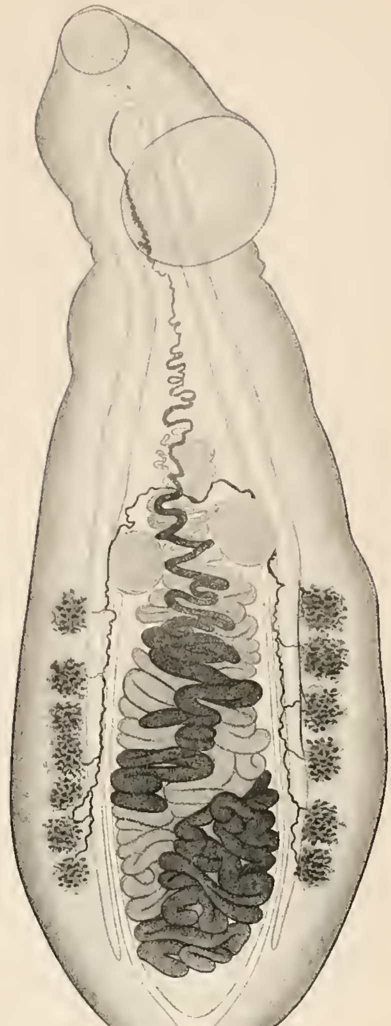

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M.L. del. E Wilson, Cambridge

GENERAL SUMMARY AND RECOMMENDATIONS.

As the results of this investigation, which has extended over four years and a half, are scattered through a number of articles in the five volumes of this Report, it seems desirable, now that the practical work is concluded, that I should give a summary account of the conclusions arrived at, and should bring together and revise the various recommendations made to the Ceylon Government from time to time. In doing so I shall omit all consideration of purely speciographic and faunistic results, as these matters will be dealt with in a separate article on Geographical Distribution at the end of the Supplementary Reports in this volume. I am here only concerned with those biological results which have a bearing upon the life-processes of the pearl oyster, the nature and characteristics of the "paars" and the prosperity of the Ceylon fisheries.

The observations upon which these conclusions are based were made :—

1. During the two cruises of the "Lady Havelock" in the Gulf of Manaar, and around Ceylon, during the spring of 1902.

2. During our subsequent work with the divers on the inspection ship "Rangasami-Poravi."

3. By Mr. Hornell at the Marine Biological Station, Galle, after I had left Ceylon.

4. During Mr. Hornell's various inspections, and the fisheries that have been held since 1902.

5. All of which observations have been corrected when necessary, and correlated where possible by the laboratory work in Liverpool upon the material sent home for investigation. In this laboratory work I have had the advantage of frequent help on special points from scientific friends in other Universities, and from some of my assistants in the Zoological Department of the University of Liverpool.

The factors which determine the problems of the life-history, prosperity and pearl-production of the Ceylon pearl oyster are so inter-related, that it is scarcely possible to make a consistent classification into mutually independent sections; still, I think it may conduce to clearness and help the reader, by providing landmarks, if I group the results under a few main headings. It will be readily seen that these overlap in places, that the groups are not all of the same value, and that it has not been possible to keep the "Summary of Conclusions" and the "Recommendations" strictly separated.

A.—SUMMARY OF CONCLUSIONS.

I. The Pearl Banks—the Physical Surroundings of the Pearl Oyster.

The pearl oyster, or rather "mussel" (*Margaritifera vulgaris*, Schum.) of the Ceylon fisheries lives in very pure and clean sea-water in the Gulf of Manaar on certain patches of hard ground known as "paars" (see charts and maps in Part I.). There is no strict line of demarcation between the paars and the neighbouring sea-bottom. We have evidence to show that the outlines, and the extent of the paars, may be altered from time to time by the weather. What is a hard patch one season may be covered by an overwash of sand in the next, and then again be swept clear by an exceptional storm or current. These changes, although they may occasionally cause damage to an oyster bed, are not wholly detrimental; they sometimes uncover fresh ground upon which young oysters may settle, and they cause us to recognise that the whole of the wide shelf within the 10-fathom line in the northern part of the Gulf of Manaar is potential paar-ground, and is susceptible of artificial improvement for purposes of cultivation.

The paars are, for the most part, at depths of 6 to 9 fathoms, and those that are best known as fishing grounds lie at a considerable distance from land, the Cheval Paar 9 to 14 miles, the Periya Paar Karai 12 miles, and the Modragams about 8 miles from the nearest coast.

The Muttuvaratu Paar, at about 4 miles off Karativu Island, is the only one where important fisheries have been held that is near the shore. In no cases have the pearl oysters been found between tide-marks, or contiguous to the beach, in the Gulf of Manaar, although it has been shown that they can live in such a position in the sheltered waters of Trincomalee. For further details as to the positions, depths, extent and other characters of the paars, see the sections on "Description of the Pearl Banks" in Part I., and on the "History of the Principal Pearl Banks" in Part II. of this Report.

The hard bottom of the paars is to some extent formed of corals and shells, but to a much larger extent by a modern rock now forming *in situ*. This has been called a "calcrete" (see "Report on the Sea-bottoms," by Mr. Lomas, in Part I., p. 147), as it is composed of the sand and neighbouring organic remains cemented into a continuous hard mass by carbonate of lime.

It has been shown in this Report that the cementing, although no doubt in part a chemical process, is in places a biological result, since it is largely due to the growth of living Nullipores and Polyzoa—especially the latter (see fig. 1).

When the bottom on the pearl banks is not calcrete, it is formed of a coarse sand, in some places almost wholly inorganic, containing large quartz grains, and derived from the waste of the granulitic rocks of Central Ceylon brought down by the rivers:

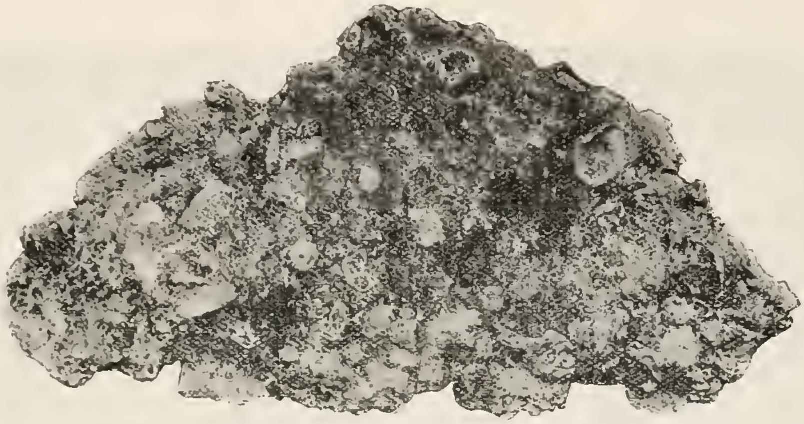

Fig. 1. Lump of calcrete showing large quartz grains and felspars with fragments of coral, shells and worm tubes, along with many Polyzoa colonies. From Jokkenpiddi Paar.

Elsewhere the sand is of organic origin, and is formed chiefly of the shells of large bottom-living Foraminifera, such as *Amphistegina lessonii*, *Alveolina melo*, *Heterostegina depressa* and *Orbitolites marginalis*, mixed with the calcareous remains of many other kinds of animals (see Report upon the Foraminifera in this volume). The divers distinguish between a hard bottom (the "paar") suitable for pearl oysters, and a sandy one which is more or less useless. The sand, however, in the neighbour-

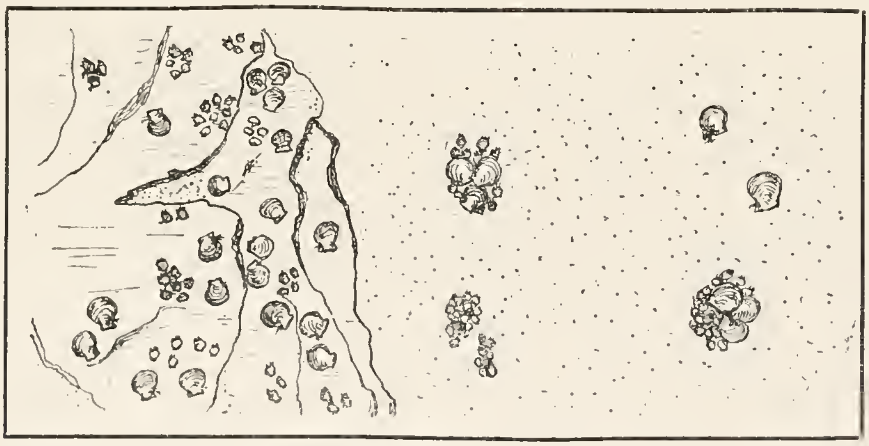

Fig. 2. Diagram showing the arrangement of pearl oysters (large and small) in clumps on the sand and singly attached to flat ledges of rock.

hood of paars often bears considerable numbers of oysters in clumps (fig. 2) adhering to fragments of dead coral, to old molluscan shells, or more frequently to nullipore nodules (*Lithothamnion fruticulosum*), see fig. 3.

Such pieces of natural cultch are of enormous importance to the prosperity of the fisheries, and the area covered by these fragments and so made available for the attachment of pearl oysters, might be largely extended by artificial "cultching." Large areas of the important Cheval Paar, for example, would be improved by further cultching.

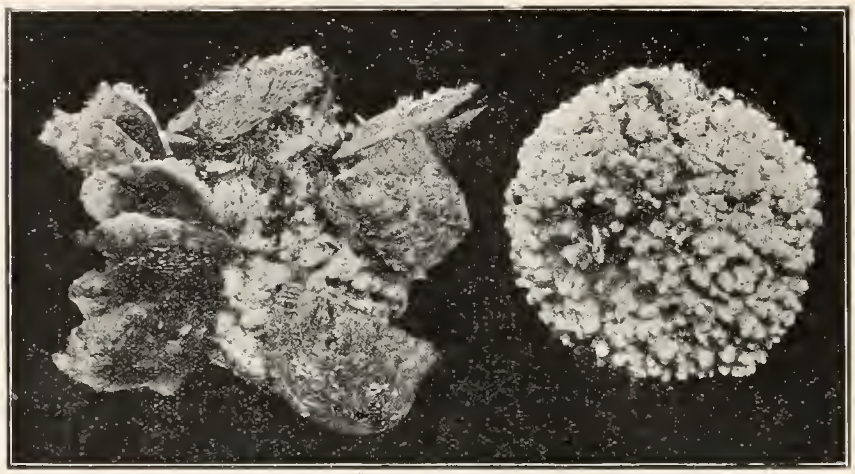

Fig. 3. Nullipore ball (*Lithothamnion fruticulosum*) with tags of byssus where pearl oysters have been attached (to the right), and a similar ball still covered with young pearl oysters (to the left); natural size.

The temperature of the sea-water in which the pearl oysters live in the Gulf of Manaar is high. In our experience in 1902 it ranged from about 77° F. in January to close on 90° F. in April. In February, 1904, the range was from 80° to 84°, in March from 81° to 86°, and in April from 84° to 88° F. In all cases the temperature was taken at a depth of 2 feet below the surface of the sea, at 7.30 A.M., noon, and 5.30 P.M. each day. Probably the normal range during the greater part of the year is from 82° F. to 86° F.

The specific gravity we found to be fairly constant at 1·023 on the pearl banks; at Galle it was slightly lower, averaging 1·022 ; at Trincomalee in the inner bay, and especially in Tampalakam, it was distinctly lower (1·015 to 1·019). At exceptional spots and seasons in the Gulf of Manaar we have found the specific gravity lower than the normal. Off Chilaw, in November, 1902, it was slightly above 1·019, and on the Muttuvaratu Paar in the same month it averaged about 1·020. No doubt on occasions of great floods on the land it may be lower still on those paars that are near the mouths of the rivers. There is no reason to think (as has sometimes been stated) that some admixture of fresh water is necessary for the prosperity of the oyster or for pearl-formation. On the contrary, exceptional floods are probably harmful to any paars they may reach. On the other hand, it is possible that the outflow from the great land-locked lagoons (*e.g.*, Portugai Bay and Dutch Bay) influence the sweep of the coastal currents and help to determine spat-falls on the neighbouring banks. The great tidal outflow from Dutch Bay probably influences deposition on the Muttuvaratu Paar by breaking up the north or south current into local eddies. Similarly the South-east Cheval and Modragam Paars are within the influence of the outflow from Portugai Bay.

There is a general drift of the water over the banks from south to north between April and September, and from north to south during the height of the north-east monsoon, with intermediate periods of calms and variable winds from February to April, and usually again in November. But we are still in want of more definite information (such as can only be obtained by some years of observation and experiment with "drifters") in regard to the usual surface drift during the periods of variable winds between the monsoons, before we can be certain of the source of "spat" supply to particular banks, or of the destiny of larvæ produced from our adult oysters. "Drift-bottle" experiments, such as have been recently made for fisheries purposes in several European seas, should be instituted in the Gulf of Manaar. It is only after such work has been carried on systematically for two or three years at least that it will be possible to determine the course taken by the larval pearl oysters between the time of hatching and the deposition of spat, and again between the attachment to floating Algæ and the appearance of young oysters on a paar. These are details which it was impossible for us to determine in the time at our disposal in 1902, but which could be readily settled by the Marine Biologist if he were given the necessary facilities. Such information will obviously be of value whenever it becomes necessary to decide upon the best section of a bed of oysters to be reserved as a breeding stock.

II. Fauna and Flora—the Biological Surroundings of the Pearl Oyster.

The Fauna and Flora of the Gulf of Manaar, comprising the whole assemblage of plants and the other animals, large and small, which surround the pearl oyster, have a profound effect upon the well-being of the stock upon the beds, and hence upon the prosperity of the fisheries. We have taken every opportunity of investigating this fauna and flora; and the results of our collecting are reported upon in detail by specialists, in the series of Supplementary Reports given in these volumes. It will suffice to point out here, that the microscopic forms floating in the water and captured by our fine silk tow-nets included (1) the pearl oyster itself in its youngest free-swimming stages, (2) its food, not merely when young, but throughout life, and (3) young stages of the parasitic worms which infest the oysters and some of which induce pearl-formation; and that the larger animals on the sea-bottom—sponges, corals, starfish, molluscs, crustaceans, and fishes—are the all-important enemies or fellow-competitors of the oyster (for food and attachment areas and growing room), which may ruin a promising bed either by their direct aggressive action or indirectly in the struggle for existence.

It is impossible, until a careful study has been made of each case, to say which members of the fauna and flora of an oyster bed are of most importance to its prosperity—probably none are wholly without influence for good or evil, so closely interwoven in past history and present function is the web of living nature.

III. Reproduction and Life-History of the Pearl Oyster.

We find that the Ceylon pearl oyster is diœcious, or has the sexes separate, not only at any one period, but throughout the life of the animal. Our observations on innumerable microscopic sections of preserved material, and Mr. Hornell's experiments at Galle (see Part I., p. 125), have shown that quite definitely; and there are no traces of hermaphroditism. Emission of the generative products takes place directly into the surrounding water, where the ova are fertilised, and consequently there is no retention of eggs or embryos within the body of the female. The male is stimulated to emit spermatozoa by the presence of ova in the surrounding water, and as the animals are gregarious, and males and females are found mature together, it becomes practically certain that all eggs will be fertilised under normal conditions.

There is no marked disproportion in numbers between the sexes; out of a couple of hundred collected together at random and examined in 1902, 87 were males, 71 females, and the remainder immature or indeterminate. Similar observations made on several occasions since have given us much the same results.

Reproduction appears to take place to some extent throughout the year, and stray individuals may be found to be sexually ripe in any month; but there are two maxima when the majority of the pearl oysters in the Gulf of Manaar become mature and shed their reproductive elements, viz., in mid-summer from May to July and in mid-winter from November to January. It must be remembered that the temperature and other conditions in these two periods of the year do not differ very greatly. The one period is during the prevalence of the south-west monsoon and the other during the north-east. Hence the importance of ascertaining precisely the resulting currents that would carry floating embryos as the result of the prevailing winds at each such period is obvious. It will be noted that these statements are only made in regard to the pearl oyster in the Gulf of Manaar. It may well be that even the same species in other localities, such as the Persian Gulf or the Red Sea, has other breeding habits.

Larval development takes place in the surface waters of the sea, and from our observations we draw the conclusion that the young animal may settle down as "spat" within 5 days of the fertilisation of the egg. At the same time, from the size of some of the larvæ we have found, we consider it probable that the free-swimming period may on occasions be considerably prolonged. We were able to rear young larval stages in the Galle Marine Biological Station, and we caught the later ones in the tow-nets on the pearl banks. We found the youngest fixed spat on Zoophytes and Algæ early in November and early in March. All fixed stages, from one similar to the latest of the free stages up to young oysters having the adult characteristics of shell, were found during March and April, 1902, attached to both rooted and floating Algæ in various parts of the Gulf of Manaar. The so-called "false-spat" (other smaller allied shell-fish, such as species of *Avicula*) also occurs on Zoophytes and Algæ; but during the time of our investigations there was undoubtedly abundance of the true pearl-oyster spat both on filamentous green and red Algæ from the bottom (Plate, figs. 32, 33), and also on floating *Sargassum* weed (fig. 4). The importance of these Algæ in thus affording attachment to the youngest stage of the spat, and in afterwards distributing it widely, can scarcely be over-estimated (for the names of the species of Algæ involved, see 'Report on the Algæ,' Part I., p. 163).

Fig. 4. Sketch of young pearl-oyster spat attached to *Sargassum*.

Mr. HORNELL has been unable, since he became Inspector of the Pearl Banks, to obtain, during the anxious and busy periods of successive inspections and fisheries, the amount of free time necessary in order to make detailed observations on the embryonic development; but we give here a brief outline, illustrated by a series of figures (see Plate), most of which he made in the summer of 1902 from embryos reared at the Galle Biological Station. Figs. 1 and 2 show the living egg on extrusion to be provided at one end with a micropyle through which fertilisation takes place, and which may be prolonged (fig. 1) as a slender tube. Figs. 3 and 4 represent the mature ovarian egg, fixed and stained as we now find it in our sections, and showing a well-marked nucleolus lying in a clear vacuole. The egg shown in fig. 4 measured about 0·05 millim. along its greater axis. Fig. 5 gives the outline of the spermatozoon much more highly magnified than the ova.

The segmentation is complete, but unequal, and the stages seen in figs. 6, 7, and 8 agree with those we are familiar with in some other allied molluscs. The enclosure of the larger macromeres by the smaller micromeres, seen in progress in figs. 7 and 8, is shown far advanced in 9 and completed in 11. The single macromere of fig. 8 has divided into two in 9 (see optical section 10) and into four in 11 (see optical section 12). Fig. 11 shows the flattening of the lower, posterior, end and the first appearance of a zonal (præ-oral) band of cilia round the widest part of the body. This is a young trochophore stage, and completed trochophores are seen in figs. 13 (22 hours), 14 and 15 (26 hours), and 16 (30 hours after fertilisation). These stages show an enteron opening to the exterior near the posterior end, a posterior patch of cilia, a long anterior tuft on the prostomium, and an equatorial præ-oral circlet of cilia (see fig. 15).

After this stage our series is not so complete, but we give such stages as we have of later larvæ, as they may be useful to future observers for comparison with forms captured in the tow-net. Fig. 17 shows a couple of unfertilised eggs, not yet beginning to decay or disintegrate, at three days after extrusion from the parent. Fig. 18 shows the first appearance of the larval shell, three days after fertilisation; and figs. 19, 20, and 21 show three pelagic (also shown in text-fig. 5), but shelled, forms. The ciliated velum (a), the adductor muscles, the mobile foot, the otocyst, a pigmented eye-spot, the developing gill filaments, &c., are readily seen.

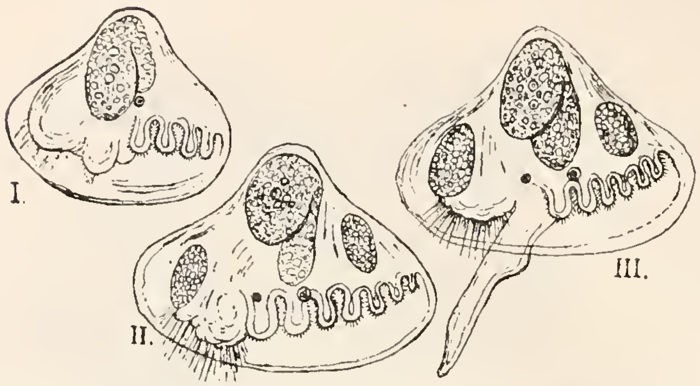

Fig. 5. Free-swimming larval stages of pearl oyster caught in the tow-net. I. has the ciliated velum retracted. II. and III. show the stage at which the larva becomes attached to Algæ. III. has the mobile foot extended.

The larva is now at a stage when it is ready to affix itself to some foreign body (Plate, fig. 32), such as the filamentous green Algæ. Figs. 22 to 27 (and also text-fig. 6) show young stages of growth of the shell after fixation. Fig. 22, the youngest fixed form we have found adhering to Algæ, measures 0·4 millim. in greatest extent, and is identical with fig. 21, the latest free-swimming stage we have found. Fig. 23 shows that the new growth added to the shell ("prodissoconch") of the "spat" after fixation is formed of prismatic substance, and is entirely different in appearance from the structureless embryonic shell marked only by concentric lines of growth. Fig. 31 shows the junction of these two layers of the shell, and also the free margin, magnified, at this stage. Further additions of prismatic substance which is gradually surrounding the embryonic shell are shown in figs. 24 and 25. The byssal sinus, indicating the anterior end of the shell, appears in these stages. In the next (fig. 26) it has worked its way further dorsally. Developing gill filaments are present in all these stages, seen through the thin shell of the "spat." In fig. 26 the filaments have become long and slender, and are about 10 in number. The spat is now 1 millim.

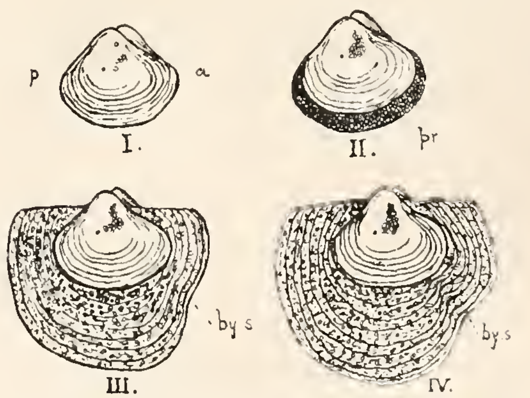

Fig. 6. Stages in the growth of the shell after the attachment of the larva. I. is identical with the latest free-swimming stage; a, anterior, p, posterior end. II. shows the first formation of prismatic shell (*pr.*). III. and IV. show the change in shape and the byssal sinus (*by.s.*).

across, and three regions are distinctly visible in the shell, the structureless, clear, embryonic shell or prodissoconch marked by very regular and delicate lines of growth, and forming the hinge (with 5 anterior and 5 posterior teeth, separated by a slight median interspace, figs. 28, 29, on each valve) and the umbo; the now very extensive prismatic part extending to the free margin all round and having very much the shape of the adult; and finally an intermediate region which in addition to the prismatic part has a lining of nacre. These three regions of the shell are still seen in fig. 27, but the prodissoconch is now becoming imbedded in the later formed shell and so loses its distinctness; its umbo, however, is still prominent. This specimen, which measures 1·5 millims. in diameter, is seen from the left side; the preceding figures were seen from the right. In fig. 27 pigment has commenced to form in the prismatic layer, producing 4 to 6 yellow or ruddy-brown radial bands, most marked at the periphery and dying away internally. These and still larger young oysters are shown in fig. 33, natural size, attached to an Alga; while a sample of "false spat" is shown in fig. 34, and enlarged in fig. 30 (*Avicula vexillum*, Reeve).

The spat in all these stages of growth is very actively locomotive. Although it can fix itself by the byssus threads, it does not usually remain fixed for long. When moving, it pulls itself along by means of the large mobile foot (see fig. 7). We have many observations showing the rapidity with which it can detach and re-attach itself, and the rate at which it can travel (see Part I., p. 68). There is no doubt, then, that in this young stage the pearl oyster can leave the weed to which it first becomes fixed and transfer its attachment to a coral or nullipore fragment on the paar, or can move from an unsuitable spot in search of a better. Its tendency to climb upwards whenever shaken on to the floor of an aquarium (see "Narrative," Part I., p. 69) is probably an indication of an instinct to ascend any solid objects on the sea-bottom, which must often save it from being smothered in the loose sand.

Fig. 7.

Our experiments on the pearl banks in 1902, and at the Galle laboratory, have shown that not only the young but also the adult pearl oyster is able to cast off its old attachment, move to a new place, and there spin a new byssus, and this not once or twice, but repeatedly, up to eight times in fourteen days, as our records show (see fig. 8).

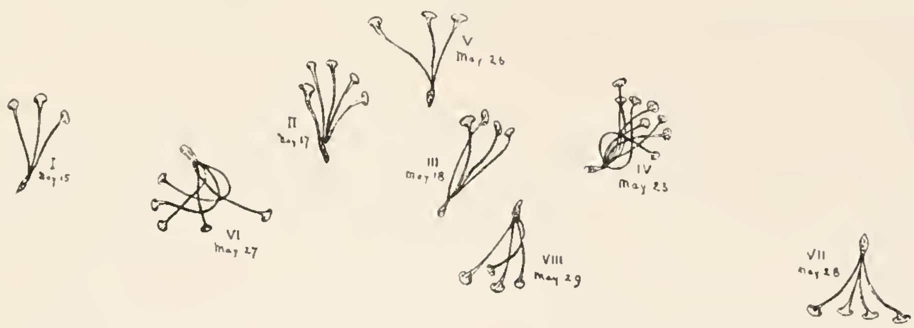

Fig. 8. Diagram showing the eight successive positions in which a pearl oyster formed new byssus strands in a fortnight. One half natural size.

We do not mean to assert that the oysters have a power of locomotion that would enable them to migrate to any great distance; but our observations have convinced us that they have powers of freeing themselves from sand, of moving to a better position, of re-attaching themselves when torn off from their moorings, and of repairing injuries to shell and mantle (for details see section 'Observations and Experiments,' &c., Part I., p. 125), with which they are not usually credited.* All these field and laboratory observations, it is scarcely necessary to point out, have an important bearing upon some of the practical recommendations that follow (p. 133).

IV. Practical Considerations.

Many of our observations and experiments were made with the view of gaining information as to the practicability of transplanting the pearl oysters from one locality to another. We have shown that the transportation of oysters, both old and young, even for considerable distances—such as from the head of the Gulf of Manaar to Galle, a matter of four or five days—at the hottest season of the year, is comparatively easy if ordinary precautions be taken to keep the water in the vessels as cool as possible and to prevent any decomposition taking place. Transplanted specimens, moreover, flourished in our hands. Both at Galle and in the Gulf of Manaar (where some batches were moved from the Muttuvaratu Paar to the Cheval) the oysters improved in health and grew rapidly in size when moved to a new locality. We have given the details of growth for both old and young oysters in preceding sections of this Report (see Part I., p. 136). These and other experiments were all undertaken because of their bearing upon that transplantation, in quantity, from overcrowded and unreliable paars to more suitable ground, which we have advocated throughout this Report.

Some of our experiments gave us a clear indication, which, however, we also obtained from observations on the pearl banks, of the kinds of foreign objects best suited for young pearl oysters to settle down upon, and also of the objects, such as living coral, to which they cannot become attached. This, then, led us to recognise the value of natural "cultch," or suitable hard objects, such as dead coral fragments, old shells and nullipores, upon the bottom, and the importance of increasing the area available for beds by the artificial "cultching" of the more sandy parts of the paar-ground.

We must not try to be too precise in regard to the positions, sizes and outlines of the paars. Our work in the "Lady Havelock" showed us that some spots around and between them are more or less hard-bottomed, and even, in some cases, bear oysters, and are evidently capable of becoming fishable paars. On the other hand, it is clear from the record of the inspections that many parts of the known paars may be

* Although Kelaart observed certain powers of locomotion and of byssus regeneration nearly fifty years ago; and more recently H. Sullivan Thomas (1884) made similar observations.

temporarily, and possibly some parts even permanently, unsuitable for the attachment and rearing of oysters.

We may consider, then, the whole pearl-bank plateau of the Gulf of Manaar as potentially paar-ground, some parts of it better suited for one purpose and some for another, some parts more constantly covered by the shifting sands, others more regularly bare and hard. It is this condition that gives man his opportunity and renders possible the farming operations, such as cultching and transplanting, which we urge in our Recommendations.

The history of the pearl fisheries in the past, especially during the nineteenth century (see Part II., p. 1), has shown that :—

1st. A number of the smaller paars, which are hard patches of limited extent largely covered with living corals, are practically worthless from an economic point of view.

2nd. Some parts, such as the Periya Paar, might be used as most valuable sources of supply of young brood oysters for transplantation, but cannot be relied upon to produce an adult stock suitable for fishing.

3rd. Others again, such as the great Cheval Paar with its various subdivisions, and the North and South Modragams, the Periya Paar Karai, and the Muttuvaratu Paar, are very valuable and fairly reliable grounds, upon which most of the successful fisheries of the past century have taken place. Others, such as Chilaw, Dutch Modragam, Alantura and Karativu, are less reliable, but may be valuable on occasions, and are also of importance as sources of spat-production available for transplantation.

It became clear to us during our work on the "Lady Havelock" in 1902—when we understood why it is that the Periya Paar is unreliable and the Cheval Paar so much more satisfactory—that the main hope of introducing some constancy of result and a more regular succession of fisheries must rest upon a system of transplanting young "strikes" or broods of oysters, whenever they make their appearance upon useless or unreliable paars, to wherever there is room for them at the time upon ground that is more certain to give them a better chance of living and growing to maturity.

Speaking generally, the Cheval appears to be the most reliable of these areas, and more especially its south, south-east, and mid-east sections. Whenever possible, the brood oysters, to replenish the Cheval Paar, should be brought from the Periya Paar, which is most suitable by reason of its proximity, the frequent spat falls thereon, and the impossibility of such spat growing to maturity on its own area. Next to the Periya Paar the most suitable grounds from which to obtain spat are the many small paars off Chilaw. Like the Periya Paar, these paars seldom bring their oysters to a fishable age, and when they do, the numbers and value are comparatively insignificant. But in the economy of the banks they have importance as sources whence the Cheval may be replenished. They should be utilised whenever the Periya Paar is not available; and even when brood oysters on the latter are to be had, it may be preferable to go to the Chilaw banks for the supply if the oysters thereon are older. If year-old oysters can be had on the Chilaw beds in quantity, while those on the Periya Paar are only three months old, then it is best to move the older, Chilaw, oysters first, since they have already survived the critical first year of life, and are probably worth three times their number of the younger brood.

The transplantation system can be extended also to older oysters. We have shown that even adults can throw off the old byssus and form a new attachment-cable whenever necessary. Consequently, overcrowding or any other source of danger should now be mitigated whenever possible by transplanting to unoccupied ground on the more favourable paars.

V. Causes of Disaster.

The above-mentioned points raise the whole question of the causes of death in the pearl oyster, the reasons of the intermittence in the history of the fisheries, and the conditions which render some paars more reliable than others. These matters have been discussed in various preceding sections of this Report (see especially Part I., p. 120, Part II., p. 35, and Part III., p. 25)

The following gives a summary of our results :—

(I.) The most important agent in causing wide-spread death of pearl oysters—both young and old—in the Gulf of Manaar is the shifting of sand due to the strong currents prevalent during the south-west monsoon, and no doubt occasionally (but rarely) to exceptional storms. We obtained a good deal of evidence as to the manner in which the sand is carried about and piled up by the currents, and is churned up in places by the swell of a strong south-west monsoon, and we made observations as to the effect of burying oysters of different sizes in various amounts of sand. The successive broods of young oysters which have appeared, and as regularly disappeared, upon the Periya Paar during the last quarter century have, there can be no doubt, been overwhelmed by the bottom currents caused by the south-west monsoon upon that bank which lies furthest from land and faces the deep water of the Indian Ocean. The destruction from this cause is enormous. In March, 1902, we ran a line of observations along more than six miles of the length of the Periya Paar, and estimated that the bank bore at that time not less than about a hundred thousand millions of young oysters. When Mr. Hornell returned the following November, he searched the ground from end to end and found only a few dead shells. In November, 1904, this paar was again found to be covered with millions of young oysters, but a year later not a single survivor was left. On the Periya Paar this colossal destruction is probably an annual occurrence. On certain other less exposed paars it happens occasionally, and loss to a minor extent from overwashes of sand may occur almost anywhere under exceptional circumstances. For example, the disappearance, from the Muttuvaratu Paar, of 72 million oysters, one year old in 1897, before 1899 was probably due to this cause; and also the sweeping away, by an exceptionally strong current, of the oysters on the north end of the East Cheval Paar between November, 1887, and February, 1888.

(II.) Next in importance come, we consider, the ravages of natural enemies, the most noteworthy of which are:—

(*a*) Voracious fishes, chiefly rays (*Rhinoptera javanica* and other allied species) and file-fishes (*Balistes mitis*, *B. stellatus*, &c.).

(*b*) Boring Gastropod Mollusca, chiefly *Sistrum spectrum* and *Pinaxia coronata*, along with species of *Nassa*, *Murex*, *Purpura*, and *Turbinella*.

(*c*) Boring Sponges (*Cliona margaritiferæ*).

(*d*) Boring worms (*Polydora hornelli*).

(*e*) Starfishes, chiefly *Pentaceros lincki*, *P. nodosus*, and *Luidea maculata*.

(*f*) Smothering Lamellibranch Mollusca, such as *Modiola barbata*, the "Suran," which weaves nests and other entanglements around masses of young oysters, and may, when present in quantity, cause serious mortality.

(*g*) Crabs and cuttle fishes, and possibly other animals also, which can tear off the byssus and crush the shell.

(*h*) Associated animals, such as Corals, Barnacles, and Sponges, adhering to the shell, which, mechanically or by competition for food, cause injury and even death.

A few of these natural enemies call for some further remarks.

The file-fishes (several species of *Balistes*) and also the "Vellamin" (*Lethrinus*, spp.) feed upon immature oysters. We have found the broken shells in the stomach; but although these fish frequently snip pieces out of the margins of quite large shells, they probably do not destroy adult thick-shelled oysters. Shells which are rendered rotten by the borings of the sponge *Cliona* fall an easier prey to all oyster-eating fish.

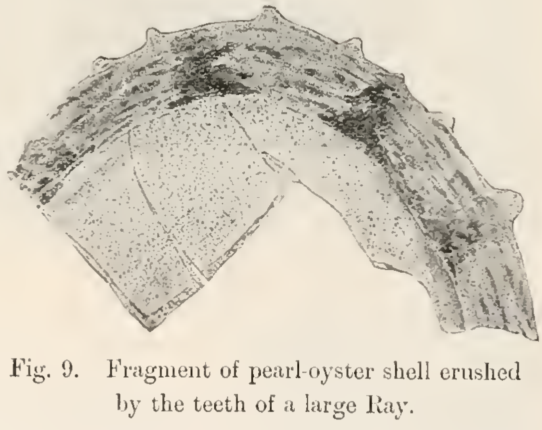

Fig. 9. Fragment of pearl-oyster shell crushed by the teeth of a large Ray.

The larger Elasmobranchs, such as the Eagle-Rays, and allied forms, may cause very serious reduction in a bed of mature oysters. In 1903 Mr. HORNELL found large rays feeding on the Periya Paar Karai, and, on exploring the bottom in a diver's dress, obtained abundance of the crushed shells left by the rays. Shells broken up by these fish have a peculiarly cracked and splintered appearance, which is characteristic (see fig. 9), the fragments of the brittle nacre being held together by the tougher prismatic margin.

In regard to these various fish enemies of the oyster it is necessary to bear in mind that, from the pearl-fisheries point of view, their influence is not wholly evil, as their ravages are closely associated with pearl-production. Although these fishes doubtless devour many of the oysters, at the same time they receive and pass on the parasite which leads to the production of pearls in others. One of the largest and most voracious of rays, *Rhinoptera javanica*, the "Valvadi tirikkai" or gregarious ray of the divers, we have found to be the host of the adult *Tetrarhynchus unionifactor*, which in its larval stages causes pearl-production in the oyster. The loss of some individuals from a bed is in that case a toll that we may willingly pay, and no one could advocate the extermination of that particular enemy, although we may desire to restrain his ravages within limits. During the fishery of 1889, the gregarious ray was present in such abundance that about 7,000 were caught in a single haul of a net, near Dutch Bay (see this vol., p. 61).

The Mollusca, which bore into shells by means of their radula, a toothed band lying in the floor of the mouth, are for the most part small Gastropods, and they are collectively known as "uri" by the divers. Fig. 10 shows a group of "uri" such as we have frequently caught in the act of penetrating the valve of a pearl oyster. It is chiefly young shells that are attacked, and amongst a large number of dead valves, about an inch in diameter, examined on one occasion, we found 60 per cent. were perforated by the neat circular hole which clearly indicated the cause of death. Probably adult pearl oysters are rarely killed by these small enemies.

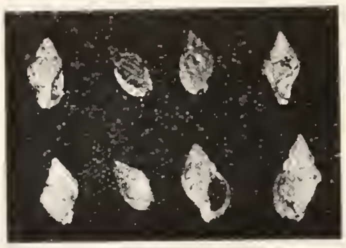

Fig. 10. "Uri," small Gastropods that destroy young pearl oysters by boring through the shells and sucking out the soft body.

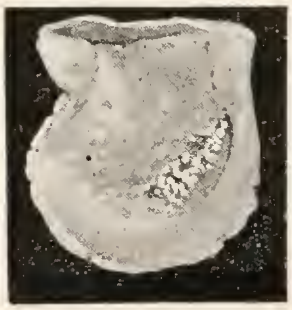

Fig. 11. Inside of pearl-oyster shell, showing adductor impression affected by *Cliona* borings on the outside. $\times \frac{1}{2}$.

During our work on the pearl banks we have not found a single full-grown shell perforated by a Gastropod. If such do occur, the enemy cannot be the small "uri" figured above, but must be more powerful animals, such as the larger species of *Murex* and the Chanks *Turbinella pyrum* and *Fasciolaria trapezoides*.

The boring Sponge, *Cliona margaritifera*, Dendy (see Part III., p. 128), may be considered damaging from two points of view—first, as causing thickened deposits of nacre and other irregularities, and hence disturbance of function, at the attachment of the great adductor muscle (see fig. 11); and secondly, as honeycombing the shell in all directions, rendering it so rotten that it can no longer hold together, and so falls an easy prey to any assailant. Many pearl oysters have their valves penetrated by *Cliona* to some extent, and in some beds a considerable proportion are as much affected as the example shown in fig. 12. This is a disease of adult life. Young shells never contain *Cliona*, and the older the affected oyster is the worse does it get. It will be noticed that the ravages of this sponge have a bearing on pearl formation. The more friable shells are eaten more readily by the voracious fishes, and consequently *Cliona margaritiferæ* may be regarded as facilitating the transference of the pearl-inducing parasite from the oyster to its ultimate host.

Fig. 12. Pearl-oyster shell honeycombed by *Cliona margaritiferæ*, DENDY.

Another boring enemy is the small Polychæte worm *Polydora* (or *Leucodore*) *hornelli*. It is questionable, however, whether this really does serious harm, except indirectly, in the case of the Ceylon pearl oyster. It no doubt, by its burrows between the layers of the shell, helps in disintegration; it lets in mud and sand-grains, and it is sometimes the cause of nacreous thickenings or blisters in the interior. It is not, however, of anything like the same importance as *Cliona* and the Gastropods, and cannot, taken by itself, be considered a cause of death. A few other organisms, lamellibranchs, worms, algæ, &c., bore in the pearl oyster's shell—which is sometimes a veritable microcosm containing representatives of nearly every group of the Invertebrata—but none of them do serious harm, and they need not be considered further.

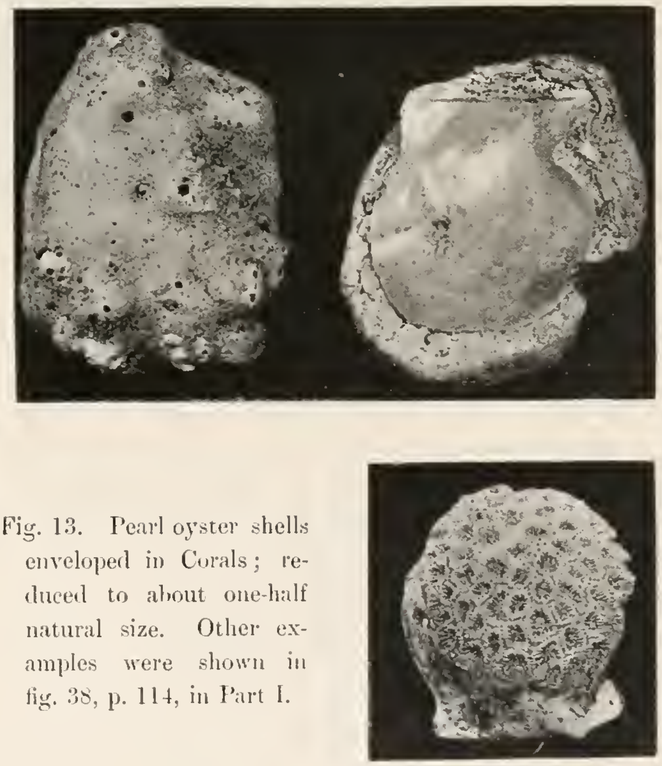

Fig. 13. Pearl oyster shells enveloped in Corals; reduced to about one-half natural size. Other examples were shown in fig. 38, p. 114, in Part I.

Similarly, the associated animals on the outside of the shell in most cases cause inconvenience rather than real injury. There are only two classes of cases where the matter may become more serious, (1) where rapidly growing corals and sponges of large size settle on the shell and practically envelop it (figs. 13 and 14) or overweight it to such an extent as to interfere with the movements and nutrition of the oyster; and (2) where the acorn-barnacles (*Balanus amphitrite*, and other species) spread, as they sometimes do, all over the shells, and are so large and active as to compete successfully for the microscopic food in the water and so lead to enfeeblement and, it may be, diseased conditions in the pearl oysters. Young barnacles in the Ceylon seas appear to settle down in April or May, and then grow with astounding rapidity, so that in a few weeks, rocks, shells, boats, stakes, ropes and any other objects in the water become covered with an almost continuous layer. The living corals on the surface of the shells may also act by depriving their host of food, and we certainly find that the Ceylon pearl oyster cannot exist on the living coral reefs or where there is much live coral scattered over the bottom.

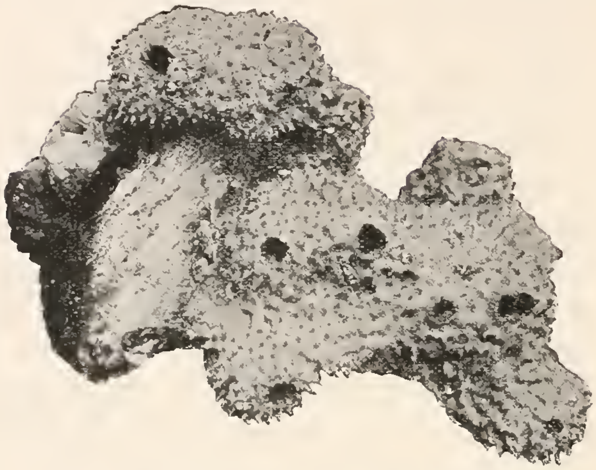

Fig. 14. Pearl oyster enveloped in a Sponge (*Pachychalina spinilamella*, DENDY).

The action of the little "smothering" mussel (fig. 15) called "Suran" by the divers is also, probably, partly mechanical and partly of the nature of competition for food. It weaves its tough byssal threads round neighbouring stones and dead and living oyster shells, entangling all in a matted mass in which it alone appears to flourish. It is, however, small and can have no effect upon adult oysters. It can only, then, do harm when it gets in large quantities amongst a bed of young oysters of its own size, and forms a blanket over and around them, interfering with respiration and nutrition. But it is very rarely sufficiently abundant, in Ceylon waters, to cause serious injury.

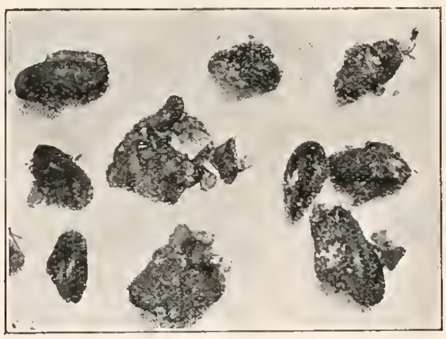

Fig. 15. "Suran," the small mussel (*Modiola barbata*) that entangles stones and small pearl oysters in its byssus; natural size.

Octopod cuttle fishes (such as *Polypus herdmani*) are abundant on some parts of the banks and are well known to subsist on oysters and mussels. Crabs are also numerous and no doubt cause some destruction; and there may be other members of the associated fauna that play their part in decimating the oyster beds.

Lastly, starfishes are probably the most serious of all invertebrate enemies. They are present in very large numbers on some parts of the pearl banks. We have a record that during the 1905 fishery, when the s.s. "Violet" was dredging for oysters on the South Modragam Paar, between 200 and 300 specimens of *Pentaceros lincki* and *P. nodosus* were brought up and destroyed each day.

Further, we know these starfishes to be exceedingly voracious, tenacious of life, active and fatal in their attacks on shell-fish. They seem to migrate from place to place in search of food, and are found to congregate round the rich feeding ground presented by a new oyster bed. One of the commonest kinds of the larger starfishes is *Pentaceros lincki* (fig. 16), known locally as the "Kondatchi Star," from its

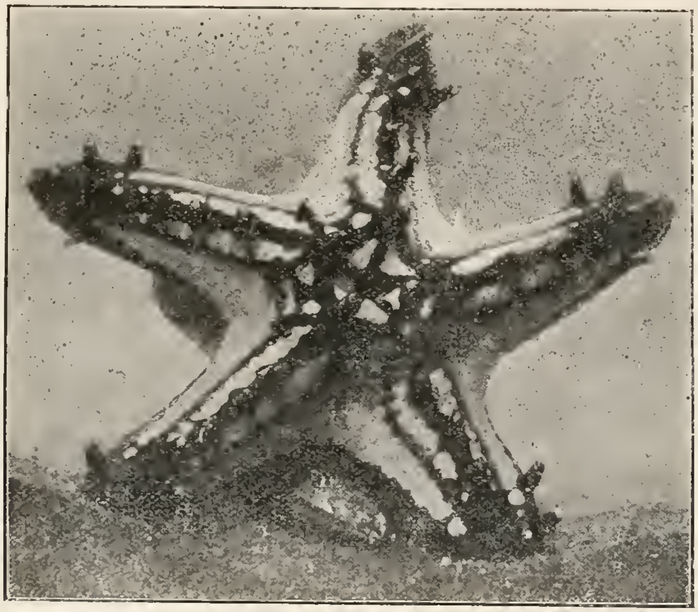

Fig. 16. *Pentaceros lincki*, DE BL., lying on a large pearl oyster, half natural size.

abundance on that paar. When we examined this bank in March, 1902, it had a bed of pearl oysters estimated at $5\frac{3}{4}$ millions. These had all gone by March, 1903, and it is probable that their disappearance may be accounted for by the very large number of starfishes present at that time.

(III.) There are still three other causes of death in pearl oysters that require mention, and may on occasion be serious, perhaps disastrous, *viz.* :—

(*a*) *Overcrowding.*—The older oysters are sometimes buried in masses of younger ones. The young are often piled together in such profusion as to interfere with each other's nutrition and growth. Thinning out must—and does—take place. If we don't do it, Nature does it for us. If it were done artificially, by transplanting some, all or nearly all might be preserved ; if we leave it to be effected naturally by survival of the fittest, the survivors may be very few indeed.

(*b*) *Disease*, due to the invasion of parasites, either (1) worm parasites which are moderately large and usually not very numerous, and which, unless abnormally abundant, probably do little or no harm; or (2) the more minute and more deadly protozoon parasites, such as sporozoa, which may on occasion be present in enormous quantities, and probably cause epidemic diseases. We have in various cases found sporozoa in the tissues of the pearl oyster. We also know that a bed of adult oysters may get into bad condition, the individuals becoming thin, discoloured and feeble; and under such circumstances rapid decimation takes place, and the bed, although not yet arrived at old age, may be practically wiped out by what is clearly a parasitic disease. It is highly probable that such diseased conditions are, if not the result of, at least generally concomitant with, overcrowding. For example, the Muttuvaratu Paar seems especially liable to dense deposits of spat, leading to overcrowding; and in our experience the oysters are more diseased and stunted and feeble on that paar than anywhere else.

(c) *Over-fishing.*—This is the exhaustion of the breeding stock of the district at a time when no further supplies of young in the larval stages are being brought by currents from neighbouring grounds. That, however, will comparatively rarely happen, and is only likely to be serious during the last year of a series of fisheries. So long as there are oysters in their second or third years on adjoining paars, which will be fished in the two succeeding years, it is safe—so far as the reproduction of the race is concerned—to take every older oyster that can be got from the ground, as those coming on, although not yet ready to be fished, are sexually mature, and may be relied upon to supply spat. But in the final year of a series of fisheries, when no further mature oysters remain for the following years, it is important to leave sufficient stock for breeding purposes. The complete clearing of the ground, which has sometimes been put forward as the ideal to aim at in a fishery, may be a short-sighted and disastrous policy.

In the future, however, if transplanting on an adequate scale is adopted, it may be expected that such a state of affairs as the last fishery of a series with no younger oysters growing up in the neighbourhood will be very unlikely to occur. Each individual case must, however, be considered on its merits, and the Marine Biologist, after an inspection of the banks, should be able to advise how the maintenance of adequate breeding reserves of adult oysters may best be secured.

VI. The Production of Pearls.

As pearl-formation is discussed very fully in another section of the present volume, it is unnecessary here to do more than add a very few sentences for the sake of completing this summary of results. In the Ceylon oyster there are several distinct causes which lead to this unhealthy or abnormal process, the production of pearls. Some pearls or pearly excrescences on the interior of the shell are due to the irritation caused by boring sponges and burrowing worms. Minute grains of sand and other foreign particles gaining access to the body inside the shell, which are popularly supposed to form the nuclei of pearls, only do so, in our experience, under exceptional circumstances. In the whole of our observations we have only records of three cases in which a grain of sand undoubtedly formed the nucleus of a pearl.

Pearls of another class are found in the muscular tissue of the animal, most frequently in the levators, in the palpar region, and in the pallial insertions. These muscle pearls have no visible foreign bodies as nuclei. They form around minute calcareous concretions—the calcospherules—which are sometimes very abundant in the tissues. Yet the pearls are very irregularly distributed. Single oysters have been known to contain from one to two hundred pearls, and, on the other hand, a hundred oysters may be opened without finding a single pearl.

The best pearls, however, the " fine " or " orient " pearls, lie in the pallial connective tissue at the sides of the body or in the tissues around the liver and kidney, or, when large, they may be free in any cavity of the body. The majority of these fine pearls contain as their nuclei the more or less easily recognisable remains of certain Platyhelminthian parasites, which we identify as the larval condition of Cestodes belonging to the genus *Tetrarhynchus*. The evidence for this will be found in the section dealing with pearl-formation (this vol., p. 19), and a description of the probable species of *Tetrarhynchus* in question will be found in SHIPLEY and HORNELL'S report on the parasites (p. 87). We have traced most stages in the life-history of this pearl-producing *Tetrarhynchus*, and find that it passes, in the adult condition, into the body of one of the larger carnivorous fishes—*Rhinoptera javanica*, a Ray. The adult parasitic worm in its last host must then set free its numerous young embryos, which pass into the sea and so gain access to the gills, liver, and mantle of the pearl oyster. But it is not sufficient for the oyster to be infected by the *Tetrarhynchus* larva. It must also live, retaining its parasite until such time as it can produce sufficient deposit of the calcareous secretion to entomb the living source of irritation, which thus becomes the nucleus of a pearl. This history is discussed more fully in another section of this volume (p. 14).

The Cysticercoid cysts of the *Tetrarhynchus* larvæ are frequently very abundant in the liver of the pearl oyster. In the case of some paars, the Muttuvaratu especially, scarcely any of the individuals examined are free ; we have counted eleven encysted larvæ in a single liver. In the gill filaments and in their membranous bases also they are common, while in many cases the mantle is infested. The gonads, the foot and the palps all occasionally harbour the parasite. The muscles are the only large organs where the cysts are rarely found. In one individual oyster Mr. HORNELL made out a total of 45 cysts for all the tissues. It may be well to repeat here that the Cestode parasites are not only common, but are also apparently very wide spread and generally distributed, and that the fish-host with its parasite occurs also generally in the seas around the Island, as well as in the Gulf of Manaar ; and that, in short, there can be no doubt as to the probable infection of pearl oysters grown at any other suitable localities around Ceylon

Pearl production in the Ceylon oyster does not commence actively until the third year of life, and progresses most rapidly after the fourth year. An example or two taken from the history of beds of known age will show how important it is to let the oysters have any time that is possible after the fourth year in which to increase, not in size, and certainly not in numbers, but in value. The successive valuations of the bed ot oysters now being fished on the Muttuvaratu Paar was as follows :—

In November, 1903, at the average age of $2\frac{1}{2}$ years, 1·50 rupees per thousand.
,, 1904, ,, ,, $3\frac{1}{2}$,, 3·15 ,, ,,
,, 1905, ,, ,, $4\frac{1}{2}$,, 22·69 ,, ,,

Finally, these oysters have sold (March, 1906) at prices frequently exceeding 30 rupees per thousand, and on one day even exceeding 40 rupees.

A striking example of increased pearl-production, and enhanced market value, is seen in the case of the remainder of a large bed of oysters on the South-east Cheval, most of which was prematurely fished along with the South Cheval in 1905.

In November, 1904, it was valued at 10·76 rupees per thousand.
,, 1905, ,, ,, 52 to 58 ,, ,,

In March, 1906, the oysters when fished sold, after the first week, at rates ranging from 112 to 282 rupees per thousand.

These oysters were, on the average, 3 years old in November, 1904, and were therefore fished in 1905 when under 4 years. At the present time those that remain are in their fifth year; and if the whole of this bed, with the neighbouring South Cheval of the same age, had been held over for the present fishery (1906), there can be no doubt that, although the number of oysters might have been somewhat reduced, the increase in pearls and in value would have been great.*

VII. Dredging.

The results of our cruises in the "Lady Havelock," detailed in the "Narrative," showed clearly the advantages of dredging both as a method of exploring and surveying the banks, and also for the purpose of raising considerable quantities of oysters from the bottom in a short time. Worked from a handy, seaworthy vessel, of the type of a large tug, or a modern steam trawler, with a steam winch near the stern, the dredge becomes in practised hands an instrument of precision, and will bring up a fair sample of everything on the ground, including the bottom deposit.

* A letter just received from the pearl-fishery camp at Marichchukaddi states that "the merchants are very pleased with the oysters of the South-east Cheval." . . . . "They say there never has been anything like it as to results, and large profits have been made by several."

Moreover, the operation is a speedy one. A line of soundings and dredgings can be run over a very considerable area in one day's work, and a much larger and more continuous, and therefore more representative, sample obtained than would be possible by diving. From such a steamer, on the occasion of a fishery, six dredges at least could be worked simultaneously, and mechanical contrivances might be devised for increasing the number still further. There need be no fear that dredging operations will be destructive to any young oysters that may be mixed with the old, or will in any way damage the ground as an oyster paar. Dredging is the usual practice on oyster beds in Europe and America, and it is well known that a certain amount of dredging improves the condition of a bed.

Our results on the "Lady Havelock" showed that neither young nor old oysters brought up by the dredge are injured, and it would be a simple matter on the steamer to separate the young and return them to the water or transport them to other ground; while it would be very difficult, if not impossible, to get this done in the divers' boats under present conditions.

On several occasions, as shown in the "Narrative," we discovered, by dredging, considerable numbers of pearl oysters on spots not recognised as known "paars." I feel confident, from the nature of the ground and our knowledge of other conditions (such as depths, currents, and the free-swimming stages of the young pearl oyster), that new deposits of spat must make their appearance from time to time at new localities, and may appear any time on some grounds outside the recognised paars—and all such new beds will probably remain unknown unless discovered by dredging traverses across the whole oyster-bearing plateau of the Gulf of Manaar. At several localities we examined the ground outside the known paars down to the 100-fathom line, with the view of ascertaining whether there is any evidence in support of statements which have sometimes been made to the effect that there were probably unknown beds of pearl oysters further out and in deeper water, from which spat was produced for the supply of the in-shore paars. No such evidence was obtained. All fresh spat which has appeared in the past after grounds have been cleared by fishing must, then, have come from other beds of adult oysters upon the plateau within the 10-fathom line—beds which have remained unknown and unfished. Kutiramalai Paar, fished in 1905, is an instance of a great bed of oysters growing to maturity outside the limits of the recognised paars. At the inspection which followed the fishery in the present year, Mr. Hornell found mature oysters in quantity to the north-north-east of the Muttuvaratu on ground that is not recognised as a paar and has never been inspected.

In addition to beds of adult oysters which may in this way be found by dredging traverses, it must be remembered that newly-established deposits of young oysters upon unsuitable ground where they cannot mature will be certainly made known from time to time, and this will give the material for re-planting paars recently cleared by a fishery. Our experiments showed that young oysters are more easily transported than older ones, and more readily re-establish themselves on new ground.

The thinning out of overcrowded beds, sometimes a very necessary operation, can be carried on concurrently with transplantation to a depleted area. For example, in November, 1905, the dredging carried on amongst the overcrowded young oysters of the Mid-east Cheval relieved pressure on that bed and at the same time provided a stock for replenishing the denuded South Cheval Paar.

As I have pointed out in a previous volume of this Report, it must be remembered that the utility of dredging is by no means confined to the finding and fishing of adult oysters, but is really manifold, and consists in the following, at least :—

(*a*) In exploring the ground ;
(*b*) In fishing oysters ;
(*c*) In cleaning the ground and removing starfishes and other enemies ;
(*d*) In thinning out overcrowded beds ;
(*e*) In oyster transplantation.

The value of dredging is not properly assessed if account be taken of only one of these, such as fishing, or even of fishing and transplanting alone. Finally, it is important to bear in mind that several of these useful operations can usually be carried on simultaneously in the same series of dredgings.

VIII.—Other Marine Economic Work.

In regard to the fish-trawling operations, I have to report that the greater part of Palk Bay presents a large open expanse with a uniform soft bottom suitable for trawling. Our hauls in both the northern and the southern parts of the area showed that there are plenty of fish, and apparently this shallow sea serves as a very valuable nursery for young sea-fish. We also found off Galle, to the east of the Gallehogalle Bank, at a depth of 25 to 30 fathoms, an area which may be regarded as a fish-nursery. Here it is evident that the young of both flat and round fish, belonging to about ten species and including such valuable forms as may be called "Soles," "Turbot," and "Plaice" (although not the same species as those in home seas), congregate in large numbers.

Fig. 17. The commercial sponge (*Euspongia officinalis*, var. *ceylonica*) from Trincomalee, as seen when alive ; reduced in size.

It will naturally be part of the duty of the Marine Biologist to the Colony to make himself acquainted with the conditions of the native fisheries, and be prepared to advise as to whether facilities should be given for introducing trawling in suitable localities, or whether any regulations are required for the protection of the fish-nurseries.

As an example of an additional investigation such as will naturally be undertaken by the Marine Biologist, I may note that during our visit in February, 1902, to Trincomalee, we found the commercial sponge living in the harbour (fig. 17). I asked Mr. HORNELL to return later in the year and look into the matter. He did so in October, and was very successful in determining the localities and mode of growth of the sponge—which is a variety of the true *Euspongia officinalis*, and is very similar to the Mediterranean form. Professor DENDY, the sponge specialist, who has examined samples for me, thinks well of the quality, and says, "the possibility of establishing a sponge-fishery is worth consideration" (see also Part III., p. 211).

Fig. 18. The edible rock oyster of Ceylon (*Ostrea cucullata*).

An edible oyster (*Ostrea cucullata*, see fig. 18) is abundant on some parts of the Coast of Ceylon. The "trepang" and other marine industries are also worthy of attention.

IX. THE MARINE BIOLOGICAL STATION.

For the proper carrying out of our work in Ceylon it was found necessary to fit up the scientific man's workshop—a small laboratory on the edge of the sea, with experimental tanks, a circulation of sea-water and facilities for microscopic and other work. For several reasons, which were given fully in the "Narrative" (Part I., p. 87), we chose Galle at the southern end of Ceylon, and we had, at first, every reason to be satisfied with the choice. With its large bay, its rich fauna and the sheltered collecting ground of the lagoon within the coral reef, it is probably one of the best possible spots for marine biological work in Eastern tropical seas. But as time went on it became clear to Mr. HORNELL that, for experimental work with the pearl oyster, such as he required to undertake in the course of his investigations, a larger area than could be obtained in artificial tanks, and a more sheltered one than the bay at Galle during the south-west monsoon, was essential. Fortunately, some very suitable buildings, in the best possible place, then passed into the hands of the Colonial Government through the abandonment of Trincomalee as a Naval Dockyard Station; and on being consulted last year by Sir HENRY BLAKE and the Colonial Office, I was able to concur with Mr. HORNELL and recommend strongly that the Marine Biological Station be transferred from Galle, in the south of the island, to the former Naval Hospital at Trincomalee, on the north-east coast. That transference has now been effected, and the magnificent almost land-locked inner bay at Trincomalee, in which pearl oysters naturally live in shallow water, is now available for experimental scientific work at all times of the year.

It is clear to me, in concluding this Summary of Results obtained so far, (1) that there is still a great deal of biological work that must be done in connection with all the Ceylon marine fishing industries; and (2) that the Marine Laboratory now at Trincomalee, enlarged if necessary and more fully equipped, is the best place in which to carry on all such investigations, and ought in the future to play an important part in the scientific work of the colony.

B.—RECOMMENDATIONS.*

The following Recommendations are based upon the conclusions briefly given in the preceding pages and also upon the detailed evidence in the "Narrative" and other sections in the preceding volumes of this Report.

1. That dredging be employed extensively to supplement diving operations, either wholly or in part, both on the inspections and also, where possible and when desirable, at the fisheries.

* These Recommendations, sent to the Governor of Ceylon in September, 1903, as a private document accompanying an "advance" printed copy of the first volume of this Report, are subordinate to my primary proposition, which was that the Colonial Government should appoint a Marine Biologist to carry on the investigations I had started. This proposition and my further recommendation that Mr. JAMES HORNELL, F.L.S., should be appointed to the post, were adopted, and Mr. HORNELL commenced his work as Marine Biologist to the Government on January 1st, 1904. A few weeks later, on the retirement of the Master Attendant of Colombo from the office of Inspector of Pearl Banks, the duties of the latter post were, temporarily, added to those of the Marine Biologist, and since that date Mr. HORNELL has acted in the dual capacity, and has thus discharged both advisory (biological) and executive (inspectional) functions in connection with the pearl banks during the last two years. The record fisheries of 1904 and 1905 have taken place under the new auspices, and of the latter (the great fishery of 1905 which brought in over £150,000 profit to the Government) it is gratifying to find that His Excellency Sir HENRY BLAKE has placed on record in his despatch of June 14th, 1905, to the Secretary of State that "This result is due to the careful and methodical examination of the banks by Mr. HORNELL."

2. That a steamer be provided, of the type of a modern steam-trawler, from which a number of dredges could be worked simultaneously; and be fitted with tanks or "fish-wells" in which large numbers of pearl oysters could be transported.

3. That attention be paid to inspecting not merely the known paars, but also to traversing with the dredge at least once a year certain lines across the pearl bank plateau, in order to search for new deposits of oysters.

4. That whenever young oysters are found in quantity on the Periya Paar or other localities where there is very little prospect of their ever arriving at maturity, as many as possible should at once be dredged up and transplanted to more favourable grounds, to be determined by careful examination of the bottom conditions and the stock of oysters already present.

Such transplantation, in order to be successful, must be conducted on a large scale. There can be no doubt that even healthy beds of oysters on favourable ground tend to diminish as they grow older, and may sometimes from the action of their natural enemies become greatly reduced in numbers before arriving at fishable age. The bed of $1\frac{1}{2}$-year-old oysters on the Muttuvaratu Paar, which was estimated in March, 1902, as 277 millions, was found in November, 1904, to be reduced to about 20 millions. Again, the bed of 3-year-old oysters on the West Cheval Paar, estimated at 123 millions in February, 1902, was found two years later to be reduced to 35 millions. No doubt these are exceptional cases, but the conclusion to be drawn is that in transplanting young oysters it is necessary to deal with large numbers, so as to allow for the natural decrease which will inevitably take place.

5. That during an inspection, or a fishery, when large quantities of young pearl oysters are found associated with older ones, or when an immature bed is obviously overcrowded, as many as possible of the young should be removed, by dredging and sorting, and be saved by transplanting to other paars unoccupied at the time. Dredging can also be made use of to remove great numbers of sponges, crabs, star-fish, and other enemies of the pearl oyster from the productive paars.

6. That if dredging cannot be wholly substituted for diving at the fisheries, at least the dredges should be kept in readiness, so that in the event of the divers failing to obtain sufficient oysters in the limited time, or in case the fishery should be unfortunately stopped prematurely by an epidemic or other unforeseen occurrence, the remaining mature oysters on the bottom may not all be lost, but may, by means of the dredges, be brought to the surface speedily in bulk.*

7. In order to increase the area available for the attachment and growth of young pearl oysters, large areas of the sandy bottom adjoining the more important paars, especially the Cheval Paar, should undergo artificial "cultching," that is, should have broken material, such as fragments of dead coral, lumps of rock and other rubble, scattered over the bottom. Such material can be obtained in quantity close to hand

* On February 4th, 1902, on the Periya Paar, in 15 minutes, one dredge brought up 14,912 young pearl oysters,

on the shores and reefs of the Gulf of Manaar, and the transport and distribution could be effected easily by means of the steamer.

8. In order to facilitate the search for new deposits of young oysters, "drift-bottle" experiments should be made, so as to determine the prevalent currents in the Gulf of Manaar, at the breeding times of the oysters.

9. Very young "spat," such as is sometimes found in great abundance attached to floating weeds, should be saved from being carried away by the currents, and may be deposited on the bottom along with suitable cultch, to which it can adhere.

10. That, in order to determine when and how the dredges should be used; where from and where to, and in what quantities, the transplantations of young oysters should be made; which mature oysters, if any, should be retained as a breeding reserve: where and how the "cultching" should be carried out, and similar matters, a Marine Biologist should be appointed as a permanent official to take part in all inspections and fisheries, to advise as to the farming operations, and carry out the work when sanctioned, and generally to supervise the pearl-oyster banks and assist in regulating the fisheries.

11. That the Marine Biologist be charged, as his first duty, with the farming of the pearl-oyster banks in such a manner as to aim at ensuring a more constant supply of mature oysters. He should search at each inspection, and where possible during a fishery, for new spat and for fresh beds of young oysters, should locate the oysters of different ages, transplant them when necessary, thin them out when overcrowded, remove young which would necessarily be killed during the fishing of the old, or would prevent their neighbours' growth; and thus he should endeavour to have all the more reliable paars occupied by stocks, some in one and some in another stage of growth, and to bring on a succession of adults ready for fishing. He should also see to the cleaning of the banks by dredging and the removal of enemies of the pearl oyster, should improve the bottom by laying down artificial cultch, and should maintain adequate breeding reserves of adult oysters. He should advise in all cases that the order of fishing of the beds be determined by practical biological considerations, affecting not merely the interests of a particular fishery, but the future prosperity of the industry.

12. That during the time of the monsoons, when it would be impossible to work in the Gulf of Manaar, the Marine Biologist should carry on his investigations at the marine laboratory. There will be plenty to do in connection with the life and growth of the pearl oyster, and the formation and abundance of pearls, to occupy his attention even if he had no other work.

But as secondary duties, when not fully occupied with pearl-oyster questions, I would recommend that the Marine Biologist should be instructed to investigate the "window-shell" oyster fishery at Tampalakam, the pearl oyster at Trincomalee and elsewhere on the East Coast, the edible oyster at various localities, the trepang fishery, chank diving, the possibility of establishing a commercial sponge fishery at

Trincomalee, and the native fish-trawling industries. With these and other practical applications of science which he would discover and make known, the time and energies of the Marine Biologist would be more than fully occupied throughout the year in useful work for the Colony.

13. If these recommendations are adopted and a Marine Biologist is permanently charged with the work of conserving and promoting the pearl-oyster and other fisheries, he must be given the means of carrying on his work satisfactorily. For inspecting, dredging, cultching, and transplanting, a steamer is necessary. It need not be large nor swift, but it must be fit for the work and specially fitted with the tanks, winch, dredges, &c., which will be necessary. He will also require laboratory equipment on shore, and the usual mechanical and clerical assistance; but it is not obvious that any useful purpose can be served, under the circumstances, by establishing a small laboratory at Aripu or elsewhere in the Gulf of Manaar (as had been suggested). It must be clear to any scientific man who knows the locality that any biological work on the pearl banks must be done at sea, from a ship, during the inspections and fisheries, and cannot be done at all during the monsoons because of the heavy sea and useless exposed shore. At these latter times the necessary laboratory work, supplementing the previous observations at sea, could be done much better at Colombo, at Galle, or at Trincomalee, than at Aripu or Manaar.

14. Consequently I recommend that the Marine Biological Laboratory, now at Trincomalee, be regarded as the headquarters of the Government Marine Biologist's work; and that, in the interests both of the various fishing industries and also of scientific investigation in general, the institution be established at once on a permanent basis, with suitable assistance and equipment. The building ought, moreover, to be of sufficient size to accommodate two or three additional zoologists, such as members of the Staff of the Museum and of the Medical College at Colombo, or scientific visitors from Europe. The work of such men would help in the investigation of the marine fauna and in the elucidation of practical problems, and the laboratory would soon become a credit and an attraction to the Colony. Such an institution would be known throughout the scientific world, and would be visited by students of science from other countries, and it might reasonably be hoped that in time it would perform for the marine biology and the fishing industries of Ceylon very much the same important practical functions as those fulfilled by the celebrated Gardens and Laboratory at Peradeniya for the botany and associated economic problems of the land.

W. A. Herdman.

EXPLANATION OF PLATE.

Figs. 1 and 2. Living eggs of *Margaritifera vulgaris*, immediately after emission.

„ 3 and 4. Preserved ovarian eggs, as seen in sections of the mature gonad. × 900.

Fig. 5. The spermatozoon, highly magnified.

Figs. 6, 7, and 8. Segmentation stages.

[The exact magnification of these figures, drawn in Ceylon, is not known.]

Fig. 9. Segmentation nearly completed, embolic gastrula. Fig. 10. Optical section of the same stage.

„ 11. Embryo showing first appearance of the zonal band of cilia, and differentiation of posterior end.

„ 12. Optical section of the same stage.

„ 13. Early trochophore stage, 22 hours after fertilisation.

„ 14. Trochophore four hours later.

„ 15. Optical section of the same stage. *a*, prostomium; *b*, apical tuft of cilia; *c*, præ-oral circlet of cilia; *d*, blastopore; *e*, enteron; *f*, posterior ciliated patch.

„ 16. Trochophore four hours later—30 hours after fertilisation.

„ 17. Two unfertilised ova, three days after extrusion.

„ 18. Free-swimming larva, three days after fertilisation, showing the first appearance of the shell.

„ 19. Free-swimming larva caught along with surface plankton in the tow-net.

„ 20. An older form when ready to settle down as the young fixed pearl oyster.

„ 21. Another larva of about the same age, showing especially the otocyst (enlarged at 21*a*), and the long mobile foot *f*, which can be extended far beyond the shell.

Figs. 22 to 27. Stages of growth in the shell of the fixed spat, from 0·4 millim. to 1·5 millims. across. Fig. 22 shows practically the same stage as fig. 19, although the latter was free and the former fixed. In fig. 27, *p.* indicates the prodissoconch, *s.* the prismatic shell, and *n.* the portion lined by nacre.

„ 28 and 29. Two views of the hinge, showing the simple, regular, interlocking teeth.

Fig. 30. Part of the shell in the 0·6-millim. stage (fig. 23), showing the characters of the prodissoconch (*p.*), of the prismatic shell (*s.*), and of the cuticular margin (*m.*). × 900.

„ 31. Very young spat (0·4-millim. stage) on filamentous Algæ. Natural size.

„ 32. Older spat of various sizes on Algæ. Natural size.

„ 33. "False spat" (*Avicula vexillum*) on Algæ. Natural size.

„ 34. Young *Avicula vexillum* ("false spat"). × 40.

Fig. 19. Bank of "window-shell" oysters (*Placuna placenta*), remaining from the last fishery in Lake Tampalakam, at Trincomalee.

J H & W A H, del

E Wilson, Cambridge

LIFE-HISTORY OF PEARL OYSTER.

REPORT

ON THE

CIRRIPEDIA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

N. ANNANDALE, D.Sc., C.M.Z.S.,
DEPUTY SUPERINTENDENT OF THE INDIAN MUSEUM, CALCUTTA.

[WITH NINE TEXT ILLUSTRATIONS.]

INTRODUCTORY.

I HAVE to thank Professor HERDMAN for sending his Ceylonese Barnacles to me for description. The collection is small, including examples of only eleven species; but some of these species are of considerable interest. Indeed, so little is known of the Indian Cirripedes that any specimens with accurate localities are of value. Professor HERDMAN has asked me to add to my report a list of the species known from Ceylon and the Gulf of Manaar. I have interpreted the request freely, adding notes as well as names in the case of forms of which I have examined specimens, even if they are not represented in the collection under review.

Every addition to our knowledge of the Barnacles tends to prove the wide distribution, not only of genera, but even of species and varieties. It is, therefore, impossible to draw precise geographical conclusions from the presence of any form in a local fauna, while its absence often means no more than that it has not been observed. The following list, in which the species obtained by Professor HERDMAN are indicated by a star, gives the names and known distribution of those recorded hitherto or for the first time in the present Report. There can be no doubt that further research will greatly increase the number found both in the Gulf of Manaar and in the Bay of Bengal.

Professor HERDMAN informs me that some species of *Balanus* are of real economic importance in competing for food with the pearl oyster in the Gulf of Manaar.

BARNACLES KNOWN FROM CEYLON.

LEPADIDÆ.	DISTRIBUTION.
1. *Lepas anserifera*, L.	Cosmopolitan.
*2. ,, *anatifera*, L.	,,
3. ,, *tenuivalvata* (ANNAND.)	Ceylon.
4. *Dichelaspis equina*, LANCH.	East coast of India, Maldives, Ceylon, Burma, Malaya.
5. ,, *pellucida*, DARW.	East coast of India, Ceylon, Burma.
6. *Pœcilasma kæmpferi*, DARW.	Gulf of Manaar, Malaysia, Japan, Madeira.
7. *Scalpellum gruvelii*, ANNAND.	Gulf of Manaar, Laccadives, Andaman Sea (859 to 1022 fathoms.)
8. ,, *alcockianum*, ANNAND.	Gulf of Manaar, Andaman Sea (859 to 960 fathoms).
9. ,, *japonicum*, HOEK	Gulf of Manaar (595 to 556 fathoms); Japan (565 fathoms).
10. ,, *squamuliferum*, WELT.	Deeper Indian seas (112 to 1840 fathoms); Japan.
? ,, *truncatum*, HOEK	Between New Guinea and Australia (1400 fathoms); (?) Gulf of Manaar (590 fathoms).
11. ,, *tenue*, HOEK	South of Indian Ocean (1375 fathoms); Gulf of Manaar (595 to 556 fathoms); Bay of Bengal (199 fathoms).
12. ,, *subflavum*, ANNAND.	Gulf of Manaar, Gulf of Oman, Andaman Sea, west coast of India (130 to 700 fathoms).
BALANIDÆ.	
13. *Chelonobia testudinaria* (L.)	Gulf of Manaar, warm and temperate seas.
14. *Creusia spinulosa*, LEACH	Ceylon, Indian Ocean and Central Pacific, West Indies
*15. *Pyrgoma conjugatum*, DARW.	Red Sea, Ceylon, Mergui.
*16. *Tetraclita serrata*, DARW.	South Africa, Ceylon.
*17. *Acasta cyathus*, DARW.	Ceylon, South America, Australia, Madeira.
*18. ,, *funiculorum*, n. sp.	Ceylon.
*19. *Balanus tintinnabulum* (L.).	Cosmopolitan.
*20. ,, *amphitrite*, DARW.	Warm and temperate seas.
*21. ,, *amaryllis*, DARW.	Indian Ocean and Central Pacific.
*22. ,, *allium*, DARW.	Red Sea, Ceylon, Western Australia.
*23. ,, *terebratus*, DARW.	Maldives, Ceylon.
*24. ,, *æneas*, LANCH.	Malaya,† Ceylon.
*25. ,, *maldivensis*, BORR.	Maldives, Ceylon.
‡26. *Chthamalus stellatus* (POLI)	Warm and temperate seas.

† It is convenient to confine the term "Malaya" to the Malay Peninsula, south of the Isthmus of Kra, and the small adjacent islands, such as Singapore and Penang, giving "Malaysia" a wider significance, to include the great archipelago.

‡ In addition to the above-mentioned species, I have lately examined specimens of a variety of *Conchoderma hunteri*, OWEN, taken by Mr. E. E. GREEN on a sea-snake (*Hydrus platurus*) from Ceylonese waters. Their valves are of typical form, but very small and feebly calcified. The relative length of the peduncle varies considerably. The integument is transparent and almost colourless; but faint vertical bars can be detected on it in certain lights.—*April* 30, 1906.

DESCRIPTION OF THE SPECIES.

LEPADIDÆ.

***Lepas anatifera**, L.

Localities:—Galle (on a buoy rope) and Cheval Paar, Gulf of Manaar.

Several of the specimens from the Cheval Paar belong to Darwin's var. A.

It is often almost impossible to distinguish tropical examples of this species from *L. anserifera* by mere examination of the shell. The pale colour of the upper part of the peduncle is a good diagnostic character of the latter, but one which cannot always be detected in faded or shrunken specimens. The only safe method of distinguishing the two species is to examine the filamentous appendages.

L. anserifera appears to be more abundant in the Bay of Bengal than *L. anatifera*. So far as my experience goes, examples of both species from the Indian region are generally small; indeed, it seems probable that they do not reach the same dimensions, except very occasionally, as those attained by individuals reared in higher latitudes. Their stalk, especially, is frequently stunted.

Lepas tenuivalvata (Annandale) (**14**).

In my account of this species (as *Dichelaspis tenuivalvata*) I did not describe the penis or the anal appendages. Having now been able to dissect a specimen in detail, I am in a position to give an account of these organs. The penis is long, slender, tapering, with a few scattered hairs on its surface. The anal appendages are uniarticulate, claw-shaped, and naked. Taking these characters into account, the species should probably be placed in the genus *Lepas*. In placing it in *Dichelaspis*, I relied chiefly on the shape of the carina. The specimens are probably immature, but the shape of this valve distinguishes it from any other representative of the former genus.

Dichelaspis equina, Lanchester (**8**).

Some doubt as to the difference between this species and Gray's *Octolasmis warwickii* is hinted at by Gruvel (**10**). The most constant external character of the former is the division of the carina into two parts by a horizontal cleft near the base of the capitulum. I have now examined a large number of specimens, which vary greatly as regards the shape of the terga and the transparency of the membrane, and all agree in this respect. It seems to be a good specific character; but two distinct forms have probably been confused, if Darwin's figure (**1**) is correct, under the name *D. warwickii* (see figs. 2 and 3).

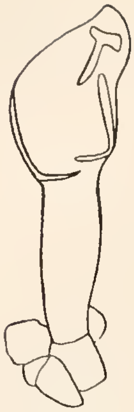

Fig. 1A.

Fig. 1.

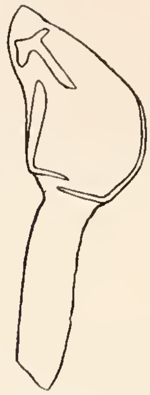

Fig. 1B.

Fig. 2.

Fig. 3.

Figs. 1, 1A, 1B. *Dichelaspis pellucida*, DARWIN. Fig. 2. *Dichelaspis equina*, LANCHESTER.
Fig. 3. *Dichelaspis warwickii* (GRAY)—After DARWIN.

D. equina is the commonest member of its family found attached to crabs from shallow water off Ceylon and the east coast of India.* It occurs both on species which swim near the surface and on those which crawl on the bottom, and is occasionally taken on sea-snakes, though less frequently than *D. pellucida*. On the crabs it does not confine itself to any particular part of the body. The following is a list of the Crustaceans on which I have found it :—*Neptunus gladiator*, *N. pelagicus*, *Scylla serrata*, *Doclea ovis*, *Egeria sp.*, *Areania septemspinosa*, and *Dorippe dorsipes*.

Dichelaspis pellucida, DARWIN (**1**).

I have recently examined a considerable number of specimens of this species from the coasts of Burma and Ceylon. They vary considerably not only in size and in the shape of the valves, but also as regards the degree of calcification of these structures and of transparency of the membrane, as well as the form and the relative proportions of the peduncle and capitulum. Figs. 1, 1A, and 1B show the outline of some specimens in the Indian Museum. Transparency, outline and proportions probably alter considerably if specimens are not carefully preserved. It seems not improbable that DARWIN'S *D. grayii* and *D. pellucida* are identical, in which case the former name would have precedence, as the description is printed before that of *D. pellucida*. I have no doubt that GRUVEL'S *D. lepadiformis* also belongs to the same species, although I separated it in my recent list of the Indian Lepadidæ (**13**). His account of the penis (**12**), which is the most striking feature of the form, does not differ very materially from HOEK'S description of that of *D. pellucida* (**4**), to which description no reference is given in GRUVEL'S monograph. Judging from specimens I have examined, the exact outline of the penis in the more

* Since this was written specimens have been received at the Indian Museum from the Persian Gulf.—*April* 30, 1906.

delicate species—and *D. pellucida* is one of the most delicate—depends to some extent on the state of preservation of the specimen examined.

D. pellucida has only been found on sea-snakes. It occurs most commonly, in Indian seas, on *Hydrus platurus;* but I have seen it on more than one species of *Distira.*

Pœcilasma kæmpferi, DARWIN **(1).**

The Ceylonese specimens (from 430 fathoms in the Gulf of Manaar) I have examined belong to the typical form of the species, which is probably circumtropical. It is found attached to various prawns.

Scalpellum gruvelii, ANNANDALE **(15).**

I give an outline of the valves of this species (fig. 4). It is one of the larger members of the section of its genus with imperfectly calcified valves, the figure being twice natural size. In the variety *quadratum*, also from the Gulf of Manaar, the carina is much more strongly bowed, and in the typical form the preumbinal portion of the carina is often relatively more extensive. The section to which this species belongs merges gradually into that with fully calcified valves, but the division is convenient for the sake of reference. In *S. gruvelii*, as in *S. alcockianum*, *S. laccadivicum*, and *S. japonicum*, the plates are actually imbedded in membrane, and traces of the imperfectly calcified parts which are not fully formed can be detected. In *S. inerme** from near Java, on the other hand, not only are the valves very much stouter, despite the shape of the tergum, but they are lightly attached to the inner surface of the membrane and their outlines are quite sharp.

Fig. 4. *Scalpellum gruvelii*, ANNANDALE. × 2.

S. gruvelii is only found at great depths, at which it is not uncommon in the Indian seas.

Scalpellum japonicum, HOEK **(3).**

Locality :—Gulf of Manaar, 595 to 556 fathoms (R.I.M.S. Ship "Investigator").

Col. ALCOCK has recently called my attention to certain Barnacles attached to living shells of *Turbo indicus* from the above locality. Two of them agree with HOEK'S description and figures of *S. japonicum* from Japanese seas. *S. laccadivicum*, which will also be found (in all probability) in the Gulf of Manaar, is related to this form, but has the valves less imperfectly calcified, especially in the variety *investigatoris.*

* I understand that HOEK regards this form as a variety of *S. stearnsii*, PILSBURY ; but his paper, read before the Royal Academy of Sciences of Amsterdam in January, has not yet reached Calcutta.—*April* 30, 1906.

Scalpellum squamuliferum, WELTNER (6).

The adult of this Barnacle is characterised by the possession of two well developed ovigerous lamellæ, which are absent from young specimens. They take the form of stout filamentous outgrowths of the integument of the body wall, rounded posteriorly and grooved on their anterior surface. The tip is generally pointed, but may be bifid, and the lamella is often more or less distinctly jointed. The lamellæ may be compared as regards relative position and extent with those of *Cryptophialus*, being situated, one behind the other, on the dorsal aspect of the thorax; the eggs form a two-layered, coherent mass surrounding the back and sides of the body, and the lamellæ are imbedded in them. These structures will be figured in the next number of the "Illustrations of the Natural History of the R.I.M.S. Ship 'Investigator,'" 1906.

I include this species among the forms recorded from the Gulf of Manaar because it is the most abundant deep-sea Lepadid in the Bay of Bengal, and has been taken just outside the Gulf to the north-west.

? Scalpellum truncatum, HOEK.

Locality:—Gulf of Manaar, 590 fathoms (R.I.M.S. Ship "Investigator").

There is a specimen in the "Investigator" collection from the Gulf of Manaar which probably belongs to this species. It differs from HOEK's figure, however, in the following particulars:—(1) The carina is relatively longer, and (2) the valves are not so closely knit together. As I have only examined one specimen, and as HOEK has only described the external characters of his single example, I do not feel quite certain of my identification; but several deep-sea species vary as regards the characters indicated.

S. truncatum was described from a depth of 1400 fathoms; but several of the Indian members of the genus have a greater range in depth than the identification of the "Investigator" specimen with HOEK's species would imply. It is noteworthy that in the Indian seas the genus is only found at a considerable depth, probably always below 100 fathoms, although in more temperate latitudes it occurs in 15 fathoms and downwards. It is probably unable to endure warm water, although it is found in every sea.

Scalpellum tenue, HOEK.

Locality:—Gulf of Manaar, 595 to 556 fathoms (R.I.M.S. Ship "Investigator").

Four specimens, together with those of *S. japonicum* recorded above, from the shell of *Turbo indicus*. My *S. subflavum* is very near this species, from which it is most readily distinguished by its smoother shell.

S. tenue was described from the south of the Indian Ocean. The only other specimen in the Indian Museum is from a depth of 1997 fathoms, in the Bay of Bengal.

Scalpellum subflavum, ANNANDALE (15).

This species belongs to the section of its genus with perfectly calcified valves and a simply bowed carina, as do all the species which have the first of these characters that have been recorded from the immediate neighbourhood of India.

It is almost as commonly found in the deeper parts of the Bay of Bengal (especially in the Andaman Sea) as is *S. squamuliferum*, but is rarer because less gregarious. More than two individuals are seldom found together. I have examined several specimens from the Gulf of Manaar.

BALANIDÆ.

Chelonobia testudinaria (L.).

THURSTON (7) records this species from Rámésvaram Island, and there are specimens (on the carapace of *Chelone imbricata*), which are probably from the Gulf of Manaar, in the Indian Museum.

Ch. testudinaria appears to be found most frequently on turtles, in all warm and temperate seas, but not to be confined to any one species; indeed, it has been observed on the shells of molluscs. GRUVEL (11) has recently described a species of the same genus from the skin of *Manatus senegalensis* under the name *Ch. manati*. I could obtain no evidence during a recent visit to the Gulf of Manaar that Barnacles are ever found on *Halicore* there.*

Creusia spinulosa, LEACH.

This species is recorded from Ceylon by WELTNER (5). I have examined specimens from Mergui on the lower surface of *Turbinaria crater*. They are of considerable size and have their shell covered by a thin layer of coral. In some specimens not only does the opening remain patent, but the junction between the basis and the shell, and even the divisions between the compartments, are visible on the surface, the former as a clear-cut line, not merely as a rounded furrow. The coral appears to have grown over the base and then to have commenced to climb the shell at one point, as much as possible avoiding narrowly all the depressions upon it, thus protecting the Barnacle without injuring it. Nevertheless, some examples of the Barnacle have been completely engulfed by the coral and so have perished, or else, having perished, have been engulfed.

***Pyrgoma conjugatum**, DARWIN.

Localities :—Coral reefs off Ceylon.

There are numerous specimens on fragments of *Turbinaria* evidently collected in a living state. Even when completely imbedded they can be recognised by the form

* They occur, however, on the Dugong in Australian waters (see DEXLER and FREUNDE, 'Amer. Nat.,' xl., 469, p. 69, 1906).

of the opening, which is a regular oval, while that of BORRADAILE'S (9) *P. madreporæ* from the Maldives, the shell of which is very similar, is rhomboidal.

WELTNER (5) has already recorded this species from Ceylon (on *Prionastræa acuticollis*). It was originally described from the Red Sea, and is abundant on specimens of *Turbinaria* and *Porites* collected by the late Dr. J. ANDERSON in Mergui.

Professor HERDMAN'S specimens occur on both the upper and the lower surface of the *Turbinaria*, but chiefly on the latter. In either case they have been covered by the living tissues of the organism while still small. In younger individuals the basis is almost flat as a whole, but deeply sulcated and with an oval depression, corresponding to the opening of the shell above, in the centre. The shell is conical. As the calcareous substance of the coral is deposited round them, the shell becomes relatively flatter and the base deeply concave from within. The whole animal is finally buried. An opening is retained for a time by the action of the cirri and possibly of the opercular plates; but in some examples examined even this has been closed over and the Barnacle has perished, its presence being indicated by a smooth, rounded mound on the surface of the coral. The division between shell and basis can usually be detected, however, on the surface of the coral. A cyst in which the opening still remains open measures 9 millims. in depth, 14 millims. in length, and 10 millims. in breadth, all the measurements being taken externally. The shell is about 1 millim. thick above, but slightly thicker at the point where the valves meet the basis. The internal depth is a little over 8 millims., of which the basal portion occupies 5 millims. The basis is barely distinguishable from the substance of the coral. In some Mergui specimens the cyst is twice as deep and far more protuberant on the surface of the coral, but the opening of the shell is still patent.

*Tetraclita serrata, DARWIN.

Locality:—On a dead *Heteropsammia* off Ceylon.

The presence of the operculum enables me to identify the single specimen obtained by Professor HERDMAN, which is small (antero-posterior diameter of base = 5 millims.). The species does not appear to have been recorded hitherto from the eastern part of the Indian Ocean.

*Acasta cyathus, DARWIN (2).

Locality:—South end of Cheval Paar, Gulf of Manaar.

The specimen is longer and less spheroidal than the one figured by DARWIN, but otherwise agrees closely with his figure. The shell is white instead of pink; but this may be due to the action of spirit. The basis, while nearly flat as a whole, bears a circular depression in its centre, if the shell be viewed from below. This is probably due to the presence of a minute Polychæte, which is coiled up, inside a transparent tube, within the depression.

The penis is extremely long and fine and bears a few scattered hairs. Although the remainder of the body is almost colourless, this organ is of a deep horn-colour, minutely ringed with purplish brown. The latter tint evidently represents a pigment common in Barnacles, but more usually associated with the mouth parts. In *Scalpellum alcockianum* it colours the limbs almost black, while in *Balanus æneas* it tinges the softer structures connected with the mouth. Many other examples of its occurrence might also be noted in both sections of the non-parasitic Cirripedes, both in shallow and in deep water.

A. cyathus has not previously been recorded from the Indian region, and is probably a scarce form where it occurs; but its distribution is evidently circumtropical.

*__Acasta funiculorum,__ n. sp.—Figs. 5–9.

Locality:—Gulf of Manaar.

Diagnosis.—Rostrum and laterals greatly enlarged; carino-laterals much reduced, generally shorter than the rostrum by about two-thirds. Radii of rostrum very

Fig. 5.

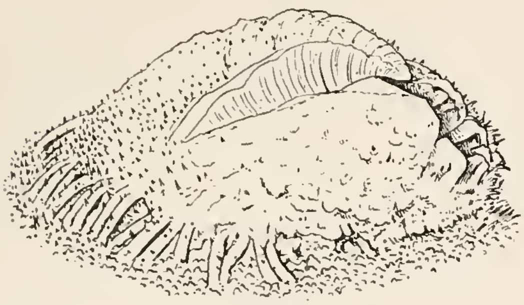

Fig. 6.

Fig. 9.

Fig. 8.

Fig. 7.

Fig. 5. *Acasta funiculorum*, n. sp., lateral view. ×10.
„ 6. „ „ view from above. ×10.
„ 7. „ „ tergum, external view. ×16.
„ 8. „ „ scutum, „ „ ×16.
„ 9. „ „ rostrum, internal view. ×10 (smaller specimen).

broad, longitudinally ridged, oblique. External surface of parietes and radii rough and irregularly spiny, with spiny, cylindrical processes connecting the basal part of the rostrum and the laterals with the coral to which the Barnacle is attached. Internal surface of parietes strongly sulcated longitudinally above and vertically below. Shell fragile, mound-shaped, generally narrower in front than behind, basis flat. Opening more or less vertical, irregularly oval, strongly denticulate. Colour, dirty white; where covered with epidermis, yellowish; tinged, more or less deeply, with steel-blue above. Scutum triangular, with muscular depressions feebly developed; tergum pointed above, much wider than high, with a broad, bluntly rounded spur.

Several dried specimens on the lower surface of *Turbinaria*.

I have been in much doubt as to the proper generic position of this form. As the basis is absolutely flat it can hardly be put in DARWIN'S Section B of *Balanus*, with which its true affinities may lie. On the other hand, its more or less globular outline, its fragile shell, and the shape of its compartments certainly ally it to *Acasta*, if this group can be given generic rank. The periphery of the basis is pierced by small irregular holes as in some species of *Acasta*. It is almost impossible to lay down an exact line between *Acasta* and Section B of *Balanus;* but in most cases there is no difficulty in seeing a difference as regards species.

No species of *Acasta* has hitherto been recorded from a Madreporarian coral. The present form occurs with *Balanus allium*, *B. terebratus*, and *Pyrgoma conjugatum*, and it is interesting to note the different ways in which the four species have been adapted for the same mode of life. With *P. conjugatum* I have already dealt. *B. terebratus* anchors itself among the living tissues of the coral by means of prolongations of the outstanding vertical ridges on its shell. These tissues do not grow over it as they do over the *Pyrgoma*, at least, in the specimens examined. By deepening its base, it can compensate to some extent for the growth of the calcareous part of the coral; but it appears to be continually thrust outwards on to the surface, and none of the specimens show any signs of being engulfed. *B. allium*, as far as one can see, is more frequently destroyed, several specimens having been completely buried. Possibly the peculiar smooth, glistening surface of their shell may be, however, in some way a protection to them, although the smoothness is of texture rather than actual surface. *A. funiculorum* is a more highly specialized form than either of the preceding two. Its cables, so to speak, are not prolongations of such ridges as occur on other species, but seem to be special structures, allied to the spines which occur on the shell of *A. cyathus*, but very much more highly developed; their closest homologues being the processes on the shell of *Balanus tintinnabulum*, var. *spinosus*. By means of them the Barnacle anchors itself to the slippery surface of the coral. If the coral commences to grow round it, it can save itself for a period by elongating the posterior part of its shell, so that the opening may approach the horizontal more closely than it usually does; but individuals are frequently buried and perish. It may be noted that while the *Pyrgoma*, which can be surrounded by calcareous substance without immediate danger to itself, is scattered all over the pieces of *Turbinaria* examined, the other forms occurring with it are almost entirely confined to the inner parts of the colony (where growth is less vigorous, the maximum thickness having been almost reached), or to parts where the living tissues have been killed or weakened by boring organisms.

***Balanus tintinnabulum** (L.).

Locality :—Cheval Paar, Gulf of Manaar.

The only specimen which I can refer with certainty to this extremely variable species belongs to the variety *communis*, which I have taken also on the Pamban Channel, between the Gulf of Manaar and Palk Bay. The shell of Professor HERDMAN's specimen is partly covered by an incrusting Alcyonarian.

***Balanus amphitrite**, DARWIN.

Localities :—Galle ; Gulf of Manaar.

Numerous specimens on shells, ropes, and submerged baskets. All but one belong to the variety *venustus*, which I have taken on an *Avicula* attached to a Gorgoniid at Kílakarai, on the Indian shore of the Gulf of Manaar. The one exception represents the variety *communis*. Both these varieties have an extremely wide distribution, and Professor HERDMAN's specimens are quite typical.

The most interesting are those on the submerged baskets, as their approximate age is known. The baskets were put into the sea on April 17 and were drawn out on May 9. The Barnacles which had formed on them during this period measure from 3 millims. to 8 millims. in their antero-posterior diameter, while the largest individuals obtained from the same seas measure about 14 millims. It is clear, therefore, that individuals of this species take, at this season, not more than three weeks to attain more than half their adult size. I have recently recorded a case in which a specimen of *B. tintinnabulum* (12) was known to have reached a great size (diameter of base, which was approximately circular, 60 millims ; height of shell, 65 millims.) in about a year at Pamban, on Rámésvaram Island.

Professor HERDMAN tells me that *B. amphitrite* and possibly other species grow on the shells of living pearl oysters in the Gulf of Manaar. They appear in April or May, and spread with great rapidity. Such forms may be classed as enemies of the pearl oyster.

***Balanus amaryllis**, DARWIN.

Localities :—Palk Bay and Gulf of Manaar.

The majority of these specimens belong to DARWIN's variety B, but a few are obscurely striped with dull pink. The opercular plates resemble those of the typical form, rather than of that noted by WELTNER (5), and later described by LANCHESTER (8) as sub-species *dissimilis*. The specimens are all small.

***Balanus allium**, Darwin.

Locality :—Coral reefs off Ceylon.

Several small specimens on *Turbinaria*, together with *B. terebratus*, *Acasta funiculorum* and *Pyrgoma conjugatum*. Probably they are immature, as the base is nearly flat, although the shell and operculum agree with Darwin's description and figures.

This Barnacle has been recorded from the Red Sea and from Australia as well as from Ceylon. It is probably another circumtropical species, its small size and inconspicuous appearance having caused it to be neglected by collectors.

***Balanus terebratus**, Darwin.

Locality :—Coral reefs off Ceylon.

Several specimens, with those of the preceding species. They agree closely with Borradaile's description (9) as regards the structure of the operculum. Darwin (2), who had examined a single specimen, said regarding it, "the interspaces between the ridges (on the basis) are penetrated by small rounded apertures, of irregular shape and unequal sizes." Borradaile was unable to see these apertures, and they are absent in some examples I have examined. In one individual, however, there appear to be indications that they have been present, but have been almost obliterated during growth. The specimens are small, the antero-posterior diameter of the largest being 7 millims., and are apparently more steeply conical than the type.

***Balanus æneas**, Lanchester (8).

Locality :—Pearl Banks, Gulf of Manaar.

Numerous small individuals, measuring about 3 millims. in antero-posterior diameter, on a piece of sodden palm fibre, on a shell, and on dead *Heteropsammia*.

In spite of their small size these individuals contain eggs inside the shell. The eggs are of a broad ovoid outline, measure 0·333 millim. in length and 0·2 millim. in maximum breadth, and are comparatively few in number. The maxillæ have in one specimen only six teeth, the third being represented merely by a short bristle; while in the other individuals there are seven.

Loose in the shell of one specimen I found a peculiar little Nematode, the affinities of which I do not venture to decide.

***Balanus maldivensis**, Borradaile (9).

Locality :—Gulf of Manaar.

Five specimens on a piece of dead coral. Possibly some other very much worn examples, fixed to a dead *Heteropsammia*, may also belong to this species. The shells are white with vertical stripes of rose-pink. Their coloration gives them a general resemblance to some specimens of *B. amphitrite*, var. *venustus*.

Borradaile's section H of the genus *Balanus*, created for this form in 1903, is not the same as Gruvel's section H, which was published for *B. dybowskii* in the same year. The definition of the former is "All parts of shell present, heavy, and without pores"; of the latter, "Basis calcareous; no radii; basis and parietes porous."

Borradaile's section approaches *Acasta* technically, although the form and character of the shell are different. It is convenient, therefore, to call it section I, retaining Gruvel's designation for *his* section H.

Chthamalus stellatus (Poli).

A common Indian species with a wide distribution. I have lately taken specimens in the estuary of the Matla River, Lower Bengal, at a place where the water was decidedly brackish. They were attached to the trunks of mangrove trees, and could only have been covered by the tide during a very small part of each day.

On the whole, the Barnacles of Ceylon, in so far as they are known, bear out the remark made in the Introductory note to this paper, that every addition to our knowledge of the distribution of the group tends to prove the wide dispersal of the species and varieties. Of the 26 species recorded above, 3 occur in all seas, their migrations being assisted by human agency; at least 6 will probably be found in every sea which is not too cold; 4 are widely spread in the Indian Ocean and the warmer parts of the Pacific, while 12 are only known from the Indian Ocean. Of the last, however, 4 come from great depths, which have been little explored, while the remaining 8 are small, inconspicuous forms. Except *Tetraclita serrata*, which is probably found at the extreme south of the West African coast, none of the 26 species are known only from the Atlantic and Pacific Oceans. It seems possible that the continent of Africa has proved a barrier in some cases as regards the migration westwards of Oriental species.

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REPORT

ON THE

MARINE HEMIPTERA (HALOBATES)

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH ONE PLATE.]

DURING his researches in the Gulf of Manaar, Professor HERDMAN collected many specimens of *Halobates*, that interesting pelagic genus of bugs, familiar to all students of insects since the publication of BUCHANAN WHITE'S classical memoir in the 'Challenger Reports.'* These insects are allied to our common "pond-skaters," and skim over the surface of the ocean in warm latitudes, as those do over the water of ponds and streams. WALKER, who has given much attention to the habits of *Halobates* in recent voyages, states† that they dive below whenever the surface is ruffled by a breeze.

All the specimens in the present collection are referable to a new species, and as the material is abundant, the opportunity has been taken to investigate some details of the external anatomy, and in particular the structure of the ovipositor.

FAMILY: HYDROMETRIDÆ.

GENUS: **Halobates,** ESCHSCHOLTZ.

Halobates herdmani, n. sp.—Plate, figs. 1 to 19.

Length of male 5·2 millims., of female 5·7 millims. Feeler with 4th segment half as long again as 3rd, slightly shorter than 2nd (figs. 3, 4). Fore foot with the two tarsal segments sub-equal (figs. 5, 6, 9). Intermediate foot with the proximal tarsal

* 'Challenger,' Zoology, vol. vii., 1883, part xix.

† 'Ent. Monthly Mag.,' vol. xxix., 1893, pp. 227–232.

segment two and a half times as long as the distal (figs. 1, 11). Abdomen of male with the 8th segment slightly asymmetrical (figs. 13, 14, 15), the "horns" being both inclined towards the left, so that while the right horn is closely applied to the 9th segment, the left is somewhat divergent from the axis of the body; both horns are falcate at the tip.

Habitat:—Coasts of Ceylon. Old Dutch Modragam Paar, numerous males and females; Galle Bay, two males and one female; off Mutwal Island, Gulf of Manaar, two females; off Manaar Island, several young specimens.

This species is most nearly allied to *H. flaviventris*, Eschs., of all members of the genus hitherto described. It differs from that species principally in the shape and in the slight asymmetry of the "horns" of the 8th abdominal segment of the male. The form of this segment in the present insect shows an interesting stage of transition between the symmetrical condition found in the great majority of the species of *Halobates* and the excessive irregularity of *H. micans*, Eschs. (*H. wüllerstorfii*, Frauenf.), in which the left horn of the segment projects almost at right angles to the axis of the body.

In colour *H. herdmani* resembles the other species of the genus. The dorsal and lateral surfaces appear deep blue-black when wet, and ashy grey (owing to the dense pubescence) when dry. On the head are the usual pair of orange triangular marks, while the feelers and legs are black. The thoracic sternum is dark centrally, showing only two pale elongate patches towards the lateral sutures (fig. 14) close to the bases of the hind legs. The abdominal sterna are mostly pale, but they appear dark laterally and along their hinder borders; the 1st abdominal segment, on which is the opening of the repugnatorial glands, is deep brown.

The sutures, partially marking the junctions of the anterior abdominal terga, can be unusually well seen in this species (figs. 1, 2), and the male has a median longitudinal suture extending from the front of the mesothorax to the hinder edge of the 2nd abdominal segment. The recognition of the transverse dorsal sutures reminds us that though the abdomen is indeed much reduced in this genus, as compared with most of its fresh-water allies, yet the peculiar modification of the body is principally due to the abnormal extension of the mesothorax, and to the backward growth of that segment and of the metathorax on either side of the anterior abdominal segments.

Fore Legs.—The fore legs of the various species of *Halobates* have been frequently described and figured, affording as they do excellent diagnostic characters. A few details are, however, worthy of especial notice. The tarsal segments in the present species are longer and more slender in the female (fig. 9) than in the male (figs. 5, 6). The whole of the limb is covered with a fine pubescence, but on the upper surface a number of short, stout spines are interspersed among the delicate hairs (fig. 5), these spines being especially strong in the male and being absent from the under surface of the foot in both sexes (figs. 6, 9). At the end of the shin, however, on this surface are a number of long, stiff bristles lying in the shallow groove close to the joint with the proximal tarsal segment. BUCHANAN WHITE drew attention to the curious row of stout, blunt hairs or spines on the edge of the inner apical prominence of the shin. In the present species there are more than twenty of these on the male's leg (figs. 5*a*, 7), and five on the female's (figs. 9*a*, 10). The arrangement of these structures is highly suggestive of a stridulating organ, and it is probable that they form an instrument for rasping along a "comb" formed by a row of sharp, strong spines (figs. 5*b*, 6*b*, 8, 9*b*), about ten in number, and increasing in length as the tip of the shin is approached. This "comb" is situated on the upper face of the apex of the shin. The "file" of each foot must of course play on the "comb" of the other—quite a possible arrangement when we remember that the fore legs in these insects are very mobile, and that the feet can be crossed over each other in front of the head. Similar structures occur towards the distal end of the shin in the allied reef-haunting genus *Hermatobates* (CARPENTER).*

Male Abdominal Segments.—As mentioned above, the present species is characterised by a comparatively slight asymmetry in the "horns" of the 8th segment in the male's abdomen (figs. 13, 14, 15); while the right horn is closely applied to the globose 9th (genital) segment, the left horn is directed laterally outwards at a slight angle. Each horn is expanded at the tip into a falcate process with a few stout black spines (fig. 15). In the allied *H. flaviventris*, ESCHS., the horns are symmetrical,† and each has a somewhat pointed process on the outer margin about the middle of its length, tapering at the tip. It is of interest to remember that *H. flaviventris*, to which the present species is most nearly allied, has been recorded from the Indian Ocean near Ceylon, while *H. micans*, the species with the very divergent "horn," inhabits all the warmer oceans. It is exceedingly likely that with these insects, as with others, our specific distinctions will become less definite as our knowledge of the possible variations in structure increases.

Female Abdominal Segments and Ovipositor.—It is rather remarkable that while the hindmost segments of the male *Halobates* have attracted much attention from entomologists, the corresponding region in the female has been neglected. This is probably because, in preserved specimens, the lateral sclerites of the 8th segment (figs. 16, 17, 18, *a*) are usually in close contact ventrally, and

* 'Sci. Proc. R. Dublin Soc.' vol. vii., 1891 (plate xii., fig. 6). For descriptions of other stridulating organs in the *Hemiptera* see HANDLIRSCH, 'Ann. Naturhist. Hofmus. Wien,' vol. xv., 1900, pp. 127–141; KIRKALDY, 'Journ. Quekett Micros. Club' (2), vol. viii., 1901, pp. 33–46; and BERGROTH, 'Proc. Zool. Soc.,' vol. ii., 1905, pp. 146–154.

† BUCHANAN WHITE states (*loc. cit.*, p. 33) that "in all the other species examined [except *H. wullerstorffi = micans*] both horns are symmetrical," though his figure of *H. flaviventris* from the dorsal aspect (plate ii., fig. 2*g*) shows the left horn only visible, and slightly divergent as in the present species. NASONOV, however, in his figure of *H. flaviventris*, var. *kudrini* ('Entomological Researches,' 1893—in Russian—Warsaw, 1897, fig. 14), shows the genital segments of the male from beneath, and the two horns appear perfectly symmetrical.

the ovipositor retracted beneath them. BUCHANAN WHITE remarks that "the ovipositor appears to consist of four valves," and NASONOV in his figures* shows only two pairs of processes (gonapophyses). Several of the females in the present collection have, fortunately, the ovipositor well extended, and it is not difficult to see that the three pairs of processes usual in the insectan ovipositor are present.

In a specimen with the ovipositor thus extended the two lateral sclerites of the 8th segment (figs. 16, 17, 18, *a*) are widely separated, and a transversely striated, flexible cuticle (figs. 17, 18, *b*) is seen to occupy the ventral region of the abdomen behind the 7th sternite. As this cuticle must be folded between the sclerites of the 7th and 8th segments when the ovipositor is retracted, and as it lies in front of the genital opening (figs. 17, 18, *c*), it is to be regarded as an intersegmental membrane, while the small sclerites that are visible behind it—a triangular pair (fig. 19, *d*) supporting the bases of the anterior processes of the ovipositor, and a very slender pair (figs. 17, 18, d^1) continuous with the chitinous rim that lies posterior to the genital aperture, must represent the 8th sternite. In front of the genital aperture the intersegmental membrane projects in the form of a hood (figs. 17, 18, c^1) with a pointed and forwardly-directed process.

The anterior pair of gonapophyses (figs. 17, 18, 19, *e*) are attached to the reduced 8th abdominal sternite, as previously mentioned. Each of these processes is broad at the base, which is pale and feebly chitinized except at the outer margin, where a firm dark ridge is developed. Distally the process becomes tapering in form, brown in colour, firm and well chitinized in texture, and beset with rows of prominent bristles. In addition to this main axis of the process there is a small delicate internal limb (figs. 17, 18, e^1) which lies close to the genital opening.

Beneath the lateral sclerites of the 8th segment there lies on each side an elongate sclerite (figs. 17, 19, *f*), whose shape and relations become evident only when the overlying 8th segment has been removed. Then it is clear that these sclerites (*f*) belong to the 9th segment. At its dorsal extremity each is produced into a dark, prominent knob, which lies just anterior to the small "tail-segment" (figs. 16, 17, 19, *j*), while at its ventral end each supports the two posterior gonapophyses. The outer pair of these processes (figs. 16, 17, 18, 19, *g*) are strong and flexible at the base, while distally each is produced into a straight, firm "guide" on which the inner process slides to and fro. When the ovipositor is extended, the tips of these hinder outer processes do not reach quite as far as the tips of the anterior processes. The inner posterior processes (figs. 16, 17, 18, 19, *h*) are very long, slender, and flexible at the base, but distally they become somewhat broad and flat, and terminate in a hook-like tip beset with fine hairs. The gonapophyses of the 9th segment remain free from one another, except for an extensive pale membrane (figs. 16, 17, 18, *i*) which is stretched between them when the ovipositor is extended. This membrane terminates in a pair of short pointed prominences.

* *Loc. cit.*, figs. 11, 12.

When the ovipositor is retracted, the slender basal portions of the hinder gonapophyses, especially of the inner pair, become bent almost in a semicircle (fig. 19), while the tips of the processes are withdrawn dorsalwards and fit just in front of the anal segment, so that they can be covered by the lateral sclerites of the 8th segment, meeting in the mid-ventral line.

It has been shown by HEYMONS* that in *Naucoris* and other Hemiptera the ovipositor is composed of the three pairs of gonapophyses usual in insects, not, as supposed by VERHOEFF,† of two pairs only. *Halobates* has therefore an ovipositor in which can be recognised all the parts typical of its order and class. But the processes of the 8th segment in *Halobates* recall by their appearance the outer pair of the 9th segment in *Naucoris* and in many other insects; while the latter pair, instead of being as is usual blunt and hairy, form in *Halobates* stiff, rod-like "guides" for the inner pair of the 9th segment. These last-named processes, which in most hemipteran and hymenopteran ovipositors are closely approximated or even fused together, remain apart in *Halobates*. Thus the ovipositor has here a somewhat primitive arrangement, intermediate between the simple condition found in the Orthoptera and the specialised form to be observed in such Hemiptera as the Cicadidæ.

The egg of *Halobates*, which is of large size, must be held between the processes of the 8th segment and the inner processes of the 9th segment. These are the processes that hold the eggs in insectan ovipositors generally.

If the narrow sclerites above-mentioned (figs. 17, 19, *f*) represent the skeleton of the 9th abdominal segment, then the "tail-segment" (figs. 16, 17, 19, *j*) (with which the large dorsal anchor-shaped sclerite in the male presumably corresponds) belongs to the 10th segment, and the small sclerite below it bounding the anal opening (figs. 16, 17, 19, *k*) represents the 11th segment. And thus all the segments of the typical insectan abdomen can be recognised in these remarkable marine bugs, in spite of the many special adaptations that they have undergone in correspondence with their wonderful manner of life.

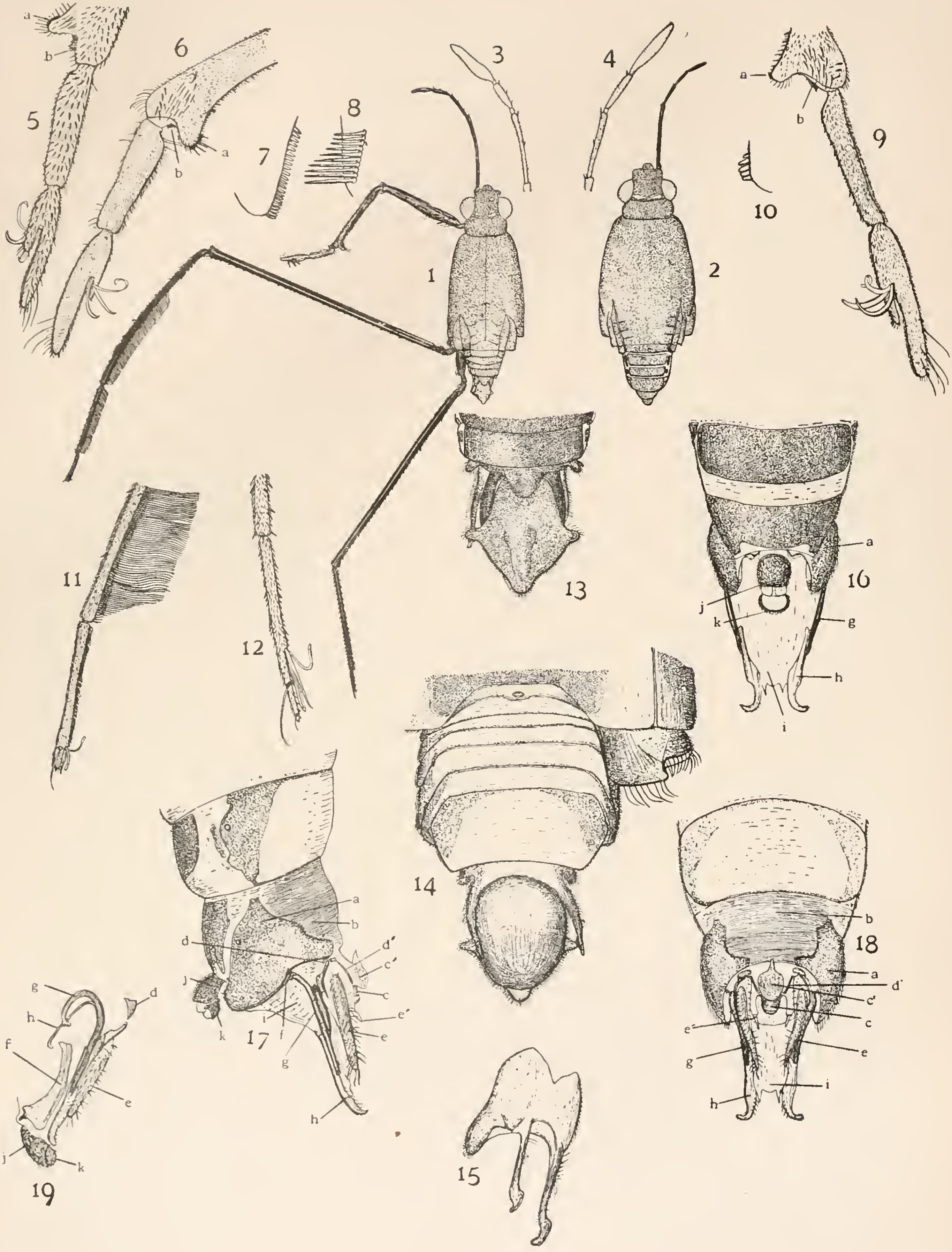
* 'Nova Acta Acad. Leopold Carol.,' lxxiv., 1899, No. 3.

† 'Entom. Nachrichten,' xix., 1893, pp. 369–378.

EXPLANATION OF PLATE.

Fig.	1.	*Halobates herdmani,*	male, dorsal view. × 8.
,,	2.	,,	female ,, ,, × 8.
,,	3.	,,	male, left feeler (terminal segments). × 20.
,,	4.	,,	female, right ,, ,, ,, × 20.
,,	5.	,,	male, apex of shin, with tarsal segments. Upper aspect. × 40.
,,	6.	,,	,, ,, ,, ,, Lower ,, × 40. *a,* "file," *b,* "comb" of stridulating organ.
,,	7.	,,	male, "file" of stridulating organ. × 250.
,,	8.	,,	,, "comb" ,, ,, × 250.
,,	9.	,,	female, apex of shin, with tarsal segments. Lower aspect. × 40. *a,* "file," *b,* "comb" of stridulating organ.
,,	10.	,,	female, "file" of stridulating organ. × 250.
,,	11.	,,	male, tip of proximal tarsal segment with distal segment of intermediate leg. × 40.
,,	12.	,,	male, tip of shin with tarsal segment of hind leg. × 40.
,,	13.	,,	,, dorsal view of "genital" segments. × 40.
,,	14.	,,	male, ventral view of abdomen, showing hinder edge of thoracic sternum and coxa of left hind leg. × 40.
,,	15.	,,	male, 8th abdominal segment isolated and viewed obliquely from the ventral aspect. × 40.
,,	16.	,,	female, dorsal view of end of abdomen with extended ovipositor. × 40.
,,	17.	,,	,, lateral ,, ,, ,, ,, ,, × 40.
,,	18.	,,	,, ventral ,, ,, ,, ,, ,, × 40.
,,	19.	,,	,, lateral view of retracted ovipositor, as seen after removal of the lateral sclerites of the 8th segment. × 40.

In figs. 16 to 19: *a,* lateral sclerites of 8th abdominal segment; *b,* intersegmental membrane; *c,* genital aperture; c^1, "hood" in front of ditto; *d,* triangular, and d^1, slender sclerites of 8th sternum; *e,* anterior gonapophyses; e^1, slender internal limb of ditto; *f,* sclerite of 9th abdominal segment; *g,* outer posterior gonapophyses; *h,* inner posterior gonapophyses; *i,* membrane extending between gonapophyses; *j,* 10th abdominal segment; *k,* anal segment.



G.H.C.

Halobates herdmani, n. sp.

[CEYLON PEARL OYSTER FISHERIES—1906—SUPPLEMENTARY REPORTS, No. XXXIII.]

REPORT

ON THE

LEPTOSTRACA, SCHIZOPODA AND STOMATOPODA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH THREE PLATES.]

THE collections of these three groups of Crustacea Malacostraca, made by Professor HERDMAN and Mr. HORNELL in Ceylon, and kindly entrusted to me for examination, are small both in number of species and, with one or two exceptions, in individuals as well. Nor is the number of new forms by any means remarkable or at all out of proportion to the total number of species, only two hitherto undescribed forms, both in the Stomatopoda, having been met with in the collection. Still, the material is not without interest, at least six very rare species being comprised therein; this afforded an opportunity for completing or adding to the published descriptions, or of increasing materially the known geographical range.

The LEPTOSTRACA are represented by a single species, which differs so slightly from the well-known and widely distributed northern form, *Nebalia bipes*, that I cannot consider it as a distinct species or even variety.

The SCHIZOPODA are on the whole distinctly disappointing. Five species are represented in the collection; but as three of these occurred only in tow-net gatherings taken on the outward journey to Ceylon, only two can therefore be regarded as belonging to the Ceylon fauna. One of these, *Euphausia latifrons*, appears to be an abundant form, but of the other, a Mysid, *Siriella paulsoni*, only a single specimen is present.

So little is known of tropical Mysidæ, that one had hoped that the collections made by Professor HERDMAN in Ceylon would have added considerably to our knowledge, especially as the material of the other groups of Crustacea, more notably the AMPHIPODA, ISOPODA, and CUMACEA, has been found to be so rich in the number of species, both described and new. Still, as, so far as I am aware, no SCHIZOPODA have previously been recorded from Ceylon waters, the present collection, though small, provides a first contribution to our knowledge in this respect.

To judge from the contents of the stomach of a ray, *Dicerobatis ergoodoo*, which contained several hundred specimens of *Euphausia latifrons*, the Euphausians in the tropics, equally with those of more temperate climes, are economically of primary importance as fish-food, an importance which can scarcely be over-estimated.

With the STOMATOPODA, Professor HERDMAN was distinctly more successful, ten species of adult and ten types of larvæ being present in the collection. Remembering the difficulty which always attends the capture of adult Stomatopoda of any kind, the results obtained must be regarded as highly satisfactory considering the limited time at Professor HERDMAN'S disposal. Five species are added to the fauna of Ceylon, two of which, *Gonodactylus herdmani* and *G. acanthurus*, are new to science, both possessing features of great interest.

Species of adult STOMATOPODA have been recorded from Ceylon by HELLER (1868), MIERS (1881), MÜLLER (1887), and HENDERSON (1890 and 1893). The full list is as follows, with the names of the recorders :—

Squilla nepa [HELLER, HENDERSON, 1890].
S. oratoria [HELLER].
S. scorpio [HENDERSON, 1890].
Lysiosquilla maculata [HENDERSON, 1890].
L. saracinorum [MÜLLER].
Pseudosquilla ciliata [MÜLLER, HENDERSON, 1890].
Gonodactylus chiragra [MÜLLER, HENDERSON, 1893].
G. glabrous [HENDERSON, 1893].
G. graphurus [MÜLLER, MIERS, HENDERSON, 1890].
G. demani [HENDERSON, 1893].
Odontodactylus scyllarus [MÜLLER].
Protosquilla trispinosa [HENDERSON, 1893].
P. trispinosa, var. *pulchella* [HENDERSON, 1890, MIERS].
P. stoliura [MÜLLER].
P. ectypa [MÜLLER].

Of this list, *Squilla oratoria*, as recorded by HELLER, is regarded by MIERS as synonymous with *S. nepa*. This leaves a total of thirteen species and one variety of Stomatopods already known from Ceylon. To these must now be added the following five species :—

Squilla raphidea, FABRICIUS.
Odontodactylus brevirostris (MIERS).
Gonodactylus herdmani, n. sp.
G. acanthurus, n. sp.
Protosquilla spinosissima (PFEFFER).

The larvæ in this collection which could be referred to already described forms are recorded below under the names given to them by their describers. Those which do not appear to have hitherto been met with, or at least not named, are not given new specific designations, as I am of the opinion that such a proceeding in connection with larval forms is not desirable. They are, however, described and figured in the hope that they may be recognised in future collections, and their life-history more fully traced.

In the preparation of this paper I have been kindly aided by Dr. NOBILI, of Turin, and Professor PFEFFER, of Hamburg, with information on various species, and to these gentlemen I desire to express my grateful thanks. I am especially indebted to Dr. W. T. CALMAN for his kindness and help while at the British Museum, and for very valuable assistance with the literature of the subject.

I.—LEPTOSTRACA.

FAMILY: NEBALIIDÆ.

Nebalia bipes (FABRICIUS).

Localities:—

Cheval Paar, February, 1902, 5 to 8 fathoms. Five.

Washings from pearl oysters, Ceylon. Thirteen.

Periya Paar, February 5, 1902, tow-net at night, surface. Few.

The specimens of *Nebalia* obtained by Professor HERDMAN in Ceylon may all, I think, with certainty be referred to the type species, though differing from northern examples of that species in one or two minor points. They do not fall into any of the numerous varieties of *N. bipes* recently indicated by THIELE (1904), but I do not propose to designate them by a separate varietal name, because the differences are too slight to deserve such an honour. Insignificant as these differences are, they serve to bring still closer together the two supposedly distinct species of this genus, *N. bipes* and *N. longicornis*. The characters which serve to distinguish the two latter species from each other have recently been defined by THIELE (1904). Briefly, *N. bipes* may be distinguished from *N. longicornis* (1) by the size of the rostrum, which in the former is much longer proportionately to the breadth than in the latter; taking the breadth of the rostrum as unity, its length in *N. bipes* is 2·62, and in *N. longicornis* 1·75;* (2) by the armature of the fourth joint of the peduncle of the first antenna. This joint in *N. bipes* is armed on its outer edge with at least three (sometimes as many as eight, *cf. N. bipes*, var. *valida*) spines and five or six setæ, whereas in *N. longicornis* there is only one spine and seven or eight setæ.

In *N. bipes* from Ceylon the rostrum is in all the specimens about two and a third times as long as broad, and shaped on the whole as in THIELE's fig. 70. The fourth joint of the peduncle of the first antenna bears on its outer edge two spines (without exception in all of the eighteen specimens) and four or five setæ. The characters, therefore, of Ceylon *N. bipes* are exactly intermediate between those of *N. bipes typica* and *N. longicornis*.

The specific differences between the two latter species as given by THIELE are very

* These figures are taken from THIELE's drawings, 1904, plate iv., figs. 66 and 70.

slight in themselves, and in the light of Ceylon specimens of the former species would appear to almost reach vanishing point.

The eye in the Ceylon examples has the sensory papilla well developed, while the fourth pair of pleopods does not appear to differ from those of typical specimens of *N. bipes*. *N. bipes* in one or other of its varieties is a very widely distributed form in the northern hemisphere. Since the examples noted by STEBBING from Sandal Bay, Lifu, and New Britain are more properly, according to THIELE, referable to *N. longicornis*, Ceylon is the southernmost point from which *N. bipes* has as yet been recorded.

II.—SCHIZOPODA.

FAMILY: EUPHAUSIIDÆ.

Euphausia mutica, HANSEN (1905).

E. pellucida (*pars*), SARS (1885).

Localities:—

Indian Ocean, south of Sokotra, surface tow-net. Three specimens of 10 millims.; and five, 6 millims and under.

Indian Ocean, between Sokotra and the Laccadives, surface tow-net. Forty, 5 to 15 millims.

Indian Ocean, between the Laccadives and Ceylon, surface tow-net. Two, 11 millims.

This species was not actually met with in Ceylon waters, but was captured on the outward journey there by means of tow-nets. All the specimens were taken at the surface in crossing the Indian Ocean from Sokotra to Ceylon.

This species has only recently been founded by HANSEN for specimens formerly referred by SARS to *E. pellucida*, DANA, in which he also included *E. mülleri*, CLAUS, and *E. bidentata* (M. SARS), as synonyms. HANSEN (1905), however, rejects *E. pellucida*, DANA, as unrecognisable from DANA's descriptions and figures, and makes *E. mülleri* the type of the genus, with *E. bidentata* as a synonym. From *E. mülleri*, *E. mutica* is chiefly distinguished by having the leaflet on the basal joint of the antennular peduncle bidigitate instead of multidigitate. This latter character is also shared by *E. recurva*, HANSEN, and *E. brevis*, HANSEN. *E. mutica*, *E. recurva*, and *E. brevis*, which all have two lateral denticles on the carapace, are separated from each other, by HANSEN, on the characters of the armature of the second joint of the antennular peduncle and the shape and direction of the antennular leaflet.

Small examples of *E. mutica* in this collection, 5 millims. in length, while in other respects agreeing fairly well with larger examples, only possessed a single lateral denticle on the carapace. This is quite in accordance with the fact that the second denticle is of late appearance, and SARS (1885), moreover, describes and figures a young Euphausian, 7 millims. long, which he refers to *E. pellucida*, and which has the second denticle on the carapace still undeveloped.

Euphausia mutica is, according to HANSEN, known from the tropical and southern Atlantic, Red Sea, Indian Ocean, and various parts of the North Pacific.

Euphausia latifrons, G. O. SARS.—Plate I., figs. 1 and 2.

Localities :—

South end of Red Sea, surface tow-net. Three, 3 to 5 millims.

Indian Ocean, between Sokotra and the Laccadive Islands, surface tow-net. One, 8 millims.

Off Kalpentyn Island, Ceylon, February 3, 1902, surface tow-net all night and early morning. Fourteen, 8 to 10 millims.

Watering Point, Galle, February 15, 1902, surface tow-net. One, 7·5 millims.

Off Mutwal Island, Ceylon, March 19, 1902, surface tow-net. One, 8 millims., and two larvæ.

North-east of Chilaw Paar, Ceylon, March 20, 1902, surface tow-net. Two, 4 and 6 millim.

Periya Paar, November 13, 1902, from stomach of a ray, *Dicerobatis ergoodoo.* Several hundreds, 8 to 10 millims.

The *carapace* is about half as long as the pleon, and has a single lateral denticle placed near the posterior end of its inferior margin just in front of the luminous organs of the penultimate thoracic limbs. It is produced in front into a squarely truncate or slightly emarginate rostral projection, the lateral angles of which are somewhat acutely pointed. The antero-lateral corners are pointed, and there is no very prominent dorsal keel.

The *segments of the pleon* decrease in depth posteriorly. The first five are subequal in length, while the sixth is about one and a half times as long as the preceding segment and has its posterior median dorsal border very slightly acuminate. The preanal spine is well developed, curved and simple. The epimera of the first five segments are rounded, those of the last segment slightly acuminate.

The *eyes* are rather small with the pigment black.

The *antennular peduncle* (figs. 1 and 2) is rather stout, with the basal joint slightly longer than the terminal two combined. The outer distal corner of the basal joint is produced into a short spine, while its inner distal margin bears about six long plumose setæ which interlock with those of the other peduncle. On the dorsal surface there is a leaflet running obliquely across the distal end of the basal joint. The leaflet is strongly curved, and the external half of its margin is divided up into eleven acutely pointed lappets. The external part of the leaflet overhangs the spine on the outer distal corner of the basal joint. The second joint of the peduncle is longer than the third.

The *antennal peduncle* is about as long as the scale, and has the terminal joint almost as long as the basal two combined.

The *antennal scale* extends to the distal end of the second joint of the antennular peduncle. It is about four times as long as broad, with its outer margin slightly curved and terminating in a distinct though feeble spine. The apex of the scale is broadly rounded, while its basal spine is short and smooth.

The *mouth parts and thoracic limbs* offer no points of special interest.

The *telson*, including the subapical spines, is about as long as the last two segments of the pleon combined. It is narrowly lanceolate in shape, with the portion beyond the insertion of the subapical spines suddenly constricted and acutely pointed. Its dorsal surface bears five pairs of dorsal denticles on its distal half. The subapical spines have rather broad insertions and their inner distal edge bears five small denticles.

The *uropods* have the plates subequal in length and very slightly shorter than the telson. The inner plate is much narrower than the outer, which terminates in a minute spine on its outer edge.

Length of the largest specimen 12 millims.

The numerous specimens in this collection which I refer to this species differ from the descriptions and figures of SARS in four points, (1) in the presence of a lateral denticle on the carapace, (2) in the very much more digitate form of the membranous leaflet of the antennules, (3) in the presence of five instead of three pairs of denticles on the telson, (4) in the greater relative development of the uropods. The last three points of difference may be accounted for by the difference in size and age of SARS' specimens and my own. SARS' descriptions and figures were taken from a specimen 7·5 millims. long, while the above description is of a specimen 12 millims. long. The first of the above-mentioned differences is due to an error on SARS' part.

The examination of the type of *E. latifrons*, for which I am greatly indebted to Dr. W. T. CALMAN, reveals the presence of a small but quite distinct spine on the lateral margin of the carapace just in front of the luminous organ of the penultimate thoracic limb. The type specimen, according to information kindly given to me by Dr. CALMAN, is one of those from Port Jackson, Australia, mentioned by SARS in his 'Challenger Report,' p. 96, as having come to hand late. It is, therefore, not the specimen figured or described. It is not quite as large as some of the Ceylon specimens, but considerably more developed than the one SARS figured. The leaflet on the basal joint of the antennular peduncle of this specimen is divided up distally into nine rather short lappets, being thus intermediate in development between SARS' figure and my own.

STEBBING (1905), in recording this species from S. Africa, notes the presence of a lateral denticle on his specimens, and is of opinion that it probably becomes obsolete in quite adult examples.

Euphausia latifrons is the smallest known species of the genus, and is at once distinguished from all other described species by the peculiar form of the rostral projection.

Distribution: -Australian seas and East Pacific near the Phillipine Islands ('Challenger'); South Africa (Stebbing).

Its occurrence at Ceylon thus fills up a gap in the distribution of the species in the Pacific. Round Ceylon it would appear to be a very abundant species, judging from the contents of the stomach of a ray, *Dicerobatis ergoodoo*, which contained several hundred specimens. All the other specimens were taken at the surface of the sea, though its occurrence in the stomach of a bottom-living fish like a ray would seem to indicate that the species does not always adopt an entirely pelagic habitat. The depth over which the species was captured by tow-nets in no case exceeded 20 fathoms.

Nematoscelis microps, G. O. Sars (1885).

N. rostrata, G. O. Sars (1885). **N. mantis**, Chun (1896). **N. microps**, Hansen (1905).

Locality:—Off Mutwal Island, Ceylon, March 19, 1902, surface tow-net. Two, 3·5 millims.

Hansen (1905) has recently demonstrated that *Nematoscelis rostrata* is in reality only the young of *N. microps*, and I here adopt his view of the matter.

The two small Ceylon specimens agree very well with the description and figures given by Sars of the Cyrtopia larva of *N. rostrata*. The rostrum is large and well developed, and the lateral spine on the carapace very prominent. Though the specimens measure only 3·5 millims. in length, the long leg is already well developed and measures about 2 millims. in length. It is too stoutly built to admit of referring the specimens to *N. tenella*. In other points, such as the general proportions of the body, the Ceylon specimens are in harmony with Sars' figures.

N. microps was taken by the "Challenger" at several stations in the tropical and subtropical Atlantic Ocean and in the Pacific to the north of New Guinea. It has since been recorded from the Mediterranean by Chun, and from the tropical Atlantic Ocean off America and Africa by Ortmann and Hansen respectively.

Family: MYSIDÆ.

Siriella paulsoni, Kossmann.—Plate I., figs. 3 to 7.

S. jaltensis, Paulson (1875), *nec*, Czerniavsky. **Siriellides paulsoni**, Czerniavsky (1880).

Locality:—Pearl Banks, Cheval Paar, March, 1902, 8 fathoms. One female, 12 millims.

The general form of the body is robust and rather stoutly built.

The *carapace* is shorter than the pleon and of equal breadth throughout. It is produced in front into a short acutely pointed rostrum.

The *pleon* has the first segment slightly longer than the next four, which are subequal in length. The sixth segment is about one and a half times as long as the fifth.

The *eyes* are large and globose, not quite reaching the distal end of the basal joint of the antennular peduncle. The pigment is black.

The *antennular peduncle* (fig. 4) is rather long and stoutly built. The basal joint is longer than the remaining two combined. The second joint is quite short and has its outer edge armed with short plumose setæ. The third joint is longer than the second. All three joints have a plumose seta on their inner distal corners.

The *antennal peduncle* is rather long and slender, with the penultimate joint about three times as long as the terminal one.

The *antennal scale* (fig. 4) extends almost to the distal end of the antennular peduncle and is about three times as long as broad. Its outer margin is entire and terminates in a strong spine, beyond which the evenly rounded apex of the scale projects for a little distance.

The *mouth parts*, in so far as they could be studied in the single available specimen, agreed well with KOSSMANN's figures.

The *first thoracic limbs* (maxillipedes) (fig. 5) are rather short when compared with the same appendage in *S. thompsoni*. The merus is longer than the carpus, the propodus is small and the nail distinct and longer than the propodus. The whole limb is moderately well armed on its inner edge with short plumose setæ.

The *second thoracic limbs* are missing in the specimen.

The *remaining thoracic limbs* (fig. 6) are somewhat slender and elongate. The tarsus is about as long as the merus and distinctly two-jointed, the first joint shorter than the second one. The nail is distinct and long, and the whole limb well armed with simple setæ, with a bunch of plumose setæ at the basal part of the nail.

The *exopods* of all the thoracic limbs are well developed, and have the outer distal corner of the expanded basal joint slightly acuminate. The flagelliform part is composed of ten joints.

The *pleopods* are of the usual type found in the females of this genus.

The *telson* (fig. 7) is about one and a half times as long as the last segment of the pleon. It is narrowly linguiform and tapering in shape with a prominent constriction at about one third of its length from the base. The apex is armed with a pair of long spines, between which are a pair of median setæ and three small equal-sized spinules. The sides below the constriction are armed with about 28 spines arranged in series of five distally, and three and four proximally. The proximal spine of each series is the shortest, the succeeding spines gradually increasing in length. Above the constriction the lateral margins are armed with three stout spines, longer than the spines arming the distal part of the margins.

The *inner uropod* is about one and a sixth times as long as the telson, narrow and having about 45 spines on its inner margin, the spines commencing at the inner posterior corner of the otocyst and extending to the tip. The spines are arranged in series of sometimes two and sometimes three, the most posterior spine nearly as long as the terminal spines of the telson. The otocyst is well developed.

The *outer uropod* is a little longer than the inner and much broader, the terminal joint being about one quarter of the length of the proximal one, the latter armed on the distal two thirds of its outer margin with 15 strong spines increasing in length posteriorly.

Length of an ovigerous female 12 millims.

The above description is based on the single Ceylon specimen in this collection, which I refer to this species. The male is as yet unknown. Professor PAULSON (1875) first described this species, though he referred his specimens at the time to *S. jaltensis*, CZERNIAVSKY. KOSSMANN (1880), who had a much larger specimen of what he believed to be PAULSON's species at his disposal, recognised that it differed rather markedly from *S. jaltensis*, and, therefore, re-described it, with figures, under the name *S. paulsoni*. CZERNIAVSKY (1880) likewise came to the conclusion that *S. jaltensis*, PAULSON, was not the same as his species, and, apparently unacquainted with KOSSMANN's earlier paper, fortunately also re-named it *S. paulsoni*. He had, however, no specimens, and drew up his diagnosis entirely from PAULSON's work.

Though both CZERNIAVSKY's and KOSSMANN's descriptions are imperfect in many points, they only differ in one important detail from the Ceylon example, namely, in the number of spines on the outer margin of the first joint of the outer uropod. CZERNIAVSKY gives the number as seven, KOSSMANN figures eight, while the Ceylon specimen has fifteen. This great difference may, I think, be explained by the difference in size of the individuals from which the various descriptions were drawn up. CZERNIAVSKY's description was based on PAULSON's specimen, 4 millims. in length; KOSSMANN's example was 8·5 millims., while the Ceylon one is 12 millims. The spinulation of the telson and uropods is known in other species of the group to vary with the size of specimens. In all other respects the present example agrees in the main with KOSSMANN's figures. *S. paulsoni* approaches nearest to *S. denticulata*, G. M. THOMPSON, among all the species of *Siriella* which have been described, but differs from the latter (1) in the length and proportion of the joints of the antennal peduncle; (2) in the deviating form of the antennal scale; (3) in the presence of spines on the lateral margins of the telson above the constriction; (4) in the much larger number of spines on the inner uropod. From the three Pacific species of the genus—*S. gracilis*, *S. thompsoni* and *S. indica*—*S. paulsoni* may be at once distinguished by having the outer uropod longer than the inner, and in having many more spines on the outer edge of the former. Previous to Professor HERDMAN's capture of this species in Ceylon it was only known from the Red Sea. Its geographical distribution has thus been considerably extended. As far as I am aware, it is the first Mysid ever recorded from Ceylon.

Haplostylus erythræus, KOSSMANN (?).

Locality :—South end of Red Sea, surface tow-net. One female, 5 millims.

In consequence of its small size and damaged condition the absolute identity of this specimen is a matter of some doubt. A description of the specimen is therefore given.

The *carapace* has the rostral projection short and bluntly rounded. It is without any trace of dorsal lobes on its hinder margin, which is slightly emarginate.

The *pleon* has the sixth segment about one and a half times as long as the preceding one, which shows no trace of a median posterior dorsal spine.

The *antennular peduncle*, which is only slightly longer than that of the antenna, has two small spines on the outer margin of the second joint.

The *antennal scale* is very short, scarcely reaching beyond the distal end of the basal joint of the antennular peduncle. Its outer margin is entire and terminates in a very strong spine. The apex of the scale does not project beyond the tip of the spine.

The *telson* is as long as the last segment of the pleon and cleft at its apex, the cleft, as usual in this sub-family, being serrated. The lateral margins bear six long and stout spines.

The *uropods* are both slightly longer than the telson, the inner a very little longer than the outer. The outer uropod has eleven strong spines on the outer margin, while the inner bears five spines on its internal margin.

Length, 5 millims.

It is probable that the above specimen belongs to *H. erythræus*. As just described, it differs from *H. normani* in the antennal scale, which has a stronger terminal spine and the apex not produced beyond the spine, and also in having a much blunter rostral projection. The males further differ from those of *H. normani* in having the inner branch of the third pleopod in the male quite absent.

H. erythræus is only known from the Red Sea, where both KOSSMANN'S types and the above specimen were obtained.

III.—STOMATOPODA.

FAMILY: SQUILLIDÆ.

Squilla raphidea, FABRICIUS.

Locality:—South-west part of Palk Bay, off Adam's Bridge and Rámésvaram Island, 7 to 9 fathoms. One male, 125 millims.

This specimen differed from large examples of this species which I examined in the British Museum in having the lateral processes of the fifth thoracic somite obtuse instead of acutely spinous.

Distribution:—*S. raphidea* has a general Indo-Pacific distribution, though not previously recorded from the coast of Ceylon.

Squilla nepa, LATREILLE.

Locality:—South-west of Palk Bay, off Adam's Bridge and Rámésvaram Island, 7 to 9 fathoms. One male, 42 millims.

Distribution :—*S. nepa* has already been recorded from Ceylon by HELLER (1868). Its distribution is general over the whole of the Pacific and Indian Oceans.

Pseudosquilla ciliata (FABRICIUS), MIERS.

Locality :—Talaivillu Paar, off south end of Mutwal Island, 10 to 14 fathoms. One male, 33 millims.

It is interesting to note that this specimen agrees with BROOKS' West Indian examples in those points in which the latter differ from the Pacific ones. I have confirmed this by an examination of BROOKS' "Challenger" specimens. BORRADAILE (1900) has proposed the varietal name *occidentalis* for this form.

Distribution :—*P. ciliata* has been recorded from Ceylon once previously by F. MÜLLER (1887). It is another widely distributed Indo-Pacific form.

Gonodactylus chiragra (FABR.), var. *smithii*, POCOCK (1893).

Locality :—Muttuvaratu Paar, 45 to 50 fathoms, in cavities of coral. One female, 12 millims.

This specimen agrees very well with LANCHESTER'S var. *smithii* (A) (LANCHESTER, 1902), except that the spine on the median carina is perhaps not so well developed.

Distribution :—China seas (POCOCK, 1893) ; Funafuti and the Loyalty Islands (BORRADAILE, 1898) ; Malay Peninsula and the Maldives (LANCHESTER, 1902).

Gonodactylus chiragra (FABR.), var *incipiens*, LANCHESTER (1902).

Locality :—Trincomalee. One male, 18 millims.

The single specimen which I refer to this variety of the type species agrees with LANCHESTER'S var. *incipiens* (A) (1902, plate xxiii., fig. 10).

Distribution :—Funafuti (LANCHESTER).

Gonodactylus glabrous, BROOKS (1885).

Localities :—

Cheval Paar, 6 to 8 fathoms. One female, 46 millims. ; one male, 16 millims.

Coral Reefs, Gulf of Manaar. Three females, 40, 30 and 15 millims. ; one male, 34 millims.

Pearl Banks, Gulf of Manaar. Two males, 18 and 20 millims.

Entrance to Galle Harbour, 4 to 7 fathoms. One male, 18 millims.

South end of Periya Paar, 8½ to 13 fathoms. One female, 22 millims. ; three males, 22, 20 and 17 millims.

South of Adam's Bridge, 4 to 40 fathoms. One male, 25 millims.

West and south-west of Periya Paar, 11 to 24 fathoms. One male, 20 millims.

West of Periya Paar, 17 to 24 fathoms. One female, 16 millims.

On weed-bearing oyster spat, south-east of Modragam, 4½ to 5½ fathoms. One male, 27 millims.

Aripu Reefs. Six males, 29, 26, 24, 20, 18 and 17 millims.; four females, 16, 15, 15 and 13 millims.

Galle Lagoon. Two females, 32 and 29 millims.

Galle, from cavity beneath Polyzoan crust. One female, 33 millims.

Off Mutwal Island, 10 to 14 fathoms. One female, 38 millims.; two males, 34 and 27 millims.

From the above list of captures it will be seen that this species is a very common one in Ceylon. In all, 33 specimens were captured, 19 of which were males ranging from 16 millims. to 34 millims. in length, and 13 females of from 13 millims. to 46 millims. in length. In no case did the depth of water over the ground on which they were taken exceed 24 fathoms. LANCHESTER (1902) in a survey of *G. chiragra* and the allied forms *G. glabrous* and *G. graphurus* expresses the opinion that the two latter species are in reality only varieties of the type species of the genus, and figures a series of telsons in support of this view, at the same time defining under separate varietal denominations a series of types leading from *G. chiragra* through *G. glabrous* to *G. graphurus*. The material in the present collection is by no means sufficient to attempt a discussion on the point raised by LANCHESTER, but its very uniformity has led me, at least for the present, to regard *G. glabrous* as a species distinct from *G. chiragra*, and constantly distinguished from the latter by the presence of two extra carinæ on the telson.

In only one specimen (not included in the above list of records, but referred to below) was any striking divergence in the form of the telson from that of the type to be noticed, and although it falls within one of the new varieties proposed by LANCHESTER, I regard it not as a definite varietal form, but as an individual abnormality.

It is true that the 33 specimens recorded above vary slightly among themselves in the relative tumidity of the carinæ of the telson, and in the absence from one or other of them of the terminal spines. But the difference between the extremes is at most slight, and the variation in any single instance (not even including the abnormality noted below) is not at all such as to cause any doubt for a single moment as to the validity of the specific separation of *G. glabrous* from *G. chiragra*.

LANCHESTER (1902) also notes on the telson of *G. glabrous* and *G. graphurus* the presence of two tubercles just beyond the distal end of the median carina. These two tubercles are present in all the Ceylon specimens, and also in BROOKS' type which I have examined at the British Museum.

A note on the colour of the Ceylon examples may be of interest. Several of the labels in the bottles had notes to the effect that the specimens contained therein were a vivid green colour when alive, and, indeed, a general bright green coloration seems to be the prevailing one in most of the specimens in the collection, many of which after three years' preservation still show strong evidence of this fact. All the specimens which appear to have been a uniform green when alive have four sharply defined though quite small dark green pigment spots, two on the sixth abdominal segment and two on the telson. Those on the sixth abdominal segment are always placed between the intermediate and lateral carinæ, and those on the telson occupy a corresponding situation. The constancy of the association of these pigment spots with a uniform green colour in the specimens of *G. glabrous* in this collection was, indeed, striking. One or two specimens, however, appear to have been a more mottled colour, with a distribution of dark pigment corresponding more or less with that noted by BROOKS for his single type specimen. In these examples the four prominent pigment spots noted above were not present.

The single abnormal specimen to which reference has already been made was a female, 24 millims. long, taken at Trincomalee. It agreed almost exactly with LANCHESTER'S var. *segregatus* (B) = var. *affinis*, DE MAN. I prefer, however, to regard it as an abnormal *G. glabrous*, having the anterior portion of the intermediate carinæ obsolete.

Distribution :—This species has a generally wide distribution throughout the Indian and Pacific Oceans.

Gonodactylus, sp.

Localities :—

10 miles north of Cheval Paar, $7\frac{1}{2}$ to 9 fathoms. One, 11 millims.

Mudalaikuli Paar. One, 8 millims.

These two specimens, apparently belonging to the same species, are still post-larval in development. They probably belong to either *Gonodactylus glabrous* or *G. chiragra*. The telson agrees fairly well with that figured by BROOKS (1886, plate xvi., fig. 5) from a specimen which he attributes to some species of *Gonodactylus*. The dactylus of the raptorial claw in both specimens has a notch on the external margin near to the proximal end.

Gonodactylus herdmani, n. sp.—Plate I., figs. 8 to 10.

Locality :—Coral Reefs, Gulf of Manaar. Two females, 28 and 26 millims.

The *rostrum* (fig. 8) is of the *Protosquilla* type, with acutely produced median and antero-lateral spines. The median spine extends for rather more than half way along the eye. The antero-lateral spines are not so much produced.

The *carapace* is rectangular in shape, and of about equal width throughout. Its antero-lateral and postero-lateral angles are both evenly and broadly rounded.

The *last three thoracic segments* have their lateral parts rounded.

The first five abdominal segments are quite smooth all over, without carinæ or furrows of any kind, and with their postero-lateral angles rounded.

The *sixth abdominal segment* (fig. 9) bears on its dorsal surface four equidistant, perfectly smooth, narrowly oval, blunt carinæ. The central two of these carinæ are slightly posterior to the lateral ones. None of the carinæ end in spines. There is also a prominent, rather sharp carina on each side of this segment, quite near to the lateral margins and running into the postero-lateral angles.

The *telson* (fig. 9) has the six marginal spines well developed, unusually stout and blunt. In the largest specimen the lateral spines are almost obsolete. The submedian spines have a small movable spinule at their tips. There are *no* submedian, intermediate, or lateral denticles whatever. The dorsal surface of the telson bears a median, broadly oval carina, and a narrower and rather sharper carina on each side of it. There is also a prominent carina running down into the submedian and intermediate spines of the telson. The median carina bears at its posterior end a prominent blunt spine, with two small blunt tubercles on each side of it. The lateral carinæ and those which run into the intermediate and submedian spines of the telson are broken up into irregular tubercles. The lateral carinæ and those of the intermediate spines are composed of three of the tubercles, those of the submedian spines of four, which are moreover rounder and more regular in shape.

The *uropods* (fig. 10) are very powerfully built. The basal joint bears a very prominent dorsal ridge, which is continued down both joints of the exopod. These joints are therefore triangular in cross section. The first joint of the exopod bears eleven stout spines on its outer edge. Both paddles are unusually tough and chitinous, and quite unlike the flat, thin, membranaceous, lamella-like paddle usually met with in Stomatopods. Both have prominent dorsal ridges, and the inner one is of a most unusual scythe shape (fig. 10). De Man figures a similar paddle to the inner uropod of *G. drepanephorus*. The setæ are mostly broken off.

Length of the largest specimen 28 millims.

The *colour* of the preserved specimens is generally pale, but there is a distribution of black pigment, which is the same for both specimens. There are three prominent black pigment spots on the posterior part of the carapace, surrounded by numerous pigment flecks. Anterior to these, on each side, on the suture separating the median from the lateral parts of the carapace, is a small, narrowly oval, pigmented area. There is a prominent median black pigment spot surrounded by numerous pigment flecks in the ante-penultimate thoracic and first, third, fourth and fifth abdominal segments, while scattered pigment flecks are to be seen on the lateral parts of all the abdominal segments.

Four species of *Gonodactylus* have been described with a *Protosquilla*-like rostrum, viz., *G. acutirostris*, de Man, *G. drepanephorus*, de Man, *G. festæ*, Nobili, and *G. demani*, Henderson. From all these *G. herdmani* is at once distinguished by the unusual bluntness and stoutness of the marginal spines of the telson, the presence of a movable spinule at the tip of the submedian spines, and the *complete absence* of submedian, intermediate, or lateral denticles on the telson. Its nearest relative is *G. drepanephorus*, which has the same peculiar paddle to the endopodite of the uropods, but the spines on the telson of the latter are much sharper and more numerous than in *G. herdmani*, while the tubercles on the sixth segment end in spines, whereas in the present species these tubercles are quite smooth.

I have named the species in honour of its discoverer.

Gonodactylus acanthurus, n. sp.—Plate I., figs. 11 to 15.

Locality:—Muttuvaratu Paar, 45 to 50 fathoms. One female, 10 millims.; one male, 8 millims.

The *rostrum* (fig. 11) is of the usual *Gonodactylus* type, with a long acute median spine reaching very nearly to the cornea of the eye, and slightly produced, bluntly rounded antero-lateral angles.

The *carapace* is rectangular in shape, of about equal width throughout. Its antero-lateral and postero-lateral angles are rounded.

The *last three thoracic segments* have their lateral parts rounded.

The *first five abdominal segments* are quite smooth all over, without carinæ or furrows of any kind. The postero-lateral angles of the first four segments are broadly rounded, those of the fifth segment produced somewhat, but rounded at the tip.

The *sixth abdominal segment* has the postero-lateral angles ending in prominent spines. On its dorsal surface are six carinæ, the submedian and intermediate of which are narrowly oval, smooth, and blunt, the lateral ones being somewhat sharper and running into the spines of the postero-lateral angles. The submedian and intermediate carinæ do not terminate in spines.

The *telson* (fig. 14) has the six marginal spines well developed, long, acute, the laterals slightly curved. There are about nine submedian, two intermediate, and a single lateral, rather long and acute denticles on each side. The dorsal surface of the telson bears three very blunt carinæ, the central one broadly oval and larger than the rather narrowly oval lateral ones. The posterior half of the telson, beyond the carinæ, is armed with long, powerful, acute spines arranged approximately in two transverse rows, five spines in a row. The first row is placed just posterior to the carinæ, and consists of a long median spine immediately below the base of the median carinæ, a long intermediate spine immediately behind the lateral carina on each side, and a rather short lateral spine. The second row, which is posterior to the first, consists of five long spines, the median one immediately below that of the first row, the intermediate and lateral ones alternating with those of the first row. There is a moderately long spine on each side of the posterior end of the median carina, and two small median spines. Each lateral carina bears two small spinules at its posterior end and immediately external to the posterior end of these lateral carinæ is a small spine.

The basal joint of the *uropods* (fig. 15) bears a strong posterior dorsal tooth. The paddle of the endopodite has its inner margin drawn out into six acute spines, its outer margin as usual fringed with setæ. The external margin of the basal joint of the exopodite bears eight strong spines. The terminal joint or paddle is small, its inner margin drawn out into three acute spines, its outer margin setose.

The *raptorial claw* (fig. 12) is of the usual type, without a notch on the external margin of the dactylus, and the internal margin of the propodus minutely serrated.

A figure of the endopodite of the first abdominal appendage of the male (fig. 13) is given for comparison with other species.

Length of the type male 8 millims., of the type female 10 millims.

The *colour* of the preserved specimens is uniformly pale, with rather a characteristic group of chromatophores on the first abdominal segment, and a less distinct group on the ante-penultimate thoracic segment.

This species of *Gonodactylus* is abundantly distinguished from all known species of the genus by the spinous inner margin of both paddles of the uropods, as well as by the rather distinctive armature of the telson.

Odontodactylus brevirostris (Miers, 1884).—Plate II., figs. 16 to 18.

Locality :—Pearl Banks, Gulf of Manaar. One female, 16 millims.

I have thought it advisable to give a brief description of the single Ceylon example.

The *rostrum* (fig. 16) is rather more than twice as wide as long, quite smooth, not sinuate but transverse, and evenly rounded in outline. The centre of the anterior margin is, however, slightly depressed, so that the rostrum, *in situ*, appears to be slightly emarginate (fig. 17).

The *carapace* is rectangular in outline, of about equal width throughout and having its antero-lateral and postero-lateral angles rounded.

The lateral parts of the last three thoracic segments are rounded.

The *abdomen* is of about equal width throughout. The postero-lateral angles of the first three segments are rounded, those of the fourth and fifth produced into short acute spines. The first five segments are quite smooth and devoid of all carinæ and ridges. The sixth segment bears six rather sharp carinæ, all of which end posteriorly in acute spines. There is also a small tubercle on each side of the sixth segment between the intermediate and lateral carinæ.

There is no spine at the articulation of the uropods.

The *telson* has the six marginal spines well developed, long and acute, the submedian ones with a movable spinule at their tips. There are sixteen submedian two intermediate, and a single lateral denticle on each side. The dorsal surface bears a median crest and four other rather sharp carinæ. The dorsal crest is interrupted slightly at its anterior end, and posteriorly it ends in a prominent spine. The carina on each side of the crest is very low and does not end posteriorly in a spine. The lateral carinæ are more elevated than the intermediate ones and not spinous posteriorly. There is also a prominent carina running into the submedian spines.

The *uropods* have the outer spine of the basal prolongation longer than the inner and reaching to the level of the tips of the submedian spines of the telson. The basal joint of the exopod bears ten strong movable spines on its outer edge.

The *raptorial claw* (fig. 18) has the dactylus very little ventricose at its base and provided with seven spines on its internal margin in addition to the terminal one.

Length 16 millims.

The *colour* of the specimen, as preserved, was dark mottled brown with traces of purple on the uropods. The second to the sixth abdominal segments have four small equidistant dark eye-spots.

The above specimen differs from the type in having only seven teeth instead of eight on the internal margin of the dactylus of the raptorial claw, but its close agreement with it in other characters leaves little doubt that it belongs to the same species.

O. brevirostris appears to be very closely allied to *O. havanensis*, BIGELOW, 1894. The latter has the rostrum more semicircular than *O. brevirostris*, and the dactylus of the raptorial claw is more dilated at the base and bears only six teeth on its internal margin.

The type, and only previously known specimen, of *O. brevirostris*, was taken in 19 fathoms off Providence Island, Indian Ocean. It is thus an addition to the Stomatopod fauna of Ceylon.

Protosquilla trispinosa (DANA), var. *pulchella*, MIERS (1880).

Localities :—

Pearl Banks, Gulf of Manaar, February, 1902, 6 to 11 fathoms. Two females, 44 and 15 millims.

South-west of Palk Bay, off Adam's Bridge and Rámeswaram Island, 7 to 9 fathoms. One female, 38 millims.

Coral Reefs, Gulf of Manaar. One female, 17 millims.

This variety differs from the type species mainly in the absence of corrugations on the median portion of the fifth abdominal somite

An examination of WHITE's type of *Protosquilla trispinosa* reveals the presence of a few scattered corrugations on the fourth segment of the abdomen. They are not present in MIERS' type of var. *pulchella*, nor in any of the Ceylon specimens.

The two large females in this collection appear to differ from the smaller ones and from MIERS' type in having the tubercles on the sixth abdominal segment much more swollen and without spines. It is possible that the spines on the tubercles are hidden by the general spinulose armature, or they may become obsolete in large examples. The small specimens had the tubercles of the telson very much less densely spinulose than the large ones.

Distribution :—*P. trispinosa*, var. *pulchella* is only known from Ceylon (MIERS) and the Indian Archipelago (DE MAN). The type form has also been recorded from Trincomalee, Ceylon, by HENDERSON, and seems to have a wide Indo-Pacific range.

Protosquilla spinosissima (PFEFFER).—Plate II., fig. 19.

Gonodactylus spinosissimus, PFEFFER, 1889.

Localities :—

Coral Reefs, Gulf of Manaar. Six females, 31, 29, 28, 28, 26 and 25 millims.; five males, 23, 23, 22, 21 and 20 millims.

Muttuvaratu Paar, 45 to 50 fathoms, from the cavities of Coral. Eight females, 28, 27, 27, 25, 24, 24, 23 and 19 millims.; eight males, 27, 25, 23, 21, 21, 21, 20 and 13 millims.

Pearl Banks, Cheval Paar. One male, 24 millims.

Talaivillu Paar. One male, 10 millims.

Through the kindness of Professor PFEFFER I have been permitted to examine the type of this species, with which I find the Ceylon specimens in perfect agreement. LENZ (1905) has recently pointed out that this species is a true *Protosquilla*, combining, as it does, a tridentate rostrum with the complete fusion of the sixth abdominal segment with the telson. It has thus no connection with *Gonodactylus spinosus*, with which BIGELOW, when describing the latter, compared it. A brief description of the species is appended, and a figure of the endopodite of the first abdominal appendage of the male given for comparison with that of other species (fig. 19).

The *rostrum* has the median spine very long and acute, extending to the corneal part of the eye. The lateral spines are acute, but not as much produced as the median one, and extend along the outer edge of the eye not quite as far as the corneal part.

The *carapace* is of about equal width throughout and oblong in shape. The antero-lateral angles are acutely rounded, while the postero-lateral angles are more broadly rounded.

The lateral parts of the last three thoracic segments are rounded.

The *abdomen* increases in width slightly from the front backwards. The postero-lateral angles of the first three segments are rounded, while those of the fourth and fifth segments are acutely produced. The first four segments have well-marked marginal carinæ, but are otherwise quite smooth. On the lateral parts of the fifth segment there are two or three sharp carinæ separated by slight furrows. The central part is almost smooth, except near the posterior margin, where a few short, scattered, transverse furrows may be noticed. The sixth segment is fused completely with the telson, though the suture is still distinctly visible. On its dorsal surface there are four rounded tubercles, the median two of which are smaller than the lateral ones, placed near to one another and separated from the lateral tubercles by a furrow. The tubercles and lateral parts of the segment are thickly beset with numerous, long, acute, upright spines.

The *telson* is longer than broad, with its lateral edges slightly curved. The posterior margin is cleft in the centre by a triangular fissure into two somewhat diverging lappets. Each of the latter is again divided by a very much shorter slit into two spines, which correspond with the submedian and lateral spines of the telson, the intermediates being suppressed. The dorsal surface bears three very prominent rounded tubercles, the median one placed anterior to the cleft, the lateral ones being placed entirely posterior to the median, one on each apical lappet. The median tubercle is bounded laterally and posteriorly by a deep furrow. The whole surface of the telson is thickly beset with spines similar to those on the sixth abdominal segment. The spines on the lateral portions of the telson external to the tubercles are arranged in three rows.

The *uropods* have the outer spine of the basal prolongation much broader and longer than the inner, and reaching to the top of the telson. The basal joint of the exopodite bears nine or ten stout spines on its outer edge. Its paddle is rather small.

Length of the largest male 27 millims., of the largest female 31 millims.

The *colour* of preserved specimens is generally dark, with various mottlings, the tubercles of the sixth abdominal segment and the telson tinged distinctly red.

This *Protosquilla* approaches most nearly to *P. brooksii*, DE MAN, and *P. hystrix*, NOBILI. The former may be distinguished from *P. spinosissima* (1) by having the four tubercles on the sixth abdominal segment quite smooth; (2) by the much fewer and much shorter spines on the telson and the sixth abdominal segment; (3) by the cleft in the lateral apical portions of the telson being nearly obsolete.

P. hystrix differs from the present species (1) in the absence of tubercles from the sixth abdominal segment; (2) in the form of the spines arming the sixth abdominal segment and the telson, which are shorter and stouter than in *P. spinosissima*, and hooked at the tip instead of simple.

Distribution:—The type and only previously known specimen of *P. spinosissima* was taken at Zanzibar, West Coast of Africa. The species would appear to be by no means rare in Ceylon.

STOMATOPOD LARVÆ.

BELONGING TO THE GENUS **Squilla**, FABRICIUS.

Alima *α*.—Plate II., figs. 20 to 25.

Localities:—

South end of Red Sea, surface tow-net. Thirteen, 11 to 23 millims.

Off Ráméswaram Island, surface tow-net. Seven, 4·5 to 7 millims.

Palk Bay, trawl. Eighteen, 12 to 27 millims.

Off Mutwal Island, surface tow-net. One, 27 millims.

All the above *Alimæ* appear to belong to one species. It will be most convenient to describe the largest specimen first, and then add a note on the small specimens.

Larva 27 millims.

Body generally greatly elongate and narrow; *rostrum* fairly short, about one-third of the length from the antero-laterals to the posterior margin of the carapace; *antero-laterals* short, not extending to the eye-stalk; *postero-laterals* rather long, reaching to the junction of the second and third abdominal segment, a single secondary spine near to its base; *postero-median dorsal spine* short; about sixteen small denticles on the lower (ventral) in-turned edge of the carapace; the latter with a very well-marked carina running down the whole of its median dorsal length and terminating in the postero-dorsal spine. Last three thoracic segments exposed behind the carapace; all the abdominal segments with their postero-lateral angles very acutely drawn out into spinous processes; sixth abdominal segment with a pair of median dorsal spines on its posterior border.

Telson (fig. 23) quite flat, without carinæ of any sort, but a series of well-marked concentric pits present, about one and a fifth times longer than broad, six marginal spines, well developed, acute, and slightly curved; margin between the submedian spines deeply emarginate, with a slight notch in the centre, and bearing seventeen denticles on each side; eleven intermediate and a single lateral denticle present on each side.

Uropods (fig. 24) barely reaching the level of the lateral spines of the telson; traces of six spines on the external edge of the outer branch; inner spine of the basal prolongation slightly longer than the outer, but not yet reaching the tip of the outer uropod.

Eyes somewhat large, placed on slender stalks.

Raptorial claw (fig. 25) with no signs of teeth as yet on the dactylus, two prominent teeth at the proximal end of the propodus, the inner margin of which is spinulose.

Last three thoracic appendages present and biramous, but still very small.

Abdominal appendages well developed, with gills just showing.

The smallest larva belonging to this species in the collection measures 4·5 millims. in length (fig. 20). It has the carapace rather wider, proportionally, than older larvæ, but the median dorsal carina is already very well marked. There are three spines on the ventro-lateral edge of the carapace between the antero- and postero-lateral spines, and a single secondary spine on the latter. The telson (fig. 21) is of somewhat different shape to the older larvæ, being much more quadrangular, with the marginal spines much shorter. The margin between the submedian spines is relatively much wider and more shallowly emarginate, without a trace of median notch. The telson bears seven submedian, five intermediate, and a single lateral denticle on each side.

The next stage, 7 millims. long, has a carapace much as in the last. The telson, however, has assumed a much more octagonal shape (fig. 22), and the margin between the submedian spines is relatively much narrower and more deeply emarginate than in the larva of 4·5 millims. The marginal spines are much more prominent, and there are fourteen submedian, ten intermediate, and a single lateral denticle on each side.

After 7 millims. the larva assumes practically the same shape as described above for a 27 millims. larva, and a slight notch appears in the margin of the telson between the submedian spines. The marginal spines likewise become longer and more acute.

This *Alima* is most closely allied to *Alima bidens*, Claus. The latter is the only *Alima*, as far as I am aware, which has a well-marked median carina on the carapace, but the present *Alima* differs from *A. bidens* in having a well-marked postero-median dorsal spine on the carapace.

Three *Alimæ*, captured in a trawl off Galle, do not seem to differ materially from the above except in size. They measure 19 millims. in length, but are more advanced in their development than the larva of 27 millims. described above. The uropods extend very nearly to the intermediate spines of the telson and have traces of seven spines on the outer edge of the external branch. The telson is about as long as broad, and bears twelve submedian, ten intermediate, and a single lateral denticle on its margins. Its shape is in substantial agreement with the 27-millims. larva described above.

Alimerichthus unidens, LANCHESTER, 1902.—Plate II., fig. 26.

Locality:—East of the Gallehogalle Bank, 16 to 30 fathoms, fine sand. Two specimens, 12 millims. and 9 millims. long, from the eye to the telson.

The largest of the Ceylon larvæ is practically the same size as LANCHESTER's type, and appears to be at the same stage of development. I am able to confirm the fact, established by LANCHESTER, that in some *Alimerichthii* at least the postero-lateral angles of the abdominal segments end in acute spines, because both in the specimens here referred to *A. unidens*, and also in another species described below, such spines are distinctly present and well developed. As points not noticed by LANCHESTER, it may be mentioned that the telson in both specimens has forty-four submedian spinules and eight intermediate ones. There are eight spines on the outer uropod of the large specimen, but only two on that of the smaller, a difference quite in accordance with the difference in size. The dactylus of the raptorial claw (fig. 26) has in both specimens one fully developed spine in addition to the terminal one and traces of two others beneath the skin. A figure of the raptorial claw is given for comparison with the other *Alimerichthus* described below.

Distribution:—Maldive and Laccadive Islands (LANCHESTER). This is the only previous record for the species, the distribution of which is now extended to Ceylon.

Alimerichthus α.—Plate II., figs. 27 to 29.

Locality:—Cheval Paar, 7 fathoms. Two specimens, 9 millims. and 10 millims. long from eye to telson.

This larva differs chiefly from *A. pyramidalis*, LANCHESTER, and *A. unidens*, LANCHESTER, the only two described species of this type of larva, in size, being only 9 millims. long, but at a stage in its development rather later than either *A. pyramidalis* at 16 millims. or *A. unidens* at 12 millims. It evidently belongs to a smaller species of adult than either of the above two. A brief description may enable the species to be recognised in any future collections.

Carapace (figs. 27 and 28) rather wide, leaving only one thoracic segment exposed, exhibiting in lateral view the same pyramidal form already noticed by LANCHESTER for the other species of the type; rostrum slightly shorter than the length of the carapace extending to about the same level as the flagella of the antennules, two ventral spinules at about the level of the eye; posterior median dorsal spine well developed, arising from the pyramidal base noted above, much shorter than the postero-lateral spines, a prominent carina running from the rostrum along the middle of the carapace, terminating in the postero-dorsal median spine; antero-lateral spines rather short, with a prominent spine of equal length arising from their bases and projecting ventrally; postero-lateral spines well developed, extending backward to the level of the boundary between the second and third segment of the abdomen, with a secondary spinule on each near the base; no prominent ventro-lateral spine on the carapace midway between the antero- and postero-lateral spines, as seen in *A. pyramidalis* and *A. unidens*; two small spinules on the ventro-lateral margin very near to the point of origin of the postero-lateral spines.

Abdomen with all its segments well developed, each having their postero-lateral corners very acutely drawn out into spines, rather more so than in *A. unidens;* sixth segment with a pair of rather long and acute spines on the median posterior border.

Telson about as long as broad, six marginal spines well developed and acute; between the submedian spines there are 32 denticles, that is, 16 on each side of the centre; between the submedian and intermediate spines on each side there are 7 intermediate denticles, and between the intermediate and lateral spines on each side there is a single lateral denticle situated at the base of the lateral spine.

Appendages of abdomen all well developed, each with a rudiment of the future gills already present.

Uropods fairly well developed, reaching slightly beyond the lateral spines of the telson; basal prolongation with the inner spine much longer than the outer, and exhibiting a very slight swelling near the origin of the latter; external edge of the outer branch showing traces of six spines.

Raptorial claws (fig. 29) having the dactylus with two developed spines in addition to the terminal one, and showing traces of two more below the integument.

Length 9 millims.

The second specimen, which measures 10 millims., agrees perfectly with the above description except that the telson only has 26 denticles between the submedian spines and six denticles between the submedian and intermediate spines on each side. The distinguishing features of this larva are:—

(1) Its small size taken with its advanced state of development;
(2) Absence of a prominent ventro-lateral spine on the carapace;
(3) The spines arming the dactylus of the raptorial claw;
(4) The spinulation of the telson.

This *Alimerichthus* at 9 millims. long is at exactly the same stage of development as CLAUS' *Alimerichthus* at 18 millims. long (CLAUS, 1871, fig. 30).

Belonging to the genus Lysiosquilla, Dana.

Lysioerichthus duvaucellii (Guérin).

Locality :—East of Gallehogalle Bank, 16 to 30 fathoms, fine sand. One specimen, 22 millims. long, excluding rostrum.

The single example which I refer to this distinct and rather remarkable species agrees in all particulars save two with Claus' figures (Claus, 1871, fig. 16). The first point of difference lies in the complete absence from the present specimen of a dorsal spine. In Claus' figure the latter is represented by a slight acumination only.

The Ceylon specimen has two very small spinules between the submedian and intermediate spines of the telson and a very small one at the base of the lateral spines. These spinules are not represented in Claus' figures, but are so small as to be easily overlooked. The raptorial claw shows indications of seven teeth below the skin, and the outer uropod is armed with five not fully developed spines.

From a comparison of the Ceylon specimen with the figures of *L. duvaucellii* given by Claus (1871), Brooks (1886), and Jurich (1904), it seems at least doubtful that all three writers were dealing with the same species.

It is unfortunate for an absolute settlement of this point that Claus omitted to mention the length of his specimen. The Ceylon example, which seems almost certainly to belong to the same species as Claus', measures 22 millims. without the rostrum, but is considerably more developed than Brooks' largest specimen (which is stated to be over an inch, *i.e.*, 25 millims. in length), in having more segments of the abdomen exposed below the carapace, in the limbs of these segments being much more advanced in development as shown by the appearance of gills and in having more spines on the outer uropod, and differs in the absence of the dorsal spine of the carapace. Jurich's largest specimen, which measures 20·5 millims. without the rostrum, agrees with Brooks' figures in all essential particulars, and the differences between them, namely, the less developed abdomen and the absence of indications of teeth beneath the skin of the raptorial claw in Jurich's specimen, are only those of age. From these considerations it seems improbable that Brooks' and Jurich's specimens belong to the same species as Claus', though certainly very nearly allied. Brooks mentions that some of his larvæ were without the dorsal spine on the carapace, but, if this latter gradually becomes obsolete as larval development proceeds, we should naturally expect that it would be his largest larvæ which would be without the spine. This is not so, as is apparent from the text. It is more probable that he had two species of larvæ under consideration. As already noted, a definite conclusion on this point is precluded by a want of knowledge of the size of Claus' larva, but the possibility of two closely allied species of larvæ having been confounded under the one specific denomination, *L. duvaucellii*, seems worthy of notice.

Distribution :—Bay of Bengal (Guérin); Indian Ocean (Claus); West Pacific ("Challenger"); Indian North Equatorial Current (Jurich).

Lysioerichthus α.—Plate II., figs. 30 to 34.

Localities :—

Off Kalpentyn Island, surface tow-net, all night. One, 8 millims.

Cheval Paar, surface tow-net. One, 8 millims.

Off Mutwal Island, surface tow-net. One, 7 millims.

This species is very closely allied to *L. ophthalmicus*, Hansen, from which it chiefly differs in having a pair of spines on the postero-median border of the sixth abdominal segment.

Carapace (fig. 30) rather small and compact ; rostrum short, about one-half of the total length of the carapace, no ventral teeth ; antero-lateral spines very small indeed ; postero-lateral spines rather short, not reaching to the posterior end of the first abdominal segment, without secondary spinules ; postero-median dorsal spine and lateral spinules of any kind absent.

Abdomen with all the segments developed, and having their postero-lateral corners acutely angulated ; pleopods all well developed, but no rudiments of gills present ; sixth abdominal segment with a pair of median dorsal spines on its posterior border.

Telson about as long as broad, six marginal spines present ; margin between the submedian spines almost straight, without trace of median cleft, and bearing twenty-four submedian denticles ; one intermediate denticle present between the submedian and intermediate spines of each side ; no lateral denticles.

Uropods (fig. 31) fairly well developed, extending as far as the level of the lateral spines of the telson ; traces of four spines on the external margin of the outer branch ; outer spine of the basal prolongation very much longer than the inner one.

Second to fourth thoracic appendages (figs. 32 to 34) agree in essential details with those figured by Hansen for *L. ophthalmicus*.

Last three thoracic appendages, though still very imperfectly developed, are, however, already biramous.

Length 8 millims.

The specimen, 7 millims. long, agrees well with the above description, but is generally less developed, having only three spines on the outer uropods, and the last three thoracic appendages are mere buds. It has also only twenty-two submedian denticles on the telson.

Among all described *Lysioerichthii* the present species comes nearest to *L. ophthalmicus*, Hansen (1895), from which it differs (1) in having a pair of submedian spines on the posterior border of the sixth abdominal segment, and (2) in the relatively smaller size of the inner spine of the basal prolongation of the uropods.

Lysioerichthus β.—Plate III., figs. 35 to 40.

Localities :—Muttuvaratu Paar, surface tow-net. Two hundred and seventy-five specimens, from 2 millims. to 6 millims. in length.

South end of Cheval Paar, surface tow-net. One specimen. 5 millims.

East Cheval Paar, surface tow-net. Two specimens. 5·5 millims. and 7 millims.

South end of Mutwal Island, surface tow-net. Seven specimens, 6·5 millims. to 8·5 millims.

North end of Chilaw Paar, surface tow-net. Three specimens, 4 millims.

Description of largest specimen:—

The length of the largest specimen of this larva was 8·5 millims. from the eye to the telson, or 11 millims. from the tip of the rostrum to the telson.

Carapace with the rostrum very long and acute, its length measured from the antero-lateral spine to its tip greater than the length from the antero-lateral spines to the posterior border of the carapace; six small spinules on the ventral edge of the rostrum; antero-lateral spines quite small; postero-lateral spines long, extending half-way along the telson, with a prominent spine at its base projecting ventrally; postero-median dorsal spine quite short; dimensions of carapace, length from antero-laterals to the posterior border, 3·5 millims.; antero-laterals to tip of rostrum, 4 millims.; postero-lateral spines, 3 millims.

Abdomen, with all the segments and their appendages developed; first segment hidden by the carapace; postero-lateral angles of all the segments rounded; sixth segment without a pair of median dorsal spines; appendages all well developed, and setose, with the gills just appearing.

Telson (fig. 41) about one-third as broad again as long; six marginal spines well developed; the margin between the submedians with two very prominent spines dividing this part of the margin of the telson into three parts, each part deeply emarginate, the central part slightly smaller than the lateral portions and each portion bearing seven spinules with very minute comb-like spinules in between; two intermediate and one lateral spinule present on each side.

Uropods short, only as yet reaching to the lateral spines of the telson; outer edge of external branch with two spines; ventral prolongation of the uropods with the two spines subequal in length.

Raptorial claw (fig. 40) still without any signs of teeth below the integument; last three thoracic appendages present and biramous, but very small.

The large number of larvæ of this type present in the collection has enabled me to trace, in a fairly complete manner, its life-history from the earliest stage, the *Erichthoidina*, to the stage described above. The most important and interesting changes are undergone by the carapace, and a study of these changes has led me to differ from Brooks in one or two points. A very brief description of larvæ at various stages may first, with convenience, be given.

Larva 2 millims. (tip of rostrum to telson). This is the smallest larva of the series, and represents the *Erichthoidina* stage. The carapace is without any trace of antero-laterals and there is no spine at the base of the postero-laterals. The rostrum is quite short and without ventral spinules. The postero-laterals are also very short (fig. 35). A larva of 3 millims. is in substantial agreement with the one at 2 millims. except that the rostrum is relatively a little longer.

Larva 4 millims. This stage (fig. 36) is distinguished by the appearance of a small spine at the base of the postero-lateral spines of the carapace. The rostrum is relatively longer than in the 3-millims. stage, and now bears a single ventral spinule. A single thoracic segment is exposed posterior to the carapace.

Larva 5 millims. This larva agrees very well with the one at 4 millims., but the rostrum is a little longer and bears two ventral teeth (fig. 37). Two thoracic segments are now exposed behind the carapace.

Larva 6 millims.—At this stage the antero-lateral spines of the carapace make their first appearance. The rostrum continues to increase proportionally in size and now bears four ventral spinules. The postero-lateral spines are likewise relatively longer and the uropods are just discernible as buds.

Larva 7 millims.—The carapace (fig. 38) is now fully formed with antero-laterals, postero-laterals, and the spine at the base of the latter, all well developed. The rostrum is as long as the remainder of the carapace from the antero-laterals to the postero-median dorsal spine, and bears fine ventral spinules. The uropods show one spine on the outer edge of the external ramus.

Later stages only differ from the 7-millim. larva in the continued relative increase in length of the rostrum and postero-lateral spines, to the proportions shown in the larva 9 millims. (fig. 39), which agrees with the still larger larva, 11 millims. long, described above.

During development the telson gradually becomes broader in proportion to its length (see figs. 36, 39 and 41), but the number of spines varies very little from the numbers given in the description of the large larva above.

A comparison of the figures here given to illustrate this *Lysioerichthus* larva with figs. 1, 2A, 2B, 4 and 5 of CLAUS' memoir (1871) will show that the species dealt with here is very closely allied to, if not identical with, the one CLAUS had under observation, and that the three supposed species of *Erichthoidina* described by the latter author under the names *E. gracilis*, *E. armata* and *E. brevispinosa* in all probability represent developmental stages in the life-history of one species only, the development of which, as gleaned from CLAUS' figures, follows very closely the lines indicated in the Ceylon larvæ. The latter are also in all probability identical with the *Erichthoidina* figured by BROOKS in his "Challenger" Monograph, plate xii., figs. 1 and 2. BROOKS has expressed the opinion that CLAUS' *E. brevispinosa* is a young stage of *Gonodactylus*, and bases his view on the presence in the latter of a spine at the base of the postero-lateral spine of the carapace which he regards as characteristic of *Gonerichthii*. The Ceylon series clearly shows that this spine, though not present in the earliest *Erichthoidina*, is a later development, and thus its presence cannot be regarded as diagnostic of *Gonerichthii*, but may be present in some *Lysioerichthii* as well (see also HANSEN, 1895, plate vii., figs. 4A and 5A, where such a spine is represented on the carapace of two species of *Lysioerichthii*). For this reason I venture to differ from BROOKS, in regarding CLAUS' *Erichthoidina brevispinosa* as a *Lysioerichthus* rather than as a *Gonerichthus*.

BELONGING TO THE GENUS **Pseudosquilla** (GUÉRIN) DANA.

Pseuderichthus communis, HANSEN (1895).

Locality :—South end of the Red Sea, surface tow-net. One specimen, 15 millims.

HERDMAN'S example is smaller than either CLAUS', HANSEN'S or JURICH'S larvæ, but agrees well with all three in its chief points. At this stage, however, only three spines are to be noted on the outer uropod. The tooth on the ventral edge of the rostrum just in front of the eye is very prominent.

Distribution :—General throughout the tropical Atlantic and Indian Oceans (CLAUS, HANSEN and JURICH).

BELONGING TO THE GENUS **Gonodactylus**, LATREILLE.

Gonerichthus *α*.—Plate III., fig. 42.

Locality :—Cheval Paar, surface tow-net. One specimen, 11 millims. long from eye to telson.

Carapace (fig. 42) with rostrum fairly long, equal in length to the rest of the carapace from the eye to posterior dorsal spine; about eight small denticles on the ventral edge of the rostrum; antero-lateral spines short; postero-lateral spines long, extending to the junction of the third and fourth segments of the abdomen; a small postero-ventral spine at the base of the postero-laterals; postero-median dorsal spine very small.

Abdomen with all the segments developed, and having their postero-lateral corners acutely angulated; sixth segment with a pair of small median dorsal spines on its posterior border; appendages all well developed, biramous and setose; gills well developed and already digitate.

Telson about as long as broad, six marginal spines well developed and somewhat acute; margin between the submedian spines somewhat deeply emarginate and distinctly notched, bearing thirty submedian denticles; two intermediate and a single lateral denticle present on each side.

Uropods very well developed and almost as long as the telson; external margin of the outer branch with only two distinct spines; inner spine of the basal prolongation much longer than the outer, which is quite small.

Raptorial claw without any signs of spines on the dactylus; last three thoracic appendages well developed and biramous.

Length 11 millims. from the eye to the telson.

This larva is distinguished among *Gonerichthii* by the somewhat unusual character of having the inner spine of the basal prolongation of the uropod much longer than the outer. In no *Gonerichthus* yet described is such a character found. In other respects the larva is a perfectly typical *Gonerichthus*, especially in the characters of the third and fourth thoracic limbs, which have not the swollen propodus characteristic of *Lysioerichthii*. The larva is very far advanced in development, but the raptorial claw shows no signs of spines on the dactylus. It must be concluded therefore that the larva belongs to the genus *Gonodactylus*.

Gonerichthus β.—Plate III, figs. 43 to 45.

Locality :—Off Kalpentyn Island, surface tow-net, all night. Forty-two specimens, from 4 to 7 millims. in length from eye to telson.

Carapace (figs. 44 and 45) with rostrum very long, the length from the antero-lateral spines to the tip of the rostrum exceeding the length from the antero-laterals to the posterior median dorsal spine ; eight small teeth on the ventral edge of the rostrum ; antero-lateral spines very small ; postero-lateral spines very long, extending to the junction of the sixth abdominal segment with the telson, a small spine at its base projecting ventrally ; postero-median dorsal spine very short.

Abdomen with all the segments well developed, and having their postero-lateral angles slightly angulated ; sixth segment with a pair of median dorsal spines on its posterior border ; abdominal appendages very well developed, with digitate gills already present.

Telson rather longer than broad ; six marginal spines present ; margin between the submedian spines emarginate, with a slight notch in the centre, and bearing twenty-four submedian denticles ; two intermediate denticles present on each side, but no lateral denticle could be discerned.

Uropods well developed, extending to the level of the intermediate spines of the telson ; traces of ten spines on the external margin of the outer branch ; outer spine of the basal prolongation extending nearly to the level of the submedian spines of the telson, much longer than the inner spine.

Raptorial claw without traces of spines on the dactylus ; third and fourth thoracic appendages of the usual *Gonerichthus* type, and not exhibiting the swollen propodus of the *Lysioerichthus* ; last three thoracic appendages fairly well advanced and already biramous.

Length 7 millims. from the eye to the tip of the telson.

The smaller larvæ referable to this type differ chiefly in the proportional length of the rostrum and postero-lateral spines, both of which increase in comparative length as the larva advances (see fig. 43).

This type evidently belongs to quite a small species of adult. At 7 millims. length it is as far advanced as type α at 11 millims., and is evidently not far from maturity. It is one of the most abundant *Erichthus* larvæ in the collection.

Gonerichthus γ.—Plate III., figs. 46 to 47.

Localities:

Off Kalpentyn Island, surface tow-nets all night. Twelve specimens, from 4 to 7 millims. in length from the eye to the telson.

Cheval Paar, surface tow-net. Three specimens, 5 to 6 millims. long.

This *Gonerichthus* is very closely allied indeed to the last, and the description there given will answer for this species, save in the following particulars:—

Rostrum (figs. 46 and 47) comparatively much shorter, the length from the antero-lateral spine to its tip being much shorter than the length from the antero-laterals to the postero-median dorsal spine; only three or four teeth on its ventral edge.

Antero-lateral spines of the carapace, though still small, are more developed than in type β.

Postero-lateral spines relatively much shorter, and only extend about half way down the second abdominal segment.

Telson, while agreeing in general shape and armature, is comparatively a little broader.

The above comparison between the types β and γ is drawn up from specimens of the same size, 7 millims., and at the same stage of development. Figs. 46 and 47 show the carapace of the type γ in dorsal and lateral view respectively, and the differences between types β and γ are readily seen in comparison with figs. 44 and 45, in which the carapace of type β is shown. Type β at 4 millims. has a carapace of about the same proportions as type γ at 7 millims. (see fig. 43). It seems clear from this that the larvæ β and γ are distinct and belong to separate though closely allied adults.

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EXPLANATION OF THE PLATES.

PLATE I.

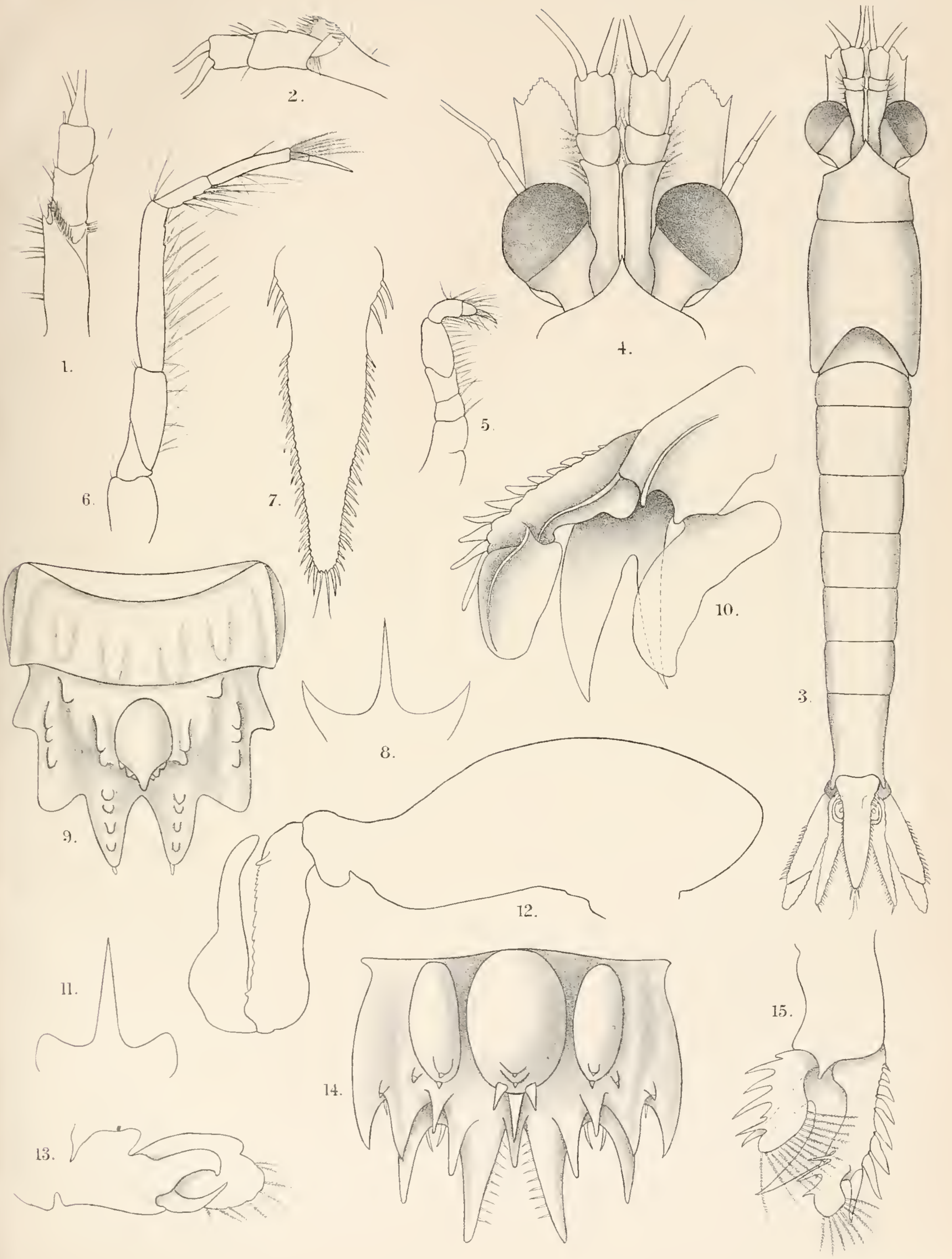
Fig. 1. *Euphausia latifrons*, G. O. SARS, left antennular peduncle, from above.
„ 2. „ „ „ „ „ the inside.
„ 3. *Siriella paulsoni*, KOSSMANN, female, from above.
„ 4. „ „ anterior end, enlarged.
„ 5. „ „ endopodite of first thoracic limb.
„ 6. „ „ „ „ third thoracic limb.
„ 7. „ „ telson.
„ 8. *Gonodactylus herdmani*, n. sp., rostrum.
„ 9. „ „ sixth abdominal segment and telson, dorsal view.
„ 10. „ „ left uropod, dorsal view.
„ 11. *Gonodactylus acanthurus*, n. sp., rostrum.
„ 12. „ „ raptorial claw.
„ 13. „ „ endopodite of first abdominal appendage of the male.
„ 14. „ „ telson.
„ 15. „ „ right uropod, dorsal view.

PLATE II.

Fig. 16. *Odontodactylus brevirostris* (MIERS), rostrum, actual outline.
„ 17. „ „ „ as it appears *in situ*.
„ 18. „ „ dactylus of raptorial claw.
„ 19. *Protosquilla spinosissima* (PFEFFER), endopodite of first abdominal appendage of the male.
„ 20. *Alima* α, dorsal view of specimen 4·5 millims.
„ 21. „ telson of same specimen, enlarged.
„ 22. „ „ specimen 7 millims.
„ 23. „ „ „ 27 „
„ 24. „ left uropod of same specimen.
„ 25. „ raptorial claw of same specimen.
„ 26. *Alimerichthus unidens*, LANCHESTER, raptorial claw.
„ 27. *Alimerichthus* α, dorsal view of specimen 9 millims.
„ 28. „ side view of carapace of same specimen.
„ 29. „ raptorial claw.
„ 30. *Lysioerichthus* α, dorsal view of specimen 8 millims.
„ 31. „ right uropod of same specimen.
„ 32. „ second thoracic limb of same.
„ 33. „ third thoracic limb of same.
„ 34. „ fourth thoracic limb of same.

PLATE III.

Fig. 35. *Lysioerichthus* β, lateral view of carapace of specimen 2 millims.
,, 36. ,, dorsal view of specimen 4 millims.
,, 37. ,, lateral view of carapace of specimen 5 millims.
,, 38. ,, ,, ,, ,, 7 ,,
,, 39. ,, dorsal view of specimen 9 millims.
,, 40. ,, raptorial claw of same.
,, 41. ,, telson of specimen 11 millims.
,, 42. *Gonerichthus* α, dorsal view of specimen 11 millims.
,, 43. *Gonerichthus* β, lateral view of carapace of specimen 4 millims.
,, 44. ,, dorsal view of specimen 7 millims.
,, 45. ,, lateral view of carapace of same.
,, 46. *Gonerichthus* γ, dorsal view of carapace of specimen 7 millims.
,, 47. ,, lateral view of same.



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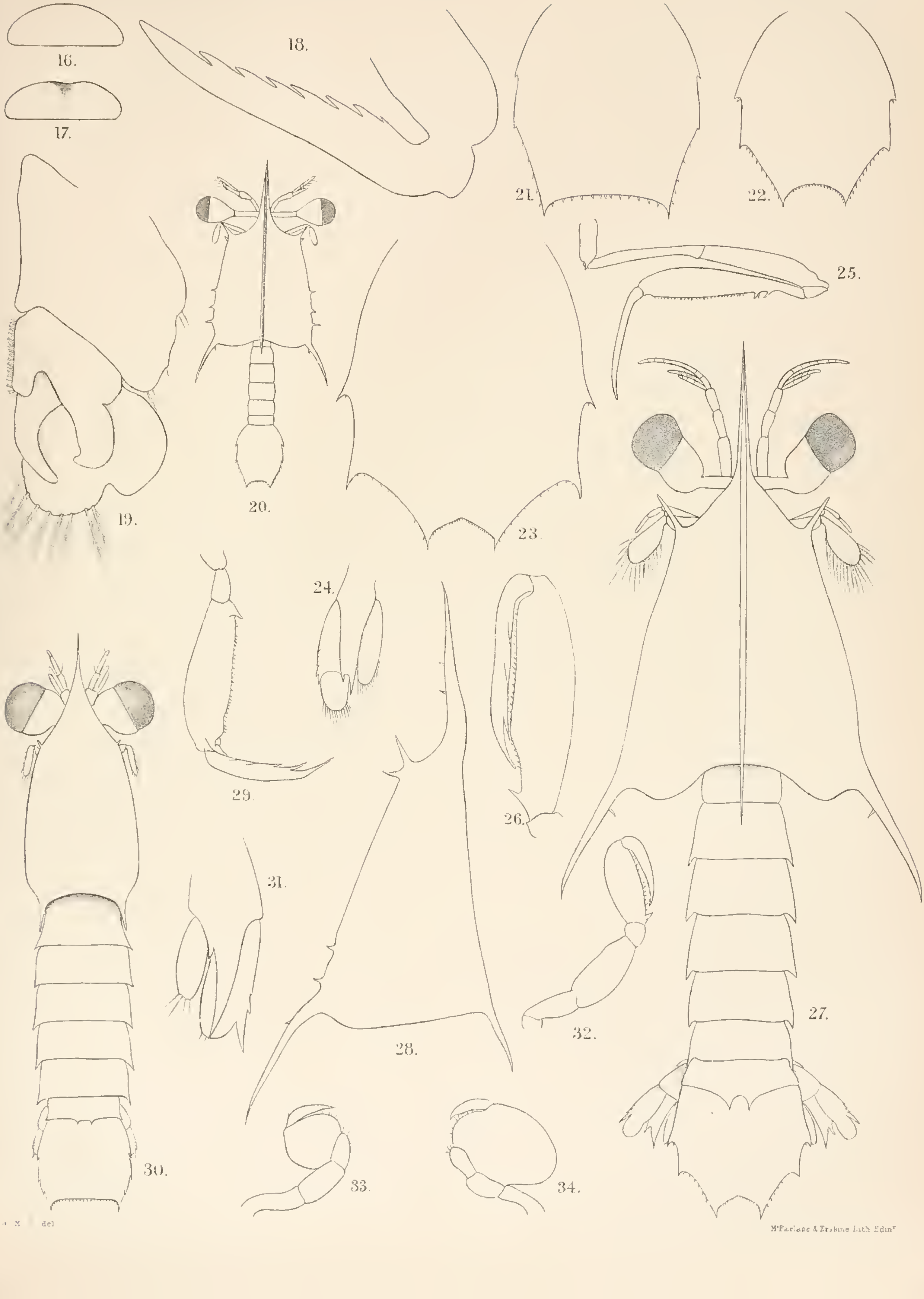

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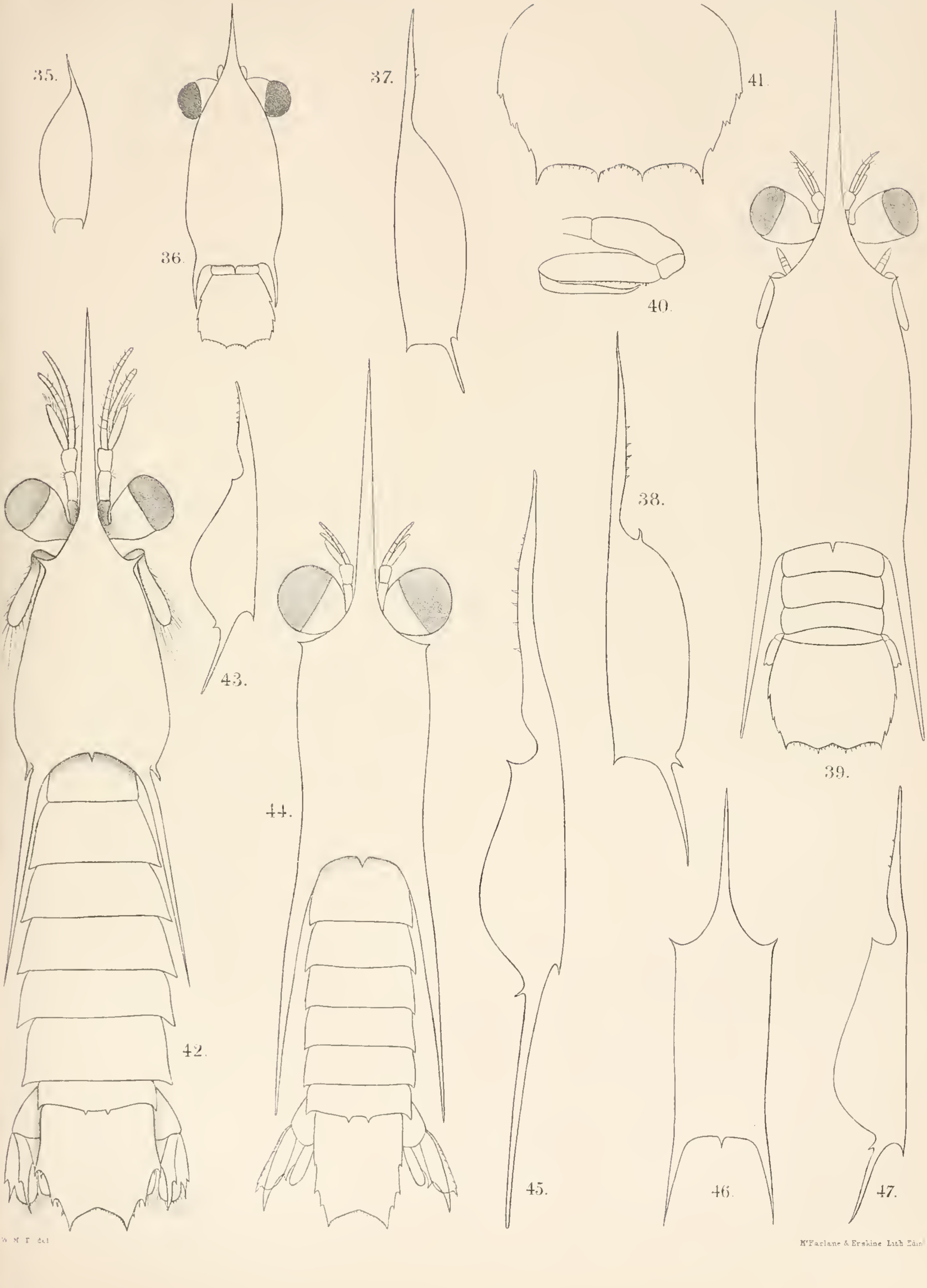

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REPORT

ON SOME

PARASITIC COPEPODA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH FIVE PLATES.]

OF this small collection of Parasitic Copepods* obtained by Professor HERDMAN and Mr. HORNELL at Ceylon it can be said with even greater emphasis than was declared by Rev. T. R. R. STEBBING of the Isopods from the same locality: "The interest of the present collection is not to be measured by the number of species, or the number of specimens, still less by the size of the animals."†

There were only five vials of the Parasitic Copepods, and yet from these were obtained four new species, two of which were the types of new genera. There were also two other species which had been previously described, but both of which were founded on a single sex and on a very limited number of specimens. Neither of these had been seen since originally described forty years ago. Of one of them the male sex is here added for the first time, while of the other many supplementary details of structure are given.

There was thus not a single species in the small collection which did not present something new and interesting—a truly remarkable record.

* The main report on the large collection of free and a few parasitic Copepoda, by the late Mr. I. C. THOMPSON and Mr. ANDREW SCOTT, will be found in Part I. of this work (1903) at p. 227.

† Part IV. of this Report, Supplementary Report XXIII., "On the Isopoda," 1905.

DESCRIPTION OF THE SPECIES.

Family: CALIGIDÆ.

Sub-family: CALIGINÆ.

Lepeophtheirus brachyurus, Heller—Plate I., figs. 1 to 10.

This species was briefly described by Heller in the 'Reise der Novara,' 1865, and has not been seen by any other investigator since. Heller's specimens were obtained near Java upon the gills of the same host as the present Ceylon specimens.

The following description, and the figures given on Plate I., supplement as well as corroborate Heller's original diagnosis :—

Female.—Carapace ovate, considerably narrowed and rounded anteriorly, widened and emarginate posteriorly. The length of the carapace is more than twice that of the rest of the body, but is a little less than its width. The grooves on the dorsal surface are distinct, with the cross-bar of the H about in the centre of the carapace, while the anterior and posterior halves of the lateral grooves are inclined like the sides of an hour-glass. The frontal plates are narrow, scarcely more than one-third the width of the carapace, with a deep but narrow central incision. The eyes are moderately large and placed far forward, about one-fifth the length of the carapace from its anterior margin. The thoracic area is large and wedge-shaped, three-quarters of the width of the carapace and slightly concave at its posterior margin, less than half the width and slightly convex at the anterior margin.

The fourth or free thorax segment is very short and concealed in dorsal view by the overlapping carapace. The genital segment is transversely elliptical, one-third wider than long, with evenly rounded sides and a nearly straight posterior margin. The fifth legs are visible at the posterior corners.

The abdomen is short and narrow, one-fourth the length and one-fifth the width of the genital segment, one-jointed, with the posterior margin wedge-shaped. The anal laminæ are minute, fastened to the sides of the wedge, and each armed with three plumose setæ and a small spine.

The egg-cases are about the same length as the entire body and as wide as the abdomen. The eggs are of medium thickness, about 70 in each string.

Of the appendages, the first antennæ are short and unusually wide, a considerable portion of the basal joint being concealed beneath the edge of the carapace. The terminal joint is only about half the length of the basal and carries a tuft of spines at its tip. The second antennæ are stout and of the usual form, with a long terminal claw bent abruptly near the tip (fig. 2).

The first maxillæ are very small and rudimentary ; the basal portion is swollen and circular, while the terminal part is slender and curved. The second maxillæ are short and simple, broadly triangular, with a narrow, pointed, and more or less curved tip. The rudimentary exopod appears as a large papilla upon the basal portion of the appendage, which is fused with the ventral surface of the carapace. These appendages are quite small, less than half the length of the mouth-tube, and are attached at some little distance to the right and left of the base of the latter. The mouth-tube itself is short and wide, somewhat triangular, with a broadly rounded tip; the mouth opening is terminal with a scanty fringe of hair (fig. 3).

First maxillipeds of the usual pattern; second pair enlarged and stout, the terminal claw strongly curved and less than half the length of the basal joint, with an accessory spine on its ventral surface near the base. Basal joint much swollen and furnished at the centre of its anterior margin with a large and stout process projecting diagonally outwards. The under surface of this process is grooved, and into this groove fits the tip of the terminal claw (fig. 4).

The furca is slender, the basal portion longer and wider than the terminal and with a large elliptical lumen, the branches slender and divergent with rounded points.

The swimming legs are of the usual pattern, but the basal joint of the second pair is very narrow. The basal apron of the third legs is also short and narrow, but it is attached so far back and the free segment is so short that it overlaps a little the genital segment. Another feature not noted by HELLER is the fact that the dorsal surface of the apron of these third legs projects backward between their rami as a rounded knob, as long as the rami themselves. These latter are small, well separated, and each is two-jointed (figs. 6 to 9).

The fourth legs are small and rudimentary, and are entirely concealed beneath the apron of the third legs, another fact not noted by HELLER. They contain only two joints of about the same length, the terminal one carrying three spines, of which the inner one is twice as long as the others.

The ovaries are rather small and triangular and are situated just behind the eyes at some distance from each other. The oviduct is coiled very regularly in the sides of the genital segment, as can be seen in fig. 10. The cement glands are comparatively wide and reach forward nearly to the anterior margin of the segment. Their anterior half is curved in toward the mid-line and is occupied by about eighteen large cells, the last two or three of which at either end diminish abruptly in size. The posterior half is even a little wider than the anterior and is filled with a homogeneous mass, in which there is no distinction of cells or ducts. The semen receptacle is bent in a half circle, the convex side forward, and is about the same diameter throughout. The vulvæ open near together on either side of the median line.

The colour of the preserved specimens is a uniform light yellowish gray, without pigment spots or lines.

Total length 4·5 millims., length of carapace 3 millims., width of same 3·35 millims., length of genital segment 1 millim., length of abdomen 0·5 millim., length of egg-sacs 4·4 millims.

There were two specimens of this species, both females, obtained from the gills of a puffer, *Tetrodon stellatus*. They may be easily distinguished from other species of the genus by the relatively large size of the carapace compared with the rest of the body, by the correspondingly diminutive size of the fourth segment and the abdomen, and by the rudimentary fourth legs, which are entirely concealed in both dorsal and ventral view. The large rounded spine which projects between the rami of the third legs is also peculiar to this species.

Lepeophtheirus æsopus,* n. sp.—Plate I., figs. 11 to 19.

Female.—Carapace ovate, considerably narrowed anteriorly, and a little more than two-fifths the entire length. Frontal plates prominent, but less than half the width of the carapace. Eyes large and placed well forward. Thoracic area exceptionally small, one-third the length and three-fifths the width of the carapace, its anterior and lateral margins forming nearly a perfect half circle, its posterior margin slightly re-entrant. Lateral lobes broad, blunt and short, leaving a wide sinus between the carapace and the genital segment, which is entirely filled by the large basal joints of the third and fourth pairs of swimming legs.

The fourth or free thoracic segment is transversely elliptical and widened considerably through the bases of the fourth legs. The genital segment is quadrate, two-thirds the size of the carapace, and a little wider anteriorly than posteriorly, with evenly rounded corners.

The abdomen is narrow, only one-sixth the width of the genital segment and less than half its length. It is indistinctly three-jointed, the middle joint larger than the other two, which are about the same size. The groove separating the terminal joints is distinct and can be traced the entire width of the abdomen, but the basal groove can be seen only at the margins, and it is not certain that the abdomen is really jointed there. The anal laminæ are narrow, three times as long as wide and pointed at the tips where each is armed with four small setæ. The egg-strings are wider than the abdomen and three-quarters of the entire length; the eggs are large, 50 or 60 in each string.

Of the appendages, the second antennæ have a large basal joint and a very slender terminal claw, which is bent sharply at right angles near its tip. The basal joint is re-enforced by a stout spine, pointing backward (fig. 12).

The first maxillæ are small and well curved, the basal half fused to the ventral surface of the carapace and only the tip free. As an offset to this, the second pair are exceptionally large and stout, with a broad, triangular base and a long, straight, and pointed tip which reaches far beyond the end of the mouth-tube. Each maxilla

* *Æsopus*, different footed, each pair of legs differing considerably from the ordinary type in this genus.

is two-jointed and is actually longer and wider than the mouth-tube. Upon the basal joint, which is fused to the carapace, appears the rudimentary exopod in the form of a small papilla bearing two setæ. It is situated near the centre of the basal joint and close to the endopod. The endopod itself is simple as in the genus *Caligus*, and not bifurcate as in many species of *Lepeophtheirus* (fig. 13).

The first maxillipeds are of the usual pattern, but the outer terminal claw is lengthened so that the two cross each other from opposite sides of the body when the appendages are at rest. The second maxillipeds are small and weak, the terminal claw only half the length of the basal joint, and slender (fig. 14). No trace of any furca could be found.

The first swimming legs are small and weak; the three terminal claws are of nearly the same length, as is also the seta at the inner corner. The basal joint of the second legs is exceptionally narrow, being but little wider than the connecting piece across the centre of the body; the rami are of the usual pattern. The rami of the third legs are so close together as to be in actual contact at their bases, but the exopod stands out at right angles to the basal apron, while the endopod is closely appressed to the margin of the latter. The exopod is three-jointed, the joints of about the same size; this gives it considerable length, which, together with its position, makes it unusually prominent. The basal joint also bears on its inner margin a wide circular lamina, which extends outward to the tip of the terminal joint and inward to overlap the endopod; this latter is of the usual form (figs. 15 to 18).

The fourth legs are also exceptional in having a stout and swollen basal joint and three small and weak terminal joints. The second joint also, instead of being cut off diagonally at the distal end as in other species, is cut squarely across.

The second and third joints each carry a single spine at the outer distal corner, while the last joint is terminated by a row of three spines; the five are approximately of the same size.

No fifth legs are visible, but the genital segment bears upon its margin at each posterior corner three small spines which probably represent the rudiments of these legs.

The oviducts are not much coiled in the genital segment; the cement glands are narrow and nearly straight, situated on either side of the mid-line and close to it. In the specimen observed the spermatophores were long and narrow, and turned forward along the ventral surface of the genital segment. Each was curved away from its fellow like a pair of parentheses marks; the anterior ends almost touched each other, but the posterior ends, entering the vulvæ, were about the diameter of the abdomen apart (fig. 19).

Colour of the preserved specimen a uniform yellowish white, without pigment spots or lines.

Total length 5·75 millims., length of carapace 2·4 millims., width of same

2·4 millims., length of genital segment 1·95 millims., length of abdomen 0·92 millim., length of egg-sacs 4·2 millims.

SUB-FAMILY: TREBINÆ.

Trebius exilis,* n. sp.—Plate II., figs. 20 to 33.

Female.—Carapace ovate, one-seventh longer than wide, contracted anteriorly, and well arched. Transverse grooves separating the cephalic and thoracic portions of the lateral areas situated far forward, leaving the thoracic portion much the longer of the two. Eyes small, purplish red, and some little distance from the anterior margin. Frontal plates better developed than either *T. caudatus* or *T. tenuifurcatus*, but still less than half the width of the carapace.

Third thorax segment only a trifle wider than the fourth and considerably shorter. It projects backward, however, nearly its whole length beyond the lateral lobes of the carapace, just as the thoracic area does in some of the Caliginæ (*Caligus rapax*, *C. rufimaculatus*, &c.). Fourth segment considerably longer than the third, and widened through the bases of the fourth legs more than in either of the other two species, giving it a spindle shape.

Genital segment almost a perfect ellipse, the only deviation being anteriorly, where it is contracted into a short and narrow neck before joining the fourth segment. It is more than three-fifths the size of the carapace and shows no spines or processes at the posterior corners. The egg-strings are about the same width as the abdomen, but are from two and a half to three times its length, thus contrasting sharply with those of *T. caudatus* which are but a trifle longer than the abdomen. The eggs are of medium thickness, 40 to 50 in each string.

The abdomen, even including the anal laminæ, is one-half shorter than the genital segment instead of one-half longer as in *T. caudatus*. It is also made up of a single joint and is of the same diameter throughout. The anal laminæ are elongate, more than twice as long as wide, well separated at the base, but convergent toward the tips, where each carries four good-sized plumose setæ. As in *T. caudatus*, the outer seta is the shortest, the inner one next in length, while the two middle ones are considerably longer.

Of the appendages the first antennæ are relatively much longer than in *T. caudatus*, the basal joint is stouter and more heavily armed with plumose setæ, while the terminal joint is slender, not enlarged at the tip, and stands out prominently. The second antennæ are large and stout; the terminal claw is wider at the base than in *T. caudatus* and is relatively as long. But the abrupt bend is at the centre instead of near the tip, and this makes the claw appear shorter. There is also a long and slender hair on the inner margin of the claw near its base (fig. 22).

* *Exilis*, slender, beautiful.

The first maxillæ are straight, small, and weak, and they are fused to the ventral surface of the carapace throughout their entire length, not even the tips being free.

The second maxillæ are also very different from those of *T. caudatus.* They are two-jointed, the basal joint being fused to the ventral surface of the carapace, and carrying at its centre the rudimentary exopod. This is in the form of a good-sized papilla armed with two setæ of about the same length, and less than one-third the length of the endopod. The latter is elongate-triangular, extends for half its length beyond the tip of the mouth-tube, and is bluntly pointed at the end, without any trace of bifurcation.

The mouth-tube is not as long as in *T. caudatus,* but is jointed similarly at the centre of the upper lip, with deep lateral incisions. The bony framework shows some similarity to that of both *Lepeophtheirus hippoglossi* and *Caligus rapax.* There are in it two sets of rods hinged together at the centre just above the joint (fig. 23). In the basal half the rods are four in number arranged in the form of the letter M. The two outside ones (*a*) start from just behind the bases of the mandibles and run diagonally forward and inward until they nearly meet at the mid-line. These must be regarded as belonging to the framework of the lower lip, although they are buried in the tissues of the ventral surface of the carapace. From their inner ends two other rods (*b*) start and run parallel with each other on either side of the mid-line outward nearly to the jointing at the centre of the mouth-tube. These evidently belong to the framework of the upper lip. From the outer ends of the first pair, just behind the bases of the mandibles, a stout rod (*c*) runs along either side of the under lip, the two curving around and meeting on the mid-line at the tip of the lip. Near the joint in the mouth-tube each of these rods divides and sends a branch rod up to the upper lip, the branch ending in the lateral incision on either side. Articulating with the end of the branch at this incision is a long bone (*d*), shaped like the human femur, which sweeps inwards and forwards until it meets its fellow from the opposite side near the centre of the tip of the upper lip.

The upper lip is thus jointed near its centre, while the lower lip articulates directly with the ventral surface of the carapace. As the mouth-tube naturally points backward the upper lip is longer than the lower lip, and this jointing at its centre greatly facilitates the freedom of motion. The mouth-opening is a terminal transverse slit, heavily fringed with hairs. The mandibles are slightly curved towards their tips, where they are toothed on the inner margin. They pass out through the sides of the mouth-tube at the lateral incisions and articulate with the ventral surface of the carapace just in front of the bony framework.

The first maxillipeds are comparatively large and stout as in *T. caudatus,* but the basal joint is not as much enlarged, being a trifle smaller than that of the second pair. The two terminal claws are about the same diameter, but the inner one is almost twice the length of the outer. The second maxillipeds are much reduced in size as compared with those in the Caliginæ; the basal joint is stouter than in

T. caudatus, but the terminal claw is as short and weak as in the latter species. No spine could be seen on its inner margin in any of the specimens examined (fig. 25).

The furca is small, the length four times the width, the branches short, simple, divergent, and pointed, leaving a V-shaped sinus, only one-fourth or one-fifth the entire length.

The first swimming legs have a broad and well-rounded basal joint, carrying a small seta on its posterior margin. Both rami are two-jointed, the exopod nearly twice the length of the endopod. The basal joint of the exopod is considerably wider than the terminal, and somewhat swollen; the terminal joint is only half the length of the basal, is not bent at a right angle as in *T. caudatus*, and is armed with three short and stout spines on its distal end, and three plumose setæ, as long as the entire ramus, on its posterior margin. The basal joint of the endopod is also twice the length of the terminal, and somewhat swollen; the terminal joint is bent at a right angle and tipped with three stout plumose setæ.

Second swimming legs similar to those of *Lepeophtheirus* in the shape and arrangement of the joints and in the number and distribution of the spines and setæ.

The third swimming legs are like the second, but differ in a few particulars. The exopod carries three spines on the outer margin of the terminal joint; the basal and second joints of the endopod are much enlarged, while the terminal joint is reduced in size and carries only four plumose setæ.

The fourth swimming legs are very different from those of *T. caudatus*. The basal joint is larger than that of the second legs, and almost circular. The exopod is three-jointed and more than twice the length of the endopod; the three joints are about the same length, the two basal ones with a stout spine at the outer distal corner, and a single plumose seta on the inner margin. The terminal joint has three spines on its outer margin, the last one more than twice the length of the other two, and four spines on the inner margin. The endopod has only two joints of about the same size, the basal one carrying a single plumose seta on its inner margin, the terminal one tipped with three such setæ.

The fifth legs are small and close to the lateral margin on the ventral surface of the genital segment, a little in front of the posterior corners.

The cement glands are comparatively wide and reach forward almost to the anterior end of the segment; their component cells are narrow and fill the entire lumen of the glands. The sperm receptacle is a nearly straight tube of uniform width, reaching across from one oviduct to the other. The spermatophores are elongate-ellipsoidal, and are fastened close together on either side of the mid-line, their long diameters parallel with the body axis (fig. 31).

Total length 5·75 millims., length of carapace (including third thorax joint) 2·5 millims., width of same 2·1 millims., length of genital segment 1·57 millims., length of abdomen 1·1 millims., length of egg-strings 3·1 millims.

Colour of preserved material a uniform yellowish white without pigment spots or lines.

Male.—Carapace ovate and narrowed anteriorly, with grooves and markings on the dorsal surface like those of the female, but it is relatively larger, being more than half the entire length, and nearly as wide as long. The eyes are distinct and small, about one-third the distance from the anterior margin.

The second and third thorax segments are wider than in the female; the fourth segment is the same width as the genital segment and only a trifle longer than the second and third segments. The genital segment is elliptical-oblong, one-fourth longer than wide, and not quite one-fifth of the entire length. Both the fifth and the sixth legs are visible dorsally, the former on the lateral margins at about the centre of the segment, the latter at the posterior corners.

The abdomen is two-jointed and at least one-half shorter than the genital segment; the two joints are equal in size. The anal laminæ are narrow, but nearly as long as the entire abdomen, each tipped with four very long plumose setæ.

Appendages and colour as in the female.

Total length 2·75 millims., length of carapace (including third thorax segment) 1·4 millims., width of same 1·3 millims., length of genital segment 0·5 millim., length of abdomen (including anal laminæ) 0·6 millim.

Developmental stages.—Young females were obtained in two stages of development respectively 2·5 millims. and 3·5 millims. long.

In the former, the second thorax segment is not yet fused with the carapace, but is semilunar in shape, with the convex side projecting a little way into the posterior portion of the carapace. The lateral processes on this segment are nearly as large as the posterior lobes of the carapace (fig. 32).

The third segment is much narrower than the second, but is still wider than it is long. The fourth segment is considerably longer than wide and has a broad spindle shape. In the genital segment each of the posterior angles projects strongly sidewise, is well rounded, and armed with two stout spines. This makes the segment twice as wide across the posterior margin as across the anterior. The abdomen is also slightly wider at its posterior end.

The first antennæ are short and thick and are appressed closely to the margin of the carapace. The other appendages are similar to those of the adult except the swimming legs, in which the rami have but two joints instead of three.

In the later developmental stage the carapace has enlarged considerably, and the second thorax segment has widened with it (fig. 33). The longitudinal and transverse grooves on the dorsal surface of the carapace are now fully formed, so that the same areas are seen as in the adult. The third and fourth thorax segments are about the same as in the previous stage, but the genital segment has changed radically. It has widened into a broad acorn shape, as wide anteriorly as posteriorly, with the posterior corners projecting slightly backwards and showing the fifth legs plainly at their tips. The abdomen has elongated and its sides are now parallel.

The appendages have assumed their final form, and the rami of the swimming legs have all become clearly three-jointed.

About ten specimens of this species were obtained from *Rhinoptera javanica*, including the two stages of early development. The species is of peculiar interest, because it is the only one besides Kröyer's original type (*T. caudatus*) of which a full description of even one sex could be obtained.

It confirms Kröyer's genus diagnosis in all but two particulars. The second maxillæ are not forked at the tip like those of *Lepeophtheirus*, but are simple and pointed like those of *Caligus*. Furthermore the endopod of the fourth legs, instead of being as large as the exopod, is reduced so much as to be rudimentary and contains only two joints. These two particulars furnished data which will at once distinguish the species from *T. caudatus*.

Sub-family: EURYPHORINÆ.

Dissonus,* n. gen.

First thorax segment fused with the head to form the carapace, which is semilunar in shape and about twice as wide as long.

Second, third, and fourth thorax segments free, each considerably wider than long, the second one only provided with lateral plates. Genital segment not much enlarged, without plates or processes, but with the entire ventral surface covered with stout spines. In the male the fifth legs are seen on the posterior lateral margins and the sixth pair at the posterior corners. Abdomen small, one-jointed in both sexes ; anal laminæ of medium size and armed with large plumose setæ.

Egg-strings four-fifths of the entire length and not quite as wide as the abdomen. Eggs large, about forty in each string.

Antennæ and mouth-parts like those in the Caliginæ. Second maxillæ longer than the mouth-tube and bifurcate at the tip. First maxillæ and furca wanting. Mouth-tube short and triangular in shape with a rounded tip, jointed transversely near the centre. The four pairs of swimming legs biramose ; rami of the first pair two-jointed, of the other pairs three-jointed ; spines and setæ almost exactly like those in *Trebius*.

Dissonus spinifer,† n. sp.—Plate III., figs. 34 to 47.

Female.—Carapace transversely semilunar, twice as wide as long ; the ventral surface around and outside of the second antennæ is raised somewhat, and beneath it

* *Dissonus*, disagreeing or different, *i.e*, not agreeing with any of the established genera.

† *Spinifer*, bearing spines (on the ventral surface of the genital segment).

can be seen the powerful muscles which move those appendages, and which radiate outward from the basal joint of the antennæ to the lateral margin of the carapace.

The dorsal surface has but a single pair of grooves, one on either side separating the lateral areas from the central cephalic area. Eyes moderately large, situated close to the anterior margin and in contact with each other on the mid-line, but not fused. In front of the eyes and on the very margin is a pair of elliptical spots, a little larger than the eyes and raised above the surrounding surface like a pair of lenses. These correspond exactly with the so-called "conspicilla" found by DANA in his *Specilligus curticaudis*, and which occur also in the males of other species belonging to the Pandarinæ. They have also been noted by KRÖYER in the male of *Trebius caudatus*, but are not found in the male of the new species of *Trebius* just described. In the present genus they are much farther forward and nearer together, being just in front of the supra-œsophageal ganglion.

The second, third, and fourth thorax segments are free and diminish regularly in size. The second segment is the same width as the body of the carapace and its lateral plates are as wide as the lateral lobes of the carapace. The third and fourth segments are considerably narrowed, but even the fourth is more than twice as wide as long, and the basal joints of the legs attached to both these segments closely resemble in dorsal view the lateral lobes of the carapace and the lateral plates on the second segment.

The genital segment is quadrangular, a little wider than long, and a little narrower than the fourth segment. The processes at the posterior corners are very small, and the fifth legs are almost invisible dorsally. The entire ventral surface of the genital segment is covered with stout scattered spines which point diagonally backward. These are thickest along the sides and must furnish a very effective preventative against slipping, as in the genus *Argulus*.

The abdomen is three-eighths the length of the genital segment, one-fourth wider than long, and one-jointed, with a shallow anal fissure. The anal laminæ are quadrangular-oblong, of medium size, each armed with four large plumose setæ. Three of these are terminal, while the other comes out of the lateral margin near the anterior end.

Of the appendages, the anterior antennæ are large and prominent, two-jointed, with the joints about the same length, but the basal one considerably thickened. Each antenna is one-fourth longer than the frontal plate from whence it comes. The setæ and spines are similar to those in the Caliginæ. The second antennæ are stout and of the same pattern as in *Caligus*. The terminal claw fits into a small pocket made for its reception in the ventral surface of the carapace near the margin (fig. 37).

The first maxillæ and furca are entirely lacking. The mandibles are slender, three-jointed, and armed with hook-like teeth along the inner margin of the slightly curved terminal joint. The mouth-tube is triangular, with a narrow and well-rounded tip; the mouth-opening is terminal and quadrilateral, with a heavy fringe of hairs.

The bony framework is peculiar in its structure, although in some particulars it shows a resemblance to *Caligus rapax* and other Caliginæ. There is in the lower lip a rod (*a*, fig. 38) along either edge, the two meeting in the centre at the distal end. The bases of these rods articulate on the ventral surface of the carapace together with the mandibles. From these articulations a short rod (*b*) extends forward and inward on either side along the ventral surface of the carapace.

From the inner ends of these rods another pair extend upward and inward along the upper lip to the lateral incision opposite the joint (*c*). From these incisions radiate four pairs of rods, three of which (*d*) are in the upper lip, while the fourth pair (*e*) extend downwards on either side to the rod that runs along the edge of the lower lip. Of the three pairs in the upper lip two extend inward side by side, one above and one below the joint, and meet on the mid-line. The lateral incisions at the joint are deeper than in any of the Caliginæ or in *Trebius*, and the mouth-tube must be very flexible.

The second maxillæ are large and powerful; although attached opposite the base of the mouth-tube they reach well beyond its tip. The basal portion of each maxilla is enlarged and flattened, and is about one-third of the entire length. The terminal portion is narrowed abruptly and then tapers gradually to a blunt point, being curved first inward toward the mouth-tube and then outward away from it. At the tip each maxilla is divided into two branches, of which the outer one is the longer and the larger. At the end of the basal portion, where it is abruptly narrowed, there is on the ventral surface a large papilla, from whose summit arise three spines, the outer one twice the length of the other two. These represent the rudiments of the exopod of the maxilla (fig. 39).

The first maxillipeds are of the pattern common to the Caliginæ, the terminal joint two-thirds the length of the basal joint and tipped with two claws, the outer of which is three times as long as the inner.

The second maxillipeds are greatly enlarged, the basal joint stout and swollen and nearly twice the length of the strongly curved terminal claw. On the proximal half of the ventral surface of the basal joint the integument forms a sort of pad with raised edges and a more or less corrugated surface. The distal edge of this pad is raised into a stout knob, down behind which the tip of the terminal claw shuts when closed.

All four pairs of legs are biramose, the rami of the first pair two-jointed, of the other pairs three-jointed. In the first pair the exopod is a little more than twice the length of the endopod. Its basal joint is three times as long as the terminal one, is heavily fringed with hairs along its posterior margin, and ends in a stout spine. The terminal joint is nearly spherical and is attached at right angles to the basal joint, not at the tip, but some distance back on the posterior border. It is armed, as in the Caliginæ, with three terminal spines, three rowing setæ, and a smaller seta at the inner distal corner. The endopod joints are about the same size, the terminal one armed with four spines on the outer margin and three rowing setæ on the inner.

The second, third and fourth swimming legs are as in other Euryphorinæ and the Trebinæ, particularly in the form of the second joint of the endopod and in the number and arrangement of the spines and setæ. The following table represents the arrangement of spines and setæ on each joint:—

Second legs,	exopod	2–1,	1–1,	1–5.
,,	endopod	0–1,	0–2,	0–6.
Third legs,	exopod	1–1,	1–1,	3–5.
,,	endopod	0–1,	0–2,	1–4.
Fourth legs,	exopod	1–1,	1–1,	3–5.
,,	endopod	0–1,	0–2,	1–3.

The fifth legs appear as small papillæ at the posterior corners of the genital segment, each armed with three setæ.

Of the reproductive organs the cement glands are rather small, broadly club-shaped, and they reach but little in front of the centre of the genital segment. The component cells are of medium size and there are about twelve in each gland. The semen receptacle is very close to the posterior margin; it is considerably curved, with the concave side directed forwards. The ends are slightly enlarged and from each a duct runs forward and empties into the oviduct anterior to the opening of the cement gland.

Colour of preserved specimens a uniform yellowish white without pigment spots or lines.

Total length 3 millims., length of carapace 0·85 millim., width of same 1·75 millims., length of free thorax 1·1 millims., length of genital segment 0·71 millim., of abdomen 0·34 millim., of egg-strings 2·35 millims.

Male.—Similar to the female in general appearance and in most of the details of structure. Carapace transversely semilunar, a little more than twice as wide as long. Second, third and fourth thorax segments diminishing slightly in width, but increasing in length, the fourth segment nearly one-half longer than the second. Second segment the only one furnished with lateral plates, but the large basal joints of the third and fourth legs have all the appearance of lateral plates in dorsal view, as in the female.

Genital segment elongate-spindle-shaped, one-third longer than wide, with evenly rounded sides; the anterior margin re-entrant, the posterior one nearly squarely truncated. Two pairs of rudimentary legs are visible, one pair on the lateral margin about one-fourth the distance from the posterior end, and the other pair at the posterior corners.

Abdomen not as wide as in the female, the anal laminæ a little smaller, but the plumose setæ considerably larger.

Of the appendages, the second antennæ are especially large and stout; their terminal claw is bent abruptly at a right angle one-third its length from the tip, and is armed on the inner margin of the basal third with a long curved and sharp spine, a short and blunt one, and a long slender hair (fig. 36). The second maxillæ are similar to those of the female but larger and more powerful. The outer branch at the tip is nearly twice as long as the inner, while the three spines which make up the rudimentary exopod are much larger and stouter. The maxillipeds and legs are the same as in the female. The ventral surface of the genital segment is also covered with spines, larger and rather more numerous than in the female (fig. 47).

Total length 3 millims., length of carapace 0·8 millim., width of same 1·9 millims., length of free segments 1·08 millims., of genital segment 0·8 millim.

This new genus is very interesting since it stands as a connecting link between the Euryphorinæ and the Pandarinæ. At first sight it would be taken for a *Nogagus* species, showing that which was so long sought after, a mature female with her egg-strings. But the description just given excludes it from that genus. The dorsal aspect, to be sure, is very similar to that of a typical *Nogagus*; the carapace is perhaps a little too short, but the free segments, the genital segment, and the abdomen are almost identical with those in some species of *Nogagus*. When we examine the ventral surface and the appendages, however, we find radical differences.

First there are no traces of sucking disks which are found in all the species of *Nogagus*. The mouth-tube, mandibles and second maxillæ are like those found in the Euryphorinæ and quite different from the typical form of the Pandarinæ.

The mouth-tube is short and broadly rounded at the tip instead of being narrow and pointed. The mandibles are curved at the tip, toothed on the concave border, and come together end to end, instead of being straight, with the toothed margins interlocked for their entire length. The second maxillæ are very long, pointed, and bifurcate at the tip, with a well defined exopod, instead of being short, triangular or broadly laminate, and without any trace of a second ramus.

The second maxillipeds have a simple swollen basal joint and an ordinary terminal claw unlike the distorted form in *Nogagus* with its swellings and knobs.

The swimming legs have three-jointed rami, except those of the first pair; a typical *Nogagus* has no ramus with more than two joints. We have here then a genus whose body-form is almost exactly like that of *Nogagus*, while its appendages are all modified and approach much nearer to those found on *Euryphorus*, *Alebion*, and *Dysgamus*. And since in any systematization, but more especially here among the Parasitic Copepods, the appendages are of more value than the body form in determining relationship, this genus must be placed with the Euryphorinæ.

It will be the only genus in the sub-family possessing three free thorax segments, but as it is an intermediate form, any close conformity to the characteristics of a single family could not be reasonably expected.

Family: DICHELESTIIDÆ.

Cætrodes,* n. gen.

Body regions distinct. Head covered with a dorsal carapace which is obovate in shape, strongly arched and considerably widened anteriorly, narrower and rounded posteriorly. This posterior portion is flattened and projects far back over the thorax segments, but is not attached to them. Frontal margin turned under the carapace a little, carrying the base of the anterior antennæ back with it on the ventral surface.

At least four (probably five) free thorax segments, indistinctly separated and diminishing in width posteriorly, the fifth one sending back a wide lobe on either side of the genital segment. Genital segment small, transversely oblong, enclosed on three sides by the fifth segment.

Abdomen small, hemispherical, one-jointed. Anal papillæ longer than the abdomen, narrow, cylindrical, and terminating in a spine and a claw.

First antennæ five-jointed, slender, with very few setæ except on the terminal joint. Second pair stout, ending in a prehensile claw. Mouth-tube short and wide; mouth-opening terminal.

First maxillipeds rudimentary, attached close beside the second maxillæ and of about the same size. Second pair slender, two-jointed. Two pairs of biramose swimming legs, close together and just behind the second maxillipeds; rami linear and two-jointed. Egg-tubes longer than the body; eggs large and uniseriate.

Cætrodes pholas,† n. sp.—Plate IV., figs. 48 to 57.

Female.—Head wider than the rest of the body and two-fifths of the entire length; covered dorsally with a strongly arched carapace which is divided into right and left halves by a prominent ridge or rib at the centre. The posterior margin of this carapace is prolonged backward in the form of a thin flattened plate which covers the anterior half of the thorax segments.

With the point of a needle, or by sharply flexing the body, this plate may be lifted away from the thorax segments, and this shows that it is not attached to them in any way. There is no trace of the median rib in this posterior part of the carapace. The passage from the arched to the flattened portion of the carapace is very irregular and forms a broken line over the posterior margin of the head. At the centre there is a wide triangular sinus extending forward, with its point on the median line. On either side of this is a blunt, rounded projection extending backward, outside of which is a wavy line curving forward as it runs toward the margin. There are no traces of frontal plates or of eyes.

The thorax is composed of at least four (probably five) free segments, which are imperfectly separated from one another.

* *Cætrodes*, like a small round shield.

† *Pholas*, lurking in a hole or burrow.

The first two of these are very short and considerably narrower than the head; the third and fourth (fused) are longer and wider, and together are about three-fifths the size of the carapace shield. The fifth segment is shorter and narrower than the fourth. It is divided transversely into thirds, the two outer divisions extending backwards in the form of wide rounded lobes on either side of the genital segment and abdomen, the median division forming a shallow rounded sinus for the attachment of the genital segment.

The genital segment and abdomen together form a hemisphere about the size of one of the posterior lobes of the fifth segment. The abdomen is one-jointed and bears on its ventral surface, at the posterior margin, two large cylindrical anal papillæ. These are longer than the abdomen itself, and each is tipped with a claw and a spine. The claw, which is on the inside, is nearly as long as the papilla, stout, and abruptly curved near the tip, exactly like the prehensile claws on the second antennæ of the Caligidæ. The spine is only one-fourth as long as the claw, and straight (fig. 57).

Egg-tubes wider than the genital segment and one-third longer than the entire body; eggs large, about 30 in each tube.

The first antennæ are five-jointed, the joints diminishing in diameter towards the tip; the setæ are very scattered except on the third and last joints. The second antennæ have a stout and conical basal joint, and a slender, strongly-curved terminal claw.

The mouth-tube is short and wide, with a rather blunt tip, enclosing the slender mandibles which are toothed on their inner margins. The second maxillæ and first maxillipeds are about the same size and close together at the sides of the mouth-tube. Each is two-jointed, and is made up of a short and plump basal joint and a slender terminal spine. The maxillipeds, of course, are rudimentary when reduced to this size, and are similar to those found in *Pseudoclavella*, *Cycnus*, *Cybicola*, and other Dichelestiids (fig. 52).

The second maxillipeds are fairly developed and much resemble the first pair in the Caligidæ. They are two-jointed, the joints about the same length, the terminal one tipped with a short and straight claw.

There are only two pairs of swimming legs, both biramose, with the rami linear and two-jointed. In each pair the exopod joints are about the same length, while the basal joint of the endopod is much shorter than the terminal.

Owing to the habit which the species has of lying in a burrow, the oviducts open on the dorsal surface, on either side of, and quite near to, the mid-line. The ovaries and the internal portions of the oviducts fill the entire thorax and even project forward into the head. The external portions (egg-tubes) start out at right angles to the dorsal surface, and are thus lifted well above the edge of the burrow. They then curve over and lie in close contact with the surface of the fish's gill outside the burrow (fig. 48).

Colour of the entire animal, a deep reddish yellow, like that of the gill on which it lives. The two arched halves of the anterior portion of the carapace are almost white, and the uneven line, where the arched portion passes into the flattened plate, stands out prominently in consequence of the meeting of this white colour with the deep yellow.

Total length 1·15 millims.; length of carapace 0·9 millim.; length of head 0·5 millim., width of same 0·9 millim.; length of thorax 0·65 millim.; length of egg-strings 1·8 millims.

This Dichelestiid is particularly interesting on account of its peculiar burrowing habit. About fifteen specimens, all females, were obtained from the gill filaments of *Tetrodon stellatus*. After fastening themselves to the surface of the filament by the prehensile second antennæ, and, we strongly suspect, by the terminal hooks on the anal laminæ, these parasites in some way irritate the epithelium until it is raised into a broad fold or flap, entirely surrounding the Copepod's body and overlapping its margin on all sides. A small convex mound is thus formed, beneath the open centre of which lies the body of the parasite, its egg-tubes projecting freely and lying along the surface of the gill filament. The anterior margin of the head and the posterior extremity of the body, including the abdomen and anal laminæ, are burrowed under the edge of the epithelium fold and fastened by their prehensile hooks.

Apparently, therefore, the parasite can have no freedom of motion, but is fastened immovably in place. No similar case of burrowing is known to the author; there are, of course, many genera among the Chondracanthidæ and Lernæidæ which bury the head and neck in the flesh of their host. There are also genera of the Dichelestiidæ, such as *Anthosoma*, *Eudactylina*, and the like, whose prehensile claws irritate the epithelium of the host until it grows up in a fold over the claws themselves.

But so far as is known, this is the only case where the epithelium folds entirely surround the body, so that the latter is securely held in place by them. The result is that the body of the parasite lies in the bottom of a hole or burrow, with only a portion of its dorsal surface visible.

Hatschekia, ? n. sp.—Plate V., figs. 58 to 60.

A single specimen of a species belonging to this genus was obtained from the stomach of *Carcharias mülleri*. It was a young female without egg-strings but with spermatophores, and was only a trifle over 1 millim. in length.

While it seems to be a new species unlike any thus far described, yet its small size, its poor condition, and the manifest fact that it is not a fully developed adult furnish sufficient reasons to prevent its establishment as a new species. The following description and the figures which accompany it must await future confirmation, therefore, before being finally established.

Female.—Head transversely elliptical, one-half wider than long, one-fifth the entire length. Thorax composed of two free joints and the genital segment. First free joint a little narrower than the head, second joint and genital segment considerably wider. The latter sends out a blunt rounded process on either side of, and nearly as large as, the abdomen. No appendages are visible on these processes or elsewhere on the genital segment. Abdomen very small and nearly spherical, with a pair of minute anal papillæ, each of which ends in three small setæ. First antennæ slender and apparently six-jointed; second pair large and terminated by a stout prehensile claw. Mouth-tube short and narrow and bluntly rounded at the tip; second maxillæ and first maxillipeds in the form of two small papillæ on each side of the mouth-tube, each tipped with a single seta. Second maxillipeds slender, the terminal joint shorter than the basal. Two pairs of biramose legs placed close behind the second maxillipeds; basal joints rounded and flattened laminæ, rami linear and cylindrical; exopods two-jointed, endopods one-jointed. Spermatophores comparatively very large and attached by long delivery ducts.

Colour a pale yellow, the ovaries and internal oviducts showing a dark brown through the transparent integument.

Total length 1·07 millims.; length of free thorax 0·35 millim.; length of genital segment 0·5 millim., width of same 0·48 millim.

Family: LERNÆIDÆ.

Peniculus, Nordmann.

Head oval or elliptical, elongate, without horn-like processes, connected with the body by a short and narrow neck, which is made up of two distinct thorax segments. Body a fusion of several thorax segments, elongate, wider than the head, and sometimes prolonged posteriorly into two elongate flattened processes.

Abdomen small, consisting of a single joint and carrying minute anal papillæ, which are tipped with non-plumose setæ. Egg-strings filiform; eggs large and uniseriate.

First antennæ reduced to mere knobs; second pair large and chelate, projecting in front of the head and forming the chief organs of prehension. Mouth a simple tube projecting from the ventral surface of the head; mouth-parts entirely wanting, except a single pair of very rudimentary maxillipeds beside the mouth tube. Four pairs of rudimentary swimming legs; first two pairs placed close behind the head, third and fourth pairs some distance from them and from each other.

Male smaller than the female and with a shorter thorax; posterior processes also shorter than those of the female, but wider and truncate at the tip.

Peniculus furcatus, Kröyer—Plate V., figs. 61 to 66.

Female.—Head elliptical, slightly widened posteriorly, about twice as long as wide, with evenly curved sides. Posteriorly the head passes into a neck of about half its width, made up of three thorax segments which are distinctly separated on both the ventral and dorsal surfaces. The fourth and genital segments are fused, with no line of demarkation except the position of the fourth legs on the ventral surface. This fused portion constitutes the body of the Copepod, which is nearly twice the width of the head, and twice as long as wide, with parallel sides.

The body widens sharply from the neck, its anterior corners well rounded, while its posterior corners are produced into a pair of wide, flattened processes, nearly as long as the rest of the animal, and either straight or slightly divergent, Along the sides, toward the centre, these processes often show incisions and grooves, very irregularly placed in different specimens and suggesting imperfect segmentation.

Between the bases of these processes lies the small abdomen, a little wider than the processes, and also a little wider than long. Its posterior corners are produced into short and rounded processes, similar to those on the genital segment but much smaller. Between these processes on the posterior margin are the tiny anal papillæ, each of which terminates in three non-plumose setæ. Of these latter, the inner and outer ones are considerably longer than the middle one (fig. 66).

The first antennæ are reduced to mere knobs, so rudimentary as to be invisible unless seen in profile and under the best conditions. The second pair are much enlarged and extend forward diagonally in front of the head. They are the organs of prehension and consist of an enlarged basal joint filled with strong muscles, and a stout terminal claw which is buried in the flesh of the host. The basal joints are united throughout their entire length, and are enlarged at the end into a double disc, from the edge of which on either side project the terminal claws. The mouth-tube is a simple hollow cone projecting but little from the ventral surface; the mouth-parts have all been aborted, with the exception of the second maxillipeds. These appear as tiny two-jointed appendages on either side of the base of the mouth-tube (fig. 64).

There are four pairs of rudimentary legs, the first three of which are close together on the thorax segments which form the neck, while the fourth pair are some distance farther back on the ventral surface. We may presume that the line of junction of the fourth and genital segments is just behind the bases of these legs. Each leg consists of a triangular basal lamina tipped with two minute, one-jointed rami scarcely larger than spines, and naked.

Colour a dark grey by reflected light, a greyish yellow by transmitted light. Under the latter conditions spots of dark pigment are seen along the sides of the head and neck, at the posterior end of the genital segment, and along the centre of the posterior processes. The two oviducts also show through the dorsal surface of the genital segment as two broad lines of dark brown, broken up into separate spherical eggs.

Total length 2·35 millims., length of head 0·35 millim., length of genital segment 0·79 millim., length of posterior processes 1 millim., length of egg-strings 0·6 millim., width of genital segment 0·4 millim.

Male.—Similar to the female, but with certain marked differences in the body proportions. The head and free thorax segments are about the same, but the genital segment is relatively longer and narrower, being nearly half the entire length.

The posterior processes are only one-third as long as in the female, and are spathulate, being somewhat enlarged and strongly flattened at the tips. Their width at the tip is three-fifths of their length, while in the female it is less than one-seventh. The abdomen lacks the posterior processes, and is nearly hemispherical in shape; the anal papillæ are relatively larger, and their setæ, also non-plumose, a trifle longer.

Colour the same, except that there are no pigment spots on the posterior processes, and there are two narrow lines of pigment parallel to the sides of the genital segment in place of the wide broken lines of eggs seen in the female.

Total length 1·6 millims., length of head 0·35 millim., length of genital segment 0·71 millim., length of posterior processes 0·35 millim., width of genital segment 0·3 millim.

This species was founded by Kröyer upon a single female obtained by exchange from the Vienna Museum. And Kröyer himself states that this specimen was imperfect, so that the description given was necessarily incomplete. This original type specimen was obtained from a species of *Holacanthus* (*Tetrodon*) taken in the Indian Ocean.

The present lot of material is from the same region and was found on the same genus of fish (*Tetrodon*)—whether upon the same species or not, is impossible to tell, since Kröyer does not name the species. The specimens include some twenty females and two males, nearly all of which are in excellent condition. We are thus justified in supplementing Kröyer's description, and in presenting a complete account of both sexes with accurate figures. A genus diagnosis is also here given for the first time (p. 206).

EXPLANATION OF THE PLATES.

PLATE I.—*Lepeophtheirus brachyurus*, Heller, and *Lepeophtheirus æsopus*, n. sp.

Fig. 1. *Lepeophtheirus brachyurus*, dorsal view of female.
,, 2. First and second antenna and first maxilla.
,, 3. Mouth-tube and second maxillæ.
,, 4. Second maxilliped.
,, 5. Furca.
Figs. 6 to 9. First, second, third, and fourth swimming legs.
Fig. 10. Genital segment, ventral surface, showing cement glands and sperm receptacle.
,, 11. *Lepeophtheirus æsopus*, dorsal view of female.
,, 12. Second antenna and first maxilla.
,, 13. Mouth-tube and second maxillæ.
,, 14. Second maxilliped.
Figs 15 to 18. First, second, third, and fourth swimming legs.
Fig. 19. Ventral surface of genital segment, showing cement glands and spermatophores.

PLATE II.—*Trebius exilis*, n. sp.

Fig. 20. Dorsal view of adult female.
,, 21. ,, ,, male.
,, 22. Second antenna of male.
,, 23. Mouth-tube and second maxilla.
,, 24. First maxilliped.
,, 25. Second maxilliped.
,, 26. Furca.
Figs 27 to 30. First, second, third, and fourth swimming legs.
Fig. 31. Ventral surface of genital segment, showing the cement glands and spermatophores.
Figs. 32 and 33. Dorsal views of young females in different stages of development.

PLATE III.—*Dissonus spinifer*, n. gen. et n. sp.

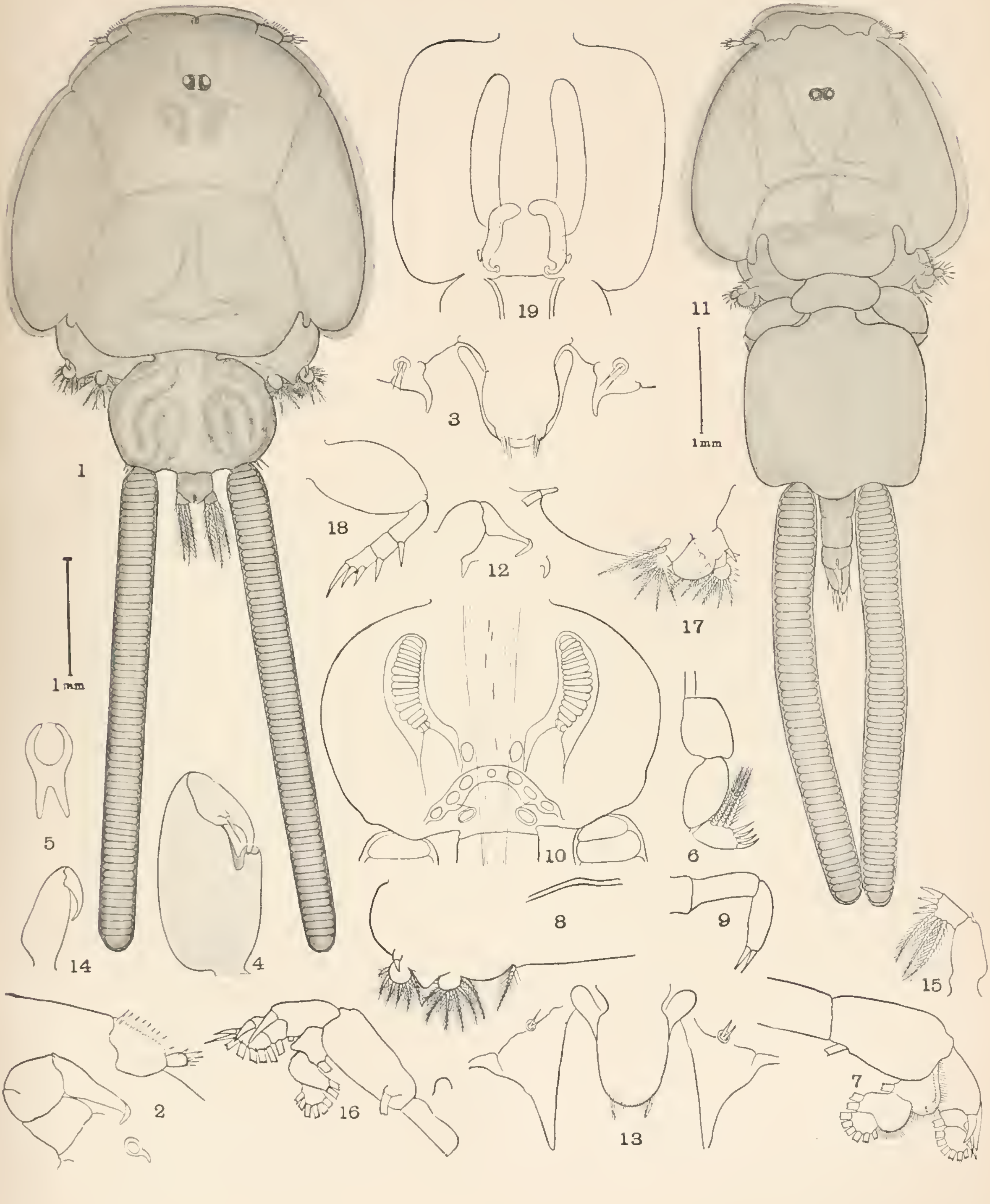
Fig. 34. Dorsal view of female.
,, 35. ,, ,, male.
,, 36. Second antenna of male.
,, 37. Ventral view of anterior part of carapace, showing relative size and position of antennæ and mouth-parts.
,, 38. Bony frame work of mouth-tube, and the second maxillæ.
,, 39. Second maxilla of male.
,, 40. Mandible.
Figs. 41 and 42. First and second maxillipeds.
,, 43 to 46. First, second, third, and fourth swimming legs.
Fig. 47. Ventral surface of genital segment of male.

PLATE IV.—*Cætrodes pholas*, n. gen. et n. sp.

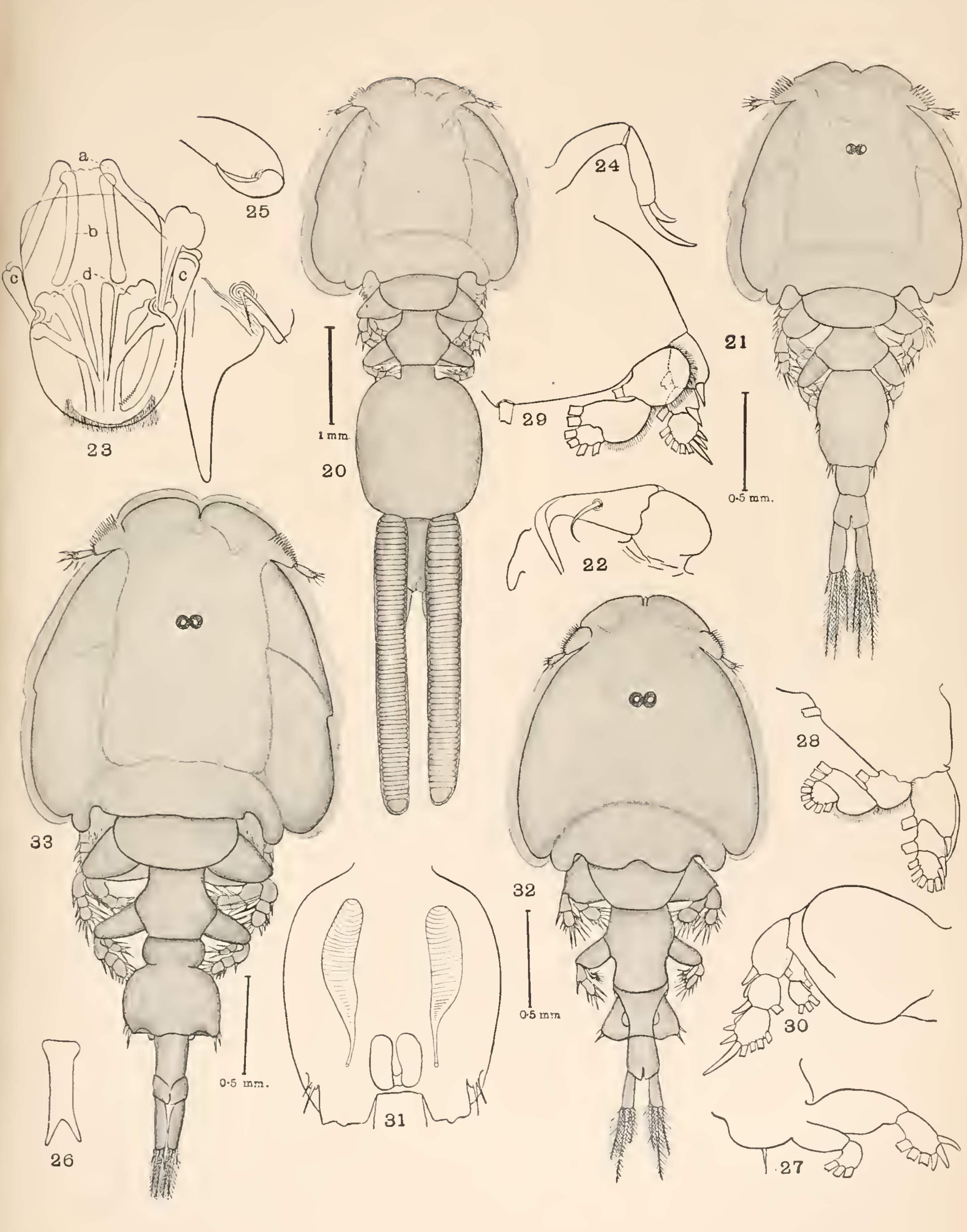
Fig. 48. Dorsal view of female in its burrow on a gill filament.
,, 49. ,, ,, same female removed from its burrow (enlarged).
,, 50. First antenna.
,, 51. Second antenna.
,, 52. Mouth-tube, second maxilla (*a*), and first maxilliped (*b*).
,, 53. Second maxilliped.
Figs. 54 and 55. First and second swimming legs.
,, 56 ,, 57. Dorsal and ventral views of genital segment and abdomen.

PLATE V.—*Hatschekia* sp. and *Peniculus furcatus*, Kröyer.

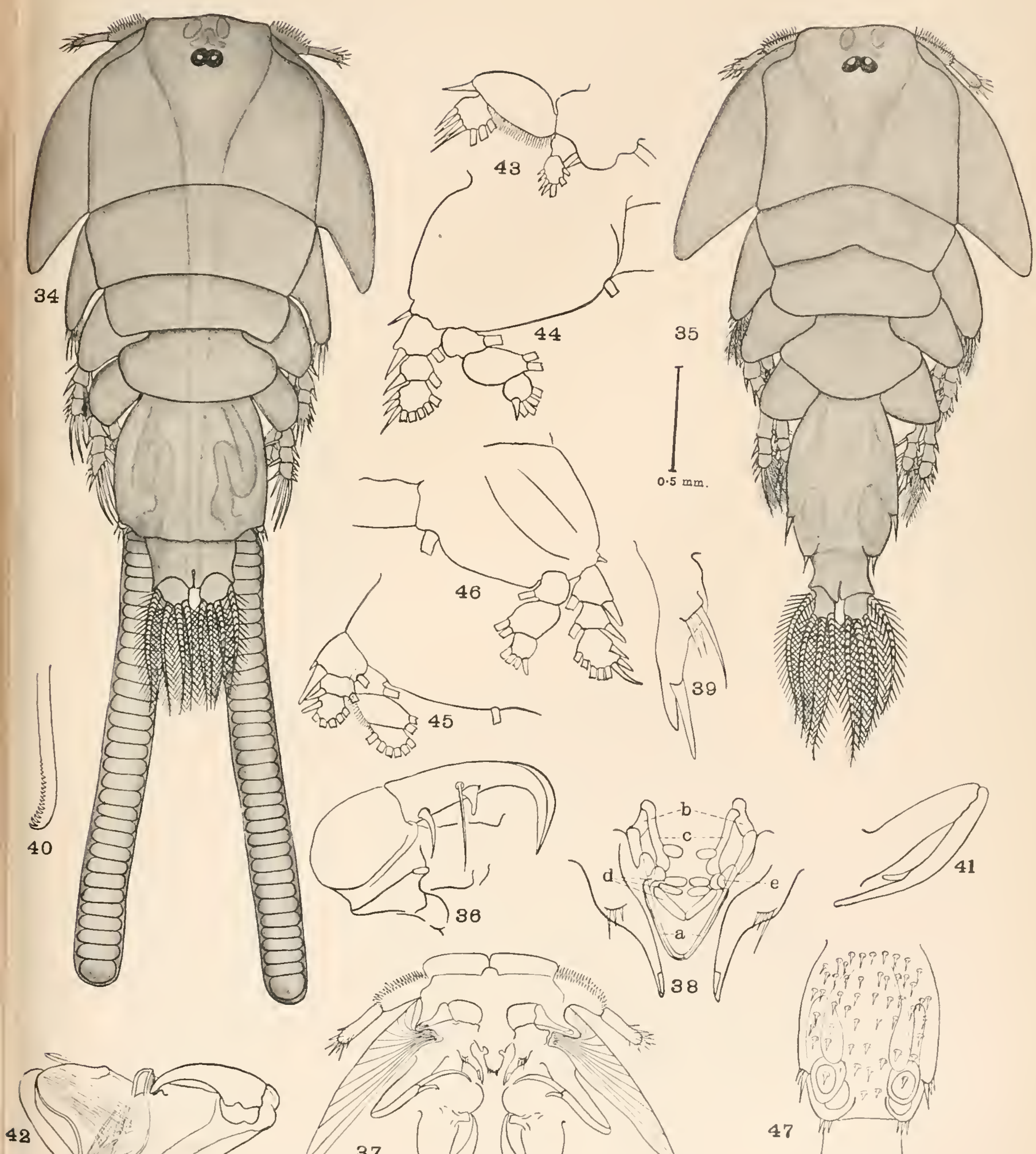
Fig. 58. Dorsal view of *Hatschekia* sp., female.
,, 59. Ventral view of head and first two thorax segments, showing (*a*) first antenna; (*b*) second antenna; (*c*) second maxilla; (*d*) first maxilliped; (*e*) second maxilliped; (*f*) first swimming leg; (*g*) second swimming leg.
,, 60. Ventral view of abdomen, showing anal papillæ and spermatophores.
,, 61. Dorsal view of female of *Peniculus furcatus*, Kröyer.
,, 62. Ventral view of same, showing egg-cases.
,, 63. Dorsal view of male.
,, 64. Profile view of head, showing (*a*) rudimentary first antenna; (*b*) prehensile second antennæ; (*c*) rudimentary second maxillipeds.
,, 65. End view of fused second antennæ, showing the terminal claws.
,, 66. Ventral view of abdomen of female.



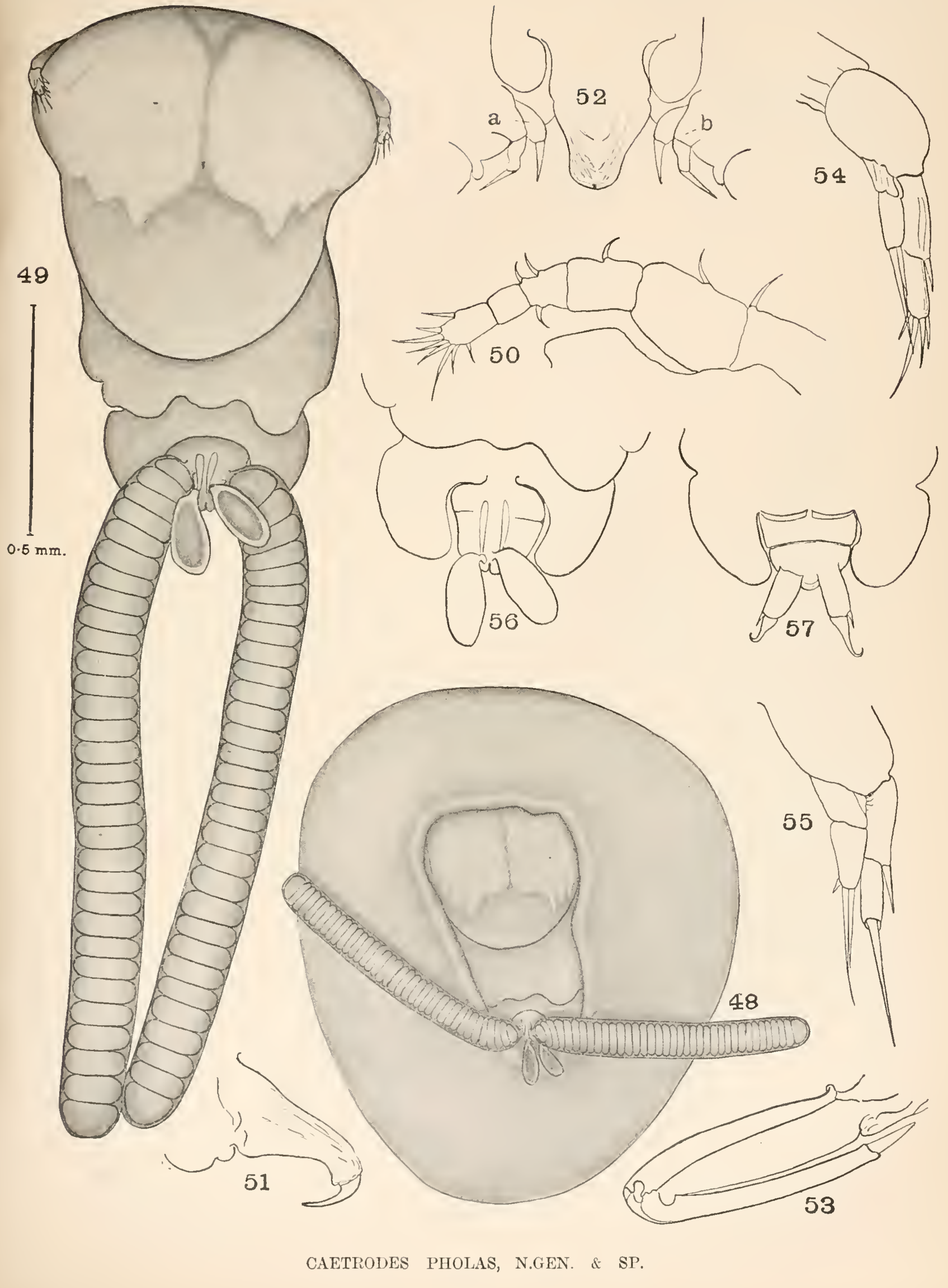
FIGS. 1—10, LEPEOPHTHEIRUS BRACHYURUS, HELLER.
FIGS. 11—19, LEPEOPHTHEIRUS AESOPUS, N.SP.



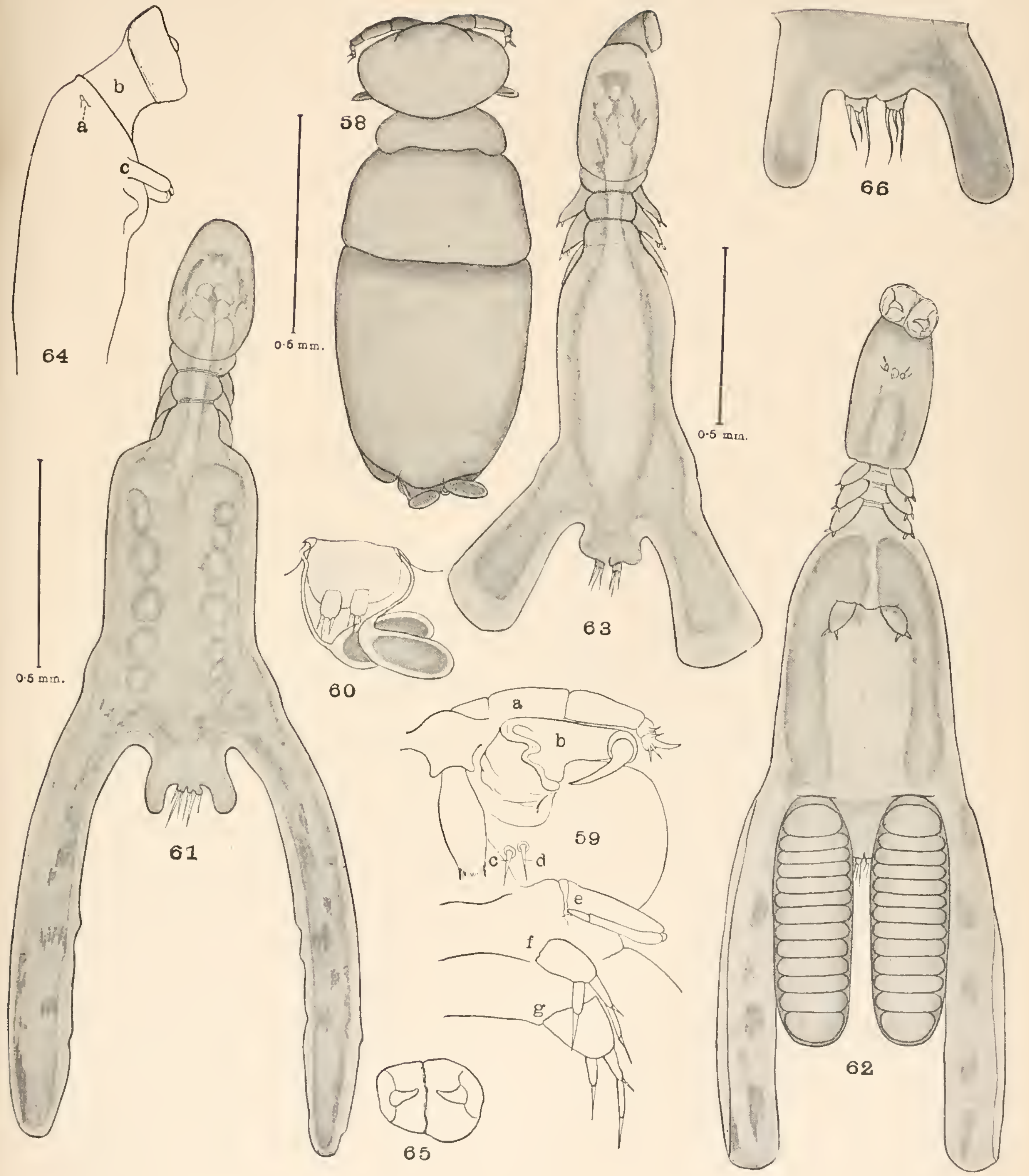
TREBIUS EXILIS, N.SP.



DISSONUS SPINIFER, N.GEN. & SP.



CAETRODES PHOLAS, N.GEN. & SP.



FIGS. 58—60, HATSCHEKIA SP.

FIGS. 61—66, PENICULUS FURCATUS, KRÖYER.

REPORT

ON THE

ANOMURA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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ASSISTANT IN ZOOLOGICAL DEPARTMENT, UNIVERSITY OF LIVERPOOL.

[WITH TEXT-FIGURES.]

THIS collection of Anomura, entrusted to me for description by Professor HERDMAN—whose kind help in many ways I desire to acknowledge here—comprises 48 species, distributed amongst 22 genera. Two of these species, viz., *Munida alcocki* and *Porcellana hornelli*, are new to science, and a number of others are new to the marine fauna of Ceylon, and add considerably to our knowledge of the geographical distribution of the group.

The Anomuran fauna of this region of the world has been made known chiefly through the descriptions (1) by HENDERSON of the material collected in the Gulf of Manaar by THURSTON, and (2) by ALCOCK of the collections made during the cruises of the "Investigator," and contained in the Indian Museum. In all, about 52 species have now been recorded from the seas around Ceylon, and the present collection adds 23 more species to that list, in addition to the two new species cited above. The species collected by the "Investigator" and described by ALCOCK are, in many cases, deep-water forms, while the following is a list of the collection made by THURSTON, and described by HENDERSON (8), from shallow water in the northern part of the Gulf of Manaar, the exact locality where the bulk of the present collection was obtained. It will be of interest for comparison with the list in the pages that follow :—

Dromidia unidentata (RÜPP).
,, *australiensis*, HASWELL.
Cryptodromia pentagonalis, HILG.
Pseudodromia integrifrons, HEND.
Raninoides serratifrons, HEND.
Hippa asiatica, MILNE-EDW.
Albunea symnista (LINN.).
* ,, *thurstoni*, HEND.
**Coenobita rugosa*, MILNE-EDW.
**Diogenes diogenes* (HERBST).
* ,, *merguiensis*, DE MAN.
* ,, *miles* (HERBST).
,, *custos* (FABR.).
,, *planimanus*, HEND.
,, *avarus*, HELLER.
* ,, *costatus*, HEND.
**Pagurus punctulatus* (OLIV.).
,, *deformis*, MILNE-EDW.
Pagurus varipes, HELLER.
* ,, *setifer*, MILNE-EDW.
**Troglopagurus manaarensis*, HEND.
**Aniculus aniculus* (FABR.).
* ,, *strigatus* (HERBST).
**Clibanarius padavensis*, DE MAN.
,, *arethusa*, DE MAN.
**Eupagurus zebra*, HEND.
Petrolisthes dentatus (MILNE-EDW.).
,, *boscii* (AUD.).
* ,, *militaris* (HELLER).
Porcellanella triloba, WHITE.
**Polyonyx obesulus*, MIERS.
,, *tuberculosis*, DE MAN.
**Galathea elegans*, WHITE.
,, *spinosirostris*, DANA.
Munida spinulifera, MIERS.

Of the above 35 species, Professor HERDMAN found the 16 marked with a star, and also 32 additional species which were not obtained by THURSTON.

ANOMURA.

HIPPIDEA.

FAMILY: HIPPIDÆ.

Remipes testudinarius, LATREILLE. (See MIERS, 10.)†

Galle, Station XXXVII., depth 7 fathoms; one specimen measuring 5·5 centims. in extreme length, and six smaller ones of 2 centims. Not previously recorded from Ceylon.

Mastigochirus gracilis (STIMPSON). (See MIERS, 10.)

Galle, Station XL., depth 34 fathoms. Three small male specimens. Not previously recorded from the Indian Ocean.

FAMILY: ALBUNEIDÆ.

Albunea thurstoni, HENDERSON (8).

Localities:—(1) Galle, Station XL., 34 fathoms; (2) off Mutwal Island, Station LXVI., 10 to 35 fathoms; (3) west of Periya Paar, Station LV., 24 fathoms; (4) on Aripu coral reef, shallow water. One specimen from each locality. The carapace of the largest specimen measures 1·6 centims.

† These numbers refer to the literature cited at the end.

PAGURIDEA.

Family: COENOBITIDÆ.

Coenobita clypeatus, Latreille. (See Alcock, 1.)

On Watering Point, Galle, Station XXXVII. One large male, carapace measuring 4·5 centims. This is a common form in the Indian Ocean, but apparently has not been previously recorded from Ceylon.

Coenobita rugosus, Milne-Edw. (See Alcock, 1.)

Localities:—(1) Foul Point, Trincomalee, Station XXV.; (2) on Watering Point, Galle, Station XXXVII.; (3) Kattanattu Point, on shore; (4) Welligam Bay, Station XXXIV., on shore.

The collection contains a large series of this common species, many of which are females bearing eggs. The average length of the carapace is 3 centims. The specimens from Watering Point at Galle, Kattanattu Point in the Gulf of Manaar, and near Mirissa in Welligam Bay, were collected in rough ground at the top of the beach. Professor Herdman's notes contain the following sentences in regard to Welligam:—" Pagurids of several species, some inhabiting the shells of Helix and other land Molluscs, were very common on the upper part of the beach and in the cocoa-nut plantations beyond. A crowd of several dozen were found congregated upon a small heap of dung, evidently feeding. Others were sheltering in numbers about the roots of the trees."

All the specimens, however, belong to *C. rugosus*, and the shells they inhabit have been identified by Mr. R. Standen, as follows:—*Ranella bufonia*, *Ranella granifera*, *Littorina scabra*, *Nassa* sp., *Sistrum spectrum*, *Sistrum* sp., *Turbo argyrostoma*, *Purpura persica*, *Nerita* sp., *Trochus* sp., *Cantharus* sp., *Rapana bulbosa*, *Murex trilobus*, *Pyrula vespertilio*, *Natica* sp., *Natica monile*, *Ampularia* sp., *Helix hæmastoma*, *Cyclophorus menkianus*, *Tritonidia nodosa*.

Family: PAGURIDÆ.

Diogenes investigatoris, Alcock (1).

Localities:—(1) Gulf of Manaar, under 10 fathoms; (2) Palk Bay, Station XVIII., 7 to 8 fathoms. Several small specimens. Carapace measuring about 5 millims. Found inhabiting shells of *Minolia* sp., *Ranella argo*, and *Buccinum pusilla*. This is a new record for Ceylon.

Diogenes rectimanus, Miers (12).

Localities:—(1) On coral reefs and pearl banks in Gulf of Manaar; (2) off Foul Point, Trincomalee, Station XXV., 8 fathoms. Six specimens found inhabiting shells of *Minolia terebra*, *Minolia* sp., *Terebra duplicata*, *Sistrum spectrum*, *Eburna caniculata*, and *Cancellaria antiquata*. This is a new record for Ceylon.

Diogenes costatus, HENDERSON (8).

Localities :—(1) Pearl banks, Gulf of Manaar, under 10 fathoms ; (2) off Foul Point, Trincomalee, Station XXV., 8 fathoms. Eight specimens ; carapace of largest measuring 7 millims. ; found inhabiting shells of *Conus generalis* and *Olivella* sp. This species was found by THURSTON at Rameswaram.

Diogenes miles (HERBST). (See ALCOCK, 1.)

Locality :—Welligam Bay, Station XXXIV., 2 to 7 fathoms. Two males, in shells of *Nassa* sp. ; length of carapace, 6 millims.

Diogenes diogenes (HERBST). (See ALCOCK, 1.)

Locality :—Stat. XV., Periya Paar, Gulf of Manaar, 9 fathoms. Thirteen specimens, in shells of *Strombus marginatus*, *Latirus* sp., *Natica melanostoma*, and *N.* sp., *Ranella bufonia*, *Oliva* sp. and *Tudicla spirillis*. Length of carapace of largest, 1·3 centims.

Diogenes merguiensis, DE MAN. (See ALCOCK, 1.)

Locality :—Pearl banks, Gulf of Manaar, under 10 fathoms. Five specimens ; carapace measuring 2 centims. ; in shells of *Cassis glauca*, *Natica* sp., *Triton* sp.

Pagurus setifer, MILNE-EDW. (See ALCOCK, 1.)

Localities :—(1) East Cheval Paar, and other pearl banks in Gulf of Manaar, under 10 fathoms ; (2) south of Adam's Bridge, Station LIV., 4 to 40 fathoms ; (3) Welligam Bay, Station XXXIV., 2 to 7 fathoms ; (4) off Mutwal Island, Station LXVIII., 10 to 14 fathoms ; (5) Trincomalee, Station XXI., 8 to 12 fathoms ; (6) Aripu coral reef, shallow water ; (7) outside pearl banks, Gulf of Manaar, Station LXIII., 50 fathoms ; (8) Chilaw Paar, Station V., 9 to 11 fathoms. This is evidently a common species, as it occurred in abundance at various parts of the Coast of Ceylon, including Welligam and Trincomalee as well as the Gulf of Manaar. Amongst the specimens were several females bearing eggs. The carapace of the largest specimen measured 3 centims., that of the smallest, 7 millims.

These specimens were found inhabiting shells of *Turbinella* sp., *Delphinium* sp., *Murex haustellum*, *Murex* sp., *Murex rota*, *Murex trispinosum*, *Natica monile*, *Trochus* sp., *Solarium* sp., *Dolium* sp., *Dolium marginalis*, *Terebra duplicata*, *Cerithium* sp., *Strombus succinctus*, *Strombus elegans*, *Strombus marginatus*, *Strombus gibberulus*, *Pinaria coronata*, *Xenophora conica*, *Xenophora* sp., *Ranella bufonia*, *Ranella* sp., *Ranella granifera*, *Nassa glans*, *Turritella* sp., *Harpa ventricosa*, *Ancilla ampla*, *Ancilla* sp., *Pyrula reticulata*, *Bulla ampulla*, *Tudicla spirillis*, *Oliva* sp., *Terebra* sp., *Cassis vibex*, *Mitra crebrilyrata*.

Pagurus asper, DE HAAN. (See ALCOCK, 1.)

Localities :—(1) Pearl banks off Aripu and elsewhere in Gulf of Manaar, under

10 fathoms; (2) west of Periya Paar, Station LXI., 12 fathoms; (3) Periya Paar Karia, Station LXII., 7 to 13 fathoms. This species, like the preceding one, was fairly abundant. The carapace of the largest measured 3 centims. The specimens were found inhabiting shells of *Dolium marginalis*, *Natica melanostoma*, *Natica* sp., *Ranella bufonia*, *Ranella crumera*, *Cerithium columba*, *Triton angulatus*, *Sistrum spectrum*.

Pagurus punctulatus, Olivier. (See Alcock, 1.)

Two male specimens, one from Station XXXIX., off Galle, depth 16 to 30 fathoms, and the other from the coral lagoon at Galle. Carapace measured 3·2 centims.; eye stalks of a maroon-red colour; chelipeds, legs, and carapace red, the latter with numerous whitish ocelli.

Clibanarius padavensis, de Man (9).

One female with eggs, from Lake Tampalakam, carapace measuring 2 centims.; also two male specimens having carapace measuring 2·2 centims., from Gulf of Manaar, in shells of *Purpura coronata* and *Natica* sp.

Clibanarius æquabilis, var. **merguiensis**, de Man (9).

Localities:—(1) Galle coral lagoon, shallow water; two males, carapace measuring 1·6 centims.; (2) Trincomalee, Station XXIII., 4 to 8 fathoms; one specimen in shell of *Cerithium maurus*.

Calcinus elegans (Milne-Edw.). (See Alcock, 1.)

Locality:—Off Galle, Station XXXVII., 7 fathoms; and also on the shore at Galle. One female and two male specimens, in shells of *Purpura persica* and *Ricinula horrida*. This is a new record from Ceylon.

Calcinus gaimardi (Milne-Edw.). (See Alcock, 1.)

Locality:—Gulf of Manaar, under 10 fathoms. Four male specimens; carapace measuring 9 millims.; in shells of *Latirus nodosus* and *Cerithium* sp. This is a new record for Ceylon.

Aniculus aniculus (Fabr.). (See Alcock, 1.)

Locality:—Lake Tampalakam, Trincomalee, shallow water. Two specimens; carapace measuring $5\frac{1}{2}$ centims.

Aniculus strigatus (Herbst). (See Alcock, 1.)

Localities:—(1) Pearl banks and coral reefs in Gulf of Manaar, under 10 fathoms; (2) Palk Bay, Station XIX., 4 to 8 fathoms; (3) Aripu coral reef, shallow water. In all about 13 specimens, including three females with eggs; carapace of largest measured 2 centims.; found inhabiting shells of *Strombus succinctus*, *Strombus auris-*

dianæ, *Strombus* sp., *Conus tesselatus*, *Conus augur*, *Conus generalis*, *Cyprea ocellata*, and *Oliva* sp. One specimen was found in association with an anemone, containing only the apex of a molluscan shell.

Eupagurus zebra, Henderson (8).

Localities:—(1) Coral reefs, Gulf of Manaar, shallow water; (2) off Mutwal Island, Station LXVI., 10 to 35 fathoms; (3) south of Galle, Station XXXIX., 16 to 30 fathoms. The largest specimen measured 1 centim. along the carapace; a few were found in association with anemones, the rest in shells of *Tritonidea nodosa*, *Latirus turritus*, *Pleurotoma tigrina*, *Nassa granifera*, *Triton* sp., and *Fusus* sp.

Eupagurus carpoforaminatus, Alcock (1).

Locality:—Station XLIII., off Kaltura, 22 fathoms. Two males, carapace measuring 1·5 centims., with the pin-hole foramen on the under surface of the carpus very distinct.

Spiropagurus spiriger (de Haan). (See Alcock, 1.)

Localities:—(1) Off Galle, Station XXXIX., 16 to 30 fathoms; (2) off Foul Point, Trincomalee, Station XXV., 8 fathoms; (3) Station XLIII., off Kaltura, 22 fathoms. Six males, and one female with eggs; carapace of largest measured 2·2 centims.; found inhabiting shells of *Pyrula reticulata*, *Natica monile*, *Natica* sp., *Natica melania*, *Latrunculus zeylanica*, *Harpa minor*.

Catapagurus ensifer, Henderson (8).

Localities:—Gulf of Manaar, under 10 fathoms; (2) west of Dutch Modragam Paar, Station LVI., 8 to 9 fathoms. Five specimens; the carapace of the largest measured 1 centim.; found inhabiting shells of *Natica*, 2 spp., carrying anemones. This is a new record for Ceylon.

Paguristes hians, Henderson (7).

Locality:—Coral reefs and pearl banks, Gulf of Manaar, shallow water. Three specimens; carapace measuring 1 centim.; in shells of *Ranella bufonia*, *Murex* sp., and *Strombus marginalis*. This is a new record for Ceylon.

Paguristes incomitatus, Alcock (1).

Locality:—Pearl banks and coral reefs, Gulf of Manaar, shallow water. Eight specimens, including two females with eggs; carapace measuring 1·1 centims.; in shells of *Tritonidia nodosa*, *Latirus turritus*, *Ranella* sp., and *Cerithium* sp. This is a new record for Ceylon.

Paguristes pusillus, Henderson. (See Alcock, 1.)

Localities:—(1) Coral reefs and pearl banks, Gulf of Manaar, shallow water; (2) Station XLIII., off Kaltura, 22 fathoms; (3) off Mutwal Island, Station XLVII., 10 to 14 fathoms. Fifteen specimens in all; two of the specimens were females bearing eggs; carapace of largest measured 2 centims; found inhabiting shells of *Cerithium citrinum*, *Ranella granifera*, *Cancellaria* sp., *Turbo* sp., *Cerithium*, 2 spp., *Seraphs terebellum*, *Pleurotoma* sp., *Triton* sp., *Strombus elegans*.

Cancellus investigatoris, ALCOCK (1).

Locality:—Gulf of Manaar, shallow water. One specimen; carapace measuring 1·5 centims.

Nematopagurus muricatus, HENDERSON. (See ALCOCK, 1.)

Localities:—(1) Gulf of Manaar, shallow water; (2) near Chilaw Paar, Station IV., 9 fathoms. One male from each; carapace measuring 5 millims.

Nematopagurus sp.

Locality:—Gulf of Manaar, shallow water. A damaged male specimen, without chelipeds and legs; carapace measuring 6 millims; cornea but little dilated; antennal acicle curved and setose, and as long as the eye peduncles; ophthalmic scales well separated; rostrum small, obtuse, and rounded, projecting but little; the ophthalmic peduncles reach the middle of the terminal joint of the antennular peduncles; vas deferens protruding on both sides, the right one being much the longer.

The character of the vas deferens shows that this form belongs to the genus *Nematopagurus*, but, in the absence of all the appendages, I cannot venture to identify it further.

Troglopagurus manaarensis, HENDERSON (8).

Locality:—Coral reefs, Gulf of Manaar, shallow water. Two specimens; carapace measuring 1 centim.

Troglopagurus jousseaumii, BOUVIER. (See ALCOCK, 1.)

Locality:—Pearl banks, Gulf of Manaar, shallow water. Five specimens; carapace measuring 7 millims. This is a new record for Ceylon.

GALATHEIDEA.

FAMILY: PORCELLANIDÆ.

Petrolisthes militaris (HELLER). (See HENDERSON, 8.)

Localities:—(1) Cheval Paar and other pearl banks, Gulf of Manaar, shallow water; (2) off Galle, Station XXXVIII., 9 to 22 fathoms; (3) Palk Bay, Station XVIII., 7 to 8 fathoms; (4) Periya Paar, Station LV., 1 1 to 24 fathoms; (5) Muttuvaratu Paar, Station VI., 6 to 9 fathoms; (6) Chilaw Paar, Station III., 9 to 14 fathoms. This species was fairly abundant, the collection comprising about 25 specimens; carapace of largest measured 1·1 centims.

Petrolisthes (?) armatus (Gibbes). (See Henderson, 7.)

One damaged specimen, from Galle lagoon, is doubtfully referred to this species.

Length of carapace, 4 millims.; the carpus of both chelipeds is armed with 3 spines; ambulatory legs missing. *P. armatus* is a West Indian species, and so would be a new record for Ceylon.

Petrolisthes serratus, Henderson (7).

Locality:—Coral reef, Galle; one female bearing eggs. Length of carapace 2 centims. This is a new record for Ceylon.

Porcellana serratifrons, Stimpson. (See Henderson, 7.)

Localities:—(1) Pearl banks, Gulf of Manaar, shallow water, five young specimens; (2) south end of Cheval Paar, Station XLIX., 9 to 13 fathoms, one specimen; (3) south of Galle, deep water, Station XLI., 100 fathoms, two specimens; (4) Galle coral lagoon, shallow water, one specimen. Carapace of largest measured 8 millims. This is a new record for Ceylon.

Porcellana quadrilobata, Miers (12).

Localities:—(1) Welligam Bay, Station XXXIV., 2 to 7 fathoms, one specimen; (2) Gulf of Manaar, outside pearl banks, Station LXIII., about 40 fathoms, one specimen; (3) off Mount Lavinia, Station XLVI., 25 to 30 fathoms, two specimens; the carapace of largest measured 5 millims. This is a new record for the Indian Ocean, as the species has only been found on the coast of Queensland.

Porcellana hornelli, n. sp.—Text-fig. 1.

Carapace oval in outline, naked, very convex, a little longer than broad,* and obscurely lineolate; front fairly prominent and four-lobed. The two median lobes—one on each side of the centre—have rounded apices which are minutely notched and are slightly longer and much broader than the two lateral lobes, each of which is triangular, curved, and terminates in a spine.

Eyes small and protruding but little.

Lateral margin of carapace armed with a series of spines. There is a large spine behind the orbit; and very near to it, but still nearer to the eye, is a much smaller one. A little further back are two additional spines, and between them is a rounded lobe bearing a few minute spines.

The external maxillipeds have the ischium a little shorter and broader than the merus. Both these joints are flattened from above, and each has its internal face produced into a rounded lobe.

Chelipeds smooth, obscurely lineolate, and a little longer than the carapace. The merus has its inner border produced into a rounded crest obscurely toothed. Carpus

* In the figure (p. 219) the carapace is shown rather too narrow.

a little longer than broad, also crested internally, the crest being entire. Palm longer than the fingers. Fingers curved, slightly gaping, crossing at their tips and minutely notched on their opposing surfaces (see figure).

Walking legs short and slender, their last two joints bearing a few setæ.

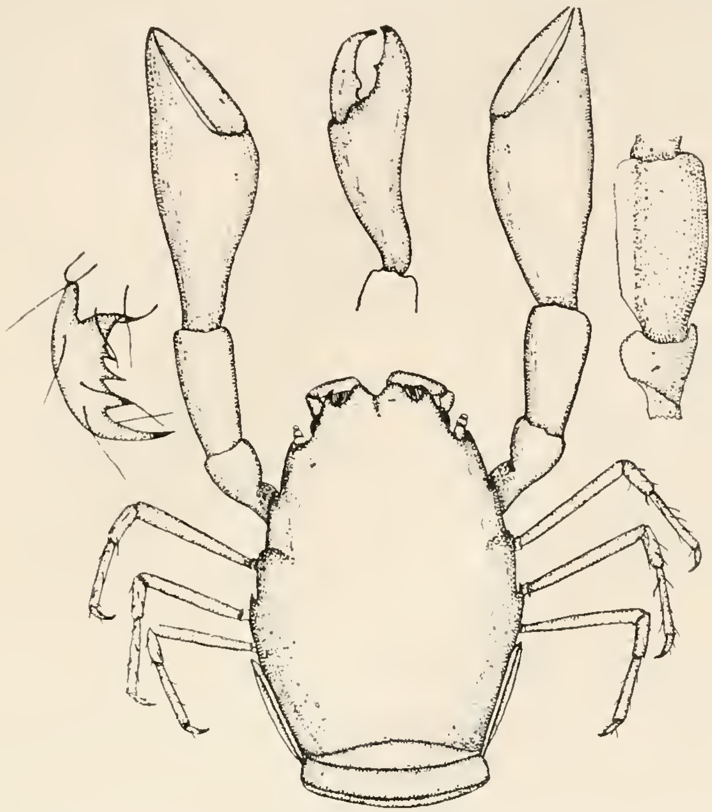

Fig. 1. *Porcellana hornelli*, n. sp., × 7; showing also right cheliped, × 6; merus and carpus of right cheliped, × 8; and dactylus of third left leg, × 30.

Localities:—(1) Aripu reef and other coral banks, Gulf of Manaar, shallow water; (2) Dutch Modragam Paar, Station LVII., 12 to 36 fathoms. Six specimens; length of carapace, 7 millims.; breadth, 6 millims.

This species is named in honour of Mr. James Hornell, F.L.S., who took an active part in making this collection.

Polyonyx biunguiculatus (Dana, 4).

Localities:—(1) Off Mutwal Island, Station LXVII., 10 to 14 fathoms; (2) coral banks, Gulf of Manaar, shallow water. Six males, and one female bearing eggs; length of carapace, 5 millims.

Dana figures the left cheliped of this species a little larger than the right one. Only one of the Ceylon specimens has both chelipeds intact, but in this case the right is very slightly larger than the left. Otherwise the specimens answer to

DANA's description and figure, and the tarsus of the walking legs is very noticeably two-clawed. This is a new record for Ceylon.

Polyonyx obesulus (WHITE). (See MIERS, 12.)

Locality:—Cheval Paar, Gulf of Manaar, shallow water. One specimen; carapace measuring 1 centim. This is a new record for Ceylon.

This and the last species seem so closely related that it is difficult to believe that they are distinct. Some of our Ceylon specimens seem intermediate in their characters.

Pachycheles pulchellus (HASWELL). (See MIERS, 12.)

Localities:—(1) Cheval Paar and other pearl banks, Gulf of Manaar, shallow water, nine specimens; (2) South of Modragam Paar, Station LXIV., 4 to 5 fathoms, one specimen.

Carapace of largest measured 9 millims. In these specimens the penultimate joints of the walking legs bear a few hairs on their external surface, and there is a little variation in the size of the crest on the carpus of the chelipedes.

This is a new record for the Indian Ocean, having only been found previously off the coasts of Australia.

FAMILY: GALATHEIDÆ.

Galathea elegans, WHITE. (See HASWELL, 6.)

Locality:—Chilaw Paar, 8 miles from shore, Station V., 9 to 11 fathoms. One specimen; extreme length 1·9 centims.

Galathea longirostris, DANA (4).

Localities:—(1) North of Cheval, Station LIII., 7 to 9 fathoms; (2) Gulf of Manaar, shallow water. Three specimens; extreme length 2 centims. Colour markings well defined. Brought up adhering to specimens of *Antedon bella*. This is a new record for the Indian Ocean.

Galathea corallicola, HASWELL (6).

Localities:—(1) South of Galle, Station XLI., 100 fathoms; (2) off Kaltura, Station XLIII., 22 fathoms; (3) coral reefs, Gulf of Manaar, shallow water. Six specimens in all; carapace of largest measuring 9 millims. This is a new record for the Indian Ocean.

Galathea australiensis, STIMPSON. (See HASWELL, 6.)

Localities:—(1) South of Galle, Station XLI., 100 fathoms; (2) off Kaltura, Station XLIII., 22 fathoms; (3) Gulf of Manaar, shallow water. In all, five males and two females bearing eggs; carapace of largest measured 1 centim.

In one of the specimens the rostrum was armed with only three teeth on the left side, the right side having four—the normal number. In STIMPSON's original description of this species, from a female, it is stated that the fingers of the chelipeds did not gape. MIERS, describing a male of the same species (see **12**), specially noticed that the fingers in his specimen "had an hiatus between them when closed." In all the Ceylon specimens the fingers are gaping, some more than others; from which one may conclude that this character is of comparatively little importance. This is a new record for Ceylon. I am inclined to agree with MIERS that this and the last species might well be joined as one.

Galathea (?) grandirostris, STIMPSON. (See HENDERSON, **7**.)

Locality:—Dutch Modragam Paar, Station LVII., 12 to 36 fathoms. A damaged specimen, without chelipeds and legs, is doubtfully referred here. Rostrum long, deflexed, triangular, with a broad base, and armed laterally with small teeth; gastric region unarmed; striæ on the carapace numerous and ciliated; length of carapace, 1·6 centims. This is a new record for Ceylon.

Munida japonica, STIMPSON (**18**).

Localities:—(1) Trincomalee, Station XX., 11 to 13 fathoms; (2) south of Galle, Station XL., 34 fathoms; (3) off Kaltura, Station XLIII., 22 fathoms; (4) outside banks in Gulf of Manaar, Station LXIII., about 40 fathoms; (5) Aripu reef, shallow water. Thirteen specimens, including some females bearing eggs; the carapace of the largest measured 1·5 centims.

ORTMANN ('Zool. Jahr.,' Band 6, Abth. f. Syst., 1891–2, p. 254), in giving a detailed description of this species, pointed out that the abdomen was unarmed, and assumed that this was the case in STIMPSON's original specimens, although STIMPSON himself did not describe the abdomen. ORTMANN also noticed that his types differed from those described by STIMPSON in having a large spine at the antero-lateral angle of the carapace.

The Ceylon specimens agree with ORTMANN's description except in the following points:—

(1) The supra-ocular spines are as long as the eye.

(2) The setæ fringing the cornea are short.

(3) The spines in the transverse row on the anterior gastral region vary a little in number. Usually there are 13, consisting of 6 pairs and a median one. In one of the Ceylon specimens there are only 11 spines, the outer pair—normally situated near the edge of the carapace—being absent. In another specimen the median spine is short, blunt and rounded, with another spine behind it in the middle line.

(4) The lateral margin of the carapace is armed with 7 or 8 spines.

(5) The chelipeds vary enormously in length. In the female the fingers of the chelipeds are as long as the palm and scarcely gaping, whilst in the male the fingers

are shorter than the palm and the gape may be very pronounced, or scarcely noticeable.

(6) A few long iridescent hairs occur on the carapace and abdomen.

It might be thought that a variety could be established on these characters, but I prefer to regard them as individual variations. This species is new to the Indian Ocean, being only previously known from Japan.

Munida alcocki, n. sp.—Text-fig. 2.

The rostrum is about one-third the length of the carapace, and has about three regular and minute notches towards the apex. It is slightly sigmoid. The supra-orbital spines are as long as the eye and half the length of the rostrum. A few setæ

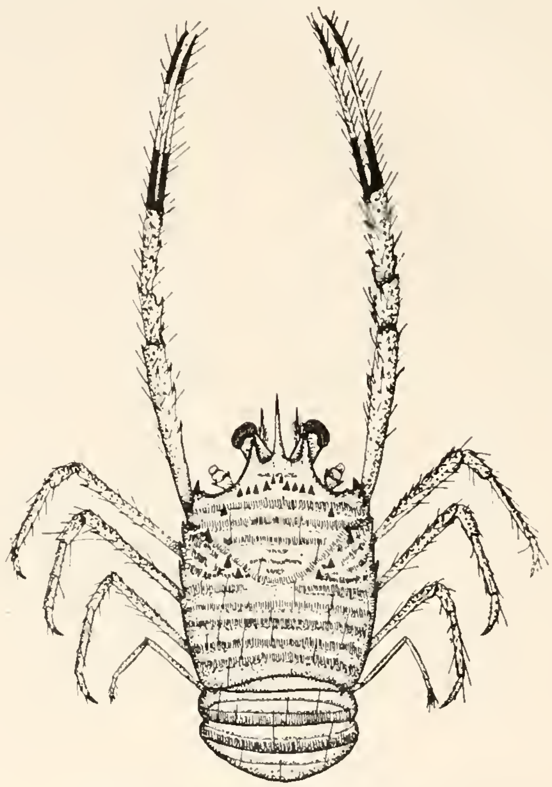

Fig. 2. *Munida alcocki*, n. sp., × 4.

overlap the cornea. The striæ on the surface of the carapace are numerous and pubescent. A few long iridescent hairs arise from the ridges of the thorax and abdomen. There is a transverse row of ten spines at the base of the rostrum. The median pair are situated a little in front of the rest, the second and fourth pairs being a little longer than the third and fifth. Separated from these by the first ciliated line is another pair of spines, situated laterally. Three additional pairs of lateral spines are situated a little behind the cervical groove, making eighteen spines in all. The lateral margin of the carapace is armed with seven spines.

The merus of the third maxilliped bears two large spines at the distal extremity.

The chelipeds are spinose and slender, nearly twice the length of the carapace, and bearing a few hairs. The spines on the merus increase in size distally. The fingers of the chelipeds are cylindrical, acute, slightly incurved, and in spirit specimens are marked with two red bands, one proximal, the other distal.

The walking legs bear a few hairs, and the tips of the anterior pair reach the base of the fingers of the chelipeds.

Localities:—(1) Dutch Modragam Paar, Station LVII., 12 to 36 fathoms; (2) Aripu Reef and elsewhere in Gulf of Manaar, shallow water; 23 specimens. The carapace of the largest individual measured 1·7 centims.

This species bears a general resemblance to *Munida honshuensis*, BENEDICT, in the disposition of the spines on the carapace, but differs from it in having (1) the abdomen unarmed; (2) the carapace a little broader; (3) the possession of long iridescent hairs; (4) the rostrum shorter; and (5) two additional spines on the carapace.

This species is named in honour of Col. ALCOCK, F.R.S., who has done so much to elucidate the Crustacean fauna of the Indian Ocean.

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REPORT

ON THE

FORAMINIFERA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

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[WITH ONE PLATE AND TEXT-FIGURES.]

THE collection of deposits from the various places where dredgings were taken during the Ceylon expedition has revealed, in most cases, a great abundance of Foraminifera, and this is especially true with regard to a few species which in some cases make up the greater part of the deposit. The material which I have worked through for the purpose of this report had been taken mainly from (1) several stations in the Gulf of Manaar, (2) Palk Bay (north of Adam's Bridge), (3) off Trincomalee, and (4) off Galle, to the south of the island. The material from the different dredgings in the Gulf of Manaar has yielded the greatest abundance of species, and that from Galle and the south of the island generally the most interesting forms, especially where, from the 100-fathom line, about 12 miles off the land, the bottom was composed of a unique marine foraminiferal deposit, composed solely of a new species of the genus *Ramulina*. In the shallower waters off Galle, however, foraminifera were much less abundant than at corresponding depths in the Gulf of Manaar.

The deposits examined were mostly from depths of less than 40 fathoms, and the collection consists, therefore, mainly of shallow-water species, and there is but little difference between the various samples, except as regards the numerical proportions in which certain forms occur. One of the most interesting points is the great abundance of *Heterostegina depressa*, which makes up as much as 40 per cent. of one deposit, and often attains a size of 18·5 millims., and *Amphistegina lessonii* is not far behind this in point of numbers. A considerable range of individual variation was noticed, especially as regards the surface markings in such a case as *Amphistegina lessonii*, and this has occasionally given rise to some difficulty in the determination of species.

The total number of species and varieties recorded is 131, belonging to 51 genera, and of these 49 species are recorded for the first time from the seas around India and Ceylon, most of the previous records being from the reports by Murray and Chapman on the deposits obtained by H.M.S. "Investigator" in the Bay of Bengal and the Arabian Sea. Only 15 species have actually been recorded previously from Ceylon, consequently nearly all those mentioned in this report are additions to the fauna of that colony.

In conclusion, I have to thank Professor Herdman for the opportunity given me to examine this interesting collection, and also for his very valuable advice throughout the work.

Note on a New Ramulina Deposit.

Along the 100-fathom line, about 12 miles south of Galle, the dredge brought up quantities of a remarkable and unique foraminiferal deposit, consisting of masses varying in size from a hazel nut to a small apple 5 centims. in diameter, and formed of many stout calcareous tubules. At first sight it would hardly oe taken to be of Protozoan origin ; and, as a matter of fact, a few other animals occur with it. Worm tubes extend into the crevices and wind about the tubules : masses of *Polytrema* and colonies of Polyzoa use the foraminifer as a support, and corals are embedded by its vigorous growth. The result is a substantial marine deposit, which cannot be of small importance in the building up of the ocean floor, and is still another, and probably the most important case in the district, of the part played by foraminifera in contributing to the form of the earth's surface, and in affecting the metabolism of the ocean. This organism has been identified as a very luxuriant and complex growth of a new species of *Ramulina*, which I desire to name after Professor Herdman, by whom it was found and first identified as a *Ramulina* (see "Narrative," this Report, Part I., 1903, p. 51).

The genus *Ramulina* of Rupert Jones, 1875, is defined by Brady in the '"Challenger" Report' as follows:—"Test free, branching ; consisting of a calcareous tube, swollen at intervals so as to form more or less definite, often irregular segments, from which lateral stolons or branches are given off. Texture hyaline." Some alteration will, however, have to be made in this definition of the genus, since this new species is certainly not hyaline. The species described by Brady is *R. globulifera*, and from the description it appears that the swellings referred to in the definition of the genus arise only at intervals, and are connected by tubular portions. In our

Ceylon species, on the other hand, there may be a whole series of globular segments opening directly one into the other.

The generic name was first applied in the 'Report and Proc. Belfast Nat. Field Club,' 1873, by JOSEPH WRIGHT, to two fragmentary specimens, and no definitions were then given. Later, the name was definitely given to the genus by RUPERT JONES, in 1875. BRADY, in 1884, named and described the species *R. globulifera*, and WRIGHT, also in 1884, figured another species, *Ramulina aculeata*, from specimens found in the cretaceous rocks of Kerry, Ireland. Mr. WRIGHT, who was consulted by Professor HERDMAN, at first recognised the resemblance of this species from Ceylon to his *R. aculeata*; but further investigation suggested that it is a new species, and with that opinion Mr. WRIGHT now concurs.

The differences leading to this conclusion are that (1) the spinous processes are not developed to such an extent on the Ceylon species as on *R. aculeata*, and (2) the cretaceous species only occurs in small fragments and does not show the complex and extensive mode of growth seen in this specimen from the Indian Ocean.

This foraminifer consists of a mass of anastomosing calcareous tubes, inextricably commingled, and assuming two principal forms of growth. Many specimens show a long series of globular segments, arranged irregularly, and opening directly into one another by large openings. These globular chambers at intervals give off numerous radiating straight tubes, varying in length from quite small outgrowths to 1·25 centims., with a diameter of 1·5 millims. to 2 millims. These straight portions may run in the same direction, separating but little, and becoming more compact (see text-fig., C), or they may at once diverge and radiate from a common centre.

A. B. C.

Three masses of *Ramulina herdmani*. Natural size.

Eventually they reach either the globular chambers or other straight tubules with which they fuse, the cavities becoming continuous (see also Plate, figs. 1–6).

The radiating straight tubes I shall term the *pipes*, and the globular chambers *ampullæ.* These masses of *Ramulina herdmani* may be in places predominantly ampullate in their mode of growth, as in text-fig. C, which shows an irregular mass of ampullæ opening into one another at different angles, and not lying simply in one and the same plane. In fig. A, on the other hand, the ampullæ are arranged in definite planes (not parallel to one another), and between these planes pass the pipes opening into the ampullæ at either end. The larger piece, shown in fig. B, is almost wholly composed of pipes, with only a suggestion of ampullæ, or perhaps two or three where several pipes open near each other.

The walls of the pipes and ampullæ are strong, calcareous, but not hyaline, and in some places as much as 0·065 millim. in thickness; but about 0·05 millim. is the average. All these walls are uniformly perforate, but the external surface differs in appearance in places, being sometimes quite smooth and elsewhere bearing minute denticles, either sparsely or more closely set. There also seem to be definite larger openings to the exterior, or *mouths* (see Plate, fig. 5). These are quite large openings, about 2·5 millims. across, and are situated where one or two ampullæ meet. They do not occur very frequently.

At such mouths the walls of the ampullæ are prolonged to form 4 to 6 protuberances of unequal size which surround the orifice.

In accordance with this description of the new species, the definition of the genus requires to be somewhat modified—which, however, was necessary before, since the original definition will not include WRIGHT'S *Ramulina aculeata.*

The definition of the genus given by BRADY was quoted above. I should suggest that this be now modified so as to read:—Test free, *or adherent,* branching and *anastomosing;* consisting of a calcareous tube, swollen at intervals to form more or less definite, often irregular segments (*ampullæ*), *opening into one another and being contiguous, or separated and connected by tubules. From these segments straight tubes (pipes) are given off.* Texture hyaline *or opaque.*

The alterations or additions are printed in italics. The definition of the new species will be given at its systematic position in the catalogue that follows.

LIST OF SPECIES.

FAMILY: MILIOLIDÆ.

Biloculina ringens (LAMARCK).

This form occurs rarely in the deposit from Stat.* LXVIII. It has been recorded (2),† (4) from the Indian seas.

Biloculina ringens, var. **striolata**, BRADY.

Of very rare occurrence in material from Stat. LXIV., south of Modragam Paar, depth 5 fathoms. This variety has also been recorded from the Indian seas (2).

* For particulars as to the Stations see "Narrative," this Report, Part I., 1903, p. 17.

† These numbers refer to the bibliography at the end.

Biloculina ringens, var. **denticulata**, Brady.

Of very rare occurrence in material from Stat. LVIII., Gulf of Manaar—a new record for Indian seas.

Biloculina lævis (Defr.).

Of rare occurrence in the Gulf of Manaar. This is a new record for Indian seas.

Miliolina cultrata, Brady.

Occurs frequently at Stats. LVI. to LVIII., near Karativo Paar, 8 to 26 fathoms. Previously recorded by Brady (1) from Ceylon.

Miliolina seminulum (Linn.).

This is common at the same stations as the last, and also off Trincomalee—a new record for Indian seas.

Miliolina scrobiculata, Brady.

This form appears rarely in the sample from Stat. LVII. It is a new record for Indian seas.

Miliolina tricarinata (d'Orb.).

Occurs very rarely at Stats. LVI., LVII. and LXVIII. It has been recorded (2) from Indian seas.

Miliolina auberiana (d'Orb.).

Found in samples from Stats. LVI., LVII. and LVIII., and also from Welligam Bay—previously recorded (2) from Indian seas.

Miliolina insignis, Brady.

This form occurs in material from Stats. LVII. and LXIV.—previously recorded from Ceylon (1) and Indian seas (2).

Miliolina valvularis (Reuss).

Occurs in material from Stat. LVIII., outside Karativo Paar, depth about 20 fathoms. This is a new record for Indian seas.

Miliolina ferussacii (d'Orb.).

Occurs very rarely in the same sample as the last, and is also a new record for Indian seas.

Miliolina circularis, Bornemann.

This form was also present in the material from Stat. LVIII.—recorded previously from Indian seas (2).

Miliolina fichteliana (D'ORB).

Present sparingly at Stat. LVIII., and also at Stat. LVI., off Kodramallai Point, depth 8 or 9 fathoms—a new record for Indian seas.

Miliolina parkeri, BRADY.

Found at Stat. LVIII. This form is usually found associated with coral banks—recorded previously from Indian seas (2).

Miliolina rupertiana, BRADY.

Occurs frequently in material from Stat. LVI.—previously recorded for Ceylon (1).

Miliolina oblonga (MONTAGU).

This form occurs rarely in two samples from the Gulf of Manaar, Stats. LXIV. and LXVIII., both under 20 fathoms; and also at Welligam Bay—previously recorded from Ceylon (1).

Miliolina agglutinans (D'ORB.).

Very rare, and occurs only at Stat. LXIV. This is a new record for Indian seas.

Miliolina reticulata (D'ORB.).

Occurs sparingly between E. and W. Cheval paars at about 6 to 7 fathoms—previously recorded from Indian seas (2).

Miliolina terquemiana, BRADY—Plate, figs. 9 and 10.

This species, described by BRADY for the first time in the '"Challenger" Report' (1), is noted as being exceedingly rare, and known only from Calpentyn, Ceylon, and the East Coast of Madagascar. It has been recorded so far from no other place in the Indian Ocean. One specimen only was present in our collection, and it was found in a deposit from the southern part of the Gulf of Manaar, only a few miles to the north of Calpentyn, where it was originally found. It is in excellent preservation and is rather larger than BRADY's specimen, the length being 0·76 millim. This rare Ceylon specimen is shown in figs. 9 and 10 on the Plate.

Spiroloculina grata, TERQUEM.

This is common in deposits from Stats. LVI and LXIV. It is a coral bank species, and has been previously recorded from Indian seas (2).

Spiroloculina limbata, D'ORB.

Frequent in deposits from Stats. LVIII. and LVI.—previously recorded from Indian seas (2).

Spiroloculina fragilissima, BRADY.

One specimen in material from Stat. LVIII.—a new record for Indian seas.

Spiroloculina arenaria, Brady.

This species occurs in material from Stat. LVIII.—previously recorded from Indian seas (2).

Spiroloculina crenata, Karrer.

Of very rare occurrence in the deposit from Stat. LVI.—a new record for Indian seas.

Hauerina ornatissima, Karrer.

Very rare in material from Stat. LXIV., S. of Kodramallai. This is a new record for Indian seas.

Hauerina complanata, n. sp.—Plate, fig. 7.

This species has the characteristic planospiral porcellaneous test, milioline only in the very early convolutions. It is very thin, with practically circular convolutions. Four of these, with indications of a fifth, are present; the outer, or last, consisting of four chambers. Diameter of specimen, 0·62 millim. This species differs from *H. compressa* in being more regular and even more compressed; the number of convolutions also appears to be greater and a larger number of chambers is present. Several specimens occur in deposits from Stat. LVIII., Gulf of Manaar.

Articulina sagra, d'Orb.

Occurs frequently in deposits from Stats. LXVIII., LXIV. and LVII. This is a new record for Indian seas.

Vertebralina striata, d'Orb.

Occurs rarely in the Gulf of Manaar—a new record for Indian seas.

Peneroplis pertusus, var. **arietinus**, Batsch.

This occurs very commonly in the deposit from Stat. LVII., and less frequently at Stat. LVI.

Peneroplis pertusus, var. **planatus** (Fichtel and Moll).

This variety is much less common than the above, and occurs rarely at Stat. LVII. These are both new records for Indian seas.

Orbiculina adunca (Fichtel and Moll).

This species is of somewhat rare occurrence in the Gulf of Manaar—previously recorded for the Indian Ocean (1).

Orbitolites marginalis (Lamk.).

One of the most common of foraminifera in the shallower deposits, but less frequent in the deeper ones. It is common, however, in all. Previously recorded from the Indian Ocean (2).

Orbitolites duplex, Carpenter.

Occurs rarely at Stat. LVII—a new record for Indian seas.

Alveolina melo (Fichtel and Moll).

This is exceptionally common in the shallow-water deposits, and makes up a large percentage of the material. In most cases also the size is above the average, the length reached being 22·5 millims. It occurs at Stats. LXIV., LVI., LVIII.; off Trincomalee and Chilaw; but is especially common in the deposit from Stat. LXVIII.

Alveolina boscii (Defr.).

This is frequent in the same deposits as the species *A. melo*. Both have been previously recorded from the Indian Ocean (2).

Family: ASTRORHIZIDÆ.

Technitella legumen, Norman.

Of very rare occurrence from the Gulf of Manaar—a new record for the Indian seas.

Saccammina spherica, Sars.

Of rare occurrence at Stats. LVI. and LVIII.—previously recorded from Indian seas (2).

Rhizammina, sp.?

One specimen from Gulf of Manaar. The species *R. indivisa* has been previously recorded from Indian seas (2).

Sagenella frondescens, Brady.

Of rare occurrence in deposits off Chilaw. This is a new record for Indian seas.

Family: LITUOLIDÆ.

Reophax difflugiformis, Brady.

Occurs somewhat frequently in Gulf of Manaar—previously recorded from Indian seas (2).

Haplophragmium canariense (d'Orb.).

Only one specimen in material from Stat. LVIII.—previously recorded from Indian seas (2).

Carterina spiculotesta (Carter).

One specimen was found in the deposit from Stat. LXIV. in Gulf of Manaar. This is of interest since the specimens described by Carter came from the same place (1).

Family: TEXTULARIIDÆ.

Textularia gramen, d'Orb.

Occurs in deposits from Stats. LVIII., LVII., LXIV., and LXVIII.—previously recorded from Indian seas (2).

Textularia agglutinans, d'Orb.

Of frequent occurrence at Stats. LVIII., LVII., and LVI.—previously recorded from Indian seas (2).

Textularia transversaria, Brady.

Occurs rarely at Stat. LVIII. A new record for Indian seas.

Textularia quadrilatera, Schwager.

Occurs rarely at Stat. LVII. This also is a new record for Indian seas.

Textularia sagittula, Defrance.

Occurs rarely in the Gulf of Manaar, at Stat. LVI.—previously recorded from Indian seas (2).

Textularia sagittula, var. **fistulosa**, Brady.

This variety is of more frequent occurrence than the above, and is probably a tropical variation of it. It was found in the Gulf of Manaar—previously recorded from Indian seas (2).

Verneuilina spinulosa, Reuss.

Occurs rarely at Stats. LVII. and LVI. in Gulf of Manaar—previously recorded from Ceylon (1).

Chrysalidina dimorpha, Brady.

Found sparingly at Stat. LVIII.—recorded previously from Ceylon (1).

Clavulina communis, d'Orb.

Very rare at Stat. LVIII. Has been previously recorded from Indian seas (2).

Gaudryina subrotundata, Schwager.

This is of moderate frequency in several deposits in the Gulf of Manaar—previously recorded from Indian seas (2).

Bulimina elegantissima, var. **seminuda,** Terquem.

This form is of rare occurrence at Stat. LVIII.—has been previously recorded from Ceylon (1).

Bolivina punctata, d'Orb.

This is of fairly frequent occurrence at Stats. LVI. and LXIV. It has been already recorded from Indian seas (1), (2).

Bolivina textularioides, Reuss.

Of rare occurrence in the Gulf of Manaar—previously recorded from Indian seas (2).

Bolivina limbata, Brady.

Of rare occurrence in the deposit from Trincomalee, W.N.W. of Foul Point, 8 fathoms—previously recorded from Indian seas (2).

Family: LAGENIDÆ.

Lagena sulcata (Walker and Jacob).

Of very rare occurrence at Stat. LVI.—recorded previously from Indian seas (2).

Lagena globosa (Montagu).

Rare in deposit from Stat. LVI.—recorded previously from Indian seas (2).

Lagena lævis (Montagu).

Of very rare occurrence in deposit from Stat. LXIV., and also from Welligam—recorded previously from Indian seas (2).

Lagena lagenoides (Williamson).

This is of very rare occurrence in the deposit from Stat. LXVIII.—recorded previously from Indian seas (2).

Lagena castrensis, Schwager.

This form is very rare in the deposit from Stat. LVIII., and also from Welligam Bay—recorded previously from Indian seas (2).

Lagena orbignyana (Seguenza).

This form is also very rare in the Gulf of Manaar.

Lagena staphyllearia (Schwager).

Of very rare occurrence in the Gulf of Manaar.

Lagena marginata, var. **semimarginata,** Reuss.

Of very rare occurrence in the Gulf of Manaar deposits. The last three species of *Lagena* have all been previously recorded from the Indian seas (2).

Lagena elcockiana, MILLET (3).

Only one specimen found in a deposit from the Gulf of Manaar. This is a new record for Indian seas. Previous occurrence in the Malay Archipelago (3).

Nodosaria obliqua (LINN.).

This species occurs sparingly at Stat. LVIII., but is more frequent at Stat. LVI., both in the Gulf of Manaar. Recorded previously from Indian seas (2).

Nodosaria cylindracea, n. sp.—Plate, fig. 8.

The test of this species is elongate, and cylindrical, 0·85 millim. in length, and terminates in a rounded apex. Chambers, about nine in number, arranged in a straight line, and separated by unconstricted sutures, which have the appearance of a series of depressions. Surface with fine longitudinal ribs, about eighteen in number, and marked with minute striæ between them. Aperture, a round opening with a slight lip in the centre of the last segment.

It is possible that this is a new species of the genus *Sagrina*, in which the early spiral arrangement has been lost, but no trace of this is seen in the specimen.

Of very rare occurrence in the Gulf of Manaar.

Nodosaria raphanus (LINN.).

This form occurs somewhat frequently in the Gulf of Manaar. Recorded previously for Indian seas (2).

Nodosaria intercellularis, BRADY.

Occurs sparingly at Stats. LVIII., LVII., and LVI. This is also previously recorded from Indian seas (2).

Nodosaria perversa, SCHWAGER.

Of rare occurrence in the Gulf of Manaar—a new record for Indian seas.

Nodosaria simplex, SILV.

Of very rare occurrence in Gulf of Manaar at Stat. LXIV.—a new record for Indian seas.

Nodosaria hispida, D'ORB.

This species is of rare occurrence in the Gulf of Manaar. This is also a new record for Indian seas.

Nodosaria scalaris, var. **separans**, BRADY.

Rare in the deposit from Stat. LXIV. This has been recorded from the Indian seas already (2).

Cristellaria tricarinella, Reuss.

Of very rare occurrence in the deposit from Stats. LVIII. and LVI. This is a new record for the Indian seas.

Cristellaria rotulata (Lamk.).

This is of rare occurrence in the Gulf of Manaar—previously recorded from Indian seas (2).

Cristellaria orbicularis (d'Orb.).

Occurs very rarely in the samples from Stat. LVI.—previously recorded from Indian seas (2).

Cristellaria vortex (Fichtel and Moll).

This is of rare occurrence in the deposit at Stat. LXIV. This is a new record for Indian seas.

Polymorphina regina, Brady, Parker and Jones.

Occurs very rarely in material from Stat. LXIV.—a new record for Indian seas.

Uvigerina aculeata, d'Orb.

This is of frequent occurrence at Stat. LXIV. in some hauls—previously recorded from Indian seas (2).

Uvigerina asperula, Czjzek.

Of rare occurrence at Stat. LVIII. This species is previously recorded from Indian seas (2).

Uvigerina pygmæa, d'Orb.

Found sparingly at Stat. LVII., and also at Welligam Bay. Also recorded before from Indian seas (2).

Sagrina raphanus, Parker and Jones—Plate, fig. 11.

Found sparingly at Stat. LVI., and also off Trincomalee—previously recorded for Ceylon (1). The specimen figured differs from the normal type by having the test bent almost at right angles in the fifth chamber from the terminal one. This appears due to greater growth having taken place on one side than on the other during the formation of this chamber.

Sagrina striata, Schwager.

Of rare occurrence in the Gulf of Manaar—a new record for Indian seas.

Ramulina herdmani, n. sp.—Plate, figs. 1–6, and also text-figs., p. 227.

Tubules anastomosing so as to form a large adherent mass. Chambers or ampullæ numerous, connected by tubules or contiguous and aggregated. Walls strong, calcareous, not hyaline, and only slightly spinose on the surface. Length of an average pipe 1 centim., diameter of an average ampulla 1·8 millims., masses up to 9 centims. in length. (See also p. 226.)

Family: GLOBIGERINIDÆ.

Globigerina bulloides, d'Orb.

This is a common form in all the deposits examined—previously recorded from Indian seas (2) (4).

Globigerina sacculifera, Brady.

Of very rare occurrence at Stat. LVI.—previously recorded from Indian seas (2) (4).

Globigerina cretacea, d'Orb.

Of very rare occurrence at Stats. LXVIII. and LVI.—previously recorded from Indian seas (2).

Orbulina universa, d'Orb.

Rare, found in material from Stat. LVI.

Hastigerina pelagica, d'Orb.

Of very rare occurrence at Stat. LVII. Both the two last named have been previously recorded from Indian seas (2) and (4).

Family: ROTALIIDÆ.

Spirillina limbata, Brady.

Common in deposits from Stat. LVII.—a new record for Indian seas.

Spirillina obconica, Brady.

Of rare occurrence from Galle and Station LXIV.—a new record for Indian seas.

Spirillina inæqualis, Brady.

Of rare occurrence at Galle and Stat. LVI.

Spirillina vivipara, Ehrenberg.

This occurs rarely in deposits from Stats. LVIII. and LVII.—previously recorded from Indian seas (1).

Spirillina decorata, Brady.

Of very rare occurrence at Stat. LVI. With the exception of *S. vivipara*, these are all new to Indian seas. They have all been recorded by Egger (5) from Mauritius.

Cymbalopora poeyi (D'ORB.).

Occurs rarely at Stat. LVI., and also off Trincomalee—previously recorded from Indian seas (2).

Discorbina rosacea (D'ORB.).

Occurs frequently at Stats. LVIII. and LXIV. This has been recorded from Indian seas (2).

Discorbina orbicularis (TERQUEM).

Of common occurrence at Stats. LVII., LXIV., and LXVIII., in the Gulf of Manaar. This is a new record for Indian seas.

Discorbina bertheloti, var. **baconica**, HANTK.

Found sparingly in deposits from Stats. LVII. and LVI., and, like the last, is a new record for Indian seas.

Discorbina patelliformis, BRADY.

Found rarely in the Gulf of Manaar. It has been already recorded from Ceylon (1).

Discorbina saulcii (D'ORB.).

Occurs rarely in the Gulf of Manaar—a new record for Indian seas.

Discorbina vilardeboana (D'ORB.).

This occurs very rarely in the Gulf of Manaar, and is probably a variety of *D. rosacea*. It is a new record for Indian seas.

Truncatulina ungeriana (D'ORB.).

Of rare occurrence in the deposits from the Gulf of Manaar—previously recorded from Indian seas (2).

Truncatulina rostrata, BRADY.

Occurs rarely in deposits from Stat. LVIII. in the Gulf of Manaar—a new record for Indian seas.

Truncatulina lobatula (WALTER and JACOB).

This species is very rare in the deposit from Stat. LXVIII.—already recorded from the Indian seas (2).

Truncatulina tenera, BRADY.

This species occurs somewhat frequently in the Gulf of Manaar. It is also a new record for Indian seas.

Anomalina ammonoides (Reuss).

Occurs frequently in deposits from Stats. LVII. and LVIII.—previously recorded from Bombay (1).

Anomalina gosserugosa (Gümbel).

This species is much more rare than *A. ammonoides*, but occurs in the same deposits—previously recorded from Indian seas (2).

Anomalina ariminensis (d'Orb.).

Of very rare occurrence at Stat. LVI.—a new record for Indian seas.

Pulvinulina menardii (d'Orb.).

Very common at Stats. LVI., LVII., LVIII., LXIV. and LXVIII.—previously recorded from Indian seas (2), (4).

Pulvinulina brongniarti (d'Orb.) (4).

This species occurs rarely in the deposit from Stat. LVII.—previously recorded from Mauritius (5) and Malay Archipelago (3)—a new record for Indian seas.

Pulvinulina umbonata, Reuss.

Occurs rarely in material from Stat. LVIII. This is a new record for Indian seas—previously recorded from Mauritius (5).

Pulvinulina oblonga (Williamson).

Of rare occurrence at Stats. LXVIII. and LVI.—previously recorded from Indian seas (2).

Rotalia calcar, d'Orb.

This species is of very common occurrence at Stats. LVI., LVII., LVIII., and also from Welligam Bay and Galle—recorded already from Ceylon (1) and Indian seas (2).

Calcarina hispida, Brady.

Of very common occurrence in all samples examined from Stats. LVIII., LVII., LVI., LXIV., and LXVIII., also off Galle and Trincomalee—previously recorded from Indian seas (2).

Calcarina defrancii, d'Orb.

This occurs somewhat sparingly at Stats. LVI. and LVIII.—a new record for Indian seas.

Calcarina spengleri, Linn.

Of rare occurrence at Stat. LVIII. This is also a new record for Indian seas, but has been recorded from Mauritius (5).

Planorbulina larvata, PARKER and JONES.

Occurs sparingly at Stats. LXIV. and LVII. It has been recorded from Indian seas previously (2).

Planorbulina mediterranensis, D'ORB.

This is of rare occurrence at Stats. LXVIII. and LVIII.—a new record for Indian seas; recorded previously from Mauritius (5).

Gypsina inhaerens (SCHULTZE).

Occurs rarely at Stat. LVII. This is a new record for Indian seas; recorded from islands south of New Guinea and from the European coast (1).

Carpenteria utricularis, CARTER.

Occurs on calcareous Algæ from the Gulf of Manaar and also off Galle. Recorded previously from the Gulf of Manaar (7).

Polytrema miniaceum, LINN.—Plate, fig. 12.

Of very frequent occurrence, and forming at Stat. LXVIII. quite a large proportion of the foraminifera. Also found at Stats. LVI., LVII., LVIII., and LXIV. A fine specimen is figured. Recorded previously from Ceylon (CARTER, 7).

Polytrema miniaceum, var. **alba**, CARTER.

Of rare occurrence in deposits from Stat. LVIII.—recorded previously from Gulf of Manaar by CARTER.

FAMILY: NUMMULINIDÆ.

Nonionina boueana, D'ORB.

Of very rare occurrence, from stations in the Gulf of Manaar. This is the first record for Indian seas; previously recorded from the Red Sea (1) and Mauritius (5).

Polystomella crispa (LINN.).

Very common in all the deposits examined from Stats. LVIII., LVI., LVII., LXIV. and LXVIII., also from Trincomalee, Welligam Bay and Galle—previously recorded from Indian seas (2).

Polystomella craticulata (FICHTEL and MOLL).

Of very rare occurrence at Stat. LVII. This is the first record for Indian seas; recorded already from Mauritius (5) and Red Sea (1).

Amphistegina lessonii, D'ORB.—Plate, fig. 13.

This is extremely abundant in all the deposits, and forms about 25 per cent. by weight and volume of the deposit from a haul at Stat. LXIV. Its surface markings are extremely variable ; one of the varieties is figured and this specimen was not in any way water worn. Noted from Stats. LVI., LVII., LVIII., LXVIII., and other hauls at Stat. LXIV., also off Galle, Trincomalee and Chilaw. Recorded from the Indian seas previously (2).

Amphistegina radiata (Fichtel and Moll).

Rather rare, from Gulf of Manaar. Recorded by Chapman (2) from Arabian seas.

Heterostegina depressa, d'Orb.—Plate, fig. 14.

This is the most abundant foraminifer at practically all the stations. Its size is on the whole above the average, often attaining a diameter of 18·5 millims., and it gives therefore the chief character to the deposit. On these grounds a figure is given here (fig. 14) from one of the most perfect specimens. Occurs at Stats. LVI., LVII., LVIII., LXIV., LXVIII., and off Galle, Trincomalee and Chilaw. Previously recorded from Ceylon (1) and Indian seas (2).

Operculina complanata (Defr.).

Occurs sparingly at Stats. LVII. and LXIV.—previously recorded from Indian seas (2).

Operculina complanata, var. **granulosa**, Leymerie.

This variety occurs somewhat frequently in the Gulf of Manaar. Like the previous species, it has been already recorded from Indian seas (2).

LIST OF WORKS REFERRED TO.

(1.) BRADY.—Report on the Foraminifera collected by H.M.S. "Challenger."

(2.) CHAPMAN.—"Foraminifera obtained by H.M.S. 'Investigator' near the Laccadive Islands." 'Proc. Zool. Soc.,' 1895, pt. i.

(3.) MILLET.—"Foraminifera of the Malay Archip." 'Journ. Microscop. Soc.' 1889-1902.

(4.) MURRAY.—"List of Forams. collected in Bay of Bengal." 'Scottish Geographical Mag.' 1889.

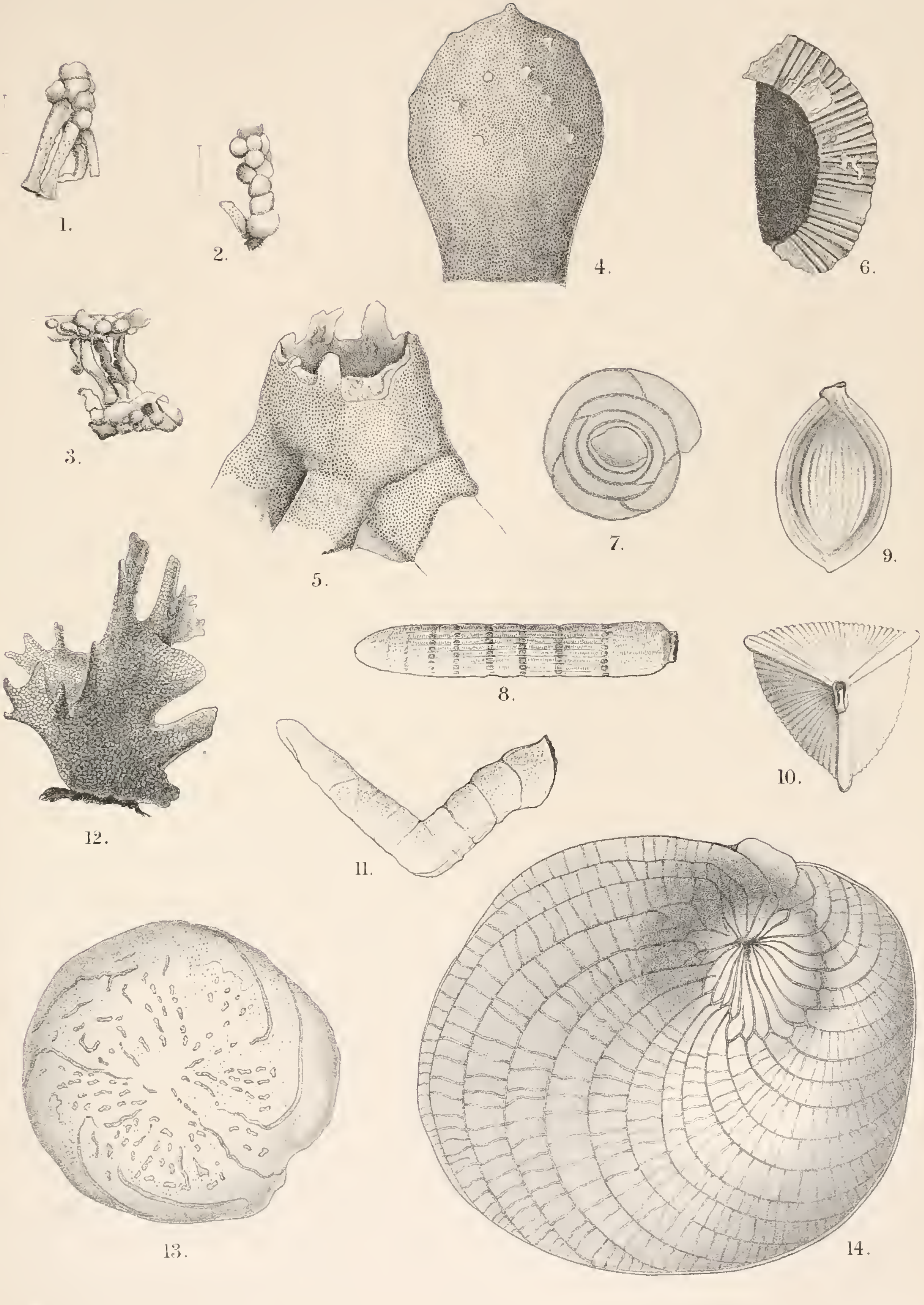
(5.) EGGER—'Abhandl. k. Bayer. Akad. Wiss. München.' 1893.

(6.) FLINT.—"Recent Foraminifera." 'Report U.S. Nat. Mus. for 1897.'

(7.) CARTER.—'Ann. and Mag. Nat. Hist.' June and July, 1880.

EXPLANATION OF THE PLATE.

Fig. 1. Specimen of *Ramulina herdmani*, n. sp., showing relation of ampullæ to pipes. × 2.
,, 2. Another specimen, showing a series of ampullæ. × 2.
,, 3. Specimen to show ampullæ in two planes connected by pipes. × $\frac{3}{2}$.
,, 4. An ampulla, to show surface. × 19.
,, 5. "Mouth" on an ampulla, showing processes. × 16.
,, 6. Section showing wall of an ampulla. × 22.
,, 7. *Hauerina complanata*, n. sp. × 48.
,, 8. *Nodosaria cylindracea*, n. sp. × 73.
,, 9. *Miliolina terquemiana*, BRADY. × 47.
,, 10. The same, oral view. × 47.
,, 11. *Sagrina raphanus*, PARKER and JONES, abnormal. × 58.
,, 12. *Polytrema miniaceum*, LINN., large specimen. × 8.
,, 13. *Amphistegina lessonii*, D'ORB. × 20.
,, 14. *Heterostegina depressa*, D'ORB. × 23.



W. J. D. del.

M'Farlane & Erskine Lith. Edinr

REPORT

ON

JOUSSEAUMIA

A NEW GENUS OF EULAMELLIBRANCHS COMMENSAL WITH THE CORALS HETEROCYATHUS AND HETEROPSAMMIA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH THREE PLATES.]

IN a very interesting paper describing the true nature of the commensalism between corals of the genera *Heteropsammia* and *Heterocyathus* and a Sipunculid belonging to the genus *Aspidosiphon*, E. L. BOUVIER (4) pointed out that there is a third partner in the commensalism in the form of a minute Lamellibranch which he figured and named *Kellia deshayesi*, without, however, giving any diagnosis of the species. As I shall point out in the course of this report, BOUVIER'S figure, though it gives a correct enough representation of the external form of the Mollusc, as seen lying in the left valve of its shell, is incorrect in the representation of the hinge teeth, and the Lamellibranch in question certainly does not belong to the genus *Kellia*, differing from it not only in the hinge teeth, but also in the sutural unions of the mantle edges and in other important particulars. Though BOUVIER announced that his colleague M. JOUSSEAUME intended to make a study of this commensal Lamellibranch, it does not appear to have been described or to have attracted any further notice until Dr. A. E. SHIPLEY in his report on the Gephyrea collected by Professor HERDMAN in Ceylon (13) mentioned its occurrence along with *Aspidosiphon* in the basal chambers of *Heteropsammia* and *Heterocyathus*, and states that it was referred by Mr. E. A. SMITH to ANGAS' genus *Mysella*.

Among the solitary corals from Ceylon sent me by Professor HERDMAN were numerous spirit-preserved specimens of *Heteropsammia michelini* and *Heterocyathus æquicostatus*, and on opening the *Aspidosiphon* chamber in one of these I was at once struck by the presence of the numerous small Lamellibranchs, many of them imbedded in the skin of the posterior part of the body of the Sipunculid, as described by BOUVIER; others lying free in the innermost coils of the chamber, especially in its terminal part.

Having many specimens of the corals at my disposal, I examined a large number of them and invariably found a number of the Lamellibranchs inhabiting the *Aspidosiphon* chamber. In some of the larger specimens of *Heteropsammia* I found as many as 30 or 35 specimens of different ages, in some of the smaller specimens of *Heterocyathus* not more than a dozen or fifteen.

BOUVIER left it an open question whether the commensal Mollusc was an adult form or not. My observations quickly showed me that a proportion of the specimens inhabiting each coral were adult, and that along with them were numerous young forms in all stages of growth. With the abundant material at my disposal I proceeded to make a careful study of the anatomy, and, as far as the circumstances allowed, the development of this hitherto undescribed species, and although but few out of the many specimens were sufficiently well preserved to admit of satisfactory microscopical examination, I found a sufficient number in good enough condition to enable me to work out the structure in some detail.

DESCRIPTION OF THE GENUS AND SPECIES.

The description of the genus *Mysella* given by ANGAS (1) is based on the characters of the shell only, and his figure of the hinge apparatus is so small that it is difficult to make out the characters of the hinge teeth clearly, but it is evident that the species commensal in the two corals cannot be referred to his genus.

The specimen on which the genus *Mysella* was founded was 7·5 millims. in length, and was found in black mud near Port Jackson. The shell is inequilateral, the anterior side being the shorter and subtruncate; judging by the figure, the umbones are prosogyrous. The ligament is internal, and there is a single small diverging subcircular flattened cardinal tooth in one valve, and two short thin horizontal lateral processes in the other valve.

My specimens agree with *Mysella* in having an internal ligament, and in having a single cardinal tooth in the right valve and two teeth in the left valve; but there are in addition well-developed lateral teeth, and the shape of the shell is quite different. Moreover, the largest of my specimens does not exceed 1·5 millims. in length and the average length of the adult forms is 1·0 millim.

It is extremely difficult to get a clear view of the hinge teeth in very small bivalve shells. BERNARD (3) has remarked on the unsatisfactory results obtained from dry specimens mounted on black paper and recommends fixing them direct on a glass slide and varying the sub-stage illumination. I found that much the most satisfactory results were obtained by thoroughly cleaning the shells in potash or Eau de Javelle and then mounting them under a coverslip in glycerine jelly. By altering the sub-stage illumination and rotating the stage one can get very clear pictures of the minutest details.

After a careful examination of the shells and of the anatomy of my specimens, I satisfied myself that they belonged to two species of a new genus, which I propose to call *Jousseaumia*, in honour of the French naturalist who first discovered this Mollusc in the *Aspidosiphon* chamber of the two above-named corals. This new genus and the two species may be defined as follows :—

Jousseaumia, n. gen.

Shell small, thin, triangular, equivalve, inequilateral, the anterior side the longer, with numerous fine concentric ridges or striations; umbones small, slightly opisthogyrous. Hinge heterodont, with a somewhat elongately oval internal ligament; a single styliform more or less obtusely pointed cardinal tooth in the right valve and two curved lamellate cardinal teeth in the left valve. Lateral teeth somewhat distant, elongate, in the form of two ridges in the left valve fitting into corresponding depressions in the right valve. Adductor impressions subequal, the anterior impression somewhat elongated; pallial line entire. Mantle largely open, with a single pallial suture; no pallial tentacles and no distinct siphons. The foot elongate, linguiform, geniculate, with a byssus consisting of a few long adhesive threads; a byssal groove on the posterior edge of the foot. Gills astartiform, homorhabdic, non-plicate, with three or at most four rows of simple interfilamentar junctions. Interlamellar junctions few, irregular; the external demibranch wanting; the reflected lamellæ of the inner demibranch more or less developed, generally at the anterior end of the gill only and attached to the sides of the foot. Hermaphrodite and protandric.

Jousseaumia heterocyathi, n. sp.

The single cardinal tooth of the right valve bluntly rounded at its extremity, with a narrower pedicle of attachment. The anterior cardinal tooth of the left valve well developed, lamella curved posteriorly; the posterior cardinal tooth a short, ill-defined diverging ridge. Found only in *Heterocyathus*.

Jousseaumia heteropsammiæ, n. sp.

The single cardinal tooth of the right valve styliform, with a bluntly pointed extremity and a broad base of attachment. The posterior cardinal tooth of the left valve well developed, longer than the anterior tooth, diverging posteriorly, its upper margin excavated to form the ligamentar fossa. Found only in *Heteropsammia.*

The differences in the cardinal teeth between the specimens found in *Heterocyathus* and those found in *Heteropsammia* appear to be constant, and are sufficient to justify my ranking them as distinct species. In addition, the mature individuals of *J. heterocyathi* seem to be rather smaller, the concentric ridges seem to be more prominent and the posterior and ventral margins of the valves appear to be more rounded than in *J. heteropsammiæ.*

As may be seen from an inspection of figs. 2 and 3, the ligament is distinctly dorsal and exterior to the posterior cardinal tooth of the left valve, and is contained in a fossa lying just behind the umbones. The hinge, therefore, is not that of a *Mactra*, to which it has a superficial resemblance from the characters of the lateral teeth, nor yet that of a *Scrobicularia* or *Syndosmya.* It may rather be compared with the hinge of a *Lucina* or *Diplodonta* in which the ligament has become very much shortened and enclosed by the overgrowth of the valve margins dorsally and posteriorly. On the other hand, the excavation of the posterior cardinal tooth suggests a first step in the evolution of the spoon-shaped ligamentar tooth of the Myidæ and many of the Anatinacea (*Thracia, Anatina*), and, as will be seen, the anatomy of *Jousseaumia* suggests some affinities with the Anatinacea.

ANATOMY AND HISTOLOGY.

As *Jousseaumia heterocyathi* and *J. heteropsammiæ* do not differ from one another in any important anatomical feature, the following account will apply to both species. A general view of the anatomy of *J. heterocyathi*, as seen in optical section, is given in fig. 1.

The mantle edge is thickened and muscular, but there are no pallial tentacles, no eyes or pigment spots. There is a single pallial suture (figs. 16, 17, 18, *p.s.*) separating a rather elongate anal or exhalant orifice from the large pedo-branchial orifice, the latter extending as far forward as the anterior adductor muscle. The mantle edges are somewhat prominent and the radiating muscle fibres are rather better developed in the region of the anal orifice than elsewhere, but there is no true anal siphon.

The foot is large, more or less linguiform, and geniculate like that of *Cardium.* There is a specially strong muscular band running down the posterior margin of the foot, below the byssus groove, and the sudden contraction of these fibres would have the effect of straightening the foot and enabling the animal to spring like a *Trigonia* or a cockle. It is difficult to conjecture of what use the geniculate and muscular foot can be to an animal leading a sedentary existence embedded in the skin of the *Aspidosiphon* with which it is commensalistic; but as I find it very well developed in the youngest forms, I suspect that these may escape from the *Aspidosiphon* chamber and use the foot for progression and for springing on and attaching themselves to an *Aspidosiphon* when projected from the basal aperture of another coral. At all events, there must be some means by which *Jousseaumia* can be transferred from coral to coral, and the highly developed musculature of the geniculate foot suggests that the transference is effected in this manner. The anterior and posterior retractors of the foot are well developed and together form an elongated muscular band, by which the foot appears to be slung up in the mantle cavity. Practically the whole of the viscera are dorsal to this band. The protractor muscle of the foot is also well developed and has a separate muscular slip ventral to the anterior adductor muscle, and it is evident that, in spite of its sedentary habit, *Jousseaumia* shows no degeneration in the organs of progression.

The attachment of the young forms to an *Aspidosiphon* inhabiting another coral would be effected by means of the byssus, which has the form of a moderately stout thread, branching and ending distally in adhesive enlargements. The posterior edge of the foot is furrowed by a well-marked byssus groove leading into a byssus cavity at the hinder end of the foot. As the structure of the byssus gland and the mode of formation of the byssus has been a subject of dispute, and as some of my specimens were sufficiently well preserved to enable me to make tolerably accurate observations, I shall describe the histology of this organ in some detail. The whole of the centre of the foot is occupied by a core of more or less polygonal relatively large glandular cells which appear pale in sections stained with borax-carmine and picro-indigo-carmine, but stain deeply in hæmatoxylin or safranin. With the last-named dye the gland cells stain brilliant scarlet, and the stain is shown by high powers of the microscope to be confined to minute granules with which the cells are stuffed. The behaviour of these cells and granules will be described later. The byssus groove begins as a very shallow furrow near the pointed extremity of the foot, and gradually deepens as it passes dorsally along the posterior edge of the foot, eventually ending in a duct which enlarges to form a considerable byssus cavity contained in the upper part of that organ. Fig. 4 is a section taken through the open part of the groove near the middle of the foot. It shows the structure described by CARRIÈRE (5) and HORST (8), namely, a furrow of irregular shape opening to the exterior, and in the depth of the furrow a crescentic gutter or demi-canal ("halbmondförmige Rinne") bounded on either side by a projecting fold. Contrary to the statements of previous authors, I find in *Jousseaumia* that the furrow is lined by a low, non-ciliated epithelium continuous with that of the external surface of the foot. This epithelium has a distinct cuticle, staining blue in picro-nigrosin or picro-indigo-carmine, and though I am unwilling to make a positive assertion in consequence of the indifferent state of preservation of my specimens, I can say that I was unable to find any trace of cilia either in the furrow or on the external surface of the foot. The crescentic demi-canal, on the other hand, is lined by larger cubical or short columnar cells, with clear cell contents and rounded nuclei, and these cells are very distinctly ciliated. Fig. 5 represents a section taken through the duct of the byssus cavity, shortly above the point where the lips of the furrow have united to enclose a canal. It can easily be seen that the duct consists of two portions, (*a*) a lower portion whose epithelium is continuous with that of the open furrow and, like it, is non-ciliated and provided with a cuticle; the walls of this region are thrown into a number of folds; (*b*) an upper portion continuous with the crescentic demi-canal, and lined by the same clear ciliated cubical or columnar cells. Fig. 6 represents a section through the middle of the byssus cavity. At the upper (really the anterior) end of the cavity is the crescentic demi-canal lined by the same clear ciliated cells as before. The remainder of the cavity is broken up by septa, of which two thick folds on either side of the demi-canal, a central partition springing from the lower (posterior) end of the cavity, and two minor lateral folds may be particularly noticed. These septa are covered by a ciliated epithelium, evidently of the same nature as that lining the demi-canal, but the cells are very much elongated and enlarged at their outer extremities. Those on the thick lateral folds are especially long, and diverge in a fan-shaped manner from the band of connective tissue and muscle fibre which forms the centre of the fold. This figure agrees in most respects with CARRIÈRES' drawing of the byssus cavity of *Cyprina islandica* (**5**, fig. 12, B). In a section taken through the deeper end of the byssus cavity, the characters of the epithelium are the same as those of the preceding section, but the cavity has been divided into two by the forward extension of the median septum, the crescentic demi-canal has disappeared, and the lateral septa are smaller. These two anterior prolongations of the byssus cavity end blindly close beneath the pedal ganglia. These three figures are drawn from horizontal sections of the whole animal, and are therefore nearly transverse sections of the foot. Fig. 7 is a highly magnified drawing (ZEISS' $\frac{1}{12}$ immersion) of a transverse section of the whole animal, which therefore cuts the foot and byssus cavity obliquely. It corresponds to the top part of a section rather anterior to that shown in fig. 6. The section was stained with safranin and licht-grün, and does not show the cell contours very clearly, but the granules of byssogen, stained bright scarlet, are very clearly seen. At *by.gl.* are seen the large polygonal glandular cells occupying the central part of the foot. On either side these cells may be seen to be breaking up and their granules are streaming outwards along definite lines to pass either into the central tongue-shaped projection (which is a part of the here incomplete median septum) or into the lateral swellings projecting into the byssus cavity. As they pass outwards, the granules form little pyriform or club-shaped masses, whose swollen ends are directed towards the lumen of the byssus cavity, and it is evident that they are travelling, probably by intercellular paths, to be discharged into the lumen, and there converted into the material of the byssus. The granules themselves are clearly not byssus substance, but "byssogen," as the lumen of the cavity is filled with a granular material (not shown in the figure) which is not stained either by safranin or hæmatoxylin, and the byssus itself is similarly unaffected. The interest of this observation consists in the demonstration that the byssus gland-cells, like those of sebaceous follicles, are broken up to form the secretion, and that the secretum travels in and among the epithelial cells for relatively long distances until it reaches the lumen into which it is finally discharged. Thus the existence of a great mass of gland cells, forming a central core to the foot, and apparently distant from the byssus cavity and groove, is satisfactorily explained. The secretion is not confined to the byssus cavity, but throughout my sections I find the same indications of granules streaming between the ciliated cells of the crescentic demi-canal, but not between the non-ciliated epithelial cells of the furrow. In spite of some differences in detail, which can be accounted for by the widely different genera examined by us, my observations agree in all fundamental particulars with those of Horst (8). The byssus, as he maintained, is undoubtedly a secretion product and not a cuticular structure. Comparing Horst's figures of *Dreissensia polymorpha* (*loc. cit.*, plate xi., figs. 2, 3, and 4) with mine, it will be seen that in the latter species the byssogenous glands are concentrated in the region of the demi-canal, and that there are numerous mucus glands, of which I could find no trace in *Jousseaumia*. And whereas he shows numerous branching and anastomosing canals passing from the cells of the byssus gland between the epithelial cells of the demi-canal, these canals becoming narrower in diameter as they approach the lumen of the byssus cavity, and gives no indication of the breaking up of the cells themselves to form the secretum, I find that the cells are broken up and the secretion travels (probably) between the epithelial cells in the form of streams or strings whose ends nearest the lumen are swollen. It appears that in both cases the secretum follows intercellular paths, and that in both cases it has the form of granules which are converted in the lumen of the byssus cavity, probably by the action of a ferment, into the material of the byssus.

The Alimentary Canal.—The labial palps are relatively large, and the upper and lower palps pass respectively into the upper and lower lips. Posteriorly the labial palps are continuous with the anterior ends of the gill plates. The palps are richly ciliated, the cilia being borne by large cubical epithelial cells with a very distinct limiting membrane, but the surfaces of the palps appear to be smooth, and not thrown into ridges as is usually the case in Lamellibranchia. The mouth leads into a buccal cavity lined by somewhat elongated columnar epithelial cells continuous with those covering the labial palps, and provided, like the latter, with a very distinct limiting membrane or cuticle, through which the cilia project. The pharyngeal cavity is wide and strongly compressed dorso-ventrally. As it passes back into the œsophagus, the shape of the lumen, as seen in transverse section, alters. There is a diamond-shaped central lumen (fig. 8), the lateral angles of which are produced into lateral diverticula, suggestive of a comparison with the œsophageal pouches of Gastropoda. Such pouches are only known in the Protobranchia among the Lamellibranchia, and in them, *e.g.*, in *Leda pella*, as figured by Pelseneer (11), they are much more highly developed than in *Jousseaumia*, but there is a correspondence between the thinner epithelium lining the lateral pouches in his figure and in mine which leads me to believe that we have here an indication, though in a very much reduced form, of these ancestral structures.

The œsophagus is triangular in section and lined by a richly ciliated columnar epithelium. It passes insensibly into the capacious stomach, whose anterior walls are richly ciliated (fig. 13, *st.*), but posteriorly the lining epithelium changes in character. Laterally and ventrally the cells retain their columnar epithelial character, but dorsally (figs. 14 and 15, *gl.c.*) they lose their cilia and become glandular. The cells throughout this region are rather long and columnar, and are full of green refringent granules. It is in this region that the thick cuticular lining of the stomach begins, and I have little doubt that these glandular cells of the dorsal wall secrete the cuticle, and give rise to the crystalline style with which the cuticle is continuous. The liver lobes are four in number, a right and left dorsal and a right and left ventral. They open into the stomach near its posterior end, just in front of the commencement of the intestine and cæcum, by wide ducts on either side, the ducts of the dorsal and ventral lobes of each side uniting just before they open into the stomach. The liver cells were too much macerated to enable me to say anything definite about their histological characters. The left upper end of the stomach is prolonged into a large conical cæcum (figs. 1, 16, and 17, *cæ.*), which projects backwards into the posterior part of the visceral mass and is a conspicuous object in specimens mounted whole. The cæcum is lined throughout by a very definite cubical epithelium, whose cells bear short, stiff, bristle-like cilia, as is the case in the cæca of other Lamellibranchia. In the anterior part of the cæcum the cells of its dorsal wall are transitional between the ordinary cæcal cells and those of the dorsal wall of the stomach, for they are filled with the green refringent granules, while retaining their cubical character and their stiff brush-like cilia. The cæcum is separated from the stomach by a constriction, and at the constriction the epithelial cells are elongated and their ends are produced into rather long irregular processes, apparently formed of fused cilia. These processes seem to form a straining apparatus, preventing particles of any size from entering the cæcum, for while the stomach, intestine, and rectum are full of the skeletons of diatoms, the cæcum is always devoid of such contents. The crystalline style is very large in some specimens, but small, or even wholly absent, in others. It projects some way forward into the stomach and some way back into the cæcum, but seldom extends to the posterior end of the latter.

The intestine leaves the stomach on the right lower side, close to the opening of the cæcum. It runs backwards as a widish, thin-walled ciliated tube as far as the posterior end of the cæcum, where it turns upwards and forwards to reach the dorsal surface of the visceral mass; there its diameter narrows to form the rectum, and it bends sharply backwards, running parallel with the posterior margin of the shell over the posterior adductor muscle to end in the anus. The rectum traverses the pericardium, and is wrapped round by the ventricle.

THE CIRCULATORY SYSTEM is of the typical lamellibranchiate character, and requires no special description. The ventricle, as has been mentioned above, is traversed by the rectum. The auricles are excessively thin and can only be distinguished with difficulty in sections. Owing to the minute size of the animal the relations of the principal blood sinuses could not be determined with certainty, but I was able to distinguish a large ventral sinus above the muscular band formed by the anterior and posterior retractor muscles of the foot, and there are the usual afferent and efferent branchial sinuses at the bases of the gills.

THE GILLS, as may be seen by an inspection of fig. 1, are of a very simple type. The outer demibranch is wanting, a feature which *Jousseaumia* shares with the Lucinidæ, *Corbis*, *Scioberetia* and the Teredinidæ. The direct lamella of the inner demibranch is always well developed, and may be described as consisting of about 18 filaments, united at regular intervals by three, or in large specimens by four, rows of non-vascular interfilamentar junctions. The reflected lamella is present in many adult individuals, but is either absent or very feebly developed in others, and it is always absent in young and immature specimens. When present, it is confined to the anterior region of the demibranch, and the upper edge of the reflected lamella is fused to the body wall along the line of junction of the foot and the visceral mass. Posterior to the foot, where the reflected lamella is absent, the lower edge of the direct lamella of one side is, in all but very young individuals, fused with the lower edge of the corresponding lamella of the other side. If the reflected lamella is absent in the region of the foot, its place is taken by a continuous sheet of membranous tissue, which is attached to the sides of the upper part of the foot. Below and behind the posterior adductor muscle the upper edges of the direct lamellæ are connected with the mantle (figs. 18 and 19), and the result of this arrangement is that the gills divide the pallial cavity into an inter-lamellar or supra-branchial chamber, opening behind by the anal pallial aperture, and a large infra-branchial chamber.

Though I have spoken of filaments, the gills are not developed as separate filamentar outgrowths which subsequently form the above described unions with one another and the body wall and mantle, but by the fenestration of a pair of lateral folds of the body wall, as has been described by other authors for *Cyclas* (STEPANOFF, **14**), *Teredo* (HATSCHEK, **7**), and *Scioberetia* (BERNARD, **2**). Although I have not been successful in finding the earliest stages of gill development, I have a complete series of post-larval stages showing that the fenestration proceeds from before backwards, and that new fenestræ are added at the posterior ends of the two gill membranes until the adult stage is reached. Fig. 27 represents a young *J. heterocyathi* in which there are five fully formed fenestrations and the commencement of a sixth posteriorly. Fig. 28 is a drawing of a somewhat older individual with seven fenestrations. In the youngest form of which I have cut sections the fenestrated gill lamellæ are not reflected, and at the sides of the foot the lamellæ of opposite sides are quite free from one another and from the body wall and foot. Behind the foot the lower edges of the lamellæ of opposite sides are united by a band of connective tissue, and still further back the organic connection between the lower ends is more complete ; a vascular connection is established, and at the extreme hinder end of the gill, where fenestration is still in progress, the gill lamellæ of the two sides are blended in a mass of embryonic connective tissue channelled by numerous irregular blood sinuses. It follows from the above description that, if we speak of the bars between the fenestræ as gill filaments, they are at all stages of growth organically united in longitudinal series at their lower ends, and as the filaments assume their complete histological structure, the chitinoid-supporting skeleton of the filaments forms a dorsal and a ventral arcade, the upper end of each hollow chitinoid gill bar curving forward to unite with the bar in front of it, and a similar connection is eventually established at its lower end. In young specimens, however, the skeletal bars pass below into a mass of undifferentiated connective tissue. As growth proceeds, this undifferentiated tissue at the lower edge of the anterior part of the gill lamella grows out in the form of a membrane, and as it grows the membrane is reflected along the sides of the foot and grows upwards, becoming fenestrated as it grows, and eventually the upper edge of what we now recognise as the reflected lamella becomes attached to the body wall along the line of union of the foot and visceral mass, thus completing the separation between the supra-branchial and infra-branchial chambers. It would, perhaps, be more correct to say that, as the reflected lamella grows upwards, the fenestræ of the direct lamellæ extend into it. When the adult relations are established, the chitinoid skeletal bars of the filaments form an arcade along the upper edge of the reflected lamella where it is attached to the body wall. In those adult individuals in which the reflected lamella is imperfectly developed or absent (and such individuals are not uncommon in both the species under consideration), it would appear that there is an arrest of development, and that the larval condition of the gill becomes permanent in the adult. This arrest of development suggests that the gills of *Jousseaumia* are degenerating. As may be expected from the order of formation of the gill fenestræ, the anterior gill filaments are the longest, and they decrease progressively in length from before backwards.

In the youngest specimens there are no interfilamentar junctions, but these are added in the course of growth, and, as can readily be understood from a consideration of the manner in which the gills are formed, the posterior filaments have fewer junctions than the anterior, as has been described by Bernard for *Scioberetia*.

A few irregularly scattered interlamellar junctions are formed soon after or during the growth of the reflected lamella. These interlamellar junctions are vascular, whereas the interfilamentar junctions are non-vascular.

Owing to the very small size of *Jousseaumia* and the minuteness of the elements composing the gill filaments, I had some difficulty in making out the details of the gill structure, but as some few of my specimens were well preserved and the very minuteness of the objects was of assistance in enabling me to study optical sections under a high power, I have been able to make out some interesting points not hitherto recorded. The individual filaments are slender, and, except for the fact that their interlamellar edges are broader than their frontal edges, they have the usual lamellibranchiate structure. The central cavity is lined by the usual chitinoid layer, thickened at the sides. I could not determine from my sections whether the cavity is divided by a transverse partition into an afferent and an efferent canal, but the appearances seen in optical section lead me to think that it is. The greater number of my specimens when mounted whole and viewed in optical section seemed to possess a large number of closely set ciliated discs, and the late Professor WELDON to whom I showed my preparations was of the opinion that there could be no doubt that ciliated discs were present. Further investigations led me to modify my first opinion, but disclosed an arrangement of the ciliated cells that merits a detailed description.

Figs. 20 and 21 are transverse sections through the gill filaments, the former of a somewhat young and the latter of an adult individual. The triangular shape of the section of the filament with the narrower frontal edge and broad interlamellar base is seen to be due to the great size and thickness of the cells marked *l.c.* Following the usual terminology, the short cilia on the narrow frontal edges may be called the frontal cilia; they are borne on two or three wedge-shaped cells with small nuclei, and the more laterally disposed frontal cilia are longer than the others, so much longer that I was disposed to regard them as latero-frontal cilia, but I do not think that they can be identified as such. The true latero-frontal cilia are very long and rather stiff and are borne on very definite longitudinal rows of columnar cells arranged in single series. These cells are large, with conspicuous round nuclei at their bases, and can be very clearly seen in optical section when the surface of the filament is brought into focus, fig. 22A. Their position and shape is clearly shown in the sections figs. 20 and 21, *l.f.* Following on these are one or two non-ciliated interstitial cells, and the sides of the filaments just above their basal angles are occupied by longitudinal rows of very large oblong cells with flattened elongated nuclei. These cells are best seen in optical section by focussing below the latero-frontal cells, as in fig. 22B, but they are clearly distinguishable in transverse section, though their elongate shape is, of course, not shown in this case. These cells bear a large number of very fine cilia, which interlock with those of adjacent filaments, and the interlocking is so effectual that when the tissues are contracted by the action of reagents the limiting membranes of the cells are torn off and remain adherent to the cilia in the interfilamentar spaces (figs. 20 and 21). The interlamellar bases of the filaments are covered by a few flattened non-ciliated cells with small nuclei. The false appearance of ciliated discs observable in so many of my specimens is due to the fact that in macerated or much contracted gills the large oblong cells become loosened from their attachment to the filament and become bent up in a crescentic form with their convexities outwards. In this condition, when the cilia remain attached to them, they may very easily be mistaken for ciliated discs, and it was only after studying well-preserved preparations with the highest powers of the microscope that I discovered the real state of the case. As far as I am aware, very large elongated cells of this shape bearing the lateral cilia have not been described before, and they seem to be peculiar to *Jousseaumia.* It is, as I have said, possible to regard the longer cilia on the frontal edges as latero-frontal, and in that case the very long stiffer cilia succeeding them would be lateral cilia, and the long fine interlocking cilia borne by the brick-shaped cells might be regarded as occupying the position of and being homologous with ciliated discs. On this view the gill of *Jousseaumia* would have to be regarded as a primitive form of filibranch gill, in which the interlocking cilia are arranged in continuous lines and are not differentiated into isolated ciliated discs. But this view is hardly tenable. The gills of *Jousseaumia* are not filibranch, for they have well-developed interfilamentar junctions. Moreover, the interlocking cilia, in addition to their being arranged in longitudinal lines and not in groups, are actually finer and longer than the fronto-lateral cilia, and lack the short, stiff brush-like character of the cilia of true ciliated discs. The fact remains, however, that they interlock, and that there is therefore a ciliary union in addition to an organic union between the filaments of *Jousseaumia.* It seems to me probable, however, that the physiological rôle of the interlocking cilia is rather to form a barrier preventing solid particles from passing between the filaments than to give mutual support to the filaments, and this view is supported by their extreme fineness, while the coarser latero-frontal cilia projecting from the corners of the frontal edges are evidently effective in sweeping solid particles over the surfaces of the gills towards the labial palps and mouth.

The interfilamentar junctions are arranged in regular rows. In most specimens there are three such rows in the anterior part of the direct lamella and one or two rows in the reflected lamella. As has been stated, these junctions are non-vascular and are formed as secondary outgrowths from the filaments, bridging across the fenestræ at regular intervals. As may be seen in figs. 17 and 21, these interfilamentar junctions are curved bars, continuous with the chitinoid lining of the central cavity of the filament, but the junctions themselves are solid, and as they are only clothed by a very thin protoplasmic sheath, they do not establish any vascular connection between adjacent filaments. As seen in section, the interlamellar edge of each filament appears to be prolonged to form a pair of bars which curve round to unite with corresponding outgrowths from the adjacent filaments. The lower part of fig. 22 shows the interfilamentar junctions as viewed in optical section under a very high power of the microscope. As a rule the interfilamentar bars are single, but occasionally they are double, as shown in the middle of the figure. The chief point of interest is that the bars are clearly shown to be formed by the agency of special cells, whose nuclei are grouped about the broad bases of attachment of the bars to the filaments. These nuclei are visible in section in fig. 21*x*. There can be no doubt that the interfilamentar junctions are formed by the agency of these cells, for their position at the attached ends of the bars is invariable, and they are not to be distinguished elsewhere. Moreover, by looking through numerous preparations, I have been able to recognise these groups of cells at points where the interfilamentar junctions are in process of formation, and have seen in optical section the processes formed by the cells projecting from, but not yet bridging over the interval between adjacent filaments. These chitin-forming cells do not appear to have been recognised by previous observers, but they are probably included in the general and somewhat vague term "sub-filamentar" tissue. BERNARD (2) gives a drawing of groups of stellate cells in *Scioberetia*, which appear to coincide in position with those which I have described, but he does not attribute any special function to them, and merely refers to them as components of a "substance conjonctive transparente à nombreuses cellules" (*loc. cit.* p. 374). It is evident from a comparison of the sections drawn in figs. 20 and 21, that these junction-forming cells in *Jousseaumia* are differentiated from the flat non-ciliated cells covering the interlamellar edges of the filaments.

THE PERICARDIUM AND RENAL ORGANS.—Owing to the minute size and the contracted state of my specimens, the relations of these organs presented great difficulties. The pericardium is a more or less triangular sac, relatively of considerable size, lying above and in front of the posterior adductor muscle. It is traversed obliquely by the rectum, and the ventricle of the heart surrounds the latter for a considerable part of its course through the pericardium. The whole of the inner lining of the pericardial walls is glandular, constituting an extensive pericardial gland, but the glandular epithelium does not appear to extend to the investment of the ventricle and auricles. Glandular epithelia are the first to suffer from the effects of long immersion in spirit, and the preservation of my specimens was not good enough to allow me to make out the details of the pericardial glandular cells with any certainty. The most that I am able to say is that they are rather large irregularly shaped cells with oval nuclei, and coarsely granular contents which stain faintly blue in picro-indigo-carmine.

The kidneys are conspicuous from the large concentrically striated concretions which they contain. These concretions are contained in a highly vacuolated protoplasmic lining of the renal sacs. The right and left renal sacs are fused together for such a considerable extent in the middle line, below the floor of the posterior end of the pericardium, that their paired nature is obscured, and can only be recognised by an examination of the paired ducts and the paired anterior and posterior horns into which the median sac is produced. Such an extensive fusion of the two kidney sacs is characteristic of the more specialised forms of Lamellibranchia, particularly of the Myacea, Pholadidæ and Anatinacea (PELSENEER, 12), and my sections through this region of the body bear a considerable resemblance to the section through the kidneys of *Lyonsiella abyssicola* and *L. norvegica* figured by PELSENEER (**11**). The median sac formed by the fusion of the right and left kidney sacs in *Jousseaumia* lies just in front of and above the posterior retractor pedis muscle, near where the latter bifurcates to be attached to the right and left valves of the shell. The two posterior horns of the sac are of considerable length, and extend along the outer sides of the diverging bundles of the retractor pedis muscle, extending blindly just below the anterior end of the posterior adductor muscle. The anterior horns of the sac are smaller and pass to the outside of the retractor pedis muscle. The median sac and its anterior and posterior prolongations are lined throughout by a thick vacuolated layer of protoplasm containing relatively large oval nuclei, but I was unable to distinguish any cell outlines. The renal concretions lie in the vacuoles and are similar to those described and figured by PELSENEER (**11**). The relations of the renal ducts and the reno-pericardial canals are shown in fig. 23, and the renal ducts are shown in section in figs. 25 and 26, *Re.d.* They are short canals lined by a cubical ciliated epithelium and open into the supra-branchial cavity, in close contiguity to the genital apertures, on a small papilla situated to the outside of the visceral commissure. The reno-pericardial ducts are very minute, and it was difficult to discover them even with the aid of the highest powers of the microscope. They are extremely fine ciliated ducts opening into the floor of the renal sac not far in front of the uroducts. Each reno-pericardial duct runs forward close below the external part of the floor of the median renal sac, and, passing to the inside of the uroduct, turns upwards and opens by a minute ciliated aperture into the pericardial cavity.

THE NERVOUS SYSTEM.—This is of the usual lamellibranchiate type, and presents few features of interest. The nerve ganglia are relatively of great size, as may be seen in figs. 9, 12, and 19. Their proportions, relatively to the whole size of the animal, may be described as larval, and this, coupled with the fact mentioned below (p. 257), suggests that the sexual products in *Jousseaumia* are precociously developed, and that we have, in fact, an example of pædogenesis. In the cerebro-pleural ganglia the separate groups of nerve ganglion cells forming the cerebral and pleural moieties of the ganglia are easily recognisable, but the cerebro-pedal and pleuro-pedal connectives leave the fused ganglia as a single nerve. The otocysts are situated above the hinder part of the large nerve mass formed by the fused pedal ganglia, and are quite separate from the ganglia and contained in special compartments of the general body-cavity or hæmocele (fig. 13, *ot.*). Each otocyst contains a single large otolith. The visceral ganglia are of great relative size, and the posterior pallial nerves are very stout. I was unable to find any trace of an osphradium in the form of a specialised patch of epithelium in the neighbourhood of the visceral ganglia, or on the course of the posterior branchial nerves.

THE GONADS AND GONADUCTS.—*Jousseaumia* is monœcious, and, as is usual among hermaphrodite lamellibranchia, is protandric. By far the greater number of the individuals examined by me contained spermatozoa only, but in some few both ripe spermatozoa and developing ova were present in the gonads, and in about half a dozen cases the gonads contained ova only and were enormously enlarged, displacing the other viscera in the visceral mass. It would appear that *Jousseaumia* is also, to a certain extent, pædogenetic, for I discovered ripe spermatozoa in a considerable number of young forms which were clearly immature as regards the structure and development of the shell and gills.

The gonad itself shows very few traces of paired structure, and varies very much in shape and extent, according as it contains spermatocytes and spermatozoa only, or developing ova or ripe ova. It may be described as consisting of a median vestibule lying in front and ventrad of the kidney and pericardium, opening behind by paired ducts on the reno-genital papillæ, and produced anteriorly into a dorsal and a ventral tubular diverticulum. The diverticula are lined by the germinal epithelium, from which first spermatocytes, then, when the spermatozoa have ripened, oocytes, are produced. In the first stage, when the protandric phase is in evidence, the extent of the gonad is small, as is shown in fig. 1. The dorsal diverticulum extends forward and upward from the vestibule below the floor of the anterior part of the pericardium, and is continued forward below the rectum as far as the point where the latter bends sharply back on itself. The ventral diverticulum is a very short tubular outgrowth from the lower and anterior face of the vestibule, and lies ventrad of the stomachal cæcum. The dorsal or anterior end of the dorsal diverticulum is bifurcated, and the two branches often lie on either side of the rectum, this and the existence of paired gonaducts being the only evidences of paired structure in the body of the gonad. The ventral diverticulum is never bifurcated. Spermatogenesis is effected mainly, though not exclusively, in the dorsal diverticulum, which in many specimens is filled with spermatocytes and spermatids in different stages of development, but the state of my preparations did not admit of my making minute investigations on this subject. The vestibule, in this phase, is filled with ripe spermatozoa, and at a somewhat later period the whole gonad contains a mass of ripe or nearly ripe spermatozoa. This was the most common condition in the numerous specimens I examined ; only in two of them could I find evidence of the simultaneous formation of ova and spermatozoa, and in those there were many ripe and a few developing spermatozoa in the dorsal diverticulum, the vestibule was filled with ripe spermatozoa, and developing ova were observed in the ventral diverticulum. The more usual course appears to be that the protandric phase is followed by a short resting stage, during which the diverticula of the gonad are empty and reduced in size, though the vestibule may remain full of spermatozoa. This is succeeded by an active development of ova in both diverticula, which become enormously distended and push their way forward among the viscera, displacing the latter to a very considerable extent. Posteriorly the vestibule bifurcates to form the right and left gonaducts. These ducts, wide at first (fig. 24, *go.d.*), rapidly diminish in diameter, and passing outwards and backwards, open just to the outside of and behind the renal apertures on the reno-genital papillæ on either side. The most remarkable feature about the gonaducts is that each, just before its external opening, is joined by the short and contracted duct of an ovoid vesicle (*Vs.*, figs. 1, 24, 25) which, in nearly all cases, is filled with ripe spermatozoa, and is clearly a seminal vesicle, in which the ripe spermatozoa are stored up pending the development of the ova. These seminal vesicles, which form very conspicuous objects in sections, are lined by a well-defined, flattened, and as far as I could determine, non-ciliated epithelium, and their relations to the gonaducts are best seen in the series of sections, figs. 24, 25, and 26, drawn under a high power of the microscope. The presence of specialised accessory organs in the shape of vesiculæ seminales on the gonaducts is, as far as I know, a unique feature among the Lamellibranchia, though PELSENEER (**12**) makes mention of an accessory gland on the male duct of *Cuspidaria*, but this gland is not described in his detailed account of the anatomy of the genus. The numerous specimens of *Heteropsammia* and *Heterocyathus*, sent me by Professor HERDMAN, were collected in February and March, and as the more mature individuals of *Jousseaumia* inhabiting them are nearly all in the same sexual condition, viz., in the protandric phase, it seems probable that in this genus there is a seasonal alternation of male and female maturity. If this conjecture is right, it is evident that the vesiculæ seminales serve as reservoirs for the spermatozoa, which are stored up until the ova are ripe and ready to be discharged from the gonaducts.

Hermaphroditism, though it is not uncommon among the Lamellibranchia, is only characteristic of a single sub-order, the Anatinacea. In all the hermaphrodite forms protandry is the rule, as in *Jousseaumia*, and this is markedly the case in the Anatinacea, as shown by PELSENEER (**11**). In this sub-order, the ovaries and testes are separate, the ovaries being dorsally and the testes ventrally situated in the visceral mass. In *Pandora*, *Thracia*, and *Lyonsia*, the oviducts and spermiducts open separately by contiguous orifices on each side of the body, and the same is the case in *Lyonsiella*, but in this last genus the male and female apertures open very close together on a small genital papilla (PELSENEER, **11**). In *Jousseaumia* the conditions are different; the gonad is single and alternately male and female in function, and there is only a single gonopore on each side. But its structure is interesting as indicating the manner in which the separate ovaries and testes of the Anatinacea may have been evolved. The dorsal and ventral diverticula of *Jousseaumia* correspond in position with the ovaries and testes of the Anatinacea, and, as I have shown, they are to a certain extent specialised, since the production of spermatozoa is nearly exclusively confined to the dorsal diverticulum. If the two diverticula were to become separate and acquire separate openings to the exterior and the function of producing ova were confined to the one, and the function of producing spermatozoa to the other, we should have a condition of things nearly identical with that of the Anatinacea. It must be observed, however, that in the latter group the testes are ventral, whereas in *Jousseaumia* the male diverticulum is dorsal, and at a later stage both diverticula become female.

Although I made a careful search, I was unable to find any ova or embryos in the supra-branchial chamber. It does not necessarily follow that *Jousseaumia* is not incubatory, and that the ova are not fertilised, and undergo the earlier stages of development in the branchial cavity, for as I have pointed out, there is probably a seasonal alternation of sexual maturity, and the specimens at my disposal were mostly in the male condition. Even those which had advanced beyond this stage and contained numerous ova in the gonads, did not give evidence of complete female maturity. In one specimen of *Heteropsammia* I found, in the *Aspidosiphon* chamber, a number of small ovoid ova, each surrounded by a thick radially striated egg-membrane, but I have no evidence that these are the ova of *Jousseaumia*. Nor was I successful, after a prolonged and careful search, in finding any larval or embryonic forms much younger than the specimen shown in fig. 27, though in every coral there was an abundance of young forms representing every stage of later growth. The specimen depicted in fig. 27 displays clearly the larval shell or prodissoconch, with its rectilinear hinge-line and internal ligament. A single-growth lamina has been added at the edge of the prodissoconch, so the animal cannot have passed very far beyond the larval stage. The principal organs of the body are, however, well developed. The anterior and posterior adductor muscles are fully formed, as is usual in young Lamellibranchs; the foot has the geniculate characters of the adult; the retractor and protractor muscles of the foot have the same relative size and importance as in the adult; the labial palps are well formed, and in the alimentary canal all the features of the adult—pharynx, œsophagus, stomach, cæcum, liver and intestine—are clearly distinguishable. Only the nerve centres and the gills retain embryonic characters. In the nervous system the ganglia are still larger, relatively to the whole size of the animal, than they are in adult, and the connectives are relatively very thick. In the cerebro-pleural ganglia the double nature of each member of the ganglion-pair, only recognisable in section in the adult, is evident in a surface view (fig. 27, *cg.*). The gills are in an early stage of development and show five fenestrations, with a commencement of a sixth. The organisation is much more advanced than, for instance, in the youngest *Scioberetia* figured by Bernard (**2**, plate xv., fig. 4). Not only is the internal organisation well advanced, but the hinge does not show the characteristic teeth of the prodissoconch, although the valves have hardly grown beyond the prodissoconch stage. On the contrary, there is no trace of a provinculum, the anterior cardinal teeth are clearly developed, and the large lateral teeth are being formed by folds of the mantle edge just above the anterior and posterior adductor muscles. In the specimen shown in fig. 28 there are four growth laminæ outside the prodissoconch. The organisation is somewhat more advanced than in fig. 27; in particular the nervous system and labial palps have assumed their adult proportions and the gills are larger and have acquired seven fenestrations, but as yet no interfilamentar junctions. The anterior cardinal teeth of the hinge are more distinct and clearly interlock with one another, and a deposition of calcareous matter round the attachments of the ligament foreshadows the formation of the posterior cardinal tooth and the ligamentar fossa. In later stages, with seven or eight growth laminæ outside the prodissoconch, the adult characters of the hinge are fully established. It would appear, then, that, as compared with the size of the shell, the visceral organs and the permanent hinge teeth are precociously developed in *Jousseaumia*, and the suppression of the provinculum and consequent abbreviation of the several stages in the evolution of the heterodont hinge may account for the ligament remaining internal and therefore in its larval condition instead of being shifted to an external position.

CONCLUSION.

I have given a full description of this interesting little Lamellibranch, because, as it seems to me, it is incumbent on students of this class to give a full anatomical account of the various forms that come under their notice. A detailed account of the anatomy of various Lamellibranchs is needed before many questions of classification can be finally settled. The researches of PELSENEER (**10**) have broken ground in this direction, but subsequent authors have not followed his example by dealing with the whole anatomy of the species they have investigated. The work of RIDEWOOD (**15**), dealing with a large number of species of all orders of the Lamellibranchia, is confined to a detailed exposition of the gill-structure, and though it forms a valuable contribution to our knowledge of this single feature of Lamellibranch anatomy, its main result has been to show how little the characters of a single organ are to be relied upon in framing the smaller subdivisions of a system of classification. There are at the present time few malacologists who will question the importance of gill-structure as a basis of the general classification of the Lamellibranchia and their division into the orders Protobranchia, Filibranchia, Eulamellibranchia and Septibranchia meets with general acceptance, the more so because these orders correspond very closely with those based upon a study of the hinge characters. But when we come to subdivide the orders into sub-orders and to arrange the latter in families, and especially when we attempt to estimate the relationship and probable lines of descent of the various families grouped together in the sub-orders, the structure of the gills becomes of less value to us. Thus, to take a single instance, in the family Donacidæ we find plicate and non-plicate, homorhabdic and heterorhabdic gills with almost every variety of interfilamentar and interlamellar connection. In the large sub-order Submytilacea, we find the simple Astartiform gill at one end of the order and the extremely specialised complex gills of the Unionidæ at the other, and no very definite series connecting the two. PELSENEER (**10** and **12**) characterises the Submytilacea as Eulamellibranchs with smooth, *i.e.*, non-plicate gills, but RIDEWOOD (**15**) has shown that the gills of *Diplodonta oblonga* and *Monocondylæa* are slightly and those of *Corbicula lydigina* markedly plicate. On the other hand, smooth or non-plicate gills are common among other sub-orders of Eulamellibranchia. The detailed study of gill structure has therefore proved disappointing for classificatory purposes, and in trying to trace the connections between the sub-groups of the Eulamellibranchia we are once more thrown back on a criticism of the *ensemble* of the anatomical characters of each family. The difficulty of placing any given genus in its proper position in the system is well illustrated by *Jousseaumia.* Its heterodont hinge, sub-equal adductor muscles, entire pallial line, single pallial suture and very simple gill structure leave no doubt that it must be placed in the Submytilacea, but when one looks for its nearest allies in this very heterogeneous sub-order, the difficulties are considerable, and they are not lessened by the fact that some systematists give a certain character as diagnostic of a family, and then proceed to describe as members of that family genera in which this diagnostic character is wanting.

Thus, *Jousseaumia* shows undoubted affinities to the Erycinidæ (Leptonidæ, Pelseneer, **12**). The members of this family are hermaphrodite, the ligament is internal, the foot linguiform, elongated and byssiferous, the gills simple and astartiform, with very little sub-filamentar tissue and scattered interlamellar junctions. Many members of the family are of minute size and some (*Lepton*) are commensal. Bouvier identified *Jousseaumia* as a *Kellia*, and E. A. Smith identified it with Angas' genus *Mysella*, which Fischer (**6**) regards as closely allied with *Kellia.* I have shown that it cannot be placed in either of these genera, and though it might be regarded as having affinities with *Lepton* or *Lasæa*, because of the single pallial suture, it differs from the whole of the Erycinidæ in the absence of the external demibranch. This last character suggests an affinity with the Lucinidæ, and more particularly with the genus *Montacuta* placed in this family by Pelseneer; *Montacuta* has a single pallial suture, a very long, linguiform, byssiferous foot and a shell which is in many respects similar to that of *Jousseaumia.* The ligament is internal, the anterior adductor impression longer than the posterior, the cardinal teeth have analogous characters, and the anterior border is longer than the posterior, and as a small point of resemblance Pelseneer describes a protractor pedis ventral to the anterior adductor (**11**, p. 203) which is paralleled by the slip of the protractor in *Jousseaumia. Montacuta bidentata* has the habit of living in old shells, and *M. substriata* is parasitic on an Echinid, and the former habit is suggestive of the manner in which *Jousseaumia* may have come into association with the Sipunculid inhabiting the basal chambers of corals. So similar is the shell of *Montacuta* to that of the Erycinidæ that Fischer places it in this family, but its gills not only lack the external demibranch, but the filaments have considerable interlamellar extrusions, the interfilamentar junctions are vascular and in these and other respects so closely resemble the gills of *Lucina* that there can be no doubt that it should be placed, as Pelseneer has placed it, in the Lucinidæ. And for the same reason that *Montacuta* is placed in the Lucinidæ, *Jousseaumia* must be excluded from this family. Its gill structure is different and it is monœcious whereas the Lucinidæ are diœcious, and there are other anatomical characters in which it differs from *Montacuta* (see PELSENEER, **11**, pp. 203, 204).

The only other members of the Submytilacea in which the external demibranch is wanting are the Corbidæ and *Scioberetia*. *Jousseaumia* has clearly no affinities with the Corbidæ, but, as has been pointed out, it has certain features in common with *Scioberetia*. Both are hermaphrodite, commensal or semiparasitic, have a similar gill structure and a single pallial suture, but in *Jousseaumia* the mantle is not reflected over the shell and it therefore must be excluded from the Galeommidæ, to which *Scioberetia* belongs.

The balance of evidence is in favour of placing *Jousseaumia* among the Erycinidæ in spite of the absence of the external demibranch. This last character, taken by itself, is of no systematic importance, since it occurs in forms as far apart as *Lucina*, *Scioberetia*, and *Teredo*. RIDEWOOD has shown that the external demibranch is liable to modification and partial suppression in a large number of widely separated genera, and its total suppression may well be accounted for by changed conditions of life affecting the respiratory and alimentary functions. I have shown that there is evidence that the gill is degenerating in *Jousseaumia*, and that the reflected lamella of the existing demibranch, never very well developed, is rudimentary in a certain number of adult individuals. The conditions which are causing the degeneration of the reflected lamella of the inner demibranch may well have caused the total suppression of the outer demibranch. On the other hand, the details of the gill structure agree very closely with those of the Erycinidæ, particularly with that of *Lasæa*, and the internal ligament, the shell characters, the hermaphroditism and other anatomical features point to a close relationship, particularly to the last-named genus, in which the external demibranch is very short and has no reflected lamella. It may be further observed that *Jousseaumia* presents an interesting example of the admixture of primitive and specialised characters which is so puzzling to the systematist. RIDEWOOD rightly regards the gills of *Astarte* as being among the most primitive of all Eulamellibranch gills. In their essential structure the gills of *Jousseaumia* are still more primitive, but at the same time they are specialised, and specialised in the direction of reduction and degeneration, as is shown by the absence of the outer demibranch, the slight development, and even the suppression of the reflected lamella of the inner demibranch, which in some individuals is only represented by a continuous sheet of tissue reflected and attached to the body wall in the region of the foot. It is obvious that this kind of reduction, if carried still further, would lead to the condition found in the Septibranchia, though I do not mean to suggest that *Jousseaumia* is closely related to this order.

As other evidences of primitive characters we may note, in *Jousseaumia*, the relics of paired œsophageal pouches (if I am right in regarding the lateral grooves in the œsophagus as such), the obvious cerebral and pleural moieties of the cerebro-pleural ganglia in the young forms, the simplicity of the alimentary tract (but this may be due to degeneration), and such minor characters as the persistence of the internal embryonic hinge ligament, the single pallial suture, &c. On the other hand, the extensive fusion of the kidney-sacs in the middle line is characteristic of more highly specialised Eulamellibranchs, such as the Anatinacea, and the presence of vesiculæ seminales is a unique feature of specialisation in connection with the reproductive apparatus.

Taking all these facts into consideration, we must regard *Jousseaumia* as an offshoot of a primitive Eulamellibranch stock, which in consequence of its commensal habits has been largely modified in the directions indicated, and that its nearest allies are the Erycinidæ and Galeommidæ, which are similarly primitive Eulamellibranchs modified in various directions in relation to their different habits of life.

It is interesting to note that the commensalism between a coral, a sipunculid, and a lamellibranch must be still further extended. In almost every specimen examined, whether of *Heterocyathus* or *Heteropsammia*, I found in the *Aspidosiphon* chamber one or two specimens of a small copepod belonging to the family Harpacticidæ, but as I am obliged to bring this paper to a close to be in time for the issue of the last volume of the "Reports on the Ceylon Pearl Oyster Fisheries," I have not had time to identify the genus and species. Furthermore, *Jousseaumia*, minute as it is, and protected within the *Aspidosiphon* chamber of the coral, is liable to the attacks of parasites. In one series of sections I found a minute trematode, distinguishable as such by its well-developed suckers, encysted in one of the dorsal lobes of the liver, and in another series a larger specimen of what is apparently a trematode, but I could not easily determine its nature from the sections, lying free in the supra-branchial cavity.

LIST OF PAPERS REFERRED TO.

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(2.) Bernard, F.—"*Scioberetia australis*, type nouveau de Lamellibranche." 'Bull. Sci. de la France et de la Belgique,' xxviii., 1895, p. 364.

(3.) Bernard, F.—"Recherches ontogéniques et morphologiques sur la coquille des Lamellibranches." 'Ann. des Sci. Nat.' (8), viii., 1898, p. 1.

(4.) Bouvier, E. L.—"Le commensalisme chez certains Polypes madréporaires." 'Ann. des Sci. Nat.' (7), xx., 1895, p. 1.

(5.) Carrière, J.—"Die Drüsen im Fusse der Lamellibranchiaten." 'Arb. a. d. Zool. Inst. Würzburg,' v., 1882.

(6.) Fischer, P.—'Manuel de Conchyliologie.' Paris, 1887.

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(8.) Horst, R.—"Ist der Byssus eine Cuticularbildung?" 'Tijdschr. Ned. Dierk. Vereen.' (2), ii., 1889.

(9.) Peck, R. H.—"The Minute Structure of the Gills of Lamellibranchs." 'Quart. Journ. Micr. Sci.,' xvii., 1877, p. 43.

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(14.) Stepanoff, P.—"Ueber die Geschlechtsorgane u. die Entwickelung von *Cyclas*." 'Arch. f. Naturgeschichte,' 1865, p. 1.

(15.) Ridewood, W. G.—"On the Structure of the Gills of the Lamellibranchia." 'Phil. Trans.,' B, cxcv., 1903, p. 147.

EXPLANATION OF PLATES.

Lettering in all the Figures.

A.ad., anterior adductor muscle.
A.ap., anal or exhalant aperture.
An., anus.
A.r.p., anterior retractor pedis muscle.
Br.m., branchial muscles.
Bucc., buccal cavity.
By., byssus.
By.c., byssus cavity.
By.g., byssus groove.
By.gl., byssus gland cells.
Cæc., cæcum.
C.g., cerebro-pleural ganglion.
Cr.s., crystalline style.
Cu., cuticular lining of stomach.
Dbr., internal demibranch.
F., foot.
fr., frontal cilia.
gl.c., glandular cells of stomach.
Go., gonad.
Go.a., genital aperture.
Go.c., gonaduct.
Go.d.[1], dorsal diverticulum of gonad.
Go.d.[2], ventral diverticulum of gonad.
Ht., ventricle of heart.
if.j., interfilamentar junctions.
il.j., interlamellar junctions.
l., lateral cilia.
l.c., oblong cells bearing lateral cilia.
l.f., latero-frontal cilia.
Li., liver.
Lig., hinge ligament.
Lm.int., internal lamella of demibranch.
Lm.ext., external lamella of demibranch.
L.p., labial palps.
M., mantle.
Oe., œsophagus.
or.exh., exhalant or anal pallial orifice.
ot., otocyst.
P.ad., posterior adductor muscle.
Pc., pericardium.
P.g., pedal ganglion.
P.r.p., posterior retractor pedis muscle.
P.s., pallial suture.
Ptr., protractor pedis muscle.
Ptr.[1], ventral slip of the protractor pedis muscle.
R., rectum.
Re., kidney.
Re.a., renal aperture.
Re.d., renal duct.
R.pd., reno-pericardial canal.
St., stomach.
Spz., spermatozoa.
Vb., vestibule of gonad.
Vc., visceral commissure.
Vg., visceral ganglion.
Vs., vesicula seminalis.
x., cells of the interfilamentar junctions.

PLATE I.

Fig. 1. An adult specimen of *Jousseaumia heteropsammiæ* lying in the right valve of the shell. × 85.

„ 2. Valves with hinge teeth of *J. heterocyathi.* × 85. *c.*, the single cardinal tooth of the right valve; *c.a.*, the anterior, and *c.p.*, the posterior cardinal teeth of the left valve; *foss.*, ligamentar fossa; *lig.*, ligament; *l.ant.*, anterior lateral, and *l.post.*, posterior lateral teeth; *L.V.*, left valve; *R.V.*, right valve.

„ 3. Valves with hinge teeth of *J. heteropsammiæ.* × 85. Lettering as in the preceding figure.

„ 4. Section through the byssus groove of *J. heterocyathi* highly magnified, showing the ciliated demicanal, *d.c.*, in the depth of the groove; *mus.*, muscle fibres of the foot.

„ 5. A section through the duct of the byssus cavity, higher up than fig. 4. The ciliated demicanal, *d.c.*, retains the same shape as in fig. 4; the remainder of the duct is not ciliated, but lined by a thick cuticle formed by the underlying epithelial cells.

Fig. 6. A section through the byssus cavity. The demicanal, *d.c.*, is still apparent, but the whole cavity is lined by a similar ciliated epithelium. *m.sp.*, median septum; *l.sp.*[1], the thick lateral septa on either side of the demicanal; *l.sp.*[2], smaller lateral septa.

„ 7. A portion of a section through the byssus cavity, somewhat anterior and oblique to the section drawn in fig. 6. The byssus gland cells, *By.gl.*, are seen to be breaking up, and the granular secretum stained red with safranin is passing between the epithelial cells. The granular secretion in the cavity itself is omitted. ZEISS' $\frac{1}{12}$ hom. imm. Comp. Oc. 4.

„ 8 A transverse section through the œsophagus of *Jousseaumia heterocyathi*. *lat.div.*, lateral diverticula of the œsophagus, resembling the œsophageal pouches of Protobranchia. ZEISS' $\frac{1}{12}$ hom. imm. Comp. Oc. 4.

PLATE II.

Figs. 9 to 19. A series of transverse sections through *Jousseaumia heteropsammiæ*. Fig. 9 passes through the cerebral ganglia and fig. 19 through the visceral ganglion pair. All the figures are fully lettered.

PLATE III.

Fig. 20. A section through the ventral end of the demibranch of an immature individual of *J. heteropsammiæ*. ZEISS' $\frac{1}{12}$ hom. imm. Comp. Oc. 4.

„ 21. A section through two adjacent gill filaments of a mature individual of *J. heteropsammiæ*, showing the interfilamentar junctions.

„ 22. Optical sections of two gill filaments of *J. heterocyathi*. A represents the filaments as seen with a high focus, and shows the latero-frontal cilia, *l.f.*, borne on columnar cells. B represents a section as seen with a somewhat deeper focus, and shows the lateral cilia, *l.*, borne on the large oblong cells, *l.c.* C, taken at a still deeper focus, shows the interfilamentar junctions, which are occasionally double, as in the centre of the figure, and the cells *x*, which give rise to the outgrowths forming the junctions.

„ 23. A diagram showing the relations of the kidney, pericardium, and gonads in *Jousseaumia*, from a reconstruction of a series of sagittal sections.

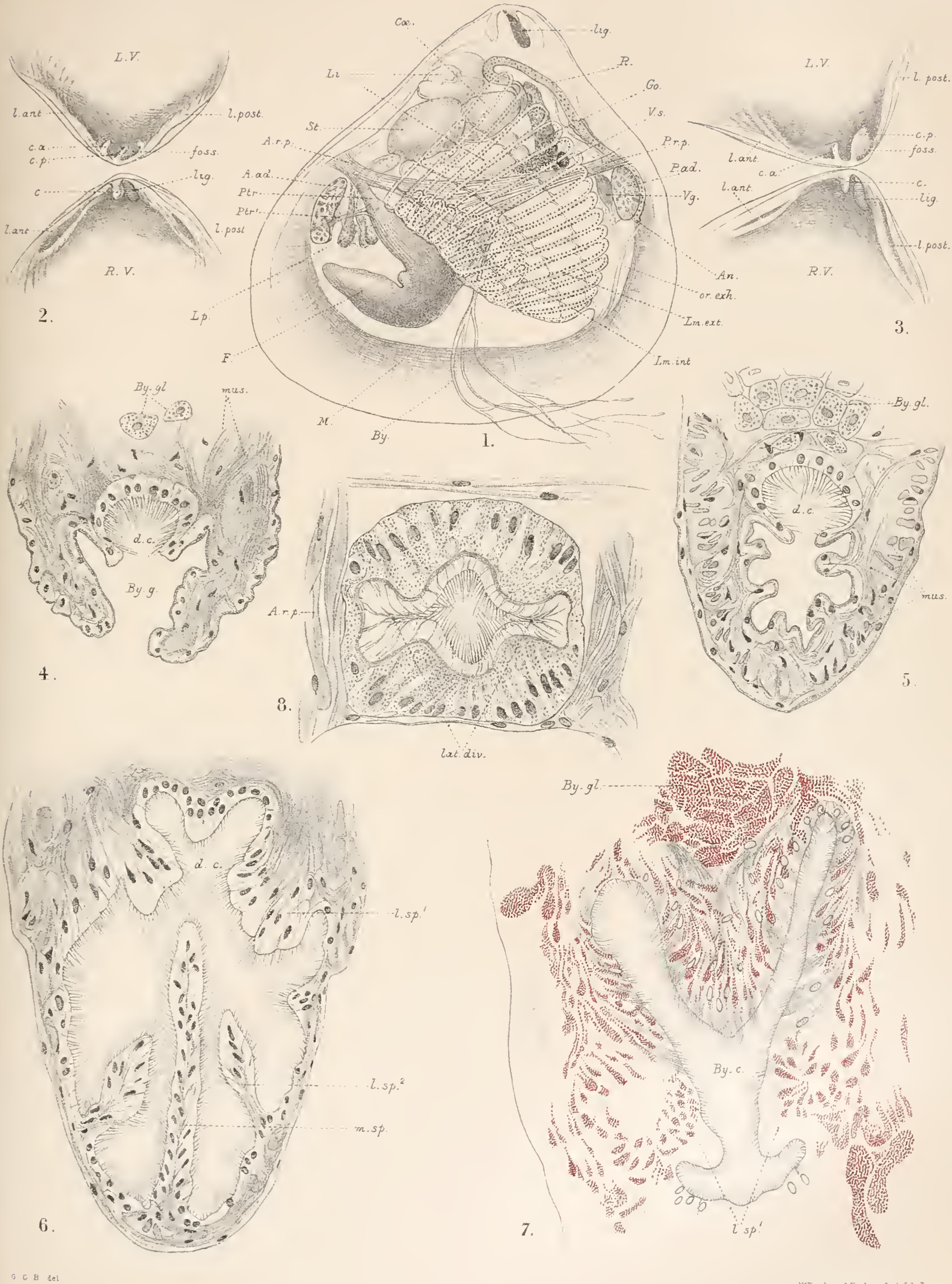
„ 24. A horizontal section through the gonaducts, vesiculæ seminales, and posterior part of the kidney of *J. heteropsammiæ*. ZEISS' $\frac{1}{12}$ hom. imm. Comp. Oc. 4. *Con.*, renal concretions.

„ 25. A section somewhat lower down from the same series as fig. 24, showing the renal duct, *Re.d.*, and the opening of the vesicula seminalis into the gonaduct; *br.*, attachment of branchial filament to the body-wall.

„ 26. A section next but one in the series to that shown in fig. 25, showing the renal (*Re.a.*) and genital (*Go.a.*) apertures.

„ 27. A young individual of *J. heterocyathi* with one growth lamella outside the prodissoconch, and with five gill fenestrations and the commencement of a sixth; *pr.diss.*, outline of the prodissoconch; *Card.a.*, anterior cardinal hinge tooth. × 150.

„ 28. A somewhat older individual of the same species with seven gill fenestrations and four growth lamellæ outside the prodissoconch. × 150.



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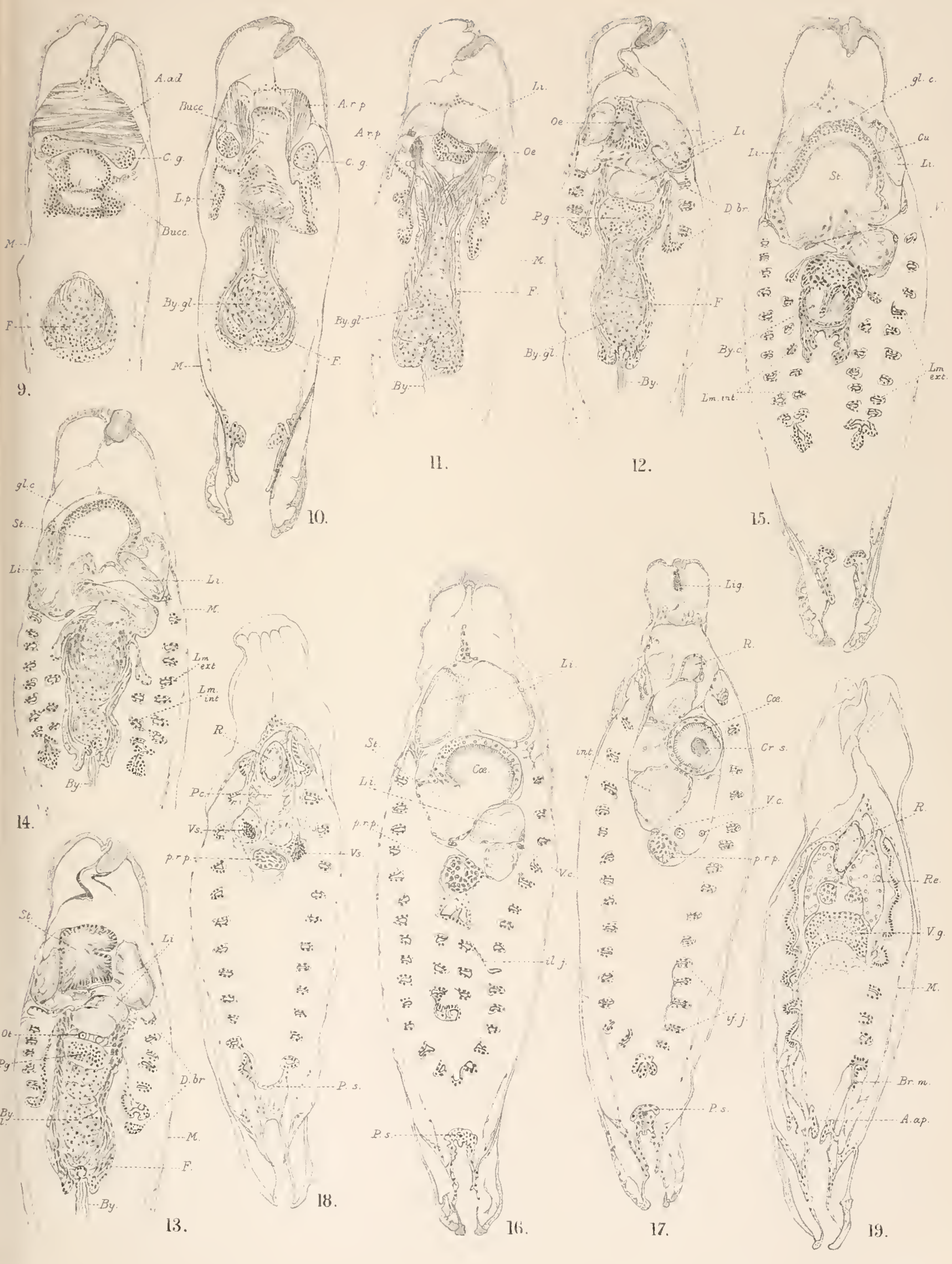
McFarlane & Erskine Lith. Edinʳ.



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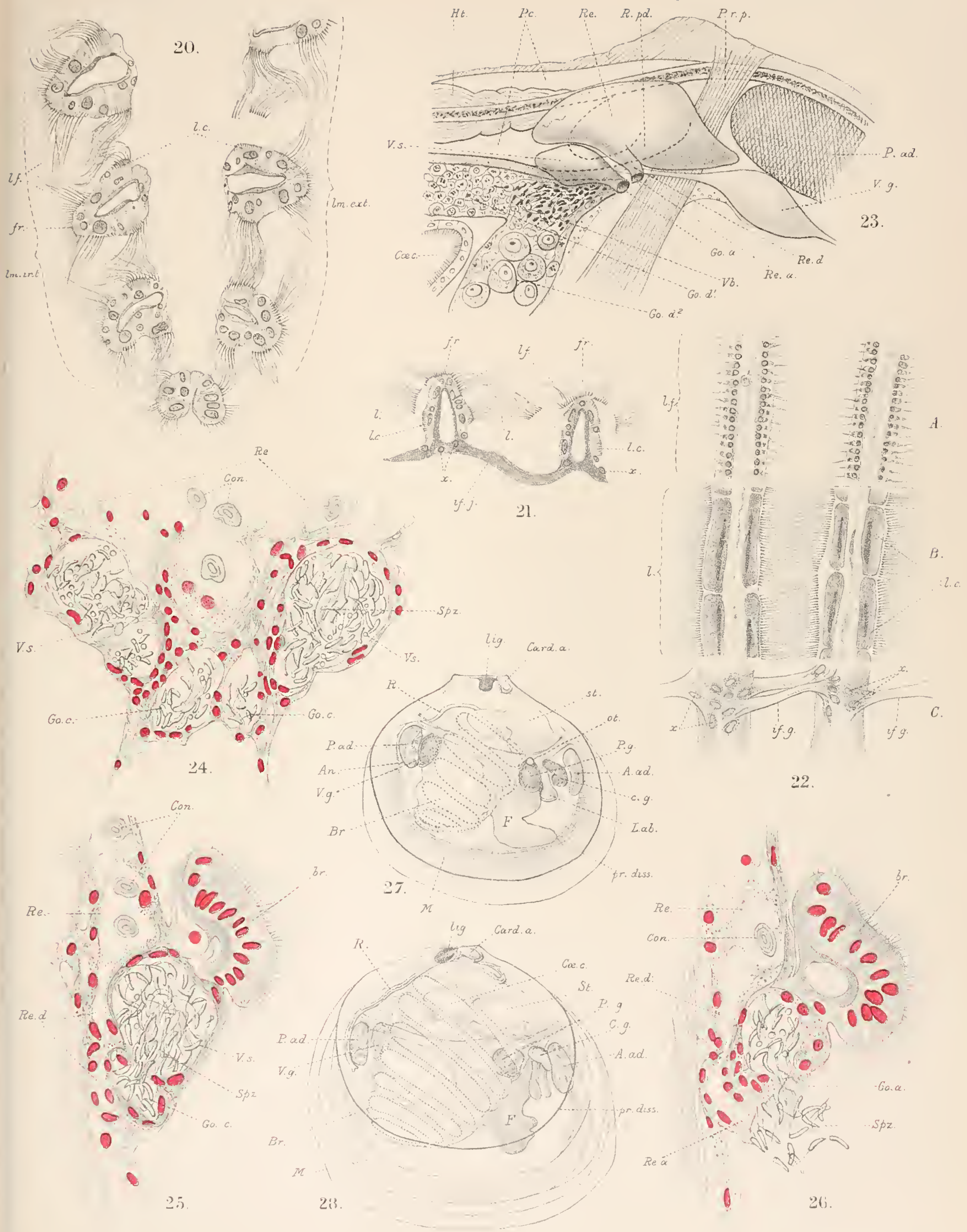
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lm.int.
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Ht.
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23.
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REPORT

ON THE

MOLLUSCAN SHELLS

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

ROBERT STANDEN (ASSISTANT KEEPER, MANCHESTER MUSEUM), AND
ALFRED LEICESTER (LIVERPOOL),
MEMBERS OF THE CONCHOLOGICAL SOCIETY OF GREAT BRITAIN, AND IRELAND.

PROFESSOR HERDMAN has placed in our hands the collection of Mollusca* obtained during his dredgings around the coasts of Ceylon, and of these we have now identified 373 Gastropoda, 5 Scaphopoda, and 142 Pelecypoda. In addition we have still unidentified 1 *Eulima*, 1 *Marginella*, 1 *Amphiperas*, 2 *Rissoina*, 2 *Triforis*, 1 *Dentalium*, 2 *Cardium*, and a few bivalves which may possibly all prove new to science; also some juvenile forms of doubtful identity; and we much regret that the time at our disposal, for the compilation of this Catalogue, does not allow of their more critical examination. We propose at an early opportunity to investigate these "remainders," and hope to publish the results in the 'Journal of Conchology.'

The material chiefly consists of the larger-sized and well-known species, with a few of the smaller forms described in recent years by the numerous workers on the Molluscan Fauna of the Indo-Pacific region. The absence from Professor HERDMAN'S dredgings of the *minutiora* which have yielded such an abundance of new forms, mostly endemic, in other collections, is somewhat remarkable, and can only be accounted for on the supposition that the mesh of the dredge nets was too large to retain such small objects. The Pyramidellidæ, Rissoidæ, and the smaller Pleurotomidæ, &c., are barely represented, whilst such genera as *Scala*, *Litiopa*, *Tornatina*, *Cyclostrema* and *Bullia* do not occur at all in this collection, common as they have

* Separate Reports on the POLYPLACOPHORA, by Mr. E. R. SYKES, on the CEPHALOPODA, by Dr. W. E. HOYLE, and on the OPISTHOBRANCHIA, by Mr. G. P. FARRAN, have already appeared in this series. The present Report deals with the shells of the remaining Mollusca collected.—ED.

proved to be on the Indian coasts generally. The chief rarity worthy of note is *Mitra tankervillei*, hitherto a unique shell of unknown locality.

In the Catalogue we have quoted localities only, as found in the various jars and bottles, or as furnished by Professor HERDMAN. Particulars as to nature of bottom, and conditions under which the specimens were obtained, are so fully given under the several headings in the "Narrative" itself (Part I., p. 17) that we do not consider it necessary to repeat them.

We must thank Professor HERDMAN for the care bestowed in the collection and preservation of his specimens, and for his help in the general assortment of the material. Also we must record our deep indebtedness to Mr. EDGAR A. SMITH, F.Z.S., Mr. J. COSMO MELVILL, M.A., F.L.S., F.Z.S., and Mr. J. M. WILLIAMS and Mr. W. J. HALLS for much valuable assistance and for advice in the case of certain critical species.

In the classification adopted, we have followed the general sequence proposed by P. PELSENEER in his 'Introduction à l'étude des Mollusques' (1892), and have also referred often to P. FISCHER'S 'Manuel de Conchyliologie' (1887). For the characters of the species we have, to a certain extent, followed TRYON'S 'Manual of Mollusca,' at the same time allowing our own views fair latitude. We have considered it quite unnecessary in this instance to burden the Catalogue with the synonymy of each species, but have endeavoured in every case to give the name sanctioned by the laws of priority.

CATALOGUE OF SPECIES.

CLASS: CEPHALOPODA.

(In addition to the species of Cephalopoda recorded by Dr. HOYLE in his report, Part II., p. 185, the shell of *Spirula peroni*, LAMARCK, was obtained at Watering Point, Galle, and at Trincomalee.)

CLASS: GASTROPODA.

ORDER: PROSOBRANCHIATA.

FAMILY: PATELLIDÆ.

Helcioniscus testudinarius (LINN.).—S. of Modragam Paar.

FAMILY: FISSURELLIDÆ.

Fissurella tenuistriata, SOWERBY.—S. of Modragam Paar.

Glyphis salebrosa, REEVE.—Trincomalee.

Family: EMARGINULIDÆ.

Emarginula puncticulata, A. Adams.—Off Galle.

Macrochisma compressa, A. Adams.—S. of Modragam Paar.

Macrochisma scutiformis, Nevill.—S. of Modragam Paar.

Scutus corrugatus, Reeve.—Gulf of Manaar.

Scutus unguis (Linn.).—N. of Gulf of Manaar; off Galle; S. of Cheval Paar.

Family: HALIOTIDÆ.

Haliotis rufescens, Sowerby.—Gulf of Manaar.

Haliotis varia, Linn.—Trincomalee.

Family: STOMATELLIDÆ.

Stomatia phrymotis, Helb.—N. of Gulf of Manaar.

Gena lentricula, A. Adams.—Off Kaltura.

Family: DELPHINULIDÆ.

Delphinula formosa, Reeve.—N. of Gulf of Manaar.

Delphinula laciniata, Lamarck.—Gulf of Manaar, Modragam Paar.

Family: LIOTIIDÆ.

Liotia cidaris, Reeve.—S. of Cheval Paar; S. of Modragam Paar; Gulf of Manaar.

Family: TROCHIDÆ.

Trochus (Tectus) obeliscus, Gmelin.—Galle.

Trochus (Infundibulum) radiatus, Gmelin.—Pearl banks, Gulf of Manaar; off Aripu; off Galle; Trincomalee.

Trochus (Lamprostoma) sacellum, Philippi.—Off Galle.

Trochus (Lamprostoma) maculatus, Linn.—Gulf of Manaar; S. of Modragam Paar; Trincomalee.

Clanculus ceylanicus, Nevill.—Off Galle.

Clanculus depictus, A. Adams.—Trincomalee.

Clanculus microdon, A. Adams.—Palk Bay; S. of Modragam Paar.

Gibbula fanuloides, Fischer.—Palk Bay.

Gibbula pulcherrima, A. Adams.—Gulf of Manaar; off Aripu; off Galle.

Monilea callifera, Lamarck.—Gulf of Manaar.

Monilea callifera, var. **masoni**, Nevill.—Chilaw Paar.

Minolia gradata, Sowerby.—S. of Adam's Bridge.

Minolia variabilis, A. Adams.—Off Galle.

Solariella variabilis, A. Adams.—Pearl banks, Gulf of Manaar.

Calliostoma scobinata, A. Adams.—Jokkenpiddi Paar.

Calliostoma tranquebarica, Chemnitz.—From stomach of *Astropecten*, off Chilaw.

Euchelus asper, Gmelin (**Aradasia**, Gray).—S. of Modragam.

Euchelus atratus, Gmelin.—Pearl banks, Gulf of Manaar.

Euchelus proximus, A. Adams.—Gulf of Manaar; Palk Bay.

Euchelus pullatus, Anton.—Between Negombo and Chilaw.

Euchelus tricingulatus, A. Adams.—Gulf of Manaar.

Umbonium (Rotella) vestiarium, Linn.—Tampalakam Lake, Trincomalee.

Ethalia carneolata, Melvill.—Gulf of Manaar; off Galle; S. of Adam's Bridge.

Ethalia guamensis, Quoy.—N. of Gulf of Manaar.

Family: TURBINIDÆ.

Phasianella variegata, Lamarck.—Pearl banks, Gulf of Manaar; S. of Cheval Paar.

Phasianella variegata, var. **nivosa**, Reeve.—S. of Adam's Br.; Modragam; off Galle.

Turbo radiatus, Gmelin.—Pearl banks, Gulf of Manaar; S. end of Cheval Paar.

Turbo radiatus, var. **chemnitzianus**, Reeve.—Cheval Paar, Gulf of Manaar.

Turbo (Marmorostoma coronatus, Gmelin.—Trincomalee.

Turbo (Senectus) argyrostomus, Linn.—Welligam Bay.

Astralium stellatum, Gmelin.—S. of Adam's Bridge; Galle lagoon.

Family: NERITIDÆ.

Nerita (Thelicostyla) albicilla, LINN.—Galle.

Nerita polita, LINN.—Welligam Bay.

Nerita (Thelicostyla) chlorostoma, LAMARCK.—Trincomalee.

Nerita (Pila) plicata, LINN.—Tampalakam Lake, Trincomalee.

Nerita (Odontostoma) rumphi, RECLUZ.—Galle.

Family: IANTHINIDÆ.

Ianthina fragilis, LAMARCK.—Trincomalee.

Family: NATICIDÆ.

Natica ala-papilionis, CHEMNITZ.—Pearl banks, Gulf of Manaar; Tampalakam Lake, Trincomalee; off Galle.

Natica antoni, PHILIPPI.—Tampalakam Lake, Trincomalee.

Natica dillwyni, PAYR.—Palk Bay.

Natica euzona, RECLUZ.—Jokkenpiddi Paar; Tampalakam Lake, Trincomalee.

Natica queketti, SOWERBY.—Pearl banks off Aripu, Gulf of Manaar.

Natica trailli, REEVE.—Off Galle.

Natica zanzibarica, RECLUZ.—Tampalakam Lake, Trincomalee.

Natica (Eunatica) tela-araneæ, MELVILL.—Cheval Paar, Gulf of Manaar.

Natica (Mamma) albumen, LINN.—N. of Gulf of Manaar.

Natica (Mamma) candidissima, LEGUIL.—Gulf of Manaar; deep water off Galle.

Natica (Mamma) columnaris, RECLUZ.—Deep water off Galle.

Natica (Mamma) mamilla, LINN.—Trincomalee.

Natica (Mamilla) melanostoma, GMELIN.—S. of Adam's Bridge; Trincomalee.

Natica (Mamilla) simiæ, DESHAYES.—Gulf of Manaar.

Sigaretus neritoideus, LINN.—Pearl banks, Gulf of Manaar.

Family: TRICHOTROPIDÆ.

Lippistes helicoides, Montfort (**Separatista chemnitzii**, A. Adams).—Donnan's Muttuvaratu Paar, Gulf of Manaar.

A fine specimen, with the animal. The exact position of this genus is not yet quite fixed, but it seems to have a certain amount of affinity with the Trichotropidæ.

Family: XENOPHORIDÆ.

Xenophora corrugata, Reeve.—Pearl banks, Gulf of Manaar; off Aripu; S. of Adam's Bridge; deep water off Galle; Trincomalee.

Xenophora indicus, Gmelin.—S.E. of Ceylon.

Family: CAPULIDÆ.

Crucibulum (Bicatillus) extinctorum, Lamarck.—Deep water off Galle; off Aripu.

Crucibulum (Bicatillus) morbidum, Reeve.—Pearl banks, Gulf of Manaar.

Crucibulum violaceum, Carpenter.—Off Cheval Paar.

Calyptræa layardi, Reeve.—S. of Adam's Bridge.

Calyptræa (Galerus) edgariana, Melvill.—Pearl banks, Gulf of Manaar; off Aripu; Trincomalee.

Crepidula (Siphopatella) walshi, Herm.—Gulf of Manaar.

Capulus lissus, E. A. Smith.—S. of Modragam Paar.

Amathina tricostata, Gmelin.—S. end of Cheval Paar.

Family: HIPPONYCIDÆ.

Mitrularia equestris, Linn.—Gulf of Manaar.

Family: SOLARIIDÆ.

Solarium lævigatum, Lamarck.—Deep water off Galle.

Solarium impressum, Nevill.—Trincomalee.

Solarium modestum, Philippi.—Pearl banks off Aripu, Gulf of Manaar.

Solarium perspectivum, Linn.—Trincomalee.

Solarium (Torinia) variegatum, Gmelin.—Gulf of Manaar.

Family: LITTORINIDÆ.

Littorina scabra, Linn.—Backwater, Manaar Island.

Family: CERITHIIDÆ.

Cerithium armatum, Phil.—Trincomalee; Periya Paar.

Cerithium citrinum, Sowerby.—Pearl banks, Gulf of Manaar.

Cerithium morus, Lamarck.—Deep water off Galle.

Cerithium tuberosum, Fabricius.—Off Mutwal Island.

Cerithium yerburyi, E. A. Smith.—S. of Adam's Bridge.

Cerithium (Vertagus) aluco, Linn.—S. of Modragam Paar.

Cerithium (Vertagus) articulatum, Adams and Reeve.—N. of Gulf of Manaar.

Cerithium (Vertagus) fasciatum, Brug., var. **martinianum**, Pfr.—Backwater, Manaar Island; Galle; S. of Modragam Paar.

Cerithium (Vertagus) kochi, Phil.—Pearl banks off Aripu, Gulf of Manaar; Trincomalee; Modragam Paar; Galle.

Cerithium (Vertagus) obeliscus, Brug.—Backwater, Manaar Island; off Galle.

Colina selecta, Melvill and Standen.—Galle.

Potamides (Tympanotonus) fluviatilis, Pot. and Mich.—Muddy Creek, N. of Manaar Island.

Potamides (Telescopium) fuscum, Schumacher.—Trincomalee.

Pyrazus palustris, Linn.—Pearl bank off Aripu; Trincomalee.

Family: PLANAXIDÆ.

Planaxis sulcatus, Born.—Deep water off Galle; Trincomalee.

Family: TURRITELLIDÆ.

Turritella carinifera, Lamarck.—Trincomalee.

Turritella triplicata, Studer.—Trincomalee.

Turritella (Haustator) candida, Reeve.—S. of Adam's Bridge.

Turritella (Haustator) columnaris, Kiener.—Deep water off Galle.

Turritella (Haustator) maculata, Reeve.—S. of Adam's Bridge ; Trincomalee.

Turritella (Zaria) duplicata, Linn.—S.E. of Ceylon ; Welligam Bay ; Trincomalee ; N. of Gulf of Manaar.

Turritella (Eglisia) vittulata, Adams and Reeve.—N. of Gulf of Manaar.

Family : VERMETIDÆ.

Vermetus (Thylacodes) dentiferus, Lamarck.—Gulf of Manaar.

Siliquaria cumingi, Mörch.—S. of Modragam Paar.

Siliquaria tostus, Mörch.—S.E. of Ceylon ; S. of Modragam Paar.

Family : STROMBIDÆ.

Strombus papilio, Chemnitz.—N. of Gulf of Manaar.

Strombus (Gallinula) isabella, Lamarck.—Trincomalee.

Strombus (Gallinula) marginatus, Linn.—N. of Gulf of Manaar ; Trincomalee.

Strombus (Gallinula) succinctus, Linn.—Pearl banks off Aripu, Gulf of Manaar ; S. of Adam's Bridge ; off Mutwal Island ; Trincomalee.

Strombus (Canarium) canarium, Linn.—Gulf of Manaar ; Trincomalee.

Strombus (Canarium) elegans, Sowerby.—Pearl banks off Aripu, Gulf of Manaar ; deep water off Galle ; Modragam Paar ; S. of Adam's Bridge.

Strombus (Canarium) floridus, Lamarck.—Trincomalee.

Strombus (Canarium) gibberulus, Linn.—Gulf of Manaar ; Trincomalee.

Strombus (Canarium) pulchellus, Reeve.—N. of Gulf of Manaar ; pearl bank, Aripu ; S. of Adam's Bridge ; Donnan's Paar ; Trincomalee ; deep water off Galle.

Strombus (Canarium) samarensis, Reeve.—N. of Gulf of Manaar.

Strombus (Canarium) urceus, Linn.—Pearl banks, Gulf of Manaar ; Trincomalee.

Strombus (Canarium) yerburyi, E. A. Smith.—N. of Gulf of Manaar ; S. of Adam's Bridge ; deep water off Galle ; pearl banks off Aripu ; Trincomalee.

Strombus (Monodactylus) auris-dianæ, Linn.—N. of Gulf of Manaar ; off Aripu.

Strombus (Monodactylus) gallus, LINN.—Modragam Paar.

Pterocera lambis, LINN.—Trincomalee.

Pterocera (Millepes) scorpio, LINN.—S. of Modragam Paar.

Rostellaria (Rimula) crispata, SOWERBY.—Pearl banks, Gulf of Manaar; Trincomalee; S.E. of Ceylon; S. of Modragam Paar.

Seraphs terebellum, MONTFORT.—Pearl banks, Gulf of Manaar; S.E. of Ceylon; S. of Modragam Paar; Trincomalee.

FAMILY: CYPRÆIDÆ.

Cypræa arabica, LINN.—Gulf of Manaar; Tampalakam Lake; Trincomalee.

Cypræa caput-serpentis, LINN.—Welligam Bay; Trincomalee.

Cypræa clandestina, LINN.—Pearl banks, Gulf of Manaar; Donnan's Paar; Palk Bay; deep water off Galle; Trincomalee.

Cypræa coffea (SOWERBY).—Trincomalee.

Cypræa caurica, LINN.—Gulf of Manaar. One typical example.

Cypræa caurica, LINN., var. **cairnsiana**, MELVILL and STANDEN ('Jour. of Conch.,' vol. xi., 1904, p. 118).—S. of Adam's Bridge; Modragam Paar; S. end of Cheval Paar; Trincomalee.

This beautiful form bears precisely the same relation to typical *caurica* that *coloba*, MELVILL (= *greegori*, FORD) does to *cruenta*, GMELIN. The Ceylonese examples are quite as fine, but slightly smaller, than the Karachi ones, and far surpass in coloration others of this same variety from Borneo and the East Indies.

Cypræa erosa, LINN., var. **straminea**, MELVILL.—S. of Modragam Paar.

Cypræa errones, LINN.—Trincomalee.

Cypræa fimbriata, GMELIN.—Gulf of Manaar.

Cypræa gangrenosa (SOLANDER), var. **melanosema**, MELVILL.—Gulf of Manaar; Modragam Paar; off Galle.

Cypræa lutea (GRONOV.).—Gulf of Manaar.

Cypræa lynx, LINN.—Trincomalee.

Cypræa moneta (LINN.).—Tampalakam; Trincomalee; Galle; S. of Modragam.

Cypræa neglecta, SOWERBY.—Gulf of Manaar; Trincomalee.

Cypræa ocellata (Linn).—S. of Adam's Bridge; Donnan's Paar; S. end of Cheval Paar; off Galle; Trincomalee; S. of Modragam Paar; off Aripu.

Cypræa onyx (Linn.), var. **adusta** (Chemnitz).—Pearl banks, Gulf of Manaar.

Cypræa tigris, Linn.—Gulf of Manaar.

Cypræa vitellus, Linn.—S. of Modragam Paar; Trincomalee.

Cypræa ziczac, Linn.—S. of Adam's Bridge.

Trivia annulata, Gray.—S. of Adam's Bridge.

Trivia brevissima (Sowerby).—Deep water off Galle.

Trivia cicercula (Linn).—Trincomalee.

Trivia globosa (Gray).—From stomach of *Astropecten*, off Chilaw, 10 fathoms.

Trivia nucleus, Linn.—Gulf of Manaar; Trincomalee.

Trivia fibula, Kiener.—Two "live" examples from Gulf of Manaar. We quite agree with Mr. J. M. Williams, to whom we submitted these specimens, that they are not the same as *Trivia globosa* (Gray).

Trivia rubinicolor (Gaskoin).—S. of Adam's Bridge. A dead shell, more like a fossil, as recently-dead *Triviæ* are invariably glossy or polished, but Mr. Williams identifies it without any doubt as this species.

Trivia staphylæa (Linn.).—S. of Adam's Bridge; Trincomalee.

Trivia staphylæa, var. **limacina**, Lamarck.—S. of Modragam Paar.

Ovula (Volva) volva, Linn.—Pearl banks, Gulf of Manaar.

Amphiperas pyriformis, Sowerby.—S. of Modragam Paar.

Family: DOLIIDÆ.

Dolium maculatum, Lamarck.—Gulf of Manaar; Trincomalee.

Dolium olearium, Bruguière.—Gulf of Manaar; Trincomalee.

Family: CASSIDIDÆ.

Cassis canaliculata, Lamarck.—N. of Gulf of Manaar; S.E. of Ceylon.

Cassis (Casmaria) vibex, H. and A. Adams.—S. of Adam's Bridge; off Galle.

Cassis (Phalium) glauca, Linn.—Pearl banks, Gulf of Manaar.

Pyrula ficus, LAMARCK (**P. lævigata**, REEVE).—Trincomalee ; off Aripu.

Pyrula reticulata, LAMARCK.—Gulf of Manaar ; off Galle ; Trincomalee.

FAMILY: TRITONIIDÆ.

Lotorium canaliferus, LAMARCK (**Triton**, MONTFORT).—Trincomalee.

Lotorium lotorium, LINN.—Pearl banks off Aripu, Gulf of Manaar ; S.E. of Ceylon ; S. of Adam's Bridge.

Lotorium olearium (LINN.).—Off Aripu, Gulf of Manaar.

Lotorium tripus, CHEMNITZ.—Trincomalee.

Lotorium (Simpulum) chlorostomum (LAMARCK).—Galle.

Lotorium (Simpulum) labiosum (WOOD).—Deep water off Galle ; S. of Cheval Paar.

Lotorium (Simpulum) pileare (LINN.).—Pearl banks, Gulf of Manaar ; Trincomalee.

Lotorium (Simpulum) rubecula, LINN.—Pearl banks, Gulf of Manaar.

Lotorium (Gutturnium) cynocephalus (LAMARCK).—Galle.

Lotorium (Gutturnium) exilis, REEVE.—Pearl banks, Gulf of Manaar.

Lotorium (Gutturnium) gallinago, REEVE.—Trincomalee.

Lotorium (Gutturnium) retusum (LAMARCK).—Pearl banks, Gulf of Manaar.

Lotorium (Gutturnium) tuberosum (LAMARCK).—Galle.

Lotorium (Gutturnium) vespaceum (LAMARCK).—Pearl banks, Gulf of Manaar ; S. of Modragam Paar.

Lotorium (Lagena) cingulatum (PFR.).—Off Aripu, Gulf of Manaar ; off Galle.

Lotorium (Epidromus) testaceum (MÖRCH).—Cheval Paar ; S. of Adam's Bridge ; pearl banks, Gulf of Manaar.

Gyrineum crumena (LAMARCK).—Palk Bay ; pearl banks off Aripu, Gulf of Manaar ; off Kaltura.

Gyrineum (Bursa) albivaricosum, REEVE.—Gulf of Manaar ; S. of Adam's Bridge.

Gyrineum (Lampas) bufonia, GMELIN.—Pearl banks, Gulf of Manaar.

Gyrineum (Lampas) graniferum, LAMARCK.—Pearl banks off Aripu, Gulf of Manaar ; S. end of Cheval Paar ; S. of Modragam Paar ; Trincomalee.

Gyrineum (Argobuccinum) bituberculare (Reeve).—Pearl banks off Aripu, Gulf of Manaar; off Mutwal Island; S. of Modragam Paar; S. of Adam's Bridge; deep water off Galle; off Mount Lavinia; Trincomalee.

Gyrineum (Argobuccinum) margaritula, Deshayes.—Pearl banks, Gulf of Manaar; deep water off Galle.

Gyrineum (Argobuccinum) pusillum, Broderip.—S. of Adam's Bridge; Donnan's Paar; S. of Modragam Paar.

Gyrineum (Argobuccinum) tuberculatum, Broderip.—Pearl banks, Gulf of Manaar.

Distorsio cancellinus, Roissy.—N. of Gulf of Manaar; Trincomalee.

Distorsio cancellinus, var. **decipiens,** Reeve.—Deep water off Galle.

Distorsio ridens, Reeve.—Pearl banks off Aripu.

Family: PYRAMIDELLIDÆ.

Pyramidella acus, Gmelin.—Trincomalee.

Family: CORALLIOPHILIDÆ.

Coralliophila violacea, Kiener.—Donnan's Paar.

Family: MURICIDÆ.

Murex malabaricus, E. A. Smith.—Gulf of Manaar.

Murex nigrispinosus, Reeve.—Deep water off Galle.

Murex ramosus, Linn.—Palk Bay; N. of Gulf of Manaar.

Murex rectirostris, Sowerby.—Deep water off Galle.

Murex tenuispina, Lamarck.—Deep water off Galle.

Murex ternispina, Lamarck.—N. of Gulf of Manaar; Palk Bay; off Galle.

Murex (Chicoreus) aculeatus, Lamarck.—N. of Gulf of Manaar; off Galle.

Murex (Chicoreus) adustus, Lamarck.—N. of Gulf of Manaar.

Murex (Chicoreus) adustus, var. **huttoniæ,** Wright.—Off Aripu, Gulf of Manaar.

Murex (Chicoreus) palmiferus, Sowerby.—Deep water off Galle; Gulf of Manaar; S. of Modragam Paar.

Murex (Chicoreus) sauliæ, Sowerby.—Deep water off Galle.

Murex (Phyllonotus) anguliferus, Lamarck.—Gulf of Manaar; Periya Paar.

Murex (Pteronotus) pinnatus, Wood.—Pearl banks off Aripu, Gulf of Manaar; S. of Modragam Paar.

Murex (Homalacantha) varicosus, Sowerby.—Donnan's Paar.

Murex (Haustellum) haustellum, Linn.—N. of Gulf of Manaar; Galle; Palk Bay; deep water off Galle; Trincomalee.

Urosalpinx contracta, Reeve.—Palk Bay.

Urosalpinx innotabilis, E. A. Smith.—Galle; S. of Adam's Bridge.

Rapana bulbosa, Solander.—N. of Gulf of Manaar.

Latiaxis diadema, Sowerby.—Off Galle.

Purpura coronata, Lamarck.—Backwater, Manaar Island.

Purpura persica, Linn.—Welligam Bay.

Purpura (Thalessa) hippocastanum, Lamarck.—Galle.

Purpura (Stramonita) bufo, Lamarck.—Welligam Bay.

Purpura (Polytropa) sacellum, Chemnitz.—Pearl banks, Gulf of Manaar.

Pinaxia coronata, A. Adams.—Pearl banks off Aripu, Gulf of Manaar; S. of Adam's Bridge; Modragam Paar; Jokkenpiddi Paar; S. end of Cheval Paar.

Cuma carinifera (Lamarck).—Tampalakam Lake, Trincomalee.

Ricinula horrida, Lamarck.—Off Galle.

Sistrum elongatum, Blainville.—N. of Gulf of Manaar.

Sistrum chrysostoma, Deshayes.—Gulf of Manaar.

Sistrum konkanense, Melvill.—Gulf of Manaar.

Sistrum spectrum, Reeve.—Pearl banks, Gulf of Manaar; Aripu Reef; Trincomalee; S. end of Cheval Paar; S. of Adam's Bridge; Jokkenpiddi Paar; off Chilaw, 10 fathoms; off Mutwal Island; S. of Modragam Paar.

Sistrum tuberculatum, Blainville.—N. of Gulf of Manaar.

Family: COLUMBELLIDÆ.

Columbella propinquans, E. A. Smith.—Jokkenpiddi Paar; Trincomalee; S. of Adam's Bridge; Donnan's Paar.

Columbella (Pygmæa) flavida, Lamarck.—Gulf of Manaar; Jokkenpiddi Paar; off Mutwal Island.

Columbella (Pygmæa) pardalina, Lamarck.—S. of Modragam Paar; pearl banks, Gulf of Manaar.

Columbella (Pygmæa) turturina, Lamarck.—Cheval Paar; Donnan's Paar; S. of Modragam Paar.

Columbella (Pygmæa) tyleri, Gray.—S. of Modragam Paar.

Columbella (Pygmæa) versicolor, Sowerby.—Off Galle.

Columbella (Conidea) flava, Brug.—Pearl banks, Gulf of Manaar; Cheval Paar.

Family: NASSIDÆ.

Nassa arcularia, Linn.—Trincomalee.

Nassa nevilliana, Preston.—Trincomalee.

Nassa pulla, Linn.—Pearl banks, Gulf of Manaar; S. of Adam's Bridge.

Nassa (Arcularia) thersites, Brug.—Tampalakam Lake, Trincomalee.

Nassa (Tritia) crenulata, Brug.—Welligam Bay.

Nassa (Alectryon) elegans, Kiener.—Gulf of Manaar; Trincomalee.

Nassa (Alectryon) glans, Linn.—Pearl banks, Gulf of Manaar.

Nassa (Zeuxis) pallidula, A. Adams.—Deep water off Galle.

Nassa (Niotha) gemmulata, Lamarck.—Pearl banks, Gulf of Manaar; off Kaltura; deep water off Galle; S. of Modragam Paar.

Nassa (Niotha) marginulata, Lamarck.—Trincomalee.

Nassa (Niotha) splendidula, Dunker.—Pearl banks, Gulf of Manaar.

Nassa (Niotha) stigmaria, A. Adams.—Pearl banks, Gulf of Manaar; S. of Adam's Bridge; deep water off Galle.

Nassa (Hima) frederici, MELVILL and STANDEN.—Gulf of Manaar; Trincomalee.

This is **Nassa (Hima) townsendi**, MELV., 'Mem. Manch. Soc.,' vol. xli., part iii. (1897), No. 7, p. 4, plate 6, fig. 1 (*non* DALL).

Cyllene grayi, REEVE.—S. of Adam's Bridge; Chilaw Paar; from stomach of *Astropecten* off Chilaw, 10 fathoms.

FAMILY: BUCCINIDÆ.

Pisania ignea, GMELIN.—Deep water off Galle; S. of Modragam.

Pisania marmorata, REEVE.—Gulf of Manaar.

Pisania picta, REEVE.—N. of Gulf of Manaar.

Tritonidea melanostoma, SOWERBY.—Pearl bank, Aripu; N. of Gulf of Manaar; S. of Modragam Paar.

Tritonidea rubiginosa (REEVE).—Galle.

Tritonidea tissoti, PETIT.—Off Galle.

Tritonidea tranquebarica, GMELIN.—Gulf of Manaar.

Tritonidea undosa, LINN.—Pearl banks off Aripu; Trincomalee.

Engina zea, MELVILL.—N. end of Manaar.

Nassaria acuminata, REEVE.—Pearl banks, Gulf of Manaar.

Nassaria nivea, GMELIN.—Palk Bay; S. of Adams' Bridge.

Nassaria suturalis, A. ADAMS.—Pearl banks off Aripu, Gulf of Manaar; S. of Adam's Bridge; deep water off Galle; Palk Bay; S. of Modragam Paar.

Phos blainvillei, DESHAYES.—Trincomalee.

Phos nodicostatus, A. ADAMS.—Gulf of Manaar; S. of Modragam Paar.

Phos retecosus, HINDS.—Gulf of Manaar.

Phos roseatus, HINDS.—Gulf of Manaar; deep water off Galle; Palk Bay; S. of Adam's Bridge.

Latrunculus spirata, LAMARCK (**Eburna**, LAM.).—Deep water off Galle; Welligam.

Latrunculus zeylanicus, BRUG.—Pearl banks, Gulf of Manaar.

FAMILY: TURBINELLIDÆ.

Turbinella pyrum, LINN. (**Turbinella rapa,** GMELIN.).—Pearl banks off Aripu, Gulf of Manaar; deep water off Galle; Trincomalee.

The "Chank" occurs in the collection from its egg-capsules, through all stages of growth, to the large and swollen spotless form distinguished by most authors as *T. rapa*, GMEL., = *gravis*, DILLW., = *clavata*, WAGN., = *napus*, LAM.; but the distinction does not hold good, the shell becoming more swollen and less spotted with increase in size.

Vasum turbinellum, LINN.—Trincomalee.

Tudicla spirillus, LINN.—Pearl banks, Gulf of Manaar; off Mutwal Island; Palk Bay; deep water off Galle; Trincomalee.

Melongena vespertilio, LAMARCK.—Gulf of Manaar.

FAMILY: FASCIOLARIIDÆ.

Fusus colus, LINN.—Pearl banks, Gulf of Manaar; Trincomalee.

Fasciolaria filamentosa, MARTYN.—Pearl banks, Gulf of Manaar; Galle.

Fasciolaria trapezium (LINN.).—N. of Gulf of Manaar; Trincomalee.

Latirus lancea, GMELIN.—Gulf of Manaar.

Latirus (Peristernia) pagodiformis, MELVILL.—Gulf of Manaar.

Latirus (Peristernia) pulchellus, REEVE.—Pearl banks, Gulf of Manaar; S. end of Cheval Paar; S. of Adam's Bridge.

Latirus (Peristernia) turritus, GMELIN.—Gulf of Manaar; Trincomalee; Mudalaikuli Paar; S. of Modragam Paar.

Latirus (Plicatella) polygonus, GMELIN.—S. end of Cheval Paar.

FAMILY: MITRIDÆ.

Mitra guttata, SWAINSON.—N. of Gulf of Manaar.

Mitra versicolor, MARTYN.—Gulf of Manaar.

Mitra (Scabricola) crenifera, LAMARCK.—Off Galle; Aripu; S. of Modragam Paar.

Mitra (Scabricola) antoniæ, H. ADAMS.—Gulf of Manaar; Trincomalee.

Mitra (Scabricola) scabriuscula, LAMARCK.—Pearl banks, Gulf of Manaar.

Mitra (Cancilla) insculpta, Reeve.—Off Galle; Trincomalee.

Mitra (Cancilla) interlirata, Reeve.—Pearl banks, Gulf of Manaar.

Mitra (Turricula) melongena, Lamarck.—S. of Modragam Paar.

Mitra (Costellaria) acupicta, Reeve.—Trincomalee.

Mitra (Costellaria) exasperata, Gmelin.—S. of Adam's Bridge.

Mitra (Costellaria) clathrata, Reeve.—Gulf of Manaar.

Mitra (Costellaria) crebrilirata, Reeve.—N. of Gulf of Manaar; Trincomalee.

Mitra (Costellaria) militaris, Reeve, var. **antonelli**, Dohrn.—Gulf of Manaar.

Mitra (Costellaria) mucronata, Swainson.—Gulf of Manaar.

Mitra (Costellaria) modesta, Reeve.—Gulf of Manaar; S. of Adam's Bridge; deep water off Galle; S. end of Cheval Paar.

Mitra (Costellaria) revelata, Melvill.—Gulf of Manaar; S. of Modragam Paar.

Mitra (Costellaria) tankervillei, Melvill,* **Mitra rugosa**, Swain.—Deep water off Galle.

Hitherto this species has been unique in the collection of Mr. J. Cosmo Melvill, and was obtained by him from the collection of the late Dr. Prevost, of Alençon, who had acquired it from the Norris collection. This last collection was celebrated for its *Mitræ*, and this was one of its most particular rarities. The figures given by both Reeve and Sowerby are, of course, taken from this specimen when it was in the celebrated collection of shells belonging to the Earl of Tankerville, dispersed in 1825. Professor Herdman's specimen is in a dead condition, and unfortunately has the apex broken, otherwise it exactly harmonises with the type. This is a most interesting discovery, establishing Ceylon as the locality for this rare shell.

Mitra (Costellaria) zebuensis, Reeve.—S. of Adam's Bridge.

Mitra (Pusia) osidiris, Issel.—S. of Modragam Paar.

Mitra (Swainsonia) fissurata, Lamarck.—S.E. of Ceylon; S. of Modragam Paar.

Family: HARPIDÆ.

Harpa conoidalis, Lamarck.—Trincomalee.

Harpa minor, Rumphius.—Tampalakam Lake, Trincomalee.

* 'Journal of Conchology,' vol. v., p. 332.

Harpa nobilis, Rumphius.—Trincomalee.

Harpa ventricosa, Lamarck.—N. of Negombo, 9 fathoms.

Family: MARGINELLIDÆ.

Marginella (Cryptospira) angustata, Sowerby.—Pearl banks, Gulf of Manaar; deep water off Galle; S. of Adam's Bridge; Palk Bay; Chilaw Paar; S. of Modragam Paar; Trincomalee; off Aripu; off Mutwal Island.

This species seems to show considerable variation; in several localities specimens of a very beautiful golden brown colour occur.

Marginella (Cryptospira) mabellæ, Melvill and Standen.*—Pearl banks off Manaar; S. of Adam's Bridge.

In form this is distinct from any near ally, but most recalls the West Indian *M. oblonga*, Sowb. It is gracefully oblong, very shining, straw-coloured, with white shining callous deposit over the columellar region and outer lip; the dorsal margin thick, with straw-coloured callus; mouth narrow, columella four-plaited.

Family: OLIVIDÆ.

Oliva (Strephona) caroliniana, Duclos.—Off Galle.

Oliva (Strephona) elegans, Lamarck.—Trincomalee.

Oliva (Strephona) irisans, Lamarck.—Trincomalee.

Oliva (Strephona) ispidula, Lamarck.—Trincomalee; S. of Adam's Bridge.

Oliva (Strephona) lepida, Duclos.—Pearl banks off Aripu, Gulf of Manaar; Galle; S. of Modragam Paar. Many beautiful colour varieties.

Oliva (Strephona) polita, Marratt.—Gulf of Manaar.

Oliva (Strephona) mantichora, Duclos.—Gulf of Manaar; Modragam Paar.

Oliva (Strephona) maura, Lamarck.—Trincomalee.

Oliva (Strephona) pacifica, Marratt.—Pearl banks off Aripu.

A dark variety, interesting as being from a new locality.

Oliva (Strephona) picta, Reeve.—Gulf of Manaar; S. of Modragam Paar.

Oliva (Strephona) reticularis, Lamarck.—Pearl banks off Aripu.

Oliva (Strephona) tremulina, Lamarck.—Pearl banks off Aripu; off Galle.

* "Moll. Pers. Gulf," 'Proc. Zool. Soc.,' 1901, p. 452, pl. xxiii., fig. 20.

Oliva (Agaronia) nebulosa, LAMARCK.—Welligam; Modragam Paar; Trincomalee.

Olivancillaria gibbosa, BORN.—Trincomalee; S. of Modragam; Aripu; off Galle.

Ancilla ampla, GMELIN.—Gulf of Manaar; S. of Modragam Paar; Trincomalee.

Ancilla albisulcata, GMELIN.—N. of Gulf of Manaar.

Ancilla cinnamomea, LAMARCK.—Gulf of Manaar; S. of Adam's Bridge.

Ancilla fasciata, REEVE.—S. of Adam's Bridge.

Ancilla tindalli, MELVILL.—Deep water off Galle; Cheval Paar; S. of Adam's Bridge; pearl banks, Gulf of Manaar; S. of Modragam Paar.

FAMILY: TEREBRIDÆ.

Terebra duplicata, LINN.—Pearl banks off Aripu, Gulf of Manaar; Jokkenpiddi Paar; S. of Adam's Bridge; deep water off Galle.

Terebra straminea, GRAY.—Off Galle; off Kaltura and Mount Lavinia.

Terebra triseriata, GRAY.—Off Galle; Trincomalee.

Terebra (Subula) crenulata, LINN.—Tampalakam; deep water off Galle.

Terebra (Subula) hastata, GMELIN.—Pearl banks, Gulf of Manaar; Palk Bay.

Terebra (Hastula) strigilata, LINN.—S. of Adam's Bridge.

FAMILY: CONIDÆ.

Conus marmoreus, LINN.—S.W. of Negombo, 20 fathoms.

Conus (Stephanoconus) lividus, BRUG.—Off Aripu; S. of Adam's Bridge.

Conus (Puncticulis) obesus, HWASS. (**Conus ceylonicus**, CHEMNITZ).—Pearl banks off Aripu, Gulf of Manaar; S. of Modragam Paar.

Conus (Dendroconus) figulinus, LINN.—S.E. of Ceylon.

Conus (Lithoconus) augur, BRUG.—Off Aripu; Modragam Paar; off Galle.

Conus (Lithoconus) literatus, LINN.—Deep water outside banks, Gulf of Manaar; S. of Modragam Paar.

Conus (Lithoconus) tesselatus, BRUG.—N. of Gulf of Manaar; S. of Modragam Paar; Trincomalee.

Conus (Lithoconus) vitulinus, Brug.—Pearl banks off Aripu; Trincomalee.

Conus (Leptoconus) elegans, Sowerby.—Modragam Paar; off Aripu; Palk Bay.

Conus (Leptoconus) lentiginosus, Reeve.—Pearl bank, Aripu.

Conus (Leptoconus) longurionis, Kiener.—Off Galle.

Conus (Leptoconus) planiliratus, Sowerby.—Pearl banks off Aripu, Gulf of Manaar; deep water off Galle.

Conus (Rhizoconus) generalis, Linn.—Pearl banks off Aripu, Gulf of Manaar; S. of Adam's Bridge; deep water off Galle.

Conus (Rhizoconus) lithoglyphus, Meusch.—Deep water off Galle.

Conus (Rhizoconus) maldivus, Linn.—Modragam Paar.

Conus (Rhizoconus) miles, Linn.—Modragam Paar; Trincomalee.

Conus (Rhizoconus) monile, Linn.—N. of Gulf of Manaar; Trincomalee; S. of Modragam Paar.

Conus (Rhizoconus) virgo, Linn.—Trincomalee.

Conus (Chelyconus) amabilis, Lamarck.—Off Aripu.

Conus (Chelyconus) catus, Brug.—Modragam Paar.

Conus (Chelyconus) lignarius, Reeve.—Gulf of Manaar.

Conus (Chelyconus) nimbosus, Brug.—Pearl banks off Aripu; Modragam Paar.

Conus (Nubecula) striatus, Linn.—Off Aripu, Gulf of Manaar; Trincomalee.

Conus (Nubecula) termineus, Lamarck.—Trincomalee.

Conus (Cylinder) amadis, Chemnitz.—Pearl bank, Aripu; Modragam Paar.

Pleurotoma crispa, Lamarck.—S. of Adam's Bridge.

Pleurotoma marmorata, Lamarck.—S. of Adam's Bridge.

Pleurotoma tigrina, Lamarck.—N. of Gulf of Manaar; off Galle; Trincomalee.

Pleurotoma (Turris) undosa, Lamarck.—Pearl banks off Manaar.

Pleurotoma (Gemmula) carinata, Gray.—Off Mutwal Island.

Pleurotoma (Oligotoma) violacea, Hinds.—S. of Modragam Paar.

Surcula cingulifera, Lamarck.—S.E. Ceylon.

Surcula javana, Linn. (= **nodifera**, Lamarck).—Galle.

Drillia crenularis, Lamarck.—Pearl banks, Gulf of Manaar; S. of Modragam.

Drillia spectrum, Reeve.—Deep water off Galle.

Cythara hypercalles, Melvill.—N. of Shoal Buoy.

Family: CANCELLARIIDÆ.

Cancellaria (Trigonostoma) articularis, Sowerby.—Jokkenpiddi Paar.

Cancellaria (Trigonostoma) crenifera, Sowerby.—Pearl banks, Gulf of Manaar.

Cancellaria (Trigonostoma) hystrix, Reeve.—S. of Adam's Bridge.

Cancellaria (Trigonostoma) lamellosa, Hinds.—Pearl banks, Gulf of Manaar.

Order: OPISTHOBRANCHIATA.*

Family: ACTEONIDÆ.

Solidula affinis, A. Adams.—Pearl bank, Aripu; Trincomalee; off Galle.

Family: SCAPHANDRIDÆ.

Atys naucum, Linn.—Trincomalee.

Family: BULLIDÆ.

Bulla ampulla, Linn.—Pearl banks, Gulf of Manaar; Trincomalee; S. of Adam's Bridge; pearl banks off Aripu; deep water off Galle; Trincomalee; S. of Modragam.

Family: APLUSTRIDÆ.

Aplustrum thalassiarchi, Martyn.—S. of Modragam Paar.

Family: RINGICULIDÆ.

Ringicula encarpoferens, Folin.—Galle.

Class: SCAPHOPODA.

Family: DENTALIIDÆ.

Dentalium attenuatum, Sowerby.—Off Galle.

* See also Mr. Farran's Report, Part III., p. 329.—Ed.

Dentalium eburneum, Linn.—Palk Bay.

Dentalium formosum, Adams and Reeve.—Off N. end of Manaar Island; S. of Adam's Bridge.

Dentalium octogonum, Lamarck.—Gulf of Manaar; S. of Adam's Bridge; Palk Bay; Trincomalee; Welligam Bay.

Dentalium subtorquatum, Fischer.—S. of Adam's Bridge.

Class: PELECYPODA.

Family: OSTREIDÆ.

Ostrea cuculata, Born.—Back water, Manaar.

Ostrea (Lopha) crista-galli, Linn.—Deep water off Galle; Trincomalee.

Ostrea (Lopha) hyotis, Linn.—Trincomalee.

Family: ANOMIIDÆ.

Anomia achæus, Gray.—S. of Adam's Bridge.

Placuna placenta, Linn.—Tampalakam Lake, Trincomalee.

Family: SPONDYLIDÆ.

Plicatula ceylanica, Sowerby.—Gulf of Manaar.

Spondylus exilis, Sowerby.—Gulf of Manaar; Trincomalee.

Spondylus flabellum, Reeve.—Trincomalee.

Spondylus imperialis, Chemnitz.—Deep water off Galle.

Spondylus layardi, Reeve.—Mutwal Island; Trincomalee.

Family: LIMIDÆ.

Lima squamosa, Lamarck.—S. of Cheval; Galle; Trincomalee; Muttuvaratu Paar.

Lima (Ctenoides) fragilis, Gmelin.—Gulf of Manaar.

Lima (Ctenoides) scabra, Born.—Gulf of Manaar.

Family: PECTINIDÆ.

Pecten flabelloides, Reeve.—Modragam Paar.

Pecten histrionicus, Gmelin.—Trincomalee.

Pecten irregularis, SOWERBY.—Galle.

Pecten layardi, REEVE.—Off Negombo, 20 fathoms.

Pecten miniaceus, REEVE.—Galle.

Pecten pallium, LINN.—Gulf of Manaar.

Pecten pseudolima, SOWERBY.—Modragam Paar.

Pecten pyxidatus, BORN.—Mudalaikuli Paar; Muttuvaratu Paar.

Pecten senatorius, GMELIN.—Trincomalee.

Pecten singaporinus, SOWERBY.—Trincomalee.

Pecten squamatus, GMELIN.—Galle.

Pecten (Pallium) pes-anatis, REEVE.—Galle; Modragam; Gulf of Manaar.

Pecten (Pallium) plica, LINN.—Trincomalee; Modragam; Gulf of Manaar.

Pecten (Pallium) velutinus, SOWERBY.—Off Mutwal Island.

FAMILY: AVICULIDÆ.

Avicula inquinata, REEVE.—Off Negombo, 20 fathoms.

Avicula iridescens, REEVE.—Off Negombo, 20 fathoms.

Avicula zebra, REEVE.—Gulf of Manaar.

Margaritifera vexillum, REEVE.—Palk Bay; Trincomalee; off Negombo.

Margaritifera vulgaris, SCHUMACHER.—Trincomalee; Gulf of Manaar, and many other localities (*vide* "Narrative").

Margaritifera margaritifera (LINN.).—Gulf of Manaar.

Malleus vulgaris, LAMARCK.—Off Mount Lavinia; W. of Pantura; Trincomalee; Gulf of Manaar.

Vulsella rugosa, LAMARCK.—Gulf of Manaar; Trincomalee.

Perna fimbriata, REEVE.—Gulf of Manaar.

Pinna attenuata, REEVE.—Gulf of Manaar.

Pinna bicolor, CHEMNITZ.—Trincomalee; Chilaw Paar; off Negombo; Gulf of Manaar.

Pinna chemnitzi, Hanley.—Trincomalee.

Pinna fumata, Hanley.—Gulf of Manaar; Trincomalee; Palk Bay.

Pinna zebuensis, Reeve.—Gulf of Manaar; Trincomalee.

Pinna (Atrina) nigra, Chemnitz.—Gulf of Manaar.

Family: MYTILIDÆ.

Mytilus dunkeri, Reeve.—Trincomalee.

Mytilus smaragdinus, Chemnitz.—Tampalakam, Trincomalee.

Septifer bilocularis, Linn.—Jokkenpiddi Paar.

Septifer nicobaricus, Chemnitz.—Modragam Paar.

Modiolus barbatus, Linn.—Gulf of Manaar; Palk Bay.

Modiolus (Volsella) japonicus (Dunker).—Gulf of Manaar; S. of Adam's Bridge, &c.

This mollusc forms a curious nest of gelatinous threads in which are entangled fragments of shell and grains of sand. These Ceylon specimens are less brightly marked, and the periostracum is darker than in specimens we have seen from Muscat.

Modiolus metcalfei, Wood.—Trincomalee.

Modiolus tulipa, Lamarck.—Aripu; Cheval Paar; Muttuvaratu Paar; Trincomalee.

Lithophagus caudigerus, Lamarck.—Gulf of Manaar; Trincomalee.

Lithophagus gracilis, Philippi.—Muttuvaratu Paar.

Lithophagus obesus, Philippi.—Gulf of Manaar.

Crenella (Modiolaria) cœnobita, Vielliot.—Gulf of Manaar.

Crenella (Modiolaria) cumingiana, Dunker.—Gulf of Manaar.

Family: ARCIDÆ.

Arca navicularis, Brug.—S. of Adam's Bridge; Aripu; Gulf of Manaar.

Arca noë, Linn.—S. of Adam's Bridge.

Arca zebra, Reeve.—Trincomalee; deep water off Galle.

Barbatia decussata, Sowerby.—Trincomalee; Muttuvaratu Paar; Gulf of Manaar.

Barbatia imbricata, Poli.—Gulf of Manaar; Muttuvaratu Paar.

Barbatia barbata, Linn.—S. of Adam's Bridge; Palk Bay.

Barbatia (Barbata) fusca, Brug.—Trincomalee; Welligam.

Barbatia (Barbata) lima, Reeve.—Galle; Trincomalee; Modragam; Navakaddu Paar; Gulf of Manaar.

Barbatia (Barbata) obliquata, Gray.—Trincomalee.

Anadara deshayesi, Hanley.—Gulf of Manaar.

Scapharca compacta, Reeve.—Palk Bay; Galle.

Scapharca pilula, Reeve.—Trincomalee.

Trisis (Parallelipipedum) tortum, Lamarck.—Palk Bay.

Cucullæa concamerata, Chemnitz.—S.E. of Ceylon; Gulf of Manaar.

Axinæa nodosa, Reeve.—Aripu; Gulf of Manaar.

Limopsis multistriata, Forskal.—S. of Adam's Bridge; Gulf of Manaar.

Family: CARDITIDÆ.

Cardita abyssicola, Hinds.—Muttuvaratu Paar; Modragam.

Cardita antiquata, Poli.—S. of Adam's Bridge; Trincomalee; Galle; Aripu; Gulf of Manaar.

Cardita radula, Reeve.—Mudalaikuli Paar; Gulf of Manaar.

Cardita variegata, Brug.—Trincomalee; Navakaddu.

Family: CRASSATELLIDÆ.

Crassatellites radiata, Sowerby.—Chilaw Paar; Trincomalee; Gulf of Manaar.

Crassatellites rostrata, Lamarck.—Gulf of Manaar; Aripu; Trincomalee.

Family: TRIDACNIDÆ.

Tridacna elongata, Lamarck.—Trincomalee.

Tridacna squamosa, Lamarck.—Trincomalee.

Family: CARDIIDÆ.

Cardium pulchrum, Reeve.—Deep water off Galle.

Cardium sueziense, Issel.—Off Negombo; Gulf of Manaar; Galle.

Cardium (Trachycardium) flavum, Linn.—Galle; Trincomalee; off Negombo.

Cardium (Trachycardium) lacunosum, Reeve.—Trincomalee; off Galle.

Cardium (Trachycardium) maculosum, Wood.—Aripu; Trincomalee.

Cardium (Trachycardium) oxygonum, Sowerby.—Trincomalee.

Cardium (Trachycardium) unicolor, Sowerby.—Trincomalee.

Cardium (Acanthocardia) asiaticum, Chemnitz.—Trincomalee.

Cardium (Cerastoderma) latum, Born.—Trincomalee.

Papyridea papyracea, Chemnitz.—Gulf of Manaar; S. of Adam's Bridge; Chilaw Paar; Galle.

Lævicardium attenuatum, Sowerby.—Trincomalee.

Lævicardium lyratum, Sowerby.—Gulf of Manaar.

Cardium (Serripes) muticum, Reeve.—Trincomalee.

Cardissa hemicardium, Linn.—Trincomalee.

Cardissa (Lunulicardia) subretusa (Linn).—Gulf of Manaar; Galle.

Family: CHAMIDÆ.

Chama foliacea, Quoy.—Trincomalee.

Chama macrophylla, Chemnitz.—Galle; S. of Cheval Paar; Gulf of Manaar.

Family: CYPRINIDÆ.

Isocardia lamarcki, Reeve.—Galle.

Family: VENERIDÆ.

Meretrix castanea, Lamarck.—Trincomalee; Tampalakam.

Meretrix sinensis, Chemnitz.—S.E. of Ceylon.

Lioconcha picta, Lamarck.—Off Negombo; Gulf of Manaar; Aripu; Trincomalee.

Circe scripta, Linn.—Aripu.

Crista pectinata, Linn.—Trincomalee.

Sunetta effossa, Hanley.—Galle.

Sunetta meroë, Linn.—Trincomalee.

Dosinia ceylonica, Dunker.—Galle.

Dosinia histrio, Gmelin.—Off Negombo ; deep water off Galle.

Dosinia radiata, Reeve.—Gulf of Manaar ; off Mutwal Island.

Chione (Omphaloclathrum) lamarcki, Gray.—Gulf of Manaar ; off Galle ; off Negombo.

Chione (Omphaloclathrum) layardi, Reeve.—Galle.

Chione (Omphaloclathrum) reticulata, Linn.—Trincomalee.

Callista phasianella (Deshayes).—Gulf of Manaar.

Anaitis foliacea, Philippi.—Off Negombo ; Modragam.

Tapes textrix, Chemnitz.—Palk Bay ; S. of Adam's Bridge.

Tapes (Amygdala) bruguierei, Hanley.—Welligam ; Trincomalee.

Family : PETRICOLIDÆ.

Petricola cultellus, Deshayes.—Modragam.

Family : CYRENIDÆ.

Cyrena tennentii, Hanley.—Trincomalee.

Family : UNGULINIDÆ.

Diplodonta bullata, Dunker.—Trincomalee.

Diplodonta indica, Deshayes.—Galle.

Family : DONACIDÆ.

Donax (Hecuba) scortum, Linn.—Welligam Bay.

Donax (Latona) cuneatus, Linn.—Trincomalee.

Family : GARIIDÆ.

Gari amethystina, Reeve (**Psammobia**, Lamarck).—Trincomalee.

Gari præstans, Deshayes.—Aripu.

Gari squamosa, LAMARCK.—Galle.

Hiatula diphos, LINN. (**Soletellina**, BLAINVILLE).—Tampalakam.

Hiatula (Psammotæa) radiata, DESHAYES.—Trincomalee.

Asaphis deflorata, LINN.—Trincomalee.

FAMILY: MACTRIDÆ.

Mactra antiquata, SPENGLER.—Gulf of Manaar.

Mactra luzonica, DESHAYES.—Gulf of Manaar; Galle.

Mactra ornata, GRAY.—Off Negombo; Aripu; E. of Ceylon.

Hemimactra (Oxyperas) triangularis, LAMK.—Off Negombo; G. of Manaar; Galle.

FAMILY: GASTROCHÆNIDÆ.

Gastrochæna clava, LAMARCK (**Fistulana**, BRUGUIÈRE).—Palk Bay.

Rocellaria lagenula, LAMARCK (**Gastrochæna**, LAMARCK).—Modragam.

FAMILY: PHOLADIDÆ.

Martesia striata, LINN.—Between Negombo and Chilaw.

FAMILY: MYIDÆ.

Corbula crassa, HINDS.—Muttuvaratu Paar.

Corbula modesta, HINDS.—Modragam; Gulf of Manaar.

Corbula scaphoides, HINDS.—Navakaddu Paar.

FAMILY: TELLINIDÆ.

Tellina (Tellinella) rostrata, LINN.—S.E. of Ceylon.

Tellina (Tellinella) virgata, LINN.—Gulf of Manaar.

Tellina (Peronæa) cygnus, HANLEY.—Gulf of Manaar.

FAMILY: CUSPIDARIIDÆ.

Cuspidaria chinensis, GRAY.—Trincomalee.

FAMILY: SCROBICULARIIDÆ.

Semele crenulatum, SOWERBY.—Modragam.

FAMILY: ANATINIDÆ.

Anatina labiata, REEVE.—Five miles N. of Cheval Paar.

REPORT

ON THE

TUNICATA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

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[WITH NINE PLATES.]

THIS collection of Tunicata is not a large one and yet it is by far the largest that has, so far as is known, ever been brought from the Ceylon seas, and it more than trebles the number of species recorded from the northern part of the Indian Ocean. Most of the Tunicata known to science have been described from specimens found on the coasts of Europe and of North America, in Malaysian seas, in the Antarctic or on the Australian shores; and it is curious how few have been found in tropical seas outside the West Indies and the Malay Archipelago.

In 1891, in the 'Revised Classification of the Tunicata,' I was able to record only 13 species as known from the Indian Ocean, and of these three were Salpidæ—the species of Ascidiacea being only *Molgula martensii*, TRAUSTEDT, *Microcosmus claudicans* (SAVIGNY), *Rhabdocynthia mauritiana* (V. DRASCHE), *Rh. pallida* (HELLER), *Polycarpa nigricans*, HELLER, *Styela areolata*, HELLER, *Corella novaræ*, V. DRASCHE, *Ascidia depressiuscula*, HELLER, *Ecteinascidia thurstoni*, HERDMAN, and *Polyclinum constellatum*, SAVIGNY.

If, however, the "Indian Ocean Area" in a wide sense be extended so as to embrace the Red Sea, the seas of Malaysia and the coasts of Australia, a very large number of additional species will be brought in. On the other hand, the 1891 list contains only three species recorded actually from the coast of Ceylon, viz., *Ascidia* *depressiuscula*, HELLER, and *Styela areolata*, HELLER, both collected by Professor SCHMARDA, and *Ecteinascidia thurstoni*, which I described, in 1890, from a colony obtained by Mr. EDGAR THURSTON on the pearl banks in the Gulf of Manaar. Another species of *Ecteinascidia* described below, although from the same locality, seems to be quite a distinct form.

Since 1891, SLUITER has described 28 new species of Ascidians from the shores of South Africa (mostly Capetown, Durban and Mozambique), but these, although in the Indian Ocean, are still between two and three thousand miles distant from Ceylon. SLUITER has also described a large number of new species from Malaysian seas, as the result of the "Siboga" expedition. A few of these occur in the present collection, but the majority of the Ascidians of the Malay Archipelago seem to be distinct from those of the coast of Ceylon, although closely allied forms. It is interesting to have re-found the two species originally brought from Ceylon by SCHMARDA, and also to have obtained the recently described, curious, compound Ascidian *Hypurgon*, I. B. SOLLAS, which forms a skeleton with its own hardened fæcal pellets.

SLUITER and I seem to have expressed somewhat divergent views, in our recent works, on the geographical distribution of Tunicata, but the differences may possibly be more apparent than real. They are due to the vibrations of the scales, as first one and then the other of us brought to be weighed fresh batches of new species from different parts of the world. Successive advances in knowledge led to changes in opinion. As the result of my examination of the "Challenger" material, I came to the conclusion, quite justified by the facts then known, that the fixed Tunicata were more abundant and larger in southern than in northern or tropical seas. A few years later SLUITER, as the result of his explorations round the island of Billiton (Dutch East Indies) described a large number of tropical new species of Ascidians, and so was led to correct my opinion—which he did vigorously. After another interval of years, the large collections belonging to the Sydney Museum passed through my hands, and this enabled me to describe such a considerable number of additional southern species as to cause me, after careful weighing of the evidence, including, of course, SLUITER'S tropical forms, to come to the conclusion that the balance was again in favour of the far south. Since then several notable additions have been made to our knowledge of the Indo-Malayan fauna; and the rapidity with which the number of known species is being added to by each successive expedition indicates that our knowledge of the distribution of the group is still far from complete. But whatever result the actual number of species from the tropics and from the polar regions may give us in the future, I believe that the Ascidian fauna of the far south is characterised by the abundance of individuals and by their large size.

Believing that in the present state of our knowledge of the species of Tunicata careful drawings are quite as important as descriptions, and realising from my own experience how valuable some detail of an illustration may be in the identification of a species, I have endeavoured, in the present case, to illustrate fully the appearance and structure of the new species, and even in some cases to give additional figures of species that are known to science.

In regard to the classification, I have arranged the species under their Families, and have not made use of any higher groupings. There is still some difference of opinion amongst authorities as to the correct position and divisions of that polyphyletic group, the compound Ascidians, and until these matters are settled there can be no practical inconvenience in omitting, in a report of this nature, the names of larger groups and in making use merely of the "Family" designations.

Sluiter, in 1900, remarked upon the scarcity of Ascidiidæ in the Pacific Ocean, and stated that the "Schauinsland" collection of 36 species contained no representative of that family. Since then, however, he has described a large number of new species of *Ascidia* from Malaysian seas in his '"Siboga" Report.' I was also struck, when in Ceylon, by the paucity of Ascidiidæ, especially when compared with northern and southern seas, where, in places, they constitute the characteristic feature of the Ascidian fauna. Another family most feebly represented in the tropics is the Botryllidæ, which contains, perhaps, the most abundant of colonial forms in northern temperate seas. The most notable character of the Ceylon Ascidian fauna is the wide distribution and abundance of the genus *Leptoclinum*, and, in fact, of calcareous and sandy forms in general. Species of *Leptoclinum*, and to a less degree of *Psammaplidium*, are found nearly everywhere around Ceylon, and are the largest and most conspicuous, as well as the most abundant of compound Ascidians. Species of *Rhabdocynthia* with calcareous spicules are also abundant, and some of them have a sandy covering. Sandy simple Ascidians are very numerous, and belong to at least three distinct families. Although most of them at first sight might be supposed to be Molgulidæ, the majority are Cynthiidæ, and some are Ascidiidæ. Sandy balls of very similar appearance have proved to belong to the genera *Ascidia*, *Styela*, *Polycarpa*, *Rhabdocynthia*, *Microcosmus*, *Molgula* and *Ctenicella*. As is usual in warmer seas, the majority of the simple Ascidians are species of *Polycarpa* and *Styela*, but *Rhabdocynthia*, *Ecteinascidia* and the Polystyelidæ may also be mentioned as characteristic forms.

Sluiter, in his '"Siboga" Report,' estimates that there are about 200 species of Tunicata in the Malaysian seas, and nearly the same number (183 recorded in 1899) are known from the coasts of Australia. Compared with these figures, the 64 species described below seem to represent rather a poor fauna, but even if this be the case in regard to species, it is certainly not true of individuals. Both on the coral reefs of Galle and Aripu, and also on some of the paars in the Gulf of Manaar, compound Ascidians are abundant, and in some places fine specimens of *Leptoclinum* bulk large in the dredge and the collecting jars.

About three-fourths of the species found seem to be new to science, but that is to be expected on a coast where the Ascidian fauna has not before been specially investigated.

As an example of the number of Tunicata that live along with, and may be said to infest, the pearl oyster, I give the following list of species found on examining the oyster-cages suspended from the ship when on the Cheval Paar: *Ascidia donnani*, *Rhabdocynthia ceylonica*, *Diandrocarpa brakenhielmi* var. *ceylonica* (many colonies), *Botryllus ater*, *Botrylloides chevalense* (many colonies), *Diplosoma gelatinosum*, and several smaller colonies of *Leptoclinum*, and other compound Ascidians undetermined. In addition, many other species were found attached to and encrusting the pearl-oysters on the bottom. Notable cases are *Styela areolata*, *Rhabdocynthia pallida*, *Psammaplidium ceylonicum*, and *Leptoclinum margaritiferæ*.

Even colonies attached to other objects on the bottom, such as the Leptoclinids growing over the sand, must have their influence in competing for microscopic food, and thus the fixed Tunicata may fairly be classed amongst the enemies of the pearl oyster in the passive struggle for existence.

DESCRIPTION OF THE TUNICATA.

Family: CLAVELINIDÆ.

Perophora hornelli, n. sp.—Plate I., figs. 1 to 8.

External Appearance.—Small colonies of a few Ascidiozooids and buds each (fig. 1), attached to a slight stolon which is encrusted with sand (fig. 3). The atrial aperture has five or six lobes (fig. 6). Colour, dull greenish brown (in spirit). Size, 4 millims. in length by 2 to 2·5 millims. in breadth.

Test very thin.

Mantle with numerous fine interlacing muscle bands, mostly transverse in direction.

Branchial Sac with rather short wide stigmata (figs. 4, 5). Some parts of the sac are papillated and others not. The papillæ split at their ends and send prolongations anteriorly and posteriorly to form incipient bars (fig. 5). In some parts of the sac the bars are complete and bear small papillæ (fig. 4).

Dorsal Languets short and triangular in shape (fig. 8).

Tentacles in three series (fig. 8). There are about 10 of each of the two larger series. Those of the third, most anterior, series are very much smaller.

Dorsal Tubercle with a simple circular aperture (fig. 8).

Alimentary Canal showing a simple stomach and several differentiated regions in the short wide intestine (fig. 7).

Locality:—On Navakaddu Paar, in the southern part of the Gulf of Manaar; depth, 8 fathoms.

This species agrees with Verrill's *Perophora viridis*, from the East Coast of North America, which is possibly the same as Lahille's *P. banyulensis* from the Mediterranean, in having the more or less complete system of internal bars in the branchial sac shown in the figures (Plate I., figs. 4 and 5).

The tentacles, however, are more numerous than in *P. viridis*, and are arranged distinctly in three rows (fig. 8). The zooids are of unusually large size, and the stolon is encrusted with sand. The atrial aperture is distinctly five-lobed. This species thus presents a combination of characters seen separately in several other species, and does not agree entirely with any. I have pleasure in associating this new species with the name of my colleague in the pearl fisheries investigation, Mr. JAMES HORNELL, F.L.S., who was with me on the barque "Rangasami-Poravi" on April 2, 1902, when the specimens were collected.

Ecteinascidia thurstoni, HERDMAN.—Plate I., figs. 18 to 23.

This species was originally found in the Gulf of Manaar by Mr. EDGAR THURSTON, and was described by me in 1890* and named in honour of its discoverer. The type specimen is in the Government Central Museum, Madras. The species has since been recorded from Bermuda by VAN NAME, and from the Bay of Djibouti, Somali-land, by GRAVIER.

The colonies which I now refer to this species were collected on Aripu coral reet on March 18, 1902, and are attached to fragments of a massive sponge. One colony (fig. 18) has about 14 Ascidiozooids, another has two or three only, the third has half a dozen large and small with a few buds in addition; and there are also a few loose Ascidiozooids (fig. 19) detached from colonies.

All the Ascidiozooids, although transparent, are of a slightly pink colour, like the sponge they grow over; but it is possible this may be a *post-mortem* effect produced by staining with the pigment dissolved out from the sponge. The largest Ascidiozooid measures 8 millims. × 3 millims.—a more usual size is 5 millims. in length. In THURSTON's specimens the Ascidiozooids were rather larger, and ranged from 7 millims. to 2 centims. in length. Otherwise the appearance of the colonies is very similar, and the internal structure is also very much the same in the two cases. In our specimens the branchial aperture may be seven-lobed and the atrial six-lobed (fig. 23). The meshes of the branchial sac generally contain three stigmata; four is the number given in the description of *E. thurstoni*. The rest of the branchial sac and the dorsal languets (fig. 21) seem to agree well; but the tentacles are not so numerous and closely placed in our present form (fig. 20), where there seem to be about 60 in all, of three sizes. Possibly the rather smaller size, fewer stigmata and less closely placed tentacles may all be co-related characters indicating merely a younger stage in growth. The course of the alimentary canal and gonads (fig. 22) seem alike in the two cases.

Ecteinascidia (? Rhopalopsis) solida, n. sp.—Plate I., figs. 15 to 17.

External Appearance.—Shape, a cylindrical finger-like mass somewhat bent at the free end, attached posteriorly by a broad base and with both apertures at the anterior end. Surface smooth; size about 2·5 centims. × 1 centim.

* 'Trans. Biol. Soc., Liverpool,' vol. v., p. 144.

Test thick and stiff, forming a more solid mass than is usual.

Mantle delicate, with about ten slight longitudinal muscle-bands on each side.

Branchial Sac with internal bars supported by wide triangular connecting ducts (fig. 16). Meshes each contain two or three rather wide stigmata.

Dorsal Lamina represented by a series of closely placed rather large triangular languets (fig. 17).

Tentacles rather long, eight larger and eight smaller.

Dorsal Tubercle very small and simple.

Locality :—Coral Reef, Galle, February 14, 1902 ; one specimen.

Ecteinascidia sluiteri, n. sp.—Plate I., figs. 9 to 14.

External Appearance.—A small transparent colony consisting of two individuals and an empty test, and some buds attached to a slender creeping stolon (fig. 9). The stolon is marked with constrictions or joints, and has some adhering sand (fig. 10). The Ascidiozooid is oblong and erect, with both siphons at the anterior end, and rapidly narrowing at the posterior end to the attachment with the stolon. The apertures are not lobed, but have many slight creases. The Ascidiozooid measures 7 millims. in length by 3·5 millims. in breadth at the atrial siphon. The stolon is about 4 centims. in length.

Test thin and colourless, allowing the branchial sac to be seen through.

Mantle thin, and for the most part transparent. The muscles are arranged in three longitudinal bands (one dorsal and two lateral) of short, transversely running forked bundles. The dorsal band is interrupted in its posterior three-fourths by the rectum (fig. 11).

Branchial Sac large, and runs the whole length of the body. The transverse vessels are narrow and all alike ; the internal bars are very narrow and the connecting ducts are slight. The stigmata are long and regular, one or two to a mesh (fig. 12).

Tentacles of two sizes, and there are about twenty in all. Those at the ventral edge are the largest (fig. 13). A large number of Acinetan parasites are seen attached to the tentacles and to the peripharyngeal band.

Dorsal Lamina represented by a series of very small languets. There is very little interruption of the stigmatic network on the dorsal edge.

Dorsal Tubercle a small simple rounded opening (fig. 13).

Alimentary Canal slender. The stomach has slight longitudinal folds and narrows at the pyloric end, where the intestine is constricted (fig. 14).

Locality :—Station LVIII., off north end of Karativo Island, 9 to 26 fathoms.

The chief peculiarities of this species are the constricted stolon and the peculiar short forked muscle bundles suggesting the condition seen in some species of *Corella* (*e.g.*, *C. japonica*), and the well-marked siphons which caused us to enter the animal when dredged as an "Ascidia-like Clavelinid" in our field-notes.

Omitting from consideration those species described as "Ecteinascidia," which have since been separated off into the allied genera *Rhopalæa*, *Rhopalopsis*, and *Sluiteria*, there remain seven closely allied species amongst which the present one must take its place; they are:—*Ecteinascidia turbinata*, Herdman, from Bermuda; *E. diaphanis*, Sluiter, from Malaysia; *E. moorei*, Herdman, from Alexandria; *E. thurstoni*, Herdman, from the Gulf of Manaar; *E. garstangi*, Sluiter, from Mozambique; *E. euphues*, Sluiter, and *E. psammodes*, Sluiter, both from the Australian Coast. From all these the present species appears to differ either in external characteristics or in internal structure. The two last-named species were described by Sluiter from Semon's collections, and are very minute forms (the Ascidiozooids being only 2 to 3 millims. long) which show some resemblance, as their author has pointed out, to the genus *Perophora*, and especially to such a species as *P. hutchinsoni*, Macdonald. The two remaining species of *Ecteinascidia*, *E. nexa*, Sluiter, and *E. multiclathrata*, Sluiter, from the "Siboga" expedition, are both somewhat exceptional forms showing an approach in some of their characters to the genus *Sluiteria*, although differing from that genus in other essential points. From these, and from all other described species of *Ecteinascidia*,* the present species differs notably in having distinct and prominent siphons (Plate I., fig. 9) which give to the anterior end of the body very much the appearance of a *Ciona*. Another noteworthy feature is the arrangement of the muscles in the mantle (fig. 11) which is quite unlike that in any other known species of this genus.

Ecteinascidia seems to be a tropical type of Ascidian structure, occurring, so far as we know at present, only between Bermuda to the north and the north coast of Australia to the south, and having its main development in eastern seas. Out of ten known species, eight occur in the Indian Ocean and Malaysian seas, viz., *E. garstangi* (Mozambique), *E. psammodes* (Australia), *E. diaphanis* (Malay), *E. euphues* (Malay), *E. nexa* (Malay), *E. multiclathrata* (Malay), *E. thurstoni* (Gulf of Manaar), and the present new species, *E. sluiteri*, from the coast of Ceylon.

I have much pleasure in naming this species in honour of Professor Sluiter, of Amsterdam—the author who has described most of the species of this genus.

Family: ASCIDIIDÆ.

Rhodosoma ceylonicum, n. sp.—Plate I., figs. 24 to 33.

External Appearance.—Body, when retracted, of short cylindrical, ovate, or deep cup-shaped form, with a rounded posterior and a flattened anterior end forming the operculum over the apertures. Attached by the anterior part of the right side just below the test that forms the hinge of the operculum. The siphons are close together and are directed forwards, a slight fold rises behind each siphon (fig. 27). Surface covered with small sharp papillæ on the anterior half, especially round the

* Such as *E. diligens*, Sluiter, from the Pacific, which seems an exceptional form.

edges of the opening, smooth on the posterior half of the body. Colour a translucent pinkish grey, or sometimes grey-green, rather redder on the anterior end and especially on the siphons which are bordered with yellowish green. Size, 1·7 centims. × 1·2 centims. × 1 centim.

Test of a soft cartilaginous consistency, semi-transparent, echinated around the anterior end, smooth posteriorly, with an occasional little tubercle; a few small shell fragments adhering to test near area of attachment.

Mantle with five pyriform muscle masses on each side; the one set run towards the atrial siphon (fig. 28) and the other set towards the branchial. In addition to these there are finer bundles and the siphons are strongly muscular (fig. 29), having both longitudinal and transverse bands of considerable bulk.

Branchial Sac with wide, regular, rounded stigmata arranged two (rarely three) in a mesh (fig. 30). The transverse vessels are all of one size. The internal bars are narrow and have short papillæ. Along the dorsal edge of the sac the internal bars are imperfect, the branches arising from the transverse vessels forming triradiate processes (fig. 31) which do not meet across the mesh to form a bar.

Dorsal Lamina a series of long narrow pointed languets (fig. 32).

Tentacles of three sizes, closely placed; about sixteen of each of the two larger sizes and about double that number of very much smaller ones.

Dorsal Tubercle deeply crescentic, the horns pointing towards one another across the opening (fig. 33).

Localities:—(1) Palk Bay, March 16, trawling, one specimen 1·7 centims. long, and one 8 millims. long; (2) Gulf of Manaar, adhering to a fragment of a large chank shell, 10 fathoms, 2 specimens, also on coral fragments; (3) off Mount Lavinia, Station XLVI., 30 fathoms, one specimen in a crevice on coral mass, "pale grey-green, apertures bordered with yellowish green."

It is not easy to say whether the specimens of *Rhodosoma* from Ceylon can be safely identified with any of the species already named (we can scarcely say "known"). In 1855 STIMPSON very briefly described two species, *Schizascus pellucidus* and *S. papillosus*, both from China, which seem to differ so little, if we may judge from the published descriptions, that they may well be one species—belonging to the genus *Rhodosoma* of EHRENBERG (1828); but not to EHRENBERG'S species *R. verecundum*. In 1878 HELLER described, almost equally briefly, *Rhodosoma seminudum* from Jamaica, and gave a figure of the exterior which, however, shows no very distinctive features; so much so that TRAUSTEDT, in 1882, describing specimens of the genus from the same neighbourhood (West Indies), hesitated to refer them to HELLER'S species, and gave them the name *Rhodosoma pyxis*, followed by a detailed description. He distinguished this species clearly from *R. callense* (LAC. DUTH.), the only other sufficiently described form. SLUITER, however, in 1898, took a different view and refused to share TRAUSTEDT'S doubts. He appropriates TRAUSTEDT'S accurate anatomical description to HELLER'S diagnosis of *R. seminudum*, and is satisfied that his own specimens (from the "Chazalie" expedition) belong to that species. The Australian forms *Pera* and *Peroides* of MACDONALD probably also belong to this genus. HARTMEYER, in 1901, re-described with anatomical details EHRENBERG'S *Rhodosoma verecundum* and STIMPSON'S *Rh. papillosum;* and SLUITER, in 1904, in reporting on the Tunicata of the "Siboga" expedition, accepts HARTMEYER'S adequate description as applying to STIMPSON'S brief diagnosis, and refers all his specimens (about a dozen) from nine localities in eastern seas to the species *Rh. papillosum*, STIMPS. He notes, however, a certain amount of difference between some of his specimens and HARTMEYER'S description. I find also certain points of difference in detail between the Ceylon specimens and the descriptions of HARTMEYER and SLUITER, and, so far as external appearance goes, my specimens when alive agreed rather better with STIMPSON'S three lines on *Schizascus pellucidus* than with his two lines on *S. papillosus.* Consequently one course open to me, if I consider my specimens distinct from *Rh. papillosum*, as re-described by HARTMEYER, would be to refer them to STIMPSON'S *Rh. pellucidum* and so place my new description under his specific name. But although there is nothing prohibitive of this in STIMPSON'S words, neither is there anything very characteristic that leads us to identify the species without doubt. Consequently, I believe it will be least confusing for future workers, and most conducive to scientific clearness, if the Ceylon specimens are described as a distinct species under a new name, as above. The characters are sufficiently given in the description and shown in the figures on Plate I. The branchial sac (fig. 30) will be seen to differ from both that of *Rh. papillosum* and that of *Rh. verecundum*, as figured by HARTMEYER ('Arch. f. Naturges.,' 1901, Beiheft, Taf. iv.).

Ascidia donnani, n. sp.—Plate II., figs. 1 to 9.

External Appearance.—Shape irregularly ovate, posterior end rounded, anterior narrower and truncated. Attached by the posterior half of the left side. Branchial aperture on dorsal part of anterior end, atrial aperture on dorsal edge of body, one-third back; both apertures somewhat prominent, lobed. Test drawn out into several jagged processes, especially on dorsal and ventral edges (fig. 1). Surface roughened with small asperities. Colour grey (in spirit). Size, 2·4 centims. × 1·5 centims.

Test thin, cartilaginous; thickened in places to form the irregular processes shown in the figure. It contains the usual vessels and bladder-cells.

Mantle with moderately developed musculature and prominent siphons. The atrial siphon is directed backwards, so as to give the body when removed from the test (fig. 2) a somewhat triangular shape. Under the microscope the muscle bands are seen to narrow very abruptly (fig. 7) and end in fine bundles of connective-tissue fibres spirally coiled.

Branchial Sac with rather large square meshes containing each about half a dozen long narrow stigmata (fig. 5). The transverse vessels are mostly narrow and nearly all of much the same size, but every fourth one is in places wider than the three intermediates and has a rather wider horizontal membrane. The papillæ on the rather narrow internal bars are large. They vary in length, but on the average extend about half-way across the mesh.

Dorsal Lamina a wide membrane with well-marked shelf-like ribs, and marginal points (fig. 6). The ribs die away as they approach the free edge.

Tentacles numerous and rather slender, 50 to 60, larger and smaller, but none very small (fig. 9).

Dorsal Tubercle large, cordate in outline, with the posterior end pointed, the opening anterior and both horns rolled inwards (fig. 4).

The Viscera occupy the ventral half of the rather wide posterior end of the body (fig. 3). The intestine is relatively wide.

Locality :—(1) Navakaddu Paar, Gulf of Manaar, 8 fathoms, 1 specimen ; (2) outer Chilaw Paar, Station LXIX., depth 8 to 11 fathoms, 2 specimens ; (3) Cheval Paar, attached to oyster cages, 2 specimens.

This species is described above from the single large specimen obtained on Navakaddu Paar ; but the couple of Ascidians from Cheval Paar and those from Chilaw Paar are probably also specimens of the same species. They have not all the same external appearance, but the internal organisation appears to correspond fairly well. One of the larger specimens is partly overgrown by a colony of *Botrylloides*, and that may account for some difference in shape and appearance, while a couple of smaller specimens (1 centim. long) are probably young and still undeveloped. The body of the larger specimen from Chilaw Paar when removed from the test is shown in fig. 8. The siphons are especially long and are ridged longitudinally and provided with slight tag-like processes of connective tissue. The muscle bundles are especially prominent round the edges of the right side of the mantle. Fig. 9 shows the dorsal tubercle and tentacles of this specimen from Chilaw Paar. In the shape of the body and especially in the long siphons, and also in the distribution of the muscle bundles round the edges of the right side (fig. 8), this specimen recalls the "*Ascidia canaliculata* (Heller) ?," described by Sluiter, in 1885, from Billiton, which he later (1898) decided to recognise as a distinct species under the name of *Ascidia divisa*—but differs markedly from that form in the structure of the dorsal tubercle. Nor does it agree with the true *A. canaliculata*, Heller, as described by Sluiter and others ; nor yet with *A. bisulca*, Sluiter, which it resembles superficially, but differs from in the details of the branchial sac and dorsal lamina. The species to which it is most nearly related is *Ascidia longitubis* (Traustedt) from the West Indies. The agreement extends to the body form, the musculature, and the dorsal tubercle ; but the two species differ in the details of the branchial sac. It is possible, however, that several of these species which have been mentioned above may come to be united when a larger range of specimens and of variations have been studied.

This new species is named in honour of Captain Donnan, C.M.G., for many years

Inspector of the Pearl Banks, Ceylon, and who was with me in the Gulf of Manaar performing his last inspection in the spring of 1902 when these specimens were collected.

Ascidia depressiuscula, Heller—Plate II., figs. 10 to 22.

Although I refer these specimens to Heller's species, I consider it desirable to give a detailed account of them with figures, as Heller's description was brief and had no illustrations of the internal structure.

External Appearance.—Body flattened, ovate in outline, attached by the whole of the left side and posterior end. Apertures both on right side, on the anterior half of the dorsal edge, small, not projecting. Right side of body rather depressed in centre with more prominent rounded edges. Surface smooth; colour (in spirit), grey, with a slight brownish tinge. Size, 2 centims. × 1 centim. to 1·5 centims. × 3 millims. to 5 millims. in thickness.

Test cartilaginous, but rather thin, semi-transparent.

Mantle with moderate siphons. The visceral mass on the left side is rather large.

Branchial Sac having the meshes square or a little elongated transversely. All the transverse vessels are very narrow, so that the ends of the adjacent rows of stigmata are very close. Every eighth transverse vessel has, however, a wider horizontal membrane than the intermediate seven. The stigmata are of moderate size and about five or six to a mesh. The internal longitudinal bars are stout with large knob-like papillæ and occasionally smaller ones between (fig. 17); there are also intermediate horizontal membranes crossing the meshes in places.

Dorsal Lamina a plain membrane with slight, but distinct, transverse ribs and small marginal denticulations (fig. 18).

Tentacles numerous, about 60 to 80, much the same size, with an occasional very much smaller one (fig. 21).

Dorsal Tubercle large, horse-shoe-shaped (figs. 19 and 20), with the opening anterior and both horns coiled inwards. The nerve ganglion is placed close up under the dorsal tubercle. The prebranchial zone is papillated.

Alimentary Canal rather bulky, intestine wide, and full of fine mud (fig. 22).

Gonads well developed. Vas deferens swollen.

Localities:—(1) Galle Bay, from a basket of pearl oysters attached to a buoy, seven specimens; (2) Station LIV., north of Gulf of Manaar, depth 4 to 40 fathoms; one specimen along with many Cynthiidæ.

The specimens from Galle are all very much alike in their characters, and figs. 10, 11 and 12 give the appearance and range in size. Fig. 14 shows the specimen from the Gulf of Manaar, measuring 2 centims. × 1·5 centims. × 5 millims.

The branchial sac of the Manaar specimen (fig. 15) differs a little from that of the Galle specimens. It has the papillæ relatively longer, the stigmata rather shorter, and the meshes squarer. But as pieces of the branchial sacs from Galle differ a little in such characters amongst themselves (figs. 16, 17), the matter is probably of no systematic importance and the whole series may be regarded as one species.

One point of interest belonging to these specimens from Galle is that, from the circumstance of their attachment to the basket which was put out on April 17 and brought in on May 9, it is known that they grew to a length of 2 centims. and became sexually mature within a period of three weeks.

This is one of those troublesome species that show no very striking characteristics and yet do not agree exactly with any other species. In external appearance the specimens agree in general with several common species of *Ascidia*, such as *A. prunum*, O. F. M., *A. obliqua*, Ald., *A. scabra*, O. F. M., and *A. mollis*, Ald. and Hanc., but they differ from all these northern species in some details of organisation. With some hesitation I have decided to identify them with Heller's *Ascidia depressiuscula* obtained in Ceylon by Schmarda. The external appearance agrees fairly well with Heller's figure ('Sitzb. Akad. Wiss. Wien.,' Jahrg. 1878), and the internal structure does not differ from Heller's brief description except in regard to the number of tentacles.

The very small number of species of the large and usually abundant genus *Ascidia* found in the Ceylon collection is remarkable, especially when we remember that Sluiter describes no less than 24 species of *Ascidia* (11 of them new to science) in the results of the "Siboga" expedition through the Indian Archipelago further east.

Ascidia (?) mikrenterica, Sluiter—Plate I., figs. 38 and 39.

There is a single specimen of an *Ascidia* with a thick sandy covering, obtained at Station LXII., 13 fathoms, which I refer with some doubt to this species. It has been torn open, probably by the dredge when captured, and the anterior end is absent. In the thick coating of sand, and in the relatively minute alimentary canal (fig. 38), it resembles the "Siboga" species, but the structure of the branchial sac (fig. 39) is different. However, I have seen so many abnormal branchial sacs, or portions of branchial sacs, amongst known species that I cannot attach much importance to the reduced size and number of the stigmata seen in this specimen.

Ascidia polytrema, n. sp.—Plate I., figs. 34 to 37.

External Appearance.—Oblong-ovate, with the posterior end rounded, the branchial aperture on the anterior end and the atrial projecting from the dorsal edge about one-third of the way back (fig. 34). Surface sandy; size, 3·3 centims. × 1·6 centims.

Test thin, with large grains of sand and shell fragments embedded in it.

Mantle thin and weak; delicate muscle bundles running transversely (fig. 36).

Branchial Sac exceedingly thin and delicate. Internal longitudinal bars bearing slight papillæ. Meshes about square, with four stigmata in each. Occasional horizontal membranes cross the meshes (fig. 37).

Dorsal Lamina with slight ribs and minute marginal denticulations.

Dorsal Tubercle with one minute opening at the apex of a deep triangular peri-tubercular area and about 20 supplementary ciliated funnels further back, but in front of the ganglion, and opening into the peribranchial cavity (see fig. 35). Pre-branchial zone with slight papillæ scattered over it.

Alimentary Canal rather large, with very weak walls, and having the wide intestine distended with mud containing many diatoms.

Locality:—South ends of Cheval and Periya paars, Station XLIX., 8 to 12 fathoms; one perfect specimen and a broken fragment of another, much larger, with no viscera.

Family: MOLGULIDÆ.

Molgula taprobane, n. sp.—Plate IV., figs. 14 to 19.

External Appearance.—Erect, rounded oblong, unattached, with the two short siphons near together on the anterior end, not diverging. Covered with fine sand (fig. 14); size, about 1 centim. across.

Test thin and soft, with a thin coating of sand.

Mantle thin and transparent (figs. 15 and 16).

Branchial Sac with seven folds on each side. Each fold shows three bars. The stigmata are for the most part straight or very slightly curved between the folds, but on each side of the dorsal lamina (fig. 17) they are well coiled.

Tentacles, 12 of one size, moderately branched, not bushy, with much smaller intermediate ones, and very minute simple tags between these.

Dorsal Lamina a plain narrow membrane (fig. 17).

Dorsal Tubercle obliquely cordate, with the aperture directed laterally and backwards (fig. 19).

Gonads present on both sides.

Localities:—(1) Station LIII., 10 miles north of Cheval Paar, 9 fathoms; (2) Station XXII., Trincomalee, 13 fathoms; (3) Station XLVI., off Mount Lavinia, 30 fathoms. Fig. 18 shows the specimen from Trincomalee.

The specific name of this first *Molgula* recorded from Ceylon is the ancient classical name of the island.

Ctenicella ridgewayi, n. sp.—Plate IV., figs. 20 to 23.

External Appearance.—Body globular, free, covered with sand. Both siphons at anterior end divergent (fig. 20). Size, 1·3 × 1 centim.

Test thin, covered with adhering sand.

Mantle with muscular siphons, and having the marginal lobes pinnate (fig. 22).

Branchial Sac with seven folds on each side. There are four bars on each side of the fold and the anterior extremities of the folds are papillose. The meshes are large and each contains many well-coiled stigmata (fig. 23).

Tentacles much branched, and at least 12 in number.

Dorsal Lamina a plain membrane.

Dorsal Tubercle a simple horse-shoe, with the opening on one side (fig. 21).

Locality :—Station LIII., 10 miles north of Cheval Paar, 9 fathoms.

This little Molgulid is externally very similar to the Polycarpa (*P. decipiens*), the *Stycla* (*S. lapidosa*), and the *Rhabdocynthia* (*Rh. ceylonica*), with which it is found.

I have named this species after Sir West Ridgeway, who was Governor of Ceylon at the time when it was collected.

Family: CYNTHIIDÆ.

Notwithstanding Michaelsen's remarks ('Zool. Jahrb.,' Suppl. viii., 1905, p. 79), and the fact that several recent writers have seen fit to relinquish the genus *Rhabdocynthia*, I believe it is both useful and natural to group together those species of "Cynthia" that show echinated unbranched calcareous rods or spindles in the connective tissue of the body. The grouping of species into genera is largely a matter of convenience, and if a set of closely related species can be defined and recognised by the possession of a common character, the application of a generic name seems justifiable, and is certainly an aid in classification. On these grounds I make use of *Rhabdocynthia* as the generic designation of the set of species which may be grouped around Heller's *Cynthia pallida.*

Rhabdocynthia pallida (Heller)—Plate II., figs. 36 to 39.

The shape is irregularly ovate or pyriform, the anterior end being rather the wider. It is attached by the posterior end and a part of either side, and the lower half may be more or less encrusted with sand and shell fragments. The four-lobed apertures are both anterior, placed on long siphons, moderately far apart and turned away from one another (fig. 36). The colour in the preserved specimens is dull milky white, becoming pale yellow in places; it was of a reddish tint when alive, and traces of pink are still to be seen in some specimens, especially at the branchial and atrial siphons.

The *Test* is of a soft leathery texture, much wrinkled on the outer surface, smooth and glistening on the inner and white in section. It is mostly from 1 to 3 millims. in thickness, but may be thickened at the posterior end up to nearly 3 centims.

The *Mantle* is rather thin and weak over the viscera, soft but opaque and muscular on the anterior half of the body and very muscular on the siphons (fig. 37). It bristles with minute calcareous spicules in all parts, which renders it rather easily torn, and very unpleasant to manipulate.

The *Branchial Sac* has nine wide folds on each side. They converge to the œsophageal opening.

The *Dorsal Lamina* is represented by a series of about 20 short curved pointed tentacular languets.

The *Tentacles* are of three sizes. There are about eight large and much branched, alternating with others half the size, while a variable number of much smaller ones occur between. If a little more regular the formula would be eight large, eight medium, and sixteen small, but the latter are not all present and the large and medium ones may vary from six to nine each.

The *Dorsal Tubercle* is large, prominent and hemispherical. It is marked with two spiral coils (fig. 38).

Localities:—(1) Five specimens were trawled at Station XIX. in northern part of Palk Bay, depth 4½ to 8 fathoms; (2) one at Station I., off Negombo, 12 to 20 fathoms; and (3) one is labelled "Gulf of Manaar."

The largest specimen measures 9 centims. × 6 centims. × 3 centims., the two next each 5 centims. × 5 centims. × 2 centims., the next 3 centims. × 3 centims. × 1 centim., and the smallest 2 centims. × 1·5 centims. × 1 centim. These specimens agree fairly well in most characteristics with *Rhabdocynthia pallida* (HELLER) to which v. DRASCHE'S *Cynthia mauritiana* is closely related. These species are described as having only eight branchial folds, while the present one has nine. They also differ in the dorsal tubercle, the tentacles and other details, but these are all points subject to individual variation. The large branchial and atrial siphons have strong sphincter muscles, from under the lower edge of which very strong radial muscle bundles emerge. There are about 16 of these on each side at the atrial sphincter, and about 30 on each side at the branchial. The arrangement of these muscles is seen in fig. 37. Large lobed gonads are present on both sides, and show through the mantle as a number of rounded masses (fig. 39), rather different in appearance from the figures of *Rh. pallida* given by SLUITER and MICHAELSEN; however, I believe the difference is only due to stages of growth. The ova occupy the wide central part of the mass, and the spermatic cæca are grouped in clumps around the margin.

I thought at first, because of the red colour when alive, that this species might be SLUITER'S *Cynthia rosea*—which is a *Rhabdocynthia*—but a closer examination showed that it differed from that form in the details of the branchial sac, in the form of the dorsal languets, and the dorsal tubercle, as well as in the shape of the body and relative positions of the apertures. However, the two species are closely related, and it is a question whether fuller knowledge of both in the future will enable us to unite them.

This large Ascidian is said by the natives to be characteristic of the West Cheval Paar, but is also found at other places in the Gulf of Manaar.

Rhabdocynthia ceylonica, n. sp.—Plate III., figs. 1 to 19.

External Appearance.—Body of globular or ellipsoidal form, covered with clear pale yellow sand and small shell fragments, except around the apertures. Siphons prominent, the atrial rather the longer; both on anterior end, and connected by a ridge of test, which, like the siphons themselves, is bare of sand (fig. 3). The lobes of the apertures are marked with white radial lines (see figs. 18, 19); size about 2 centims. × 1·5 centims.

Test thin, transparent; containing branched vessels with knobs and also spicules.

Mantle transparent except for the muscle bundles and the spicules. There is a loose felt-work of fine spicules all over the surface, and the mantle is flecked with white on the siphons. There are four lines of white pigment dots down the inside of each siphon (fig. 18).

Branchial Sac with seven folds on each side, the most ventrally placed one on the left side being very slight. The transverse vessels are of three sizes (fig. 7), in the wider of which spicules are found. There are six internal bars on a fold, and the meshes, between the folds, are square and contain about six stigmata. They are crossed and sometimes interrupted by the third order of transverse vessel.

Dorsal Lamina represented by moderate-sized triangular languets (fig. 17).

Tentacles.—About ten large, branched, with smaller ones between (figs. 10, 11). Another specimen showed eleven larger and eleven smaller alternately placed, with occasional still smaller ones (figs. 10, 11).

Dorsal Tubercle large, but simple; horse-shoe shaped, with both ends turned in (figs. 8, 9). One specimen showed, as an abnormality, a double tubercle (fig. 16).

The *Alimentary Canal* forms a long open loop on the left side of the body.

Gonads are present on both sides. Each is hermaphrodite, the spermatic cæca being arranged around the masses of ova.

Localities:—(1) Alentura Paar, Station LVIII., 26 fathoms, two specimens; (2) Station I., off Negombo, 12 to 20 fathoms, two specimens (of a reddish colour when alive); (3) Station IV., off Karkopani, 6 to 9 fathoms, one specimen (1·6 centims. × 1·2 centims., with atrial siphons 6 millims. long, and very little sand); (4) Galle Bay (from basket hung to a buoy), one specimen about 1 centim. long (the fixation and growth must have taken place entirely between April 17 and May 9; (5) Station LIII., 10 miles north of Cheval Paar, 7 to 8 fathoms, four specimens; (6) Trincomalee, 11th February, one small specimen; (7) Aripu Reef, 18th March, one small specimen. The two specimens from Alentura Paar are entered in our field-notes as "Two transparent Cynthias with red edges to the siphons and sand on the test." These two specimens were preserved in strong formol and are still very soft and transparent. The inside of the test is in a gelatinous condition, is continuous with the mantle, and adheres strongly to it round the anterior end. In dissecting, the animal is as soft and gelatinous as when alive.

A sandy *Rhabdocynthia* is a novelty, and if we consider the allied species of *Cynthia* we find that this species differs from *Cynthia arenosa*, Hrdn., in the details of the branchial sac and in the spicules and the dorsal tubercle.

The spicules are of the usual *Rhabdocynthia* type, and are sufficiently illustrated in the figures (figs. 12 to 15). I have considered the possibility of this form, the largest specimen of which is only 2·5 centims. in length, being a young stage of *Rh. pallida* (Heller) which attains a size of 9 centims.; but there are in the collection small specimens of the latter species measuring only 2 centims. across, and these have already the characters of the adult and are entirely different from *Rh. ceylonica* of corresponding size. It differs from *Rhabdocynthia tenuis*, HRDN., in the external appearance and in the dorsal tubercle.

Microcosmus manaarensis, n. sp.—Plate II., figs. 23 to 31.

External Appearance.—A rough mass of sand, foraminifera, and shell fragments, stiff but brittle, with more or less of the anterior end and two short siphons projecting, and having the posterior end thickly covered and prolonged into root-like sandy wisps (figs. 23, 24). Size about 2 centims. in diameter; colour varying with the sand. The siphons may be echinated with slight projections.

Test white in section, leathery, but more or less completely buried in the crust of sand, which may extend to nearly 1 centim. in thickness. The inside of the test is quite firm and glistening, and is marked by the impress of the strong muscle bundles of the mantle. The outside of the test bears numerous hair-like processes which run out into the sandy coating (fig. 25).

Mantle yellowish brown and very strong. The siphons are long and muscular (fig. 28). Atrial aperture bilobed on inside (fig. 27).

Branchial Sac with six folds on each side. There are five bars on a fold and three in the interspace. The meshes are elongated transversely and contain about 10 stigmata. There are seven narrower transverse vessels between each pair of very much wider; narrow horizontal membranes cross some meshes (fig. 31).

Dorsal Lamina a plain membrane.

Tentacles six large and six smaller alternately, much branched (fig. 29).

Dorsal Tubercle small, cordate in outline, with the opening anterior and both horns turned in (fig. 30).

The peripharyngeal bands have a characteristic undulating course.

Localities:—(1) Station LIII., 10 miles north of Cheval Paar, 7 to 8 fathoms, two specimens which differ in the amount of sand they bear; (2) Station XLVI., off Mount Lavinia, 30 fathoms, two specimens; (3) "Gulf of Manaar," three specimens; (4) Trincomalee, Station XXIV., 30 fathoms, three specimens.

This species differs from those already known from eastern seas, such as *M. helleri*, *M. ternatanus*, *M. propinquus*, *M. affinis*, and *M. ramsayi*, and also from the two new species found by the "Siboga" expedition, *M. hæmisphærium* and *M. arenaceus*. The last-named species is a sand-covered form like the present one, but differs notably in the dorsal tubercle, which is broken up into several separate openings, and in having papillæ on the horizontal membranes at each longitudinal vessel.

The species to which the present seems most nearly allied is *M. gleba*, TRAUSTEDT, from the Pacific; a species which differs in having 10 large tentacles and in some details of the branchial sac.

This species forms dark sandy balls about the size of a walnut, and in most specimens the fringe of sandy rootlets at the posterior end is conspicuous (fig. 23).

The coating of sand is so thick and dense that in some cases it can be peeled off the test as a coherent shell, so as to give the appearance of one test lying within another (fig. 26). In life the siphons are very long, and their terminations are yellow tubes, marked with dark red bands.

Eleven young fishes were found in the peribranchial cavity of one specimen from off Mount Lavinia.

Microcosmus longitubis, n. sp.—Plate II., figs. 32 to 35.

External Appearance.—The body is ovate, with two very long siphons diverging from the narrow anterior end. It is encrusted with sand and shell fragments, which are especially large and thickly placed on the rounded posterior half of the body (fig. 32). Size, about 5 centims. from the end of the branchial siphon and 3 centims. across the wider posterior part of the body.

Test stiff and leathery, ranging up to 2 millims. in thickness. Greyish white and glistening on the inner surface, white in section. There are numerous large vessels, and there are long branched processes on the surface to which the sand is attached.

Mantle strong, very muscular (fig. 33), the body with the test removed having the appearance of a ball of tightly wound threads, with the two very long siphons protruding. The branchial is the longer and straighter, the atrial being curved dorsally.

Branchial Sac with six folds on each side; rather narrower than those of the last species, and having four or five bars, but none in the interspace. There are five to seven narrow transverse vessels between the very much wider ones. The meshes may extend the whole distance from fold to fold and then contain 20 to 24 stigmata, or may be interrupted by irregular oblique or curved vessels (fig. 34). The stigmata are rather short and neatly shaped.

Dorsal Lamina a plain membrane.

Tentacles branched. There are 10 of large size, some rather larger than others, and a few very small additional ones placed between.

Dorsal Tubercle having a symmetrical semicircular outline, with both ends lightly rolled in (fig. 35).

Locality :—Tampalakam, Trincomalee.

Cynthia transversaria, Sluiter, var. **manaarensis,** nov.—Plate III., figs. 20 to 24.

External Appearance.—Shape ovate or pyriform, with widely divergent prominent apertures at the narrower anterior end (fig. 20). Attached by posterior half of left side. Surface even, but closely encrusted with fine sand grains all over. Siphon square in section, with slight ridges at the angles. Colour, greyish-yellow; size, 3 centims. × 1·5 centims. × 1 centim.

Test thin, but tough and stiffened by the embedded sand; a little thickened at posterior end; dirty white on inside and in section.

Mantle yellow; strongly muscular on the long siphons and the anterior half of body, less so over the viscera and posteriorly (fig. 21).

Branchial Sac with six well-formed folds on each side converging to the œsophageal aperture. Stigmata running transversely in place of longitudinally, so as to cross the internal bars at right angles (fig. 24). There are thus no meshes, and the wide vessels between the rows of stigmata run more or less parallel with the folds in place of across them. The folds have six to eight bars, and the interspaces two or three each. The connecting ducts supporting the bars sometimes come from the transverse vessels, and are sometimes interstigmatic.

Dorsal Lamina represented by a row of closely placed small tentacular languets (fig. 22), smaller and more distant in front, rather stouter and much closer together further back.

Tentacles compound, of three sizes: six of the largest, six of the second, and twelve of the smallest size.

Dorsal Tubercle having a simple ovate slit (fig. 22) placed in the mouth of a deep triangular peritubercular area.

Alimentary Canal forming a long narrow loop placed transversely to the body (fig. 21); stomach ridged longitudinally.

Gonads one on each side (fig. 21), long irregularly lobed yellow bodies, lying transversely in a curve concave anteriorly.

Locality:—Station LIV., in the north part of the Gulf of Manaar, 10 fathoms.

This form is certainly closely related to Sluiter's *Halocynthia transversaria* from Ki Island and Banda, in the Malay Archipelago, but differs in so many minor points from the "Siboga" specimens that I place it as a distinct variety, "*manaarensis*." The Ceylon specimen agrees with Sluiter's description in the remarkable transverse arrangement of the stigmata and in the general characters of the tentacles and the dorsal tubercle, but differs in the following points:—The sandy investment of the body is much slighter and the shape is different, allowing the two siphons to stand out prominently (Plate III., fig. 20). The interspaces between the branchial folds have only two or three internal longitudinal bars each (fig. 24) in place of seven as in Sluiter's specimens. The examination of further material will, no doubt, show whether these differences are bridged by intermediate conditions, or whether they are maintained as the characters of two closely related species.

The living specimen is described in our field-notes as "milky grey, mottled and streaked with dull purple; thin coating of hairs with mud on surface."

Cynthia crinitistellata, Herdman.—Plate III., figs. 25 to 29.

One small specimen from Station IV., off Karkopani, 6 to 9 fathoms. Size, 1·4 centims. in length × 1·5 centims. in breadth × 7 millims.

This species is only known from Port Jackson.

The five specimens in the collection of the Australian Museum, Sydney, were described in 1899.* The present little specimen from Ceylon (fig. 25) agrees perfectly in external characters, including the spines and the remarkable stellate hairs (figs. 26 to 29), forming a fine down over the surface of the test, with the Australian specimens.

Cynthia aripuensis, n. sp.—Plate III., figs. 30 to 39.

External Appearance.—Body of irregularly globular or pyriform shape, with the narrower anterior end cleft into the two long crumpled siphons. The branchial siphon is especially long (fig. 31). Attached by the posterior end. Surface corrugated. Colour, creamy yellow, browner in places; some specimens have a pink tinge. Size of a large specimen, 4 centims. × 2·5 centims. × 1·5 centims.

Test leathery and tough, up to 2 millims. in thickness, wrinkled on the outer surface, creamy yellow, smooth and glistening on the inside, white in section. The invaginated test lining the siphons bears slender sharp-pointed scales (fig. 33).

Mantle strong, opaque anteriorly, more membranous and transparent posteriorly, of a yellowish colour becoming red on the siphons. Strong muscle bundles radiate from the bases of the siphons (fig. 35).

Branchial Sac with six folds on each side. About nine to twelve internal bars on the fold, and four to six rows of meshes in the interspace. There are three smaller transverse vessels between each pair of much larger ones (fig. 32). The mesh is transversely elongated, contains about six rather small stigmata, and is divided by a horizontal membrane. Parasitic Copepoda are present in the branchial sac.

Dorsal Lamina represented by closely placed long tentacular languets (fig. 37).

Tentacles large, much branched, and closely placed; about 18 larger ones and the same number of very much smaller ones placed so that the bases touch (fig. 36).

Dorsal Tubercle simple, ovate in outline, with the opening anterior or lateral, and the horns coiled slightly inwards (figs. 38, 39).

Gonads large, yellow; present on both sides, in a double row of about 20 masses.

Locality:—(1) Aripu coral reef, shallow water, about a dozen specimens; (2) "Gulf of Manaar," four specimens; (3) Station LXVI., off Mutwal Island, 10 to 35 fathoms, three specimens; (4) Station IV., off Karkopani, 6 to 9 fathoms, two specimens.

This is probably a fairly common *Cynthia* in the Gulf of Manaar, as a number of specimens were obtained while wading on Aripu coral reef, of which about a dozen were preserved. The specimens dredged off Mutwal Island are certainly the same species, although the shape is a little longer and less globular (fig. 30). That slight difference may well be due to the place of attachment or to the accidents of preservation. The internal organisation is the same as in the Aripu specimens.

This species recalls SLUITER's *Halocynthia polycarpa* from the "Siboga" expedition, but differs notably in the tentacles and the dorsal tubercle, and in the details of the branchial sac. From ROULE's *H. corallina* this species also differs in several

* 'Descriptive Catalogue (No. XVII.) of Tunicata in Australian Museum,' Sydney, 1899, p. 34.

particulars. The spines of the branchial aperture, moreover, are characteristic (figs. 33 and 34).

Cynthia lanka, n. sp.—Plate IV., figs. 1 to 13.

External Appearance.—A sandy mass of ovoid form, with a narrower anterior end raised to form a slight ridge, at the extremities of which the apertures are placed (figs. 3 and 4). Size, 2·5 centims. × 2 centims.

Test closely encrusted with a layer of sand, not thick.

Mantle thin and transparent, with prominent muscular siphons, atrial the longer (figs. 5, 6). Branchial siphon lined by closely placed, sharp-pointed spines (fig. 12).

Branchial Sac with six folds on each side. There are five to seven internal bars on a fold and about three to five rows of meshes in each interspace. The meshes are square, contain each four stigmata, and may be crossed by a narrow horizontal membrane (fig. 11).

Dorsal Lamina in the form of short curved tentacular languets (fig. 10).

Tentacles much branched.

Dorsal Tubercle small, widely cordate, with the opening anterior (figs. 7 to 9).

Gonads a double row on each side opening into a zig-zag duct (figs 5, 6, 13).

Localities:—(1) Station XLIX., south-west of Cheval Paar, 8½ fathoms, one specimen; (2) Station LXVI., off Mutwal Island, 10 to 35 fathoms, two specimens; (3) Station XIX., Palk Bay, 8 fathoms, five specimens; (4) Station XXIV., Outer Bay, Trincomalee, 24 to 46 fathoms, half a dozen specimens.

This sandy *Cynthia*, to which I have given the ancient native name of Ceylon, seems undescribed. The appearance of the alimentary canal and gonads, as seen when the test is removed (figs. 5 and 6), recall *Cynthia jacatrensis*, Sluiter, from Malaysia, *C. molguloides*, from Australia, and Van Name's var. *munita* of Traustedt's West Indian *C. riiseana*, from Bermuda, but our Ceylon species differs from all of these. Notwithstanding the very complete armature of spines lining the branchial siphon (fig. 12), there were several parasitic Copepoda in the branchial sac.

The zig-zag arrangement of the oviduct connecting the gonads is a conspicuous feature. Fig. 13 shows a portion of the organ enlarged.

Family: STYELIDÆ.

Styela lapidosa, n. sp.—Plate V., figs. 7 to 15.

External Appearance.—Of oblong, ovate form, apparently unattached, with the anterior end rather the wider, and covered closely and uniformly with coarse quartz sand grains (figs. 7 to 9). Apertures both on the rounded anterior end, not prominent, inconspicuous. Surface and colour due to the sand; size, 2·3 centims. long by 1·2 centims. wide.

Test thin, but stiffened by the sand, brittle, transparent on inner surface letting the sand grains show through distinctly.

Mantle thin, transparent and very slightly muscular, except on the two short siphons, where there are strong sphincters.

Branchial Sac with four slight but well-formed folds on each side. About six bars on a fold, and four to six rows of meshes in the wide interspaces (fig. 14). The meshes are square, contain each about five rather large closely placed regular stigmata, and are divided horizontally by a membrane. Narrower and wider transverse vessels alternate.

Dorsal Lamina is a corrugated membrane.

Tentacles of three sizes (fig. 15), eight of the largest, eight of the second, and sixteen of the smallest.

Dorsal Tubercle with a simple but wide funnel-shaped opening (fig. 15). Peri-tubercular area narrow.

Alimentary Canal with a wide intestinal loop (fig. 10); stomach ridged.

Gonads a curved, slightly lobed organ on each side of the body, having the ovary along the middle and the spermatic cæca on the edges.

Localities:—(1) Stations LIII. and LIV., in north part of Gulf of Manaar, 4 to 40 fathoms, a few specimens; (2) Station XLVI., off Mount Lavinia, 30 fathoms, four specimens; (3) Station XXIV., Outer Bay, Trincomalee, 24 to 46 fathoms, a dozen specimens; (4) Station XLIX., South Periya Paar, 13 fathoms, eight specimens; (5) Station LXIII., West of Periya Paar, 17 to 55 fathoms, nine specimens.

This seems to be a common species around Ceylon, as a number of specimens were found at localities on both sides of the island.

The appearance of the tentacles and of the dorsal tubercle (fig. 15) is very suggestive of a Polystyelid or a Botryllid.

The apertures are striped with yellow and red when alive. The stiff brittle sandy test and the large curved gonad on each side are characteristic features.

Styela areolata, Heller—Plate IV., figs. 24 to 33.

It is necessary to re-describe this species, with figures, since Heller's description was very brief and no illustrations have been published showing the structure.

External Appearance.—Body ovate, attached by a few slight tag-like processes at the posterior end. Siphons slight, both on dorsal edge, apertures small, cross-slit. Surface uneven, but smooth. Colour, milky white. A little sand adhering towards the posterior end (fig. 24). Size about 2 centims. × 1·5 centims.

Test thin and semi-transparent, smooth on the surface except where encrusted with sand. The test may be reduced to a very thin layer in the middle of the posterior end, and has thickened edges round the area of attachment. There are vessels in the test.

Mantle semi-transparent, allowing the viscera to show through. The muscle bundles are very fine.

Branchial Sac with four wide folds on each side. There are five internal bars on a fold and three rows of meshes in the interspace. The transverse vessels are of three orders. The meshes are elongated transversely and contain eight or nine stigmata, and may be crossed by a narrow horizontal membrane (fig. 33).

Tentacles simple, numerous, large and small alternately.

Dorsal Lamina a plain membrane.

Dorsal Tubercle having a simple rather angular horse-shoe curve with a wide opening. The ends turn slightly either in or out (figs. 31 and 32).

Alimentary Canal large, stomach ridged longitudinally, intestine wide, forming a close loop.

Gonads four to six on the right side, one or two on the left (figs. 27 to 30).

Localities:—(1) Aripu coral reef, four specimens; (2) Station LIII., 10 miles north of Cheval Paar, 7 to 8 fathoms, four specimens; (3) Station I., off Negombo, 12 to 20 fathoms, four specimens (one of these is almost bare of sand and another is more than half covered with reddish brown large sand grains so as to closely resemble in appearance the sandy *Rhabdocynthia, Rh. ceylonica*, found in the same neighbourhood); (4) Station X., East of Cheval Paar, 6 fathoms, three specimens—one large (fig. 26) with half a dozen young pearl oysters adhering, almost free from sand, test milk-white and corrugated at anterior end, one smaller half-covered, and one wholly covered with red-brown sand except the two siphons and a strong ridge of test connecting them; (5) Station LIV., North end of Gulf of Manaar, half a dozen small specimens from 1 centim. to 2·5 centims. in length; (6) Station XLIX., South end of Periya Paar, 13 fathoms., one specimen.

Although HELLER'S description is very brief, the name he gives the species inappropriate, and his single figure of the external appearance not characteristic, still I have no doubt that his specimen, brought from Ceylon by SCHMARDA, belonged to the same species as those I have now before me. The milk-white colour and the long tubular gonads, about four on the right side and two on the left, are characteristic features mentioned by HELLER which render the identification fairly certain. He does not mention the sand which is usually present on the surface, and the areolation of which he makes so much is by no means always present. However, feeling confident that it is the same species that is in question, I have re-described and figured HELLER'S *S. areolata* from the specimens in the present collection.

The few prominent tubular gonads on each side of the body in this species recall the arrangement seen in SLUITER'S eastern species *Styela oligocarpa* and *Styela sedata*; but in other points of structure and in external appearance the Ceylon specimen differs from both of these, although they must be regarded as allied forms.

Styela ascidioides, n. sp.—Plate V., figs. 27 to 32.

External Appearance.—Body oblong, erect, attached by a short narrow stalk or posterior thickening. Branchial aperture on anterior end, atrial on dorsal edge, one-third of the way back. Both apertures very regularly four-lobed (fig. 28). Colour, grey. Size, 2·5 centims. × 1 centim.

Test cartilaginous, full of bladder cells (fig. 30) and pigment cells (blue, black, red and yellow).

Mantle having a fine network of fibres running in all directions.

Branchial Sac large and loosely disposed, with four folds on each side. Transverse vessels rather wide, of three sizes. Internal bars wide, ribbon-like; from eight to sixteen on a fold and six to eight in the interspace. Meshes square, containing each four or five stigmata (fig. 32).

Tentacles large and closely placed, about 30 (fig. 31).

Dorsal Lamina a plain membrane.

Dorsal Tubercle small and inconspicuous, placed close to the tentacles (fig. 31).

Nerve Ganglion and neural gland forming a conspicuous spot.

Alimentary Canal forming a narrow loop at posterior end of left side (fig. 29); stomach simple, ovate.

Gonads nine prominent yellow masses on each side, closely packed, pyriform, with ducts directed towards the atrial aperture.

Locality :—Station LVIII., Alentura Paar, Gulf of Manaar, 9 to 26 fathoms.

The cartilaginous test, with its *Ascidia*-like structure, and the minute dorsal tubercle placed close to the tentacles, are special features of this species.

Styela pigmentata, n. sp.—Plate VI., figs. 24 to 26.

External Appearance.—Of quadrate shape, broader than long, attached by a wide base (fig. 24); somewhat encrusted and covered with growths of weed, &c., but not stiff. Colour dark; size, about 3 centims. × 3 centims.

Test leathery, but rather soft and flexible, with *Crenella* embedded in its thickness; yellowish grey and glistening on the inside.

Mantle soft, and opaque dark brown; not muscular; inner surface pigmented yellow and white.

Branchial Sac pigmented with yellow and white, with four well-marked folds on each side. There are at least six internal bars on a fold and three in the interspace. The meshes contain each eight stigmata (fig. 25).

Endostyle with very wide, white pigmented lips.

Dorsal Lamina a plain membrane.

Tentacles pigmented yellow and white.

Dorsal Tubercle represented by a diffused triangular area covered with minute pores (fig. 26).

Locality :—Jokkenpiddi Paar, Gulf of Manaar, 8½ to 10 fathoms.

Polycarpa aurata, Quoy and Gaimard—Plate V., figs. 1 to 6.

External Appearance.—Shape oblong, erect, with both apertures at anterior end, sessile, not distant (fig. 1). Attached by posterior end, and having a little encrusting sand or shell fragments; surface more or less corrugated. Colour from dull brownish grey to blackish brown; size, 2·3 centims. × 1·3 centims. × 0·5 centim.

Test leathery, but rather soft; dark grey in the interior, and pigmented with minute black spots to varying degrees having numerous pigmented vessels (fig. 2).

Mantle moderately thick, but not very muscular, of a dark colour (fig. 3) and having the gonads embedded in it; apertures and siphons black.

Branchial Sac nearly black in colour, with four large closely placed folds on each side; six internal bars on a fold, and three in each interspace (fig. 6).

Dorsal Lamina a narrow plain membrane.

Tentacles about 30, all of same size.

Dorsal Tubercle an indefinite spongy mass with many small apertures (fig. 5).

Alimentary Canal small, intestine slight.

Gonads, 10 to 12 round polycarps, sunk in the mantle on each side.

Localities:—(1) Station IV., off Karkopani, 6 to 9 fathoms, one specimen; (2) Station XLVI., off Mount Lavinia, 30 fathoms, one specimen; (3) Gulf of Manaar, three specimens adhering in a clump.

It is possible that these Ceylon specimens of this widely distributed and somewhat variable species ought to be separated off as a distinct variety. As they have some distinct characteristics, I have drawn up the above description. All the specimens have more brown and black pigmentation than I have seen in the species before, which gives them a "tanned" appearance both inside and out, while the apertures are practically black. In all these characters they agree with HELLER's *Polycarpa nigricans*, from Mauritius, which, however, is described as having a basal stalk and root-like processes which are not present in the Ceylon specimen. It is possible that HELLER's species is the same as QUOY and GAIMARD's, in which case *aurata* remains as the name of the species and *nigricans* becomes a synonym.

Polycarpa mutilans, n. sp.—Plate IV., figs. 34 to 44.

External Appearance.—Shape oblong or trapezoidal, with a narrow anterior end and a sloping dorsal edge. Apertures both moderately prominent, but not on long siphons; branchial anterior and atrial about the middle of the dorsal edge (fig. 38). Surface uneven and corrugated. Colour, dirty greyish yellow; size, 3·5 centims. × 2·2 centims. × 1·5 centims.

Test tough and leathery, very irregular on outer surface, smooth on inner, white in section.

Mantle moderately muscular, with fine, but numerous, bundles of fibres running both longitudinally and transversely.

Branchial Sac, when present, with four folds on each side. The fold has about six internal bars and there are about three in each interspace. The meshes are nearly square and contain each four to six long narrow stigmata (fig. 37).

Dorsal Lamina a narrow plain membrane (fig. 37).

Tentacles large and numerous, all one size, bases touching, about 80 in all (fig. 39).

Dorsal Tubercle simple, with an anterior opening and the horns rolled slightly inwards in one specimen (fig. 44) and turned outwards in another (fig. 43).

Alimentary Canal with an open loop and a closely ridged stomach; but it may, like the branchial sac, be completely absent.

Gonads.—A row of about 14 yellow sausage-shaped polycarps on the right side of the body and fewer on the left. Many endocarps on both sides.

Locality:—Station LIV., in north part of Gulf of Manaar, 4 to 40 fathoms, three specimens.

Of the three specimens of this species obtained together at the one spot, two are in an interesting condition. The specimen shown in fig. 38, and from which the above description has been drawn up, is perfect and normal in all its organs; but the other two which, externally, seem as well grown and as complete (see fig. 34), were found on dissection to have no alimentary canal and no branchial sac (see fig. 35).

Sluiter, in 1885, described a single specimen of a *Styela* which he found at Billiton, in the Malay Archipelago, under the name *Styeloides abranchiata*, as a new species belonging to a new genus because of the absence of branchial sac and alimentary canal. As it was scarcely possible to believe that such could be the normal condition of the species, in my 'Revised Classification of the Tunicata' (p. 578), in 1891, I expressed some doubt and suggested that Sluiter's specimen was an individual abnormality.

In 1895, Sluiter, in his "Report on the Tunicata of the Semon Expedition," described a new species, *Styela solvens* (Semon, 'Forschungsreisen,' Bd. v., p. 182), in which, out of three specimens found at Amboyna, the branchial sac was absent in two and the intestine in all. This observation caused Sluiter to relinquish his genus *Styeloides*, and suggest that in the species of *Styela* in question the branchial sac, &c., might become lost as a normal process. The following year, however, Willey, in his "Letters from New Guinea" ('Quart. Journ. Micr. Sci.,' 1896, p. 161), described the ejection of the viscera which he had actually observed in a species of *Styela* which he, following Sluiter, named *Styeloides eviscerans*. Sluiter refers further to the three mutilated species, *Styela abranchiata*, *St. solvens*, and *St. eviscerans* in his paper on Weber's South African Tunicata ('Zoolog. Jahrb.,' 1898), and raises the question whether regeneration can be in progress in such cases. Finally, two additional specimens of *Styela abranchiata*, both also in the mutilated condition, were obtained by the "Siboga" expedition.

The condition of affairs in the three specimens from Ceylon, which I am now describing as *Styela mutilans*, confirms the impression I expressed in the 'Revised Classification' in 1891, and upon which agreement seems now to be general.

The Ceylon specimens do not belong to any of the previously described species of Sluiter or Willey. They differ from all in various particulars, and belong clearly to the genus *Polycarpa*; but here is a case where, if the first specimen which I examined had alone been found, or even if the first and second only had been known, the species might have been described as destitute of branchial sac, stomach, and intestine. And yet the third example, which there is no reason to think belongs to a different species, shows a perfectly normal structure. I have no doubt that specimens one and two have lost their alimentary tract. From WILLEY's observations it seems possible for an Ascidian by a powerful contraction of the mantle under some abnormal conditions to perform evisceration and get rid of the entire free portion of the canal, from the peripharyngeal bands to the anus, and that seems to be the best explanation of all such abranchiate specimens.

The tentacles remain, as they are firmly attached to the muscular body-wall, and they are alike in all the three Ceylon specimens. Fig. 39 shows the appearance of a stained preparation of a tentacle, where (*a*) indicates a band of ciliated columnar epithelium, the rest of the surface being covered with squamous cells, while (*b*) is a tract of solid connective tissue, along the convex edge, which stains a bright red with picro-carmine, and is probably skeletal in function. The rest of the interior contains lacunæ with many blood corpuscles (*c*).

The only difference that is apparent between the normal and the abranchiate specimens is that the latter have a more abundant crop of endocarps projecting from the body-wall (fig. 36), and as these are individually larger (figs. 40 to 42) and contain lacunæ in connection with those of the mantle outside (fig. 36), and show many blood corpuscles in their interior, I would suggest that this greater development of these thin-walled vascular processes has taken place in order to compensate for the absence of the branchial sac by promoting respiration. SLUITER, in his original mutilated specimen, *Styela abranchiata*, found that the mantle was thickened and highly vascular, and he recognised that its condition compensated for the absence of the normal respiratory organ. In *Styela solvens*, however, no unusual development of the mantle is described. Whether any nutrition can be effected by amœboid cells in the body-wall absorbing particles brought into the single large cavity by the branchial and atrial apertures, and whether the animal can maintain life for long in this abnormal state, there is no evidence to show. Experimental work on eviscerated specimens would be necessary to determine such points.

If the animal is able to carry on existence in this mutilated condition, two physiological points arise: the one as to respiration and the circulation of the blood, the other as to digestion and nutrition. The heart and the chief blood-vessels have gone with the other loose viscera. The abundant thin-walled endocarps containing blood lacunæ and projecting freely into the sea-water in the peribranchial cavity no doubt perform respiration effectively, and it is possible that they pulsate like the ampullæ in the test of *Botryllus* and so keep the blood in movement. The other possibility is that contraction of the muscles in the mantle squeezes the blood irregularly from place to place in the body-wall and so prevents stagnation.

In regard to nutrition, it seems possible that amœboid cells in the connective-tissue of the body-wall, and from the blood lacunæ, might take up nutrient particles brought in by the water and ingest and digest them in an intracellular manner. Although, in the absence of the branchial sac, there can be no strong current through the animal, still the muscles of the mantle, and especially the sphincters of the siphons, will no doubt suffice to draw in and to expel supplies of water, and the cilia of the peripharyngeal bands and of the tentacles will be able to separate out, guide, and retain the diatoms and other nutrient particles.

If the food can be brought within reach of the amœbocytes and ingested, there is probably no difficulty in regard to digestion. Such cells are probably able to form the necessary ferments and effect solution and absorption of the food. It is known that ordinary tissue-cells in even a higher animal contain erepsin, and possibly other ferments, and can exercise a slow proteolytic action. It seems highly probable* that leucocytes and other undifferentiated cells—especially in plastic organisms like the Ascidians, where tissue differentiation is not highly marked—contain amylolytic and proteolytic ferments sufficing for intra-cellular digestion of microscopic organic food.

Polycarpa sluiteri, n. sp.—Plate V., figs. 16 to 21.

External Appearance.—Shape pyriform or oblong with a narrower anterior end terminated by the branchial aperture. Atrial aperture half-way down dorsal edge (fig. 16). Surface rough, corrugated, having a few shell fragments and other foreign bodies adhering. Attached by posterior end and parts of left side. Colour, very dark grey, nearly black in places. Size, 3 centims. × 2 centims. × 1·5 centims.

Test tough and leathery, rough and irregular on outer surface, quite opaque, smooth, but rather dark on the inner surface and grey in section.

Mantle dark coloured, not thick, with strong muscular siphons.

Branchial Sac with four wide folds on each side, with about nine or ten bars in the folds and five rows of stigmata in the interspace. Transverse vessels alternately larger and smaller. Meshes square, containing each seven or eight rather long narrow stigmata (fig. 21).

Dorsal Lamina a plain membrane with no ribs and no marginal teeth.

Tentacles of two sizes, six very large and six much smaller.

Dorsal Tubercle rather small and slight, in a deep narrow triangular peritubercular area, with the opening anterior and the horns turned one in and one out but not coiled (fig. 17). Two other tubercles are shown in figs. 18 and 19.

Gonads numerous; from 15 to 20, dull yellow, sausage-shaped polycarps on each side of the body, arranged roughly in a row facing the atrial aperture (fig. 20). A few dark-coloured endocarps projecting between them.

Locality:—(1) Station V., Chilaw Paar, 10 fathoms, three specimens; (2) Aripu coral reef, one specimen.

This species in some respects resembles *Polycarpa mutilans*, but differs from it so

* In the light of recent work by Ascoli and Mareschi, Vernon, Rulot, and the Ladisls.

completely in the tentacles, as well as in other points, that there can be no question of their distinctness. It is, however, exceedingly like the form described by SLUITER from Billiton (Malay) under the heading "*Styela elata* (HELLER) (?)," in 1885. MICHAELSEN, in his revision of HELLER'S types, dealt with *Polycarpa elata*, HELLER, assured us that SLUITER'S form does not belong to that species and suggested the name *P. seriata* for it. The agreement of the Ceylon form with SLUITER'S description extends to the gonads, the branchial sac and the dorsal tubercle, but the tentacles are not alike, and there are other differences in detail, so I consider it safest to give the above full description of my specimens under the name *P. sluiteri*. In the dorsal tubercle this species closely resembles *Styela ambonensis*, SLUIT., of the "Siboga" expedition.

Polycarpa chalmersi, n. sp.—Plate V., figs. 22 to 26.

External Appearance.—Shape rounded or quadrate, somewhat flattened; attached to lumps of coral or to the tubes of the large Foraminifera *Ramulina herdmani* in such a way that the anterior end, dorsal edge, and a large part of both sides is exposed (fig. 23). Apertures sessile, cross-slit when closed, opening out into short siphons with wide square ends when alive. Surface somewhat creased, produced into roughened lobes about the anterior end. Colour, red and grey when alive, siphons streaked with red and white; dull bluish-grey in spirit. Size, 1·8 centims. × 1·3 centims. × 6 millims.

Test thin, but tough and leathery, thickening to over 1 millim. on the roughened anterior end.

Mantle very thin, closely adherent to test. Muscle bands very fine, forming a close net-work.

Branchial Sac with four well-marked folds on each side. There are about nine internal bars on a fold, and about three rows of meshes in each interspace (fig. 24). The meshes are nearly square and contain half a dozen stigmata. There are three narrower transverse vessels between each pair of larger ones.

Dorsal Lamina a plain narrow membrane.

Tentacles long and slender, of two sizes, about 30 in all.

Dorsal Tubercle small and simple, in the form of a narrow U-shaped slit, with the opening anterior and placed in a small triangular peritubercular area (fig. 25).

Alimentary Canal rather short and wide, stomach ridged.

Gonads small hermaphrodite bottle-shaped polycarps (fig. 26), 10 or 12 on each side.

Localities:—(1) Station XLI., 12 miles south of Galle, 100 fathoms, several specimens; (2) Station XXXV., Galle Bay, 7 fathoms, four specimens on a bit of old coral (fig. 22).

These specimens show the change which may occur of an Ascidian which is bright red in life into a bluish-grey colour when preserved in alcohol. I have noticed this so frequently in both simple and compound Ascidians that when, in a preserved collection, one comes upon specimens showing this opaque dull bluish-grey appearance, there is at least a strong probability that the colour in life was red. I have pleasure in dedicating this interesting little species to my friend Dr. A. J. CHALMERS, Professor in the Medical College at Colombo.

Polycarpa alentura, n. sp.—Plate V., figs. 33 to 37.

External Appearance.—Body conical or dome-shaped (fig. 33), attached by a broad base at the posterior end. Apertures on the narrow anterior end, not projecting, inconspicuous. Colour, yellowish grey; size, 2 centims. × 1·5 centims.

Test smooth, slightly wrinkled, leathery.

Mantle thin, pigmented, having a very fine felting of delicate muscle fibres.

Branchial Sac with four wide folds on each side, about 15 internal bars on a fold, and about seven rows of meshes in the interspace. Transverse vessels of several sizes; meshes narrow, containing three to five stigmata each (fig. 37); the stigmata are crossed by a narrow horizontal membrane.

Dorsal Lamina with a few slight denticulations at the anterior end (fig. 35), behind that a plain membrane.

Tentacles rather short and irregular, 14 in number, differing a little in size.

Dorsal Tubercle curiously shaped (fig. 36) with the aperture posterior, one end turned in and the other out.

Alimentary Canal with a widely open intestinal loop; stomach yellow-brown, striated longitudinally (fig. 34).

Gonads consisting of a few polycarps only. Large numbers of small endocarps engorged with opaque yellow blood corpuscles project from the body-wall.

Locality:—Station LVIII., off Alentura Paar, 9 to 26 fathoms, one specimen.

Polycarpa decipiens, n. sp.—Plate VI., figs. 33 to 39.

External Appearance.—Body rounded and covered with sand like a *Molgula*, unattached. Both siphons on the anterior end, but rather distant (fig. 33); size, about 1 centim. across.

Test thin, but covered with a soft, rather loose, coating of sand.

Mantle thin and transparent.

Branchial Sac with four slight folds on each side (fig. 34). Each fold has only three or four internal bars, and there are no bars in the interspaces. Between the endostyle and the 1st fold are 16 stigmata, between the 1st and 2nd 8, between the 2nd and 3rd 8, between the 3rd and 4th 10, and between the 4th and the dorsal lamina 14. The stigmata are shown in fig. 35.

The *Dorsal Lamina* is a plain membrane.

The *Tentacles* are about 20 large, not all quite the same size, and intermediate very much smaller ones.

Dorsal Tubercle simple, ovate, with the opening slightly on one side and the horns turned in (fig. 36).

Alimentary Canal forming an open loop; intestine short and wide.

Gonads flattened, ovate, hermaphrodite polycarps, placed on both sides of the mantle, 10 on left side and 12 on right (fig. 37). The oviduct and vas deferens are shown in fig. 38, and part of the testes in fig. 39.

Locality:—Station LIII., 10 miles north of Cheval Paar, 9 fathoms, one specimen.

Polycarpa palkensis, n. sp.—Plate VI., figs. 5 to 8.

External Appearance.—An ovate sandy mass, attached by a large area to a dead chank shell. Apertures inconspicuous, at opposite ends of the body. Size about 2 centims. in length by 1·5 centims. in breadth.

Test stiff, entirely encrusted with sand to a thickness of about 5 millims.

Mantle opaque. When the test is removed the body is of fusiform shape with the two prominent siphons almost at opposite extremities and directed away from one another (fig. 5).

Branchial Sac with four folds on each side; about six bars on each fold, and three rows of meshes in the interspace. The transverse vessels are of two sizes (fig. 7), the meshes are transversely elongated, with six or seven stigmata in each.

Dorsal Lamina a very narrow plain membrane.

Tentacles rather long, about 30, not all same length.

Dorsal Tubercle rather large and complicated (fig. 6). The opening is anterior, both horns are rolled inwards and one is much larger than the other.

Alimentary Canal forming a small canary-yellow compact mass.

Gonads, numerous elongate ovate polycarps (fig. 8), about 20 on each side.

Locality:—Trawled at Station XIX., in Palk Bay, 8 fathoms, one specimen.

This species shows some resemblance to SLUITER's *Styela floccosa* obtained by the "Siboga," but differs in the gonads and other details of structure.

Polycarpa colletti, n. sp.—Plate VI., figs. 1 to 4.

External Appearance.—Shape erect, cylindrical, almost rod-like; attached by the posterior end with the branchial aperture on the anterior end and the atrial about half-way down the dorsal edge (fig. 1). Surface finely creased or corrugated. Colour, creamy white; size, 2·5 centims. × 8 millims.

Test leathery.

Mantle strong, opaque, yellow, closely adhering to the test.

Branchial Sac with four low, rounded folds (fig. 3) on each side. Each fold has 14 or more closely placed bars, and there are two bars in the interspace separating a very wide central row of meshes from two lateral narrower rows. The wider mesh contains about eight stigmata and the narrower half that number. The transverse vessels are of three sizes, arranged with regularity, and there may also be narrow horizontal membranes crossing the stigmata (fig. 4).

Dorsal Lamina a low plain ridge.

Tentacles of two sizes, about 20 larger and the same number of smaller, placed alternately (fig. 2).

Dorsal Tubercle a large circular area with a small opening at one side, around it is a swollen spongy area.

Locality :—Station XLIX., South-west of Cheval Paar, 13 fathoms, one specimen.

This species is named in honour of the late Mr. Oliver Collett, an excellent naturalist in Ceylon, much interested in the pearl oyster investigation.

Polycarpa willisi, n. sp.—Plate VI., figs. 9 to 15.

External Appearance.—Elongated ovate, almost fusiform, with the large siphons at opposite extremities of the body (fig. 9); each opening very distinctly four-lobed and surrounded by a square rim (fig. 11). Surface sandy; size, 1·4 centims. in length.

Test thin, sparsely covered with adhering sand.

Mantle opaque, pigmented with orange and pale yellow; siphons long (fig. 10).

Branchial Sac with four folds on each side. About five bars on each fold, and two rows of meshes between. The stigmata (fig. 12) are very short, and rather irregular; they form ovate or rounded holes from two to four in a mesh.

Dorsal Lamina a narrow plain membrane.

Tentacles of three sizes arranged regularly (fig. 13), there being eight large, eight medium, and sixteen smaller between.

Dorsal Tubercle a rounded mass with no distinct horns (fig. 13).

Alimentary Canal a narrow, short loop; stomach smooth, and coloured yellow.

Gonads about 12 elongated orange-brown polycarps on each side of the endostyle (fig. 14), and a number of more rounded pale lemon-yellow endocarps (fig 15) scattered between. Each gonad has the ova in the centre and the testes placed around.

Locality :—Station LXII., Periya Paar, 13 fathoms, three specimens of about the same size.

The interior of the body is much pigmented with opaque yellow, especially the alimentary canal, the endocarps, and the mantle.

I have pleasure in naming this species after my friend Dr. J. C. Willis, Director of the Royal Botanic Gardens at Peradeniya, Ceylon.

Polycarpa twynami, n. sp.—Plate VI., figs. 27 to 32.

External Appearance.—Body erect, oblong, attached by the rather narrower posterior end. Branchial aperture anterior atrial a little way along dorsal edge, both sessile (fig. 27). Surface somewhat corrugated and wrinkled. Colour, brown; size, 3·5 centims. × 1·5 centims.

Test leathery but soft, and irregularly thickened, brown inside.

Mantle opaque brown, adhering closely to the test.

Branchial Sac of a dark brown colour, with four folds on each side. About six internal bars on the fold and eight rows of stigmata in the interspace. There are three or four narrower transverse vessels between much wider ones. The meshes are nearly square, with 3 or 4 stigmata in each (fig. 31).

Dorsal Lamina a plain membrane.

Tentacles at least 30 in number, large, with occasional smaller ones (fig. 32).

Dorsal Tubercle simple, horse-shoe-shaped, with the opening anterior and the horns not coiled (fig. 29).

Alimentary Canal dark brown, anus surrounded by about eight finger-like processes (fig. 28).

Gonads, numerous polycarps and endocarps, all of a very dark brown colour, partly sunk in mantle.

Locality.—(1) Jokkenpiddi Paar, Gulf of Manaar, 10 fathoms, two specimens; (2) Station LXIX., Chilaw Paar, 11 fathoms, one specimen.

Two larger and several smaller specimens of a *Crenella* were embedded in one test. This species is dedicated to Sir WILLIAM TWYNAM, of Jaffna.

Polycarpa manaarensis, n. sp.—Plate VI., figs. 16 to 22.

External Appearance.—Somewhat quadrate in shape, with the apertures on two equal projections, giving the anterior end a cleft appearance (fig. 16). Surface corrugated and encrusted with sand and shell fragments. Colour, dark brown on surface, with a pearly lustre inside; size about 4 centims. × 3·5 centims.

Test leathery, hard and stiff. In section it is seen that the sand-grains are embedded in, as well as attached to, the test.

Mantle thick, opaque, ruddy brown.

Branchial Sac with four folds on each side. There are about nine bars on a fold and six in the interspace. The transverse vessels are of three orders with still smaller ones crossing the stigmata frequently and irregularly (fig. 22). The meshes are nearly square and have about four stigmata each.

Dorsal Lamina a narrow plain fold (fig. 21).

Tentacles placed a long way in front of the peripharyngeal band (figs. 17, 20); about 40, larger and smaller alternately.

Dorsal Tubercle a widely open horse-shoe, with the opening anterior and the horns not turned in (figs. 18, 19). Pre-branchial zone pigmented.

Alimentary Canal a wide loop, stomach globular.

Gonads, many large rounded polycarps sunk in the thick mantle.

Locality:—(1) Station LXII., Periya Paar, 13 fathoms, one specimen; (2) Station LXVI., off Mutwal Island, 10 to 35 fathoms, one specimen; (3) Jokkenpiddi Paar, Gulf of Manaar, 10 fathoms, one specimen.

Specimens of *Synalphæus comatulorum* were found in either the branchial sac or the atrium of all the specimens.

Polycarpa, sp.—Plate VI., fig. 23.

External Appearance.—Body oblong-ovate with a dorsal projection; posterior end pointed; branchial aperture on anterior end, atrial on dorsal edge about one-third of the way back. Surface covered with sand and shell fragments. Size, about 6 centims. × 3 centims.

The single specimen dredged at Tampalakam, Trincomalee, on February 11, is found on examination to be in bad condition, so that the internal structure cannot now be determined. It was probably dead when collected. The test is quite stiff and is strengthened by embedded sand. The mantle is thin and appears to have few muscle bundles. The branchial sac is slight, but beyond the four folds on each side little can be made out. There are numerous small polycarps scattered over the body-wall.

It is impossible to identify this with any described form, and the condition prevents it from being described as new. But it may be useful to place on record that a *Polycarpa* with these general characters (fig. 23) was found at Trincomalee.

Family: POLYSTYELIDÆ.

Some writers, led by Michaelsen, have of recent years substituted a new term "Polyzoidæ" for the above well-known family name Polystyelidæ. I cannot follow them. Even if it be proved that Lesson's "*Polyzoa opuntia*" is the same animal that Cunningham described later as *Goodsiria coccinea*, it by no means follows that because *Goodsiria* becomes *Polyzoa*, Polystyelidæ must become Polyzoidæ. The type-genus of the family Polystyelidæ is, of course, not *Goodsiria*, but is *Polystyela*. But it is premature to change even the generic name. It is by no means certain that Lesson's "*Polyzoa*" belonged to this family. His description would apply at least as well to a species of *Colella*, such as one resembling the "*Aplidium pedunculatum*" of Quoy and Gaimard, which is found in the same neighbourhood (Straits of Magellan and Falkland Islands) as to *Goodsiria coccinea*.

Michaelsen has recently asked* why Heller's term Polycynthiæ should not have priority over Polystyelidæ as the name of the family or sub-family. The answer is simply because Heller did not propose that term as the title of a family or sub-family, nor did anyone else, until Michaelsen, in 1904. According to the 'International Rules of Zoological Nomenclature' (Paris, 1905): "Art. 4. The name of a family is formed by adding the ending *idæ*, the name of a sub-family by adding *inæ*, to the root of the name of its type-genus." Heller did not do that. He formed no family or sub-family. He merely remarked that the group Cynthiæ fell into simple and compound forms (Monocynthiæ and Polycynthiæ). There was no question here of naming or defining a family or a sub-family. No family for this group of genera existed previous to 1886. In that year, in the 'Report on the "Challenger" Tunicata,' Part II., I formed and defined the new family Polystyelidæ, choosing as

* 'Deutsche Tiefsee-Expedition, 1898–1899,' Bd. vii., 1904.

my type-genus *Polystyela*, GIARD, and naming the new family in strict accordance with the rules of nomenclature. After the definition I added: "I form this family for a very interesting little group of Ascidians, the position of which is difficult to determine. I regard them as Compound Ascidians which are allied to the Cynthiidæ amongst Simple Ascidians, and have been evolved from the sub-family Styelinæ." I then gave an outline of the history of the genera which I considered would find their place along with *Polystyela* in the family. The family was properly constituted in 1886, and the name cannot be altered until the name of the type-genus (*Polystyela*) is changed. If MICHAELSEN can prove that LESSON'S "*Polyzoa opuntia*" is the same as GIARD'S *Polystyela lemirri*,* then *Polystyela* will become a synonym of *Polyzoa* and the family name will change to Polyzoidæ, or, if it be regarded as a sub-family, to Polyzoinæ—but not till then. In the meantime, if it is placed as a sub-family of Cynthiidæ the name of the sub-family must be Polystyelinæ.

I may add that in the 'International Rules for Nomenclature,' now generally recognised and followed, there is no direction that in forming a new family the oldest generic title within the bounding line is to be selected as the type and give its name to the family. The oldest genus may be quite unsuitable for such a purpose as it may be an aberrant form very far from typical of the family. Surely it is only common sense that it should be left to the founder of a new family to choose as the type-genus that central form or assemblage of species which seems to him best to typify the new group which he is defining.

So far as to the family name—now let me add a few remarks as to some generic designations formed recently.

MICHAELSEN, in 1900, expressed his dissatisfaction with the definitions of the existing genera in this family, and introduced a new generic term, "*Alloeocarpa*," of a provisional nature (he says†: "Dieser neue Name kann nur als provisorisch angesehen werden") for those species which have a certain character of reproductive organs. But he adds: "Als Typus der Gattung *Alloeocarpa*, MCHLSN., mag *A. incrustans* (HERDMAN) (= *Synstyela incrustans*, HERDMAN) gelten." He does not sub-divide the old genus and does not retain any portion under the old name. He merely substitutes a new name because he wishes to emphasize a new character. Surely a better course would have been, if he finds that my *Synstyela incrustans* will serve as a type of what he desires to put forward, to add the new characters (if necessary) to the definition of the genus, retaining the old name *Synstyela*. As a matter of fact, the unisexual character of the polycarps was described and figured in the case of *Synstyela incrustans* in the '"Challenger" Report' (1886), and in all probability holds for other species of *Synstyela*. It would be simple to restrict the

* MICHAELSEN has suggested ('Mitteil. Naturh. Mus. Hamburg,' xxi., 1904) that GIARD'S genus possibly does not belong to the Polystyelidæ, but I find no basis in fact for this idea.

† "Die holosomen Ascidien des magalhaensisch-südgeorgischen Gebietes"; in 'Zoologica,' Bd. xii., Heft 31; Stuttgart, 1900.

genus to such forms. I prefer, therefore, to retain the old generic title in that sense and to add the word "unisexual" before "polycarps" in the definition. MICHAELSEN'S *Gynandrocarpa*, as he first defined it, would then be the corresponding genus containing those species which have hermaphrodite polycarps. More recently ('Mitth. Naturh. Mus. Hamburg,' XXI.) MICHAELSEN has introduced still further generic sub-divisions of *Gynandrocarpa* based upon details of arrangement of the reproductive organs which seem to me to be of only specific value. If similar details were to be recognised in the genera *Styela* and *Polycarpa* almost every species would become a separate genus.

Gynandrocarpa nigricans, SLUITER.

This is a very dark coloured species which the "Siboga" found at the Island Sarassa, in Malaysia, at a depth of 16 fathoms. Our Ceylon specimens were from Talaivillu Paar, in the Gulf of Manaar, where we obtained a number of colonies from 6 centims. × 3 centims. downwards, in size, growing over coral and shell fragments. The ascidiozooids are very closely placed, there being little or no common test except at the edges of the colony. The general appearance of the animal when alive is black and white, the parts that are not deeply pigmented being transparent.

The arrangement of the vessels in the branchial sac and other points in the internal structure agree with SLUITER'S description. The darkly pigmented blood channels in the marginal parts of the colony are a remarkable feature in this species.

Gynandrocarpa (Eusynstyela) imthurni, n. sp.—Pl. VII., figs. 1 to 9; Pl. IX., fig. 4.

Colony encrusting, forming a thin sheet 1 millim. to 2 millims. in thickness (Plate VII., figs. 1 to 3), and over 9 centims. × 7 centims. in greatest extent (Plate IX., fig. 4).

Ascidiozooids from 6 millims. × 3 millims. on the surface down to 1 millim. in diameter, much flattened from above downwards, so as to form at most slight rounded elevations on the free surface. Ascidiozooids not quite closely placed, leaving some spaces of free test between. Colour (in alcohol) a dull slate-blue, pinkish-red when alive; the test nearly white, with a slight pearly lustre.

Mantle moderately muscular, not pigmented, with well-marked siphons. The atrial siphon has about 20 very delicate tentacles at its base (fig. 7) and there are also some convoluted thread-like outgrowths from the mantle hanging into the peribranchial space.

Branchial Sac with four well-marked folds on each side, with four to six internal bars on each (Pl. VII., fig. 4). The dorsal interspace has one bar, close to the first fold, the next interspace has one, the next two have each two bars, and the ventral interspace has no bar dividing its row of eight or nine stigmata. Most of the meshes contain four or five stigmata each (fig. 4).

Dorsal Lamina a plain narrow membrane.

Tentacles 20 to 22 in number, of two sizes, placed a little irregularly (fig. 5). The tentacles have large swellings at their bases, and the interior of the branchial siphon is marked out into rectangular areas by slight depressions.

Dorsal Tubercle of small size, horse-shoe-shaped (fig. 6).

Gonads hermaphrodite, about 12 on left side of endostyle and six on right. Each gonad has ova in the centre and two testes, one on each side (figs. 8 and 9).

Locality:—Station LXIX., outer Chilaw Paar, 8 to 11 fathoms; along with large colonies of *Leptoclinum*.

This is a handsome species which, from its hermaphrodite gonads, belongs to the genus *Gynandrocarpa* and differs in internal structure from all the described species. It belongs to that section which Michaelsen would separate as the genus *Eusynstyela*, and is allied to Sluiter's two species *Gynandrocarpa maxima* and *G. latericius*, both obtained in Malaysian seas by the "Siboga" expedition. From *G. maxima* our species differs in the smaller size of the ascidiozooids, in the arrangement of the longitudinal bars of the branchial sac and in having fewer tentacles. From *G. latericius* it differs in the details of the branchial sac (see fig. 4), and also in the dorsal tubercle (fig. 6), which is more like that of *G. maxima*. In the tentacles our form agrees with *G. latericius*, and it possesses also those curious long, coiled, thread-like outgrowths from the mantle (fig. 7) to which Sluiter has drawn attention. In fact, the Ceylon species, while possessing a characteristic branchial sac of its own, is in other characters intermediate between the two "Siboga" species. It differs also in details of branchial sac, dorsal tubercle, tentacles, &c., from both the species of *Eusynstyela* described by Michaelsen, viz., *E. tincta* (Van Name) from Bermuda, and *E. hartmeyeri* from the Red Sea, Gulf of Suez, and African coast.

I have great pleasure in dedicating this interesting form to my friend Sir Everard im Thurn, K.C.M.G., who was Colonial Secretary and Lieut.-Governor of Ceylon at the time of my expedition, and who did much to encourage and promote scientific work in the colony.

Other species of Polystyelidæ have been found in far eastern seas and also in the southern part of the Indian Ocean, on the Agulhas bank, but none of these are closely related to the present species.

My "Field-notes" contain the following record as to the colour of this species when alive:—"March 20th, 1902, on outer Chilaw Paar, masses of coral and calcareous tubes covered with colonies of *Leptoclinum* (white, pink, dark neutral tint, &c.), and also a large colony of a Polystyelid of a pink or pale-crushed strawberry tint over the general surface with red apertures and a few red dots between the apertures; between the ascidiozooids the test has a slight bluish-grey tint."

Diandrocarpa brakenhielmi, Michlsn., var. **ceylonica**, n.—Plate VII., figs. 10 to 18.

There are several colonies of a beautiful transparent Polystyelid from the Gulf of Manaar which, from the condition of its gonads, falls, according to Michaelsen's system

('Mitth. Naturh. Mus., Hamburg,' 1904), into the genus *Diandrocarpa*, VAN NAME, and agrees fairly well in details of structure with the species *D. brakenhielmi*, MICHAELSEN. It shows a single hermaphrodite gonad (fig. 12) on each side of the body, and the spermatic sacs are deeply cleft into lobes (fig. 15). There are, however, some points of difference. There are only about 12 folds in the stomach-wall, certainly not so many as 14 or 15, the ducts from the spermatic cæca are certainly longer than MICHAELSEN represents, and, finally, the Ceylon species appears to be more transparent and does not in life, at least, show the bluish grey and other colours noted in the described forms of *D. brakenhielmi*. I do not attach much importance to the last point, since it is probable that MICHAELSEN'S specimens from the Berlin and Hamburg Museums were preserved colonies which had lost their transparency and changed their colour. And as I find that individuals vary somewhat in the folds of the stomach wall, in the proportions of the tentacles, and in other details of structure, I think it best to refer this to the described species with which it closely agrees, calling it the Ceylon variety and figuring its peculiarities. I have specimens in the collection from three localities, and my field-notes in regard to two of these are as follows:—

(1) North end of Periya Paar, Station LXII., 12 fathoms.—"(?) Polystyelid on young pearl oyster shell, translucent grey with lemon-yellow pigmentation, especially along a line (? endostyle) between the apertures, and also around the atrial siphon. Line of red around the edge of each aperture. Under low power of microscope surface is seen to have a reticulum of yellow, pale-blue and red-brown lines which are sinuses filled with pigment corpuscles."

(2) Cheval Paar, 6 fathoms, several colonies.—"A very thin transparent (?) Polystyelid with large ascidiozooids up to 4 millims. long, with very conspicuous branchial sac because the vessels are all engorged with coloured corpuscles. One colony covers a large area in the interior of an old pearl oyster shell and allows the nacre to show through distinctly. Ascidiozooids slightly grey, test between transparent, with a few meandering coloured lines which are vessels."

The third locality is—Attached to oyster cages suspended from the ship on the Cheval Paar; about 20 colonies ranging from 1 centim. × 1 centim. to 7 centims. × 6 centims. over all.

These specimens, although differing a little in appearance, are clearly the same species, and figs. 10 to 18, on Plate VII., show the leading points in structure. There are 10 to 12 rows of stigmata in the branchial sac, and the transverse vessels are very conspicuous from being filled with coloured corpuscles. The vessels in the test, and especially in the marginal parts of the colony, are a conspicuous feature (figs. 11 and 17). There are 12 oral tentacles of three orders, which show, however, some variation in arrangement (figs. 14 and 18). They may be 1, 3, 2, 3, 1, &c., or 1, 3, 3, 3, 1, 3, 2, 3, 3, 3, 2, 3, or 1, 3, 3, 2, 3, 3, 1, &c. There are about 20 much more delicate atrial tentacles (fig. 18) which have not been previously noticed. Fig. 13 shows the alimentary canal and fig. 15 the gonads.

In examining a very simple Polystyelid such as this, with no folds in the branchial sac, one cannot but be struck with the resemblance not merely to the Styelidæ and to the Botryllidæ, which has often been insisted upon, but also to such Clavelinidæ as the genus *Ecteinascidia.* The fact is, that the Polystyelids are an annectant group, and such simple forms as *Diandrocarpa* lead on from the more advanced Clavelinids (such as SLUITER'S *Ecteinascidia nexa*) to the Botryllids and the Styelids.

FAMILY: BOTRYLLIDÆ.

Botryllus ater, n. sp.—Plate VII., figs. 19 and 20.

Colony a small irregular, encrusting patch from the oyster cages on the Cheval Paar.

Test clear and transparent, crowded with terminal knobs in its marginal part.

Ascidiozooids small, and especially narrow; pigmented very darkly and having the branchial aperture so black that it appears to the eye as a distinct dot upon the outer end of the ascidiozooid. From five to ten ascidiozooids in a system.

Mantle and *Branchial Sac* densely crowded with dark pigment.

Botrylloides chevalense, n. sp.—Plate VII., figs. 21 to 24.

Colony thin and encrusting, of irregular form; six colonies range from 3 centims. × 1 centim. to 5 centims. × 3 centims.; of a red colour (in formol), varying from pale brick red to purple.

Ascidiozooids, measuring 1·5 millims. × 1 millim., arranged in elliptical or linear, rarely branching systems (fig. 21).

Branchial Sac richly pigmented, and having about 10 rows of stigmata (fig. 23).

Test clear and transparent, but having a large number of terminal knobs of vessels in its marginal part (fig. 22).

Tentacles of two sizes (fig. 24), four larger and four smaller.

Locality:—Attached to pearl oysters from the oyster cages suspended from the ship while on the Cheval Paar.

Botrylloides nigrum, n. sp.—Plate VII., fig. 25.

Colony small smooth glossy black patches encrusting the branches of *Colella arenosa.* Systems forming a net-work of branching lines (fig. 25).

Test very tough on surface, deeply pigmented.

Mantle with longitudinal muscles only.

Branchial Sac with many rows of stigmata.

Locality:—South of Modragam Paar, 6 fathoms.

Family: DISTOMIDÆ.

Colella arenosa, n. sp.—Plate VII., figs. 26 to 29.

Colony consisting of branched masses (fig. 27) growing through sponges and other attached organisms, and partly encrusted with the black *Botrylloides niger.* The base and larger branches are thickly covered with attached and embedded sand. The twigs terminate in rounded knobs of a pale violet colour and nearly free from sand (fig. 26). Some of the larger masses measure 6 centims. × 3 centims. over all; the branches are 2 millims. to 3 millims. in diameter; the knobs are about 4 millims. across the free end.

Ascidiozooids placed in the free ends of the knobs, from 12 to 20 in each, and having the usual structure of the genus (fig. 26).

The violet pigmentation of the test in these specimens is found, even in the branches, under the sandy coating.

Locality:—South of Modragam Paar, 6 fathoms; half a dozen colonies and fragments. There are also three colonies from Station LXIX., Chilaw Paar, 8 to 11 fathoms, which have exactly the appearance and structure of the above except that the violet pigment is absent, and the free ends of the knobs are dark grey.

Cystodytes ceylonensis, n. sp.—Plate VIII., figs. 23 to 25.

About a dozen small, rounded, or lobed (fig. 23), encrusting colonies belonging to the genus *Cystodytes* were obtained from Talaivillu Paar, 8 fathoms. They were of a bright red purple colour when alive, and range in size from 1 centim. across to 2 centims. × 1·5 centims. The thickness from the attached to the free surface is 5 millims. The colour now, after preservation in alcohol, is a dark greyish brown, and the ascidiozooids show through indistinctly as dirty yellow streaks. Each ascidiozooid has the usual thick calcareous envelope (fig. 24), and the component discs are marked with delicate radial striæ (fig. 25).

A group of several little similar brown colonies, which are indistinguishable from the above in the preserved condition, were dredged at the south-east end of Ceylon on February 13. The colour when alive was not noted.

In structure this form closely resembles *Cystodytes philippinensis*, Hrdn., obtained by the "Challenger" expedition, but differs in colour and in having the discs relatively thinner and more finely striated.

Family: POLYCLINIDÆ.

? Polyclinum nigrum, Hrdn.

A large black colony and some smaller pieces from the pearl banks, Gulf of Manaar, measuring about 6 centims. × 6 centims. and extending up to 1·5 centims. in thickness, may be this Australian species. Our colony has a very smooth shining black surface, and occurs growing over masses of sponges, &c. The surface is marked by large circular depressions, about 1·5 millims. across, which probably correspond to the ends of the ascidiozooids, but no distinguishable remains of the latter are visible on dissection. It is probable that the colony was either dead or regenerating at the time when it was collected.

Amaroucium sp. ?—Plate VIII., fig. 43.

There are several small colonies from the Gulf of Manaar which probably belong to this or one of the allied Polyclinid genera. The largest colony is shown in fig. 43. They are mostly in poor condition, or have lost the ascidiozooids, and consequently I only refer to them for the purpose of stating that a species belonging to this group occurs in the locality.

Psammaplidium ceylonicum, n. sp.—Plate VIII., figs. 8 to 11, and Plate IX., fig. 9.

Colony a large and very sandy mass of rather flabellate form, with vertical walls and buttresses, recalling the appearance of some sponges (see Plate IX., fig. 9); surface lobed, uneven and rough, divided up into small areas (Plate VIII., fig. 11) and very thickly encrusted with sand; size, 15 centims. × 10 centims. × 8 centims.

Ascidiozooids small for the size of the colony, scarcely 3 millims. in length, and less than 1 millim. in greatest breadth; abdomen and post-abdomen very slender, thorax wide (Plate VIII., fig. 8).

Test densely crowded with sand-grains, having the ascidiozooids arranged in its superficial layer only (fig. 10).

Mantle with both longitudinal and transverse muscle bands on the thorax; over the abdomen the longitudinal bands coalesce into two strong bundles which course along the post-abdomen and terminate in two projecting points (fig. 8), which show strong echinations under a high power (fig. 9).

Alimentary Canal long and slender (fig. 8); stomach folded longitudinally.

Tailed larvæ are present in the colony (taken March 7).

Locality:—Station LIV., in north part of Gulf of Manaar, 10 to 30 fathoms.

There are several smaller colonies, and fragments, from various parts of the Gulf of Manaar which are indistinguishable in structure from this species, although they may differ somewhat in appearance on account of the colour or size or amount of the sand-grains taken up by the test.

Psammaplidium aurantiacum, n. sp.—Plate VIII., figs. 2 to 6, and Plate IX., fig. 8.

Colony a large rounded mass (Plate IX., fig. 8), slightly lobed, with a smooth surface only slightly sandy; of a dull orange colour; size, 9 centims. × 7 centims. × 4 centims.

Ascidiozooids up to 3 millims. in length, and rather less than 1 millim. in greatest breadth; dull yellow in colour, embedded in a clear orange-grey test. The anterior ends of the ascidiozooids as seen on the surface are grey.

Test with a few sand-grains scattered on the surface and others embedded in the superficial layers (fig. 2); numerous pigment cells present which give the orange colour to the colony (figs. 3 and 4).

Mantle with strong muscle bundles running both longitudinally and transversely, and causing considerable corrugation of the thorax (fig. 5).

Alimentary Canal forming a large loop, stomach with longitudinal folds, rectum wide (fig. 6).

Locality :—Cheval Paar, 7 fathoms, one colony.

There are two other colonies in the collection from the Gulf of Manaar which, notwithstanding their rather different appearance, I am inclined to refer also to this species. The one is a grey *Psammaplidium* measuring 7 centims. × 5 centims. × $1\frac{1}{2}$ centims., rounded, smooth, and only slightly sandy. The test is grey and transparent, allowing the more opaque grey ascidiozooids to show through, and only differing from the test of *Ps. aurantiacum*, as described above, in the absence of pigment cells.

The other colony is a hemispherical mass, 4 centims. × 4 centims. × 2 centims., of grey colour, but not so transparent as the last and having a yellowish tint. The thorax, abdomen and post-abdomen are each about 1 millim. in length; there are eight large tentacles; the stigmata are small and of rounded form.

Psammaplidium, spp., A and B (? n. spp.)—Pl. VIII., fig. 7: Pl. IX., figs. 10, 11.

In addition to the two species of *Psammaplidium* described above, there are two others which may possibly be distinct from all known species, and from one another, but which I do not feel sufficiently certain of to describe from the present specimens. Both species are densely sandy, and of both one or two large colonies were found in addition to fragments.

The first form (A) is a plano-convex mass, the largest colony measuring 9 centims. × 6 centims. × 3 centims., and probably attached by the whole of the flat surface. The upper rounded surface is divided up into many lobes (Plate IX., fig. 10) which, however, are closely packed together. The mass is most closely impregnated with sand, both on the surface and throughout its depths, so as to appear on section like a consolidated mass of sand. The ascidiozooids are small, not at all abundant, and can only be separated in fragments. They show nothing unusual or specially characteristic in their structure. This colony was dredged in the Gulf of Manaar in February, 1902; and a second, measuring 6 centims. × 5 centims. × $2\frac{1}{2}$ centims., is from Station LIII., 10 miles north of Cheval Paar, 10 fathoms.

The second colony (B) measures 7 centims. × 4 centims. × 3 centims., and is irregularly lobed and produced into bars which join, leaving holes. The surface is covered with a reddish sand, formed of very fine and uniform grains of ellipsoidal shape and quite smooth, which surround the anterior ends of the ascidiozooids (Plate VIII., fig. 7). In addition to these uniform red granules, which are singularly like fæcal pellets, there are a few ordinary irregular sand-grains embedded in the test.

The ascidiozooids are very small, of a translucent grey colour, rather closely placed, and are mainly in the superficial 2 millims. This colony (fig. 11) was dredged at Station LIV., in the northern part of the Gulf of Manaar; depth, 10 to 30 fathoms.

A few other smaller *Psammaplidium* colonies were found which are too fragmentary or imperfect to describe. Some of these are from Muttuvaratu Paar (Station LIX.), 9 fathoms. Others are small sandy lobed masses with areas of black test showing at the ends of the lobes. The test is densely pigmented black, the branchial aperture is eight-lobed, and the atrial has a languet. The masses are about 3 centims. × 1 centim., and the locality is Gulf of Manaar.

Family: DIDEMNIDÆ.

Hypurgon skeati, I. Sollas—Plate VIII., fig. 1, and Plate IX., fig. 5.

This remarkable form was described by Miss I. B. J. Sollas from a specimen found at Pulau Bidang in the Malay Peninsula; and my specimen, from the pearl banks in the Gulf of Manaar, agrees sufficiently closely in detail to be referred not only to the genus but to the same species.

The single Ceylon colony measures over 8 centims. × 4 centims. between its extremes, but is spread over a slightly branched tube and some tufts of Algæ, as seen in Plate IX., fig. 5. The surface is of a warm grey-green colour; and the ascidiozooids, measuring 0·3 millim. across their free ends, are arranged in single lines on each side of the branched cloacal tubes which meander over the surface, with some few occasionally scattered between (Plate VIII., fig. 1)—a more regular arrangement than is described by Miss Sollas.

Didemnum areolatum, n. sp.—Plate VIII., figs. 26 and 27.

Colony encrusting, about 6 centims. × 4 centims. over all, of irregular shape, and 2 millims. thick; with numerous small systems of four, six, or more ascidiozooids (figs. 26), which gives the surface an areolated appearance.

Ascidiozooids of a dirty white colour, due to the calcareous spicules that surround them, while the test between is an amber brown. The branchial apertures show as conspicuous dark points. Ectodermal processes run out into the test.

Test much vacuolated in the lower part (fig. 27) and having many small pigment cells in the upper part giving the brownish colour. There are also spherical calcareous spicules which in some places become stellate with blunt rounded points, but in others are merely knobbed (fig. 27).

Tailed larvæ are present in the test (taken March 20).

Locality:—Station LXIX., Chilaw Paar, 8 to 11 fathoms.

Leptoclinum margaritiferæ, n. sp.—Plate VIII., figs. 19 to 22, and Plate IX., fig. 7.

The *Colony* is a large, moderately thick encrusting mass covering a clump of four pearl oysters (Plate IX., fig. 7). The surface is smooth and soft. The colour when alive was greyish, mottled and streaked with black and white; now, after preservation, it is of a pale pink or crushed-strawberry tint. The size of the mass of oysters and Ascidian together is 9 centims. × 7 centims. × 6 centims. over all.

The *Ascidiozooids* are numerous all over the surface of the colony, and are usually scattered irregularly. In some places they are in double rows, or there are vacant tracts between them (see fig. 7). Common cloacal apertures are few and small. The anterior ends of the ascidiozooids are about 0·5 millim. across.

The *Test* is soft and not opaque. It is of a greyish colour with a slightly pink tint. The calcareous spicules are stellate (fig. 20), but are not very abundant. A thin layer is found on the surface, and in deeper sections they occupy the lines of test which separate the ascidiozooids (fig. 19). There is also a clump of spicules on each side of the thorax of the ascidiozooid. Rounded masses of pigment granules are also present in abundance in the test (fig. 20), as well as small branched test-cells.

The *Branchial Sac* has four rows of short rounded stigmata (fig. 22).

The *Tentacles* are short and thick, 16 in number.

The *Testis* is lobed, with the usual spiral vas deferens (fig. 21).

Locality:—Station XIX., Palk Bay, south of Mandativu, trawl, 5 fathoms.

Leptoclinum pantherinum, Sluiter.

One colony measuring 12 centims. × 6 centims. and several smaller fragments, obtained from Talaivillu Paar at a depth of 8 fathoms, appear to belong to this species. They are of a dirty cream colour streaked with brown. The colour is due to aggregations of pigment corpuscles in the test. There were fully developed tailed larvæ in the colony when collected (April 1). Another small colony was dredged at Station LXIX., Chilaw Paar, 8 to 11 fathoms.

Leptoclinum ceylonicum, n. sp.—Plate VIII., figs. 15 to 18; Plate IX., figs. 1, 2.

A number of colonies, large and small, of a white *Leptoclinum*, which occurs growing over the coarse sand and calcareous fragments of the sea-bottom both in the Gulf of Manaar and in the lagoon at Galle, are so similar in their general characters that, although they show some variation, I think it right to unite them as one species. Two somewhat divergent colonies are reproduced about half natural size, from photographs, in figs. 1 and 2 on Plate IX. Fig. 1 is a colony measuring 16 centims. × 15 centims. × 8 centims., from Station XIX., in Palk Bay, 8 fathoms; while fig. 2 is a mass of about 12 centims. × 10·5 centims. × 6 centims., of plano-convex form, from Station II., off Chilaw, 14 fathoms (the flat surface is shown). In each case those figured are samples of several other colonies, and they show well the characteristics of the species. Colonies were also obtained from the coral reef at Galle and from Aripu reef in the Gulf of Manaar.

The included coarse sand-grains and shell fragments are readily seen, especially in fig. 1, and the interior of the mass contains others which render the substance very brittle. In macroscopic structure this species is sponge-like, there being numerous passages and spaces bounded and crossed by bars of tissue (Plate VIII., fig. 15). The walls of the deeper passages are raised up to form numerous tubercles, as shown in Plate VIII., fig. 16, which represents an optical section.

There are very few cloacal openings visible on the colony, and the ascidiozooids, which show as greyer and more translucent spots on the opaque white surface, seem quite irregularly scattered over the surface (fig. 17). They are small and numerous and have no marked characteristics. The stellate spicules are very abundant, especially near the surface, and as a result the colony has a gleaming white appearance. The rays of the spicules are short and blunt or even rounded at the end (fig. 18).

Leptoclinum ceylonicum, var. **planum**—Plate IX., fig. 4.

I place in this variety two large colonies, measuring 18 centims. × 11 centims. and 12 centims. × 12 centims., and one smaller (12 centims. × 7 centims.), which (along with a colony of *Gynandrocarpa imthurni*) is figured from a photograph (fig. 4) about half natural size. All three occur encrusting dead corals and masses of *Vermetus* tubes from Station LXIX., Chilaw Paar, depth 8 to 11 fathoms, in the Gulf of Manaar. They are very similar to the colonies of *L. ceylonicum* in structure and as seen in thin sections, but differ in forming more of a flat continuous sheet in place of lobes and bars. That difference, however, may be due to the firmer sub-stratum which they encrust. They have not quite the same gleaming white appearance, but this is a character in which parts of the same colony may differ; so I cannot consider these colonies from Station LXIX. as being of more than varietal rank.

Leptoclinum ramosum, n. sp.—Plate VIII., figs. 12 to 14, and Plate IX., fig. 3.

This species is represented by a single very large colony growing over the dead sclerobase of an Alcyonarian coral dredged just outside the pearl banks in the Gulf of Manaar. The colony measures about 20 centims. in length and is about 7 centims. across at the widest, an average width is 5 centims. The colony branches and anastomoses in a characteristic manner (Plate IX., fig. 3) so as to leave numerous spaces and passages. The branches or bars are about 5 millims. in diameter on the average. The colour is a dead milk-white. Very few cloacal openings are visible, and the ascidiozooids are not conspicuous. In most parts they are few and distant, in some few places they are more abundant and more conspicuous. The marks caused by the ascidiozooids vary in size from 0·5 millim. to 1 millim. across.

The spicules are much larger than those of the last species and are more densely packed on the surface, where they form an opaque layer even in thin sections (fig. 12), and less densely deeper down, where they frequently run in lines so as to form a reticulation (fig. 13). The rays of the spicules are much more regular (fig. 14) and more sharply pointed than in the case of the last species.

Leptoclinum viride, n. sp.—Plate VIII., figs. 28 to 33.

Colony small encrusting masses (fig. 28) covering the stems of the large zoophyte *Campanularia juncea;* extent about 3 centims. × 2 centims.; of a green colour when alive, dull white when preserved.

Test with the surface layer packed with small rounded cells containing green granules (fig. 29); deeper layer (fig. 30) contains many stellate calcareous spicules.

The surface of the colony is marked off into areas by branching grooves, along the sides of which the ascidiozooids are arranged (fig. 28). The distribution of the ascidiozooids and spicules, as seen in a surface section, is shown in fig. 33. The spicules are placed most densely between the ascidiozooids, and only sparingly over the surface in lines radiating from the branchial aperture.

Fig. 31 shows one of the round cells containing green granules highly magnified, and fig. 32 is one of the larger spicules to show the characteristically blunt points.

Locality:—Station XLIX., south of Periya Paar, 13 fathoms.

Leptoclinum, spp. (?).

In addition to the species of *Leptoclinum* described above, there are many smaller colonies and fragments in the collection which seem too indeterminate and imperfect to be identified. Some of them may be undescribed forms, but if so they are probably poor specimens which possibly do not show well some characteristics of their species. It may be worth while, however, to mention the localities of some of these colonies in order to give a more correct impression of the abundance of the genus round the coast of Ceylon.

On Chilaw Paar:—

A smooth yellow-brown *Leptoclinum.*
A snow-white solid species.
An echinated form (Plate VIII., figs. 41 and 42) with many cloacal apertures.
Also an ordinary dull white form.

On Cheval Paar:—

Small white colonies encrusting sponges.
A snow-white densely calcareous form.
Pieces of a brown *Leptoclinum.*

On Navakaddua Paar:—

Some small fragments of an ordinary white form in which the spicules are spherical, with low flat knobs in place of projecting points.

Off Negombo:—

Ordinary dull creamy-white colonies.

Off Mutwal Island, March 19:—

Mottled dark blue-black and white form.

Off Mount Lavinia, 30 fathoms:—

Ordinary white *Leptoclinum.*

On the Coral Reef, Galle:—

Fragments of white, grey, drab and dark purple Leptoclinids too small to describe satisfactorily.

Family: DIPLOSOMATIDÆ.

Diplosoma viride, n. sp.—Plate VIII., figs. 34 to 40, and Plate IX., fig. 6.

Colony rounded to elongate, moderately thick, encrusting on Algæ and Coral fragments (Plate IX., fig. 6); surface even and soft; colour, rich green; size, from 2 millims. in diameter up to 4 centims. in length × 1 centim. in breadth × nearly 1 centim. in thickness.

Ascidiozooids about 0·5 millim. across anterior end; arranged irregularly, in the smaller colonies forming a single row round the edge (Plate VIII., fig. 34).

Test having two distinct layers; the spreading margin of the colony, often drawn out into delicate processes (fig. 36) for attachment, is formed of highly vesicular test, full of bladder cells, while the deeper part in which the ascidiozooids are embedded is much denser, has no bladder cells, and is crowded with small test cells and with large spherical green bodies which give the colour to the colony.

Branchial Sac with four rows of rather small rounded stigmata (figs. 37 and 38). The transverse vessels have muscle fibres.

Tentacles six in number, all one length.

Alimentary Canal large, stomach smooth-walled, rectum conspicuous, containing three or four fæcal pellets (fig. 36).

Localities.—(1) On Coral Reef, Galle; (2) Talaivillu Paar, 8 fathoms.

The colonies of this small dark green *Diplosoma* are very abundant at both localities where they were found. On Talaivillu Paar they occur growing over broken fragments of Madrepores and other dead corals, and in the lagoon at Galle they are abundant, encrusting calcareous and other Algæ. Most of the colonies are small and rounded, but some become more elongated and form small encrusting sheets. The usual occurrence, however, is numerous small rounded colonies, closely placed, which may cover an area up to 8 centims. × 5 centims. When alive, the centre of the colony where the common cloacal aperture is placed is depressed and of a paler green colour. The zone of ascidiozooids is also paler, while the outer ring of the colony, outside the ascidiozooids, is the darkest and is usually of a very rich green colour (see fig. 40). The preserved specimens have entirely lost their colour and are now opaque white.

The green colour is due to immense numbers of small round bodies which are probably symbiotic Algæ. They have a central clear space (fig. 35), while around that is a finely granular pigmented layer. These pigmented cells are specially abundant in the outer layers of the test; they are also around the bodies of the ascidiozooids, and they extend more sparsely scattered through the loose lacunar test that occupies the centre of the colony (fig. 40). Vessels with swollen terminal knobs (fig. 36) are a conspicuous feature in the thin expanded margin of the colony.

Diplosoma crystallinum (Giard).

A number of small colonies of a grey semi-transparent *Diplosoma* which were found encrusting pearl oysters and sponges, &c., in the oyster cages suspended from the ship at the Cheval Paar, are indistinguishable from the common European *D. crystallinum*. There are long pointed lobes to the branchial siphon, the ascidiozooids have large eggs, and many tailed-larvæ are embedded in the test (taken in April). Ten colonies range from 1 centim. to 3 centims. in length.

Diplosoma, sp. (?)—Plate VIII., fig. 44.

Four small reddish-brown colonies were dredged from Muttuvaratu Paar (Station LIX.), 9 fathoms, which resemble *D. viride*, from Galle, in structure, but have pigment spherules of a different colour in the test. The colony is fixed by a small base, has overhanging edges and a flat upper surface with a little central tubercle which probably marks the position of the common cloacal aperture (fig. 44). The ascidiozooids show as dots on the surface, and in profile on the margin. The test is very tough, is vacuolated as in the case of *D. viride*, and contains many rounded pigment masses of a reddish colour.

Family: SALPIDÆ.

Salpa cylindrica, Cuvier.

Some individuals of both the solitary and the aggregated forms of this species were obtained in tow-net gatherings on the West Cheval and the Periya paars, and in Palk Bay. The solitary forms extend up to 29 millims. in length, and single members of the chain form up to 14 millims.

My "Field-notes" contain some observations on the specimens of this species taken in Palk Bay. "The body is nearly cylindrical, when alive, with projecting ridges along the sides. The 'nucleus' is marked with yellow, brown, and red. The stomach is brown with yellow cæca around it. When swimming, the tubular orifices are drawn in and shot out again almost simultaneously. They certainly do not alternate. If not quite simultaneous the order is:—oral, atrial, long pause, oral, &c. The aggregated forms are arranged longitudinally in chains and are iridescent when in movement, and look pale blue on a black background."

Salpa runcinata-fusiformis, Cham.-Cuv.

Considerable numbers of both the solitary and the aggregated forms were found along with the last species both in Palk Bay and also on the West Cheval and Periya paars. The solitary form reaches 30 millims. and the aggregated 24 millims.

In some hauls of the tow-net taken off Negombo at Station I. some small specimens of both the solitary and the aggregated form (reaching only 9 millims. or 10 millims.) were obtained.

Salpa democratica-mucronata, Forsk.

Some of the aggregated form were taken in the bay at Galle in February. Many of both solitary and aggregated forms were obtained off Negombo at Station I. with the last species. A few occurred also in Palk Bay.

Family: DOLIOLIDÆ.

Doliolum sp. (?).

Unfortunately the specimens of *Doliolum* are no longer in the collection, but the genus was noted as being present at the following localities :—

On West Cheval and Periya paars (" nurse-form with broad bands").

Galle Harbour, February 17 (" small adult form").

The genus can therefore be recorded from both ends of the island.

Family: APPENDICULARIIDÆ.

Oikopleura sp. (?).

A small species of *Oikopleura*, with no noticeable characteristic features, occurred :—(1) off Negombo, Station I.—many small individuals ; and (2) Galle Bay, February 17.

One of the specimens obtained at Galle was larger than the rest, had a large flat pointed tail bearing two crimson spots near the end. There is some violet pigment in the branchial sac and a yellow spot at the anterior end of the endostyle. We do not yet know the permanence and the value of these pigments in classification. Dr. A. Willey got bright yellow and brilliant blue specimens in New Britain, and Mr. E. T. Browne found an *Oikopleura* with crimson pigmentation at Valencia, in Ireland. All that I can do at present is to record that the genus *Oikopleura* (probably two species) occurs round the coast of Ceylon.

EXPLANATION OF PLATES.

PLATE I.

Figs. 1 and 2. *Perophora hornelli*, n. sp. Nat. size.
Fig. 3. Part of the stolon. × 40.
Figs. 4 and 5. Parts of the branchial sac. × 40.
Fig. 6. The atrial aperture, from the inside. × 40.
,, 7. The alimentary canal. × 20.
,, 8. Tentacles, dorsal tubercle, languets. × 40.
,, 9. *Ecteinascidia sluiteri*, n. sp. × 2.
,, 10. Part of the stolon. × 5.
,, 11. The dorsal edge, to show muscles. × 10.
,, 12. Part of the branchial sac. × 40.
,, 13. The tentacles, dorsal tubercle, &c. × 40.
,, 14. The alimentary canal. × 10.
,, 15. *Ecteinascidia solida*, n. sp. Nat. size.
,, 16. Part of the branchial sac. × 40.
,, 17. The dorsal languets. × 40.
,, 18. *Ecteinascidia thurstoni*, HRDN. Nat. size.
,, 19. The largest ascidiozooid a little enlarged.
,, 20. The tentacles. × 40.
,, 21. The dorsal languets. × 40.
,, 22. The gonads. × 20.
Fig. 23. Branchial and atrial siphons, from interior. × 10.
Figs. 24, 25 and 26. *Rhodosoma ceylonicum*, n. sp. Nat. size.
Fig. 27. Anterior end opened to show siphons.
,, 28. The short lateral muscle bundles.
,, 29. The branchial siphon and tentacles. × 40.
,, 30. The branchial sac. × 40.
,, 31. Connecting ducts and imperfect bars. × 300.
,, 32. The dorsal languets. × 40.
,, 33. The dorsal tubercle. × 40.
,, 34. *Ascidia polytrema*, n. sp. Nat. size.
,, 35. Dorsal tubercle and neighbouring parts. × 40.
,, 36. Transverse muscles of the mantle. × 40.
,, 37. The branchial sac. × 40.
,, 38. *Ascidia mikrenterica*, SLUIT., the alimentary canal. × 3.
,, 39. Part of the branchial sac. × 40.

PLATE II.

Fig. 1. *Ascidia donnani*, n. sp. Nat. size.
Figs. 2 and 3. With the test removed, from right and left sides.
Fig. 4. The dorsal tubercle. × 40.
,, 5. The branchial sac. × 40.
,, 6. The dorsal lamina. × 40.
,, 7. The muscles of the mantle. × 40.
,, 8. Another specimen (Chilaw), with test removed.
,, 9. Dorsal tubercle of the same. × 40.
Figs. 10 to 12. *Ascidia depressiuscula*, HELLER, three specimens. Nat. size.
Fig. 13. With test removed.
,, 14. Another specimen.
,, 15. Branchial sac of same. × 40.
Figs. 16 and 17. Other parts of branchial sac. × 40.
Fig. 18. Dorsal lamina. × 40.
Figs. 19 and 20. Two dorsal tubercles. × 40.
Fig. 21. Tentacles. × 40.
Fig. 22. Alimentary canal, enlarged.
Figs. 23 and 24. *Microcosmus manaarensis*, n. sp.
Fig. 25. Same opened, to show hairs of test.
,, 26. Showing the test free inside sandy coat.
,, 27. Atrial aperture, from inside.
,, 28. Test removed.
,, 29. Part of a tentacle.
,, 30. Dorsal tubercle and peripharyngeal bands. × 40.
,, 31. Part of branchial sac. × 40.
,, 32. *Microcosmus longitubis*, n. sp. Nat. size.
,, 33. Same, test removed.
,, 34. Part of branchial sac. × 40.
,, 35. Dorsal tubercle. × 40.
,, 36. *Rhabdocynthia pallida*, HELLER.
,, 37. Test removed.
,, 38. Dorsal tubercle.
,, 39. Atrial aperture, alimentary canal and left gonads, from inside, slightly enlarged.

PLATE III.

Figs. 1, 2, 3 and 4. *Rhabdocynthia ceylonica*, n. sp. Nat. size.
Figs. 5 and 6. Test removed from right and left sides.
Fig. 7. The branchial sac. × 40.
Figs. 8 and 9. Dorsal tubercles. × 40.
Fig. 10. Tentacles, face view. × 40.
,, 11. Tentacle, in profile. × 40.
Figs. 12, 13, 14 and 15. The echinated calcareous spicules.
Fig. 16. The dorsal tubercle and tentacles. × 40.
,, 17. The dorsal languets. × 40.
,, 18. White pigment flecks down the inside of each branchial lobe (alive).
,, 19. The same white pigmentation after preservation in formol.
,, 20. *Cynthia transversaria*, var. *manaarensis*, n. Nat. size.
Fig. 21. With test removed.
,, 22. Dorsal tubercle, languets, tentacles. × 40.
,, 23. The stigmata. × 40.
,, 24. Part of the branchial sac. × 40.
,, 25. *Cynthia crinitistellata*, Hrdn. Nat. size.
,, 26. One of the stellate hairs, enlarged.
,, 27. A group of hairs, enlarged.
Figs. 28 and 29. An echinated spine. × 40.
Figs. 30 and 31. *Cynthia aripuensis*, n. sp. Nat. size.
Fig. 32. Part of branchial sac. × 40.
,, 33. Lining of branchial siphon. × 40.
,, 34. Three of the spines enlarged. × 200.
,, 35. Test removed. Nat. size.
,, 36. The tentacles. × 40.
,, 37. The dorsal languets. × 40.
Figs. 38 and 39. Two dorsal tubercles. × 40.

PLATE IV.

Fig. 1. *Cynthia lanka*, n. sp., left side. Nat. size.
,, 2. Another, with a *Rhodosoma ceylonicum* (*Rh.*) adhering.
,, 3. Another, with a more marked ridge containing the apertures.
,, 4. Anterior end showing the ridge with the apertures.
,, 5. Test removed, left side.
,, 6. Test removed, right side.
Figs. 7, 8, and 9. The dorsal tubercle of different individuals. × 40.
Fig. 10. Three of the dorsal languets. × 40.
,, 11. Part of the branchial sac. × 40.
,, 12. The spicules lining the branchial siphon (× 40), two shown enlarged with the bases *in situ*.
,, 13. Part of the gonad, enlarged.
,, 14. *Molgula taprobane*, n. sp. Nat. size.
Figs. 15 and 16. The same from right and left sides, test removed. Nat. size.
Fig. 17. Part of the branchial sac and dorsal lamina. × 40.
,, 18. Specimen from Trincomalee. Nat. size.
,, 19. The dorsal tubercle. × 40.
Fig. 20. *Ctenicella ridgewayi*, n. sp., test removed, left side. × $2\frac{1}{2}$.
,, 21. The dorsal tubercle. × 40.
,, 22. The branchial siphon. × 10.
,, 23. Part of the branchial sac. × 40.
,, 24. *Styela areolata*, Heller. Nat. size.
,, 25. An unusually sandy specimen.
,, 26. A large specimen with a group of seven young pearl oysters adhering.
Figs. 27 to 30. The right and left sides of two specimens, with test removed, to show gonads.
,, 31 and 32. The dorsal tubercle of two specimens. × 40.
Fig. 33. Part of the branchial sac. × 40.
,, 34. *Polycarpa mutilans*, n. sp. Nat. size.
,, 35. The same cut open to show the interior with no branchial sac.
,, 36. Section of the body-wall to show the abundant endocarps. × 15.
,, 37. Dorsal lamina and branchial sac. × 40.
,, 38. Another specimen of this species.
,, 39. One of the large simple tentacles. × 40.
Figs. 40 to 42. Outlines of endocarps, enlarged.
,, 43 and 44. Dorsal tubercle of two specimens. × 40.

PLATE V.

Fig. 1. *Polycarpa aurata*, Q. and G. Nat. size.
,, 2. Section of the test, to show the pigment in the vessels. × 40.
,, 3. Part of the mantle, to show the pigment masses. × 40.
,, 4. Dorsal edge of prebranchial zone. × 5.
,, 5. Surface of dorsal tubercle. × 40.
,, 6. Part of branchial sac. × 40.
Figs. 7 to 9. *Styela lapidosa*, n. sp. Nat. size.
Fig. 10. Test removed, from left side. Nat. size.
,, 11. Another specimen with finer sand.
,, 12. The same, test removed, left side.
,, 13. Another specimen, right side.
,, 14. Part of branchial sac. × 40.
,, 15. The tentacles and dorsal tubercle. × 40.
,, 16. *Polycarpa sluiteri*, n. sp. Nat. size.
,, 17. Dorsal tubercle and tentacles. × 40.
Figs. 18 and 19. Dorsal tubercle of two other specimens. × 40.
Fig. 20. Gonads of left side. Nat. size.
,, 21. Part of branchial sac. × 40.
,, 22. Group of four *Polycarpa chalmersi*, n. sp., on a piece of coral. Nat. size.
,, 23. *Polycarpa chalmersi* adhering to *Ramulina* tubes. Nat. size.
,, 24. Part of branchial sac. × 40.
,, 25. Dorsal tubercle. × 40.
,, 26. One of the polycarps. × 40.
,, 27. *Styela ascidioides*, n. sp. Nat. size.
,, 28. Branchial aperture of same, enlarged.
,, 29. Test removed, left side. Nat. size.
,, 30. Section of test. × 40.
,, 31. Tentacles and dorsal tubercle. × 40.
,, 32. Part of branchial sac. × 40.
,, 33. *Polycarpa alentura*, n. sp. Nat. size.
,, 34. Alimentary canal. Nat. size.
,, 35. Two anterior dorsal languets. × 40.
,, 36. Dorsal tubercle, &c. × 40.
,, 37. Part of the branchial sac. × 40.

PLATE VI.

Fig. 1. *Polycarpa colletti*, n. sp. Nat. size.
,, 2. Tentacles and dorsal tubercle.
,, 3. Diagram of a branchial fold.
,, 4. Part of the branchial sac.
,, 5. *Polycarpa palkensis*, n. sp., removed from the sandy test. Nat. size.
,, 6. Dorsal tubercle. × 40.
,, 7. Part of branchial sac. × 40.
,, 8. One of the gonads. × 25.
,, 9. *Polycarpa willisi*, n. sp. A little enlarged.
,, 10. With test removed. Nat. size.
,, 11. Branchial aperture. Enlarged.
,, 12. Part of branchial sac. × 40.
,, 13. Tentacles and dorsal tubercle.
,, 14. Inside of body-wall, opened ventrally, to show the gonads. *p.*, polycarp; *end.*, endocarp.
,, 15. A pigmented endocarp.
,, 16. *Polycarpa manaarensis*, n. sp. Nat. size.
,, 17. Dissection to show wide prebranchial zone between tentacles and dorsal tubercle. Enlarged.
Figs. 18 and 19. Dorsal tubercle of two individuals.
Fig. 20. Tentacles.
,, 21. Dorsal lamina. × 40.
,, 22. Part of branchial sac. × 40.
,, 23. *Polycarpa* sp. (?). Nat. size.
,, 24. *Styela pigmentata*, n. sp. Nat. size.
,, 25. Part of branchial sac. × 40.
,, 26. Dorsal tubercle. × 40.
,, 27. *Polycarpa twynami*, n. sp. Nat. size.
,, 28. Rectum, showing fringed anus. Enlarged.
,, 29. Dorsal tubercle.
,, 30. Another specimen, right side. Nat. size.
,, 31. Part of branchial sac. × 40.
,, 32. Tentacles and dorsal tubercle. × 20.
,, 33. *Polycarpa decipiens*, n. sp. Nat. size.
,, 34. Diagram of one side of branchial sac, to show the folds (I.–IV.) and the number of stigmata in the meshes (14, 10, 8, &c.).
,, 35. Part of branchial sac. × 40.
,, 36. Dorsal tubercle. × 40.
,, 37. Alimentary canal and gonads. Enlarged.
,, 38. A polycarp, showing the ducts (*o.d.* and *r.d.*). × 30.
,, 39. Some of the spermatic cæca from a polycarp. × 40.

PLATE VII.

Fig. 1. *Gynandrocarpa imthurni*, n. sp., group of ascidiozooids.
,, 2. Part of the colony in profile.
,, 3. Part of a section to show the flattening of the ascidiozooids.
,, 4. Part of the branchial sac. × 40.
,, 5. The tentacles and dorsal tubercle. × 40.
,, 6. The dorsal tubercle more magnified.
,, 7. The atrial tentacles. × 40.
,, 8. The hermaphrodite gonad. × 40.
,, 9. The same in profile. × 40.
,, 10. *Diandrocarpa brakenhielmi*, var. *ceylonica*. Nat. size.
,, 11. A few ascidiozooids showing pigmentation and marginal vessels. × 20.
,, 12. Ascidiozooid removed from the test. × 25.
,, 13. The alimentary canal. × 40.
Fig. 14. The tentacles. × 40.
,, 15. The gonads of one side. × 40.
,, 16. Part of the branchial sac. × 40.
,, 17. Marginal vessels from the test. × 40.
,, 18. Branchial and atrial apertures, showing tentacles, &c. × 40.
,, 19. *Botryllus ater*, n. sp. Nat. size.
,, 20. The terminal knobs of vessels in the test. × 40.
,, 21. *Botrylloides cheralense*, n. sp. Nat. size.
,, 22. Four adjacent ascidiozooids. × 40.
,, 23. Part of branchial sac magnified more highly.
,, 24. Some of the branchial tentacles. × 100.
,, 25. *Botrylloides nigrum*, n. sp. Nat. size.
,, 26. *Colella arenosa*, n. sp., head. × 3.
Figs. 27 to 29. Parts of a colony. Nat. size.

PLATE VIII.

Fig. 1. *Hypurgon skeati*, Sollas, showing arrangement of ascidiozooids, enlarged.
,, 2. *Psammaplidium aurantiacum*, n. sp., section of test.
,, 3. Section of colony (nat. size), to show ascidiozooids.
,, 4. Surface to show ascidiozooids and sand, enlarged.
Figs. 5 and 6. Ascidiozooids. × 40.
Fig. 7. *Psammaplidium* sp. B, showing the red grains around the ascidiozooids.
,, 8. *Psammaplidium ceylonicum*, n. sp., an ascidiozooid. × 40.
,, 9. The terminal process of the post-abdomen, enlarged.
,, 10. Section of the colony. Nat. size.
,, 11. Surface of colony, a little enlarged.
,, 12. *Leptoclinum ramosum*, n. sp., section of colony, enlarged.
,, 13. Deeper section to show network of spicules. × 20.
,, 14. Single spicule. × 40.
,, 15. *Leptoclinum ceylonicum*, n. sp., section across a bar of the colony. Nat. size.
,, 16. Optical section of a passage through the colony. Nat. size.
Fig. 17. Surface showing common cloaca, &c., a little enlarged.
,, 18. Two spicules. × 40.
,, 19. *Leptoclinum margaritifera*, n. sp., horizontal section. × 40.
,, 20. Part of test. × 300.
,, 21. Testis and spiral vas deferens. × 300.
,, 22. One side of branchial sac. × 300.
,, 23. *Cystodytes ceylonensis*, n. sp., three colonies. Nat. size.
,, 24. Overlapping calcareous discs. × 40.
,, 25. One disc showing structure. × 50.
,, 26. *Didemnum areolatum*, n. sp. Nat. size.
,, 27. Section of colony, some spicules enlarged.
,, 28. *Leptoclinum viride*, n. sp. Nat. size.
,, 29. Section through upper surface. × 300.
,, 30. A deeper section. × 300.
,, 31. A spherical pigment cell, enlarged.
,, 32. One of the spicules. × 1000.
,, 33. Surface view of the colony. × 40.
,, 34. *Diplosoma viride*, n. sp., a large and a small colony. Nat. size.
,, 35. Section of test. × 300.
,, 36. Small colony, mounted whole. × 40.
,, 37. Thorax of ascidiozooid. × 300.

Fig. 38. One side of branchial sac. × 300.
,, 39. Ascidiozooid and advanced bud. × 300.
,, 40. Small colony, mounted whole. × 40.
,, 41. Echinated *Leptoclinum* sp. (?). Nat. size.
Fig. 42. Three spiny papillæ from the surface, in profile, enlarged.
,, 43. *Amaroucium* sp. (?). Nat. size
,, 44. *Diplosoma* sp. (?), two colonies. Nat. size.

PLATE IX.

(All the figures on this plate are reproduced from photographs.)

Fig. 1. *Leptoclinum ceylonicum*, n. sp., Palk Bay.
,, 2. Another colony from off Chilaw.
,, 3. *Leptoclinum ramosum*, n. sp.
,, 4. *Leptoclinum ceylonicum*, var. *planum*, below, with *Gynandrocarpa imthurni*, n. sp., above.
,, 5. *Hypurgon skeati*, Sollas.
Fig. 6. *Diplosoma viride*, n. sp.
,, 7. *Leptoclinum margaritiferæ*, n. sp.
,, 8. *Psammaplidium aurantiacum*, n. sp.
,, 9. *Psammaplidium ceylonicum*, n. sp.
,, 10. *Psammaplidium* sp. A.
,, 11. *Psammaplidium* sp. B.

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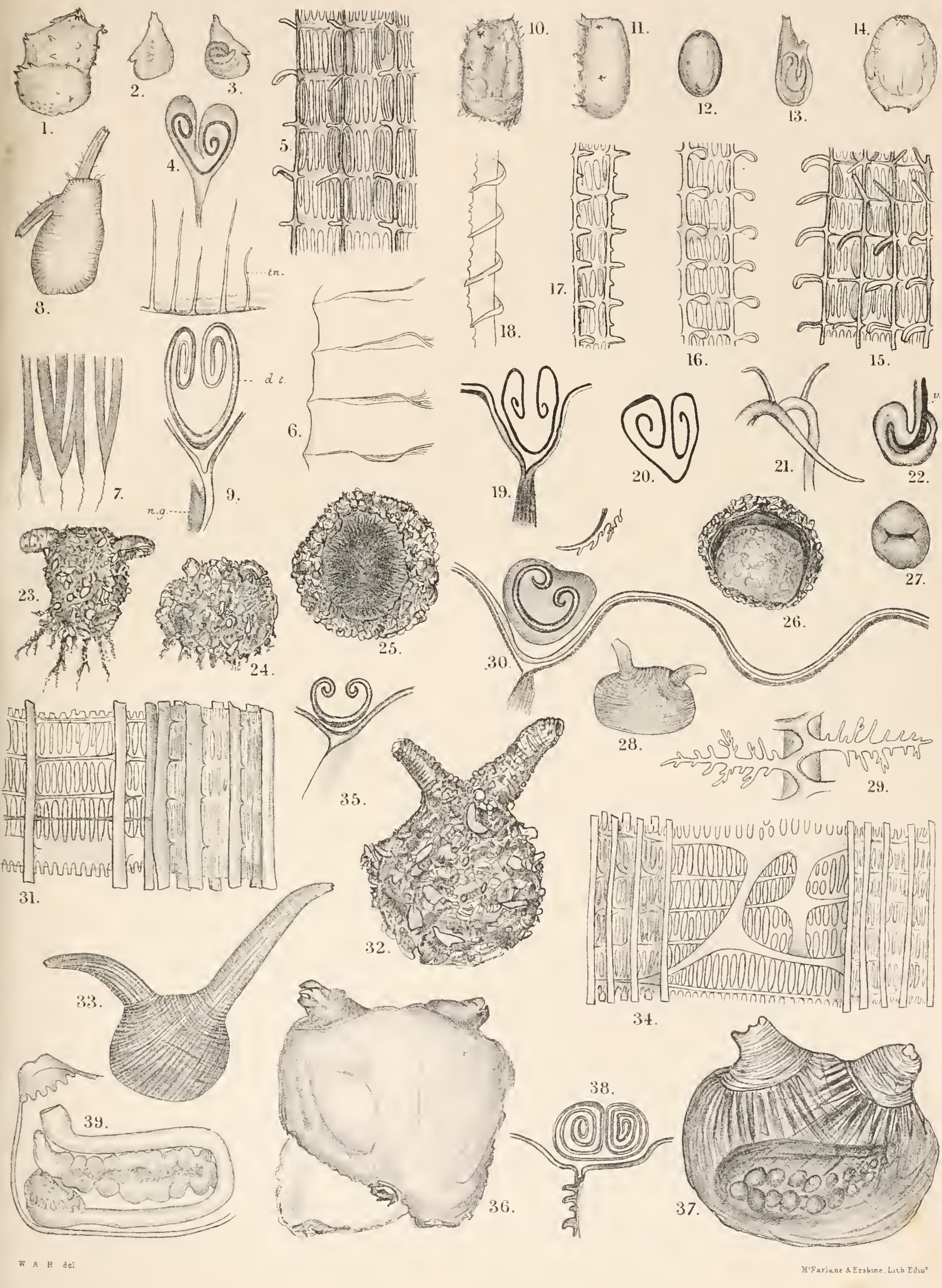

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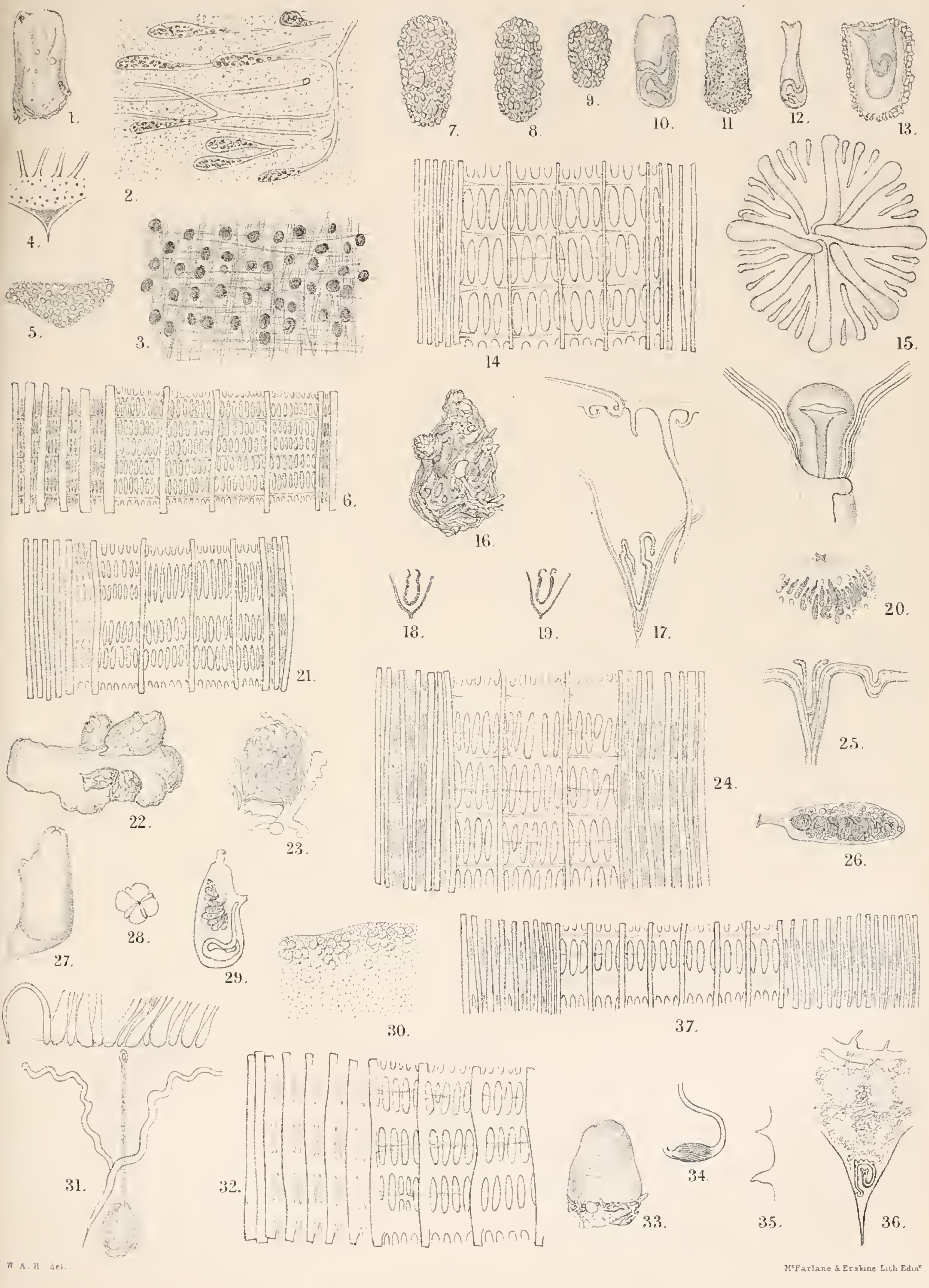

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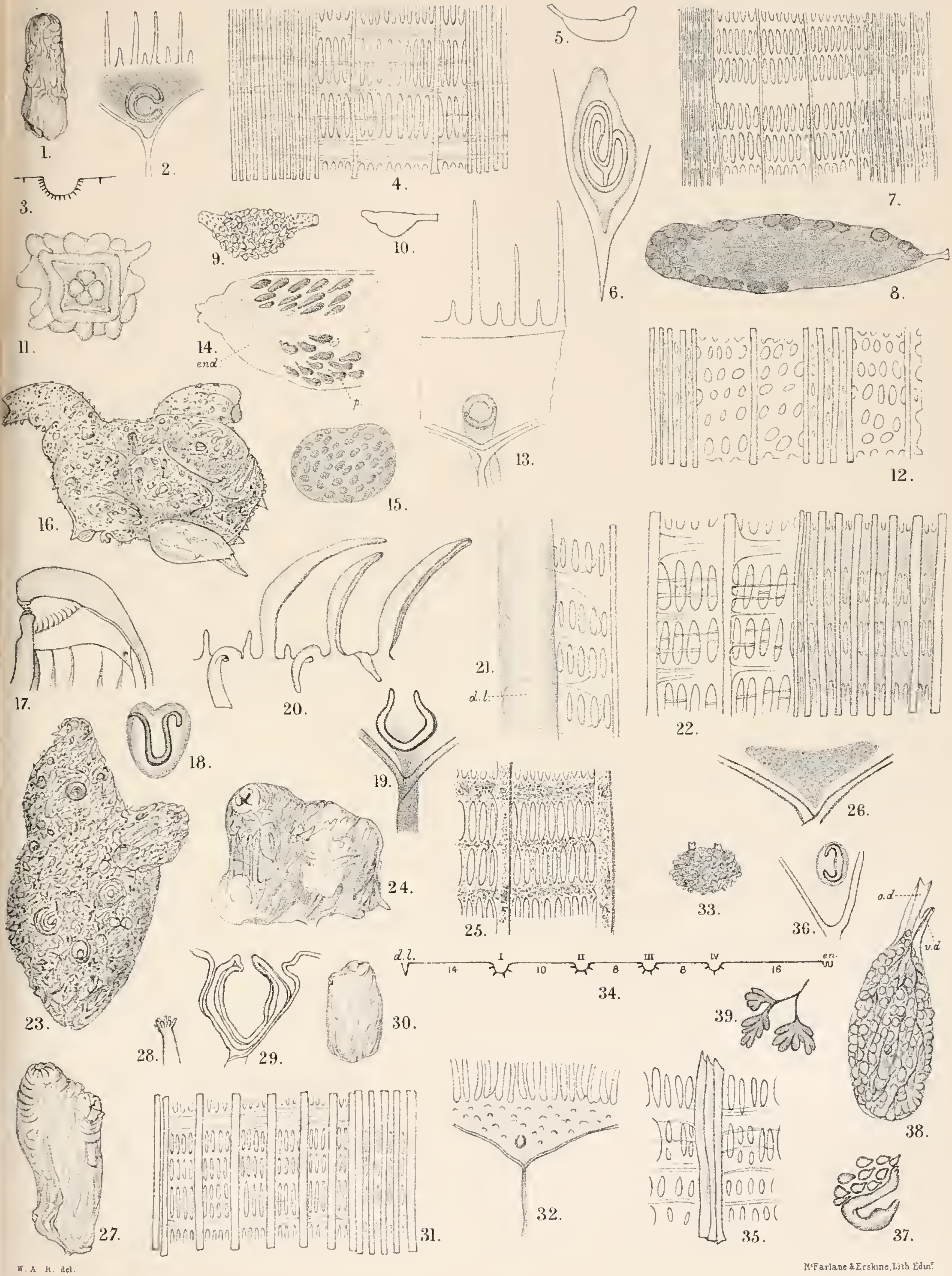

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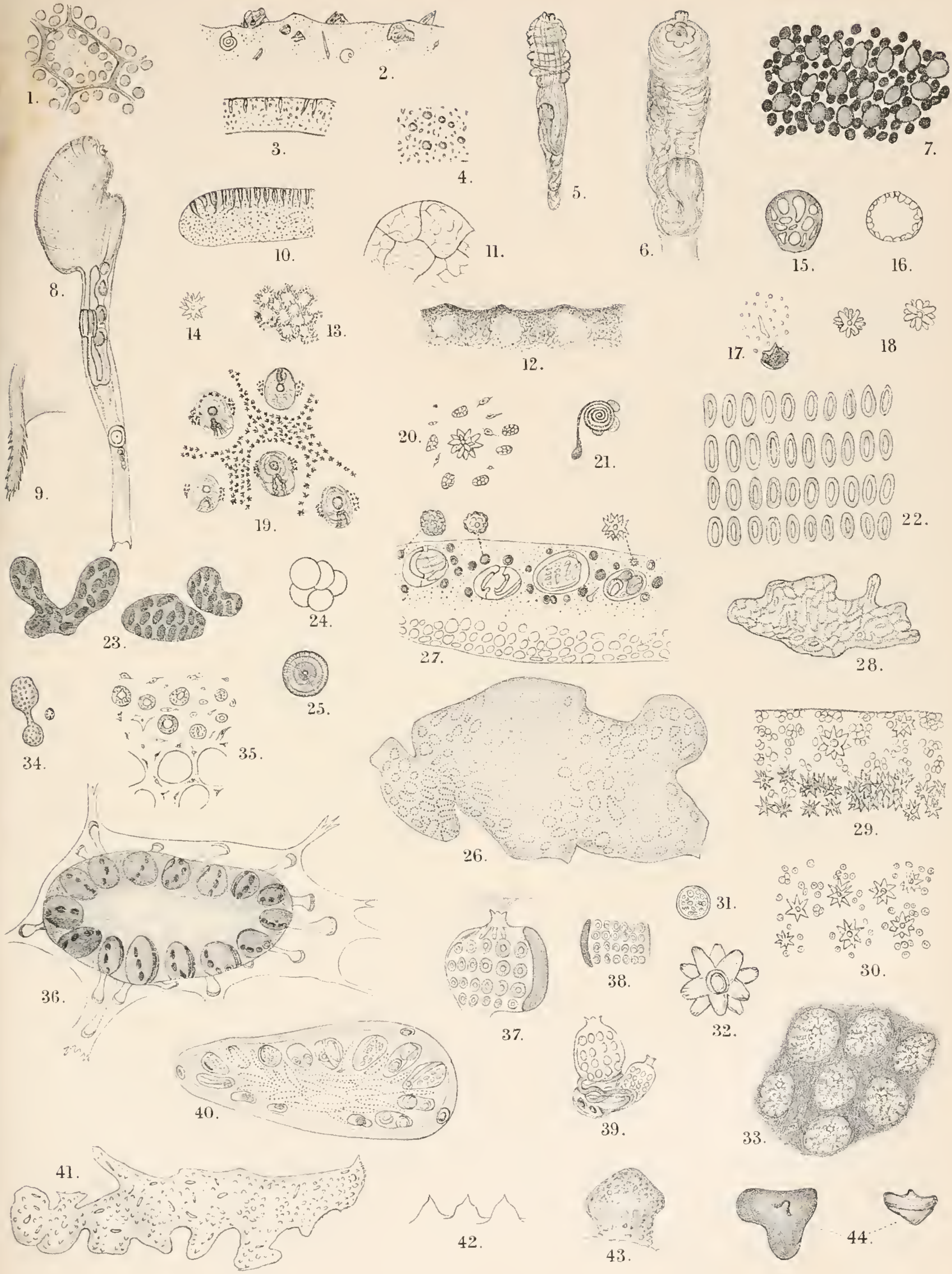

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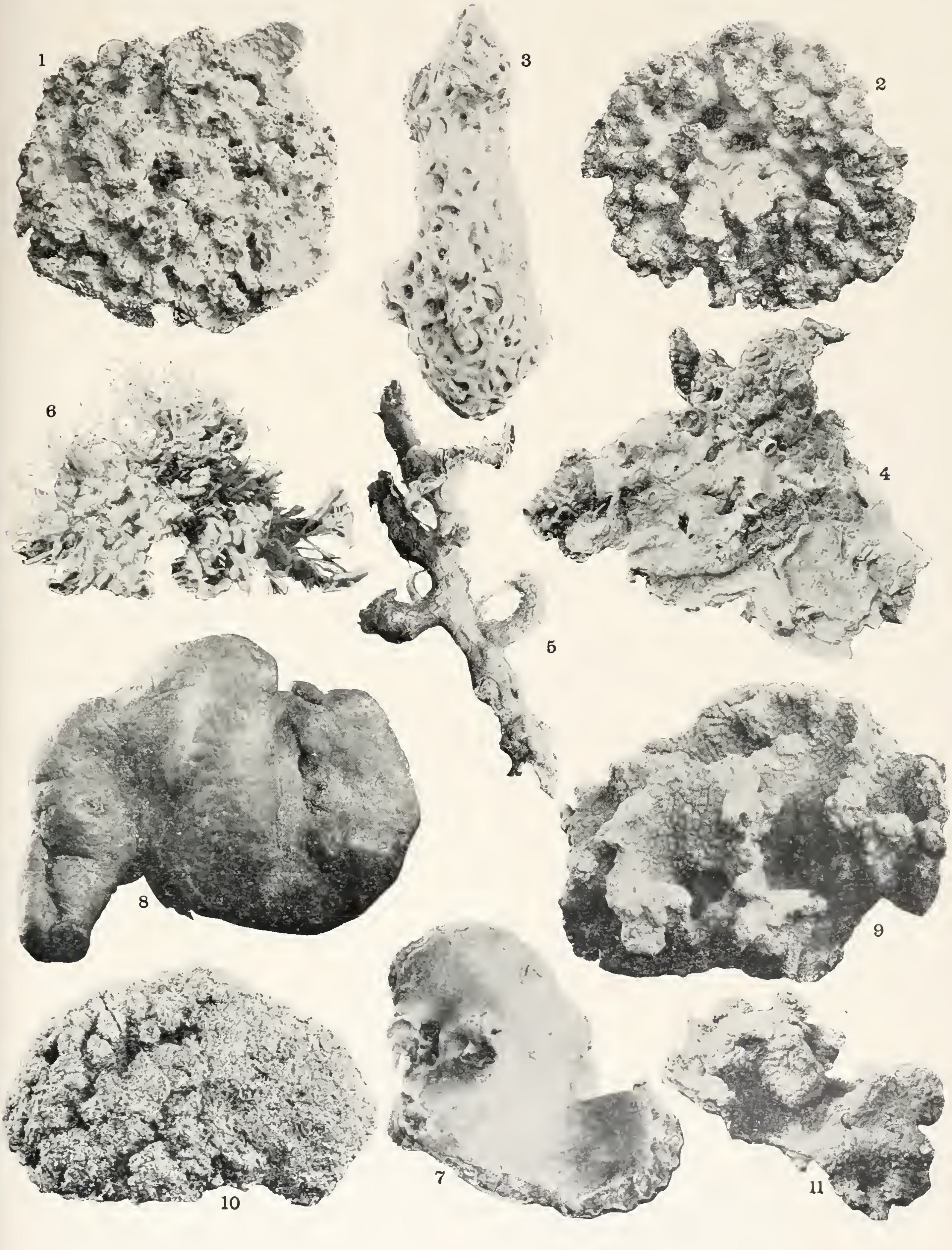
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REPORT

ON THE

BRACHYURA

COLLECTED BY

PROFESSOR HERDMAN, AT CEYLON, IN 1902.

BY

R. DOUGLAS LAURIE, B.A. (OXON.),
DEMONSTRATOR OF ZOOLOGY IN THE UNIVERSITY OF LIVERPOOL.

[WITH TWO PLATES AND TEXT-FIGURES.]

INTRODUCTORY.

THE collection comprises 208 species, of which 15 are described as new, and of the latter, three are referred to new genera. Of the three new genera, two are Xanthids (one a large crab which I place near to *Zozymus*—the other a curious little animal with a *Kraussia*-like carapace and a most remarkable hand); the third belongs to the interesting group of Rhizopinæ.

The new species belong to the following genera :—*Dromia* (1), *Tlos* (1), *Achæus* (1), *Halimus* (2), *Cryptopodia* (1), *Doclea* (1), *Actæa* (1), *Euxanthus* (1), *Neptunus* (2), *Pinnoteres* (1), and the three new genera, *Demania* (1), *Mertonia* (1), and *Calmania* (1).

Descriptions of some little known forms have been revised in the light of examples contained in the collection. Among these may be mentioned *Philyra adamsi*, about which there has been misunderstanding. Many of the species and even some of the genera in the collection are new to the India fauna, and the majority had not previously been recorded from the coast of Ceylon.

A matter of considerable interest—both general and systematic—is well illustrated among the Oxyrhyncha collected. I refer to the phenomenon which GEOFFREY SMITH has recently* investigated very thoroughly in *Inachus scorpio* (= *dorsettensis*)

* 'Mittheil. Zool. Stn. Neapel,' xvii., p. 312; see also H. A. HAGEN, "N. Amer. Astacidæ," in 'Ill. Cat. Mus. Comp. Zool. Harvard,' 1870; W. FAXON (1) 'Amer. Journ. Sci.,' xxviii., p. 42, and (2) 'Revision of the Astacidæ,' part i., 1885.

and termed by him facultative dimorphism. SMITH has shown that in males of this species there are at least two breeding periods ("low" and "high" respectively) characterised by well-developed secondary sexual characters, and that between these is intercalated a non-breeding phase ("middle") in which the secondary sexual characters are not evident. What SMITH has concluded for *Inachus scorpio* from statistical evidence, WALTER FAXON had found in a *Cambarus* reared by him in an aquarium. HAGEN had previously described two types of male *Cambarus* and considered them to be characteristic of different individuals, but FAXON, observing aquarium-kept animals, found that the two conditions detailed by HAGEN were alternate phases in the life-history of the same individual correlated with the breeding and non-breeding period respectively; the breeding male with pronounced secondary sexual characters changed by a moult to the non-breeding form with much resemblance to the young. A very beautiful example of facultative dimorphism is added to the above by a series of *Menæthius monoceros* in the present collection. There is evidence that the same kind of thing is of wide occurrence amongst the Oxyrhynchs.

The importance of the matter for systematic zoology may be emphasised by reference to *Simocarcinus simplex* and *S. pyramidatus*, one of the very few differentia between which is the cheliped character—a difference for which the theory of facultative dimorphism offers an alternative explanation.

In working over a large collection of crabs, attention is constantly attracted by the considerable amount of growth and of correlation-change which commonly occurs after sexual maturity.

Certain contractions have been found convenient in the following pages:—

C. = carapace. Ch. = cheliped, W.L. = walking leg, F. = finger (dactylus of cheliped), H. = hand, l. = length, b. = breadth, Bord. = border, R. = rostrum. Unless otherwise stated, Ch.l. is measured along the morphological ventral border, and is the sum of (1) a straight line uniting the base of the appendage to the distal end of the merus, and (2) a straight line uniting the last-named point to the tip of the fixed finger. In Oxystomata it is measured along middle of posterior surface.

Measurements are in all cases given in millimetres.

Colonel ALCOCK'S "Materials for a Carcinological Fauna of India" is indispensable to the student of Indian crabs. I have followed him where possible in matters of nomenclature and classification.

Space forbids synonymies; I have in most cases made reference to one good account only of the species in question. A useful list of the literature will be found in KLUNZINGER (1906). The following contractions have been employed:—

A.1.–A.6. = ALCOCK, "Materials, &c.," No. 1–No. 6, in 'Journ. Asiat. Soc. Bengal, 1895 to 1900.

A.Cat. = ALCOCK, 'Cat. Ind. Decap. Crust. Ind. Mus.' Part I. Brachyura. Fasc. 1. Dromiacea, 1901.

A.Invest. = ALCOCK, "Crust." in 'Illusts. Zool. "Investigator."'

B.I.–B.XIII. = BORRADAILE'S Crust. in GARDINER'S 'Fauna, &c., Mald. and Lacc.'

N. = NOBILI, 'Bull. Sci. France et Belg.,' vol. xl., 1906.

K. = KLUNZINGER, 'Spitz- u. Spitzmund-Krabben d. Rothen Meeres.' Stuttgart, 1906.

C. = CALMAN, 'Trans. Linn. Soc.,' ser. 2, Zool., vol. viii., 1900.

H. = HENDERSON, 'Trans. Linn. Soc.,' ser. 2, Zool., vol. v., 1893.

R. = RATHBUN, 'Bull. U.S. Fish. Comm. for 1903.'

My thanks are due in the first instance to Professor HERDMAN for entrusting to my examination this large and interesting collection. Much of the work has been done at the British Museum, and my indebtedness is great to Dr. CALMAN for the courtesy and kindness with which he has facilitated my work among the collections under his charge. Finally, I thank Miss WOODWARD for her excellent drawings and Mr. H. HERRING and Mr. W. J. DAKIN for valuable photographic aid.

DESCRIPTION OF THE SPECIES.

DROMIACEA.

Dromia intermedia, n. sp.

Locality :—Deep water off Galle, one specimen.

Description :—Female, non-ovigerous, but quite possibly mature.

C.l. 23·50, including frontal teeth.

$C.b._1$ 23·50, straight line uniting tips of last pair of antero-lateral teeth.

$C.b._2$ 23·00, straight line uniting tips of teeth immediately behind cervical groove.

W.L.2.l. 27·25, sum of dorsal borders of (1) meropodite and (2) the three distal segments together (9·0 + 18·25). W.L.3.l. 14·00 (5·5 + 8·5). W.L.4.l. 16·00 (7·0 + 9·0).

It agrees with ALCOCK'S description (A.5, p. 138; A.Cat., pl. ii., fig. 5) of *Dromia cranioides*, DE MAN, except in two very obvious particulars, in which it resembles *Dromia rumphi*, FABRICIUS, 1798 (A.5, p. 137; A.Cat., pl. ii., fig. 4), namely :—(1) Walking leg 4 but little longer than walking leg 3; (2) the sternal grooves of the female terminate on very prominent tubercles set well apart on anterior portion of segment of walking leg 1. A third difference from *D. cranioides* is that the spine on the distal end of the "posterior" border of the propodite of walking leg 4 is slender and only about ½ length of "anterior" spine (*i.e.*, the one opposing the dactylopodite). There are on the same segment various smaller spinules.

Dromidia unidentata (RÜPPELL), 1830—A.5, p. 139; A.Cat., pl. ii., fig. 6.

Locality :—West of Periya Paar, Station LXIII., 17 to 24 fathoms, one specimen.

Description : Ovigerous female, C.l. = 11·00; C.b. ÷ C.l. = 1·00.

The present example is about half the size of those recorded by ALCOCK, DE MAN, and HENDERSON.

Dromidiopsis australiensis (HASWELL), 1882—A.Cat., p. 76.

Localities:—Chilaw Paar, Station LXIX., 8 to 11 fathoms, one specimen (*a*); Jokkenpiddi Paar, 10 fathoms, one specimen (*b*).

Description:—(*a*) Ovigerous female, agrees fairly well with ALCOCK'S description, C.l. = 16·50; C.b. ÷ C.l. = 0·97. (*b*) This is BORRADAILE'S var. *bidens*, 1903 (B.IX., p. 576), C.l. = 9·25; C.b. ÷ C.l. = 0·97.

Cryptodromia canaliculata, STIMPS., 1858—A.5, p. 142; A.Cat., pl. ii., fig. 8.

Locality:—Galle, one specimen.

Description:—Young male, C.l. = 4·25; C.b. ÷ C.l. = 1·12.

In this young specimen the second of the two teeth on the antero-lateral border of the carapace is represented by a bluntly angular lobe.

Cryptodromia bullifera, ALCOCK, 1899—A.5, p. 143; A.Cat., pl. ii., fig. 9.

Locality:—Cheval Paar, one specimen.

Description:—Young female, C.l. = 5·50; C.b. ÷ C.l. = 1·00.

Cryptodromia demani, ALCOCK, 1899—A.5, p. 144.

Locality:—Station LIV., 10 fathoms, south of Manaar Island, two specimens.

Description:—

	(*a*) ovigerous female.	(*b*) ad. non-ov. female.
C.l.	5·40	5·50
C.b. ÷ C.l.	1·02	1·04

I believe the present forms may be placed under the above species, which has not been hitherto figured. The characteristic dorsal hepatic tooth is weak in (*a*), a little more strongly developed in (*b*). The dactylopodite of walking leg 4 is apposed by a quite fairly developed spine of the propodite; the propodite of walking leg 3 bears a similar but smaller spine. A transverse groove runs behind the front and orbits. The sternal grooves end apart, without very obvious tubercles, just behind the segment bearing the chelipeds.

Cryptodromia hilgendorfi, DE MAN, 1887—A.5, p. 145; A.Cat., pl. iii., fig. 11.

Locality:—Mutwal Island, Station LXVI., 30 fathoms, one specimen.

Description:—Ovigerous female, C.l. = 14·50; C.b. ÷ C.l. = 1·03.

There is a slight indication of a second tooth on the antero-lateral border of the carapace, behind the tooth at the antero-lateral angle.

Remarks:—BORRADAILE has in his suggestive revision of the Dromiacea ('Ann. Nat. Hist.,' ser. 7, vol. xi., p. 299, 1903) included the present species in a new genus, *Dromides*. NOBILI (p. 93) criticises this genus

Cryptodromia gilesi, Alcock, 1899—A.5, p. 146; A.Cat., pl. iii., fig. 13.

Locality :—Gulf of Manaar, one specimen.

Description :—Male, C.l. = 8·25; C.b. ÷ C.l. = 1·03 (C.b. = straight line uniting tips of last antero-lateral teeth).

Conchœcetes artificiosus (Fabr.), 1798—A.5, p. 151; A.Cat., pl. iii., fig. 16.

Locality :—Trincomalee, three young specimens (*a*, *b*, *c*).

Description :—

	(*a*)	(*b*)	(*c*)
C.l.	7·00	7·00	7·25
C.b. ÷ Cl.	—	0·96	0·96

Remarks :—New to the Ceylon fauna.

Conchœcetes andamanicus, Alcock, 1899—A.5, p. 152; A.Cat., pl. iii., fig. 17.

Locality :—Pearl banks, Gulf of Manaar, one specimen.

Description :—Male, probably adult. C.l. (frontal teeth included) = 10·25; C.b. ÷ C.l. = 1·00.

It confirms Alcock's doubtfully created species, showing, however, certain additional points of difference from *C. artificiosus* not mentioned by Alcock :—(1) Prominent fringe of longish hairs on antero-lateral borders of carapace; (2) well-marked median longitudinal groove on anterior part of the carapace running back from notch between the frontal teeth (its length ÷ C.l. = 0·19); (3) the well-developed pair of frontal teeth more strongly deflexed; (4) sub-hepatic regions by no means so swollen, in correlation with which one finds that the antero-lateral border of the buccal cavern slopes downwards from the straight anterior border of the same region at a more obtuse angle (80° approximately instead of 65° approximately); (5) a kind of elongated tubercle occupies middle region of a not very well-marked ridge connecting lateral termination of cervical groove and antero-lateral angle of buccal cavern.

The specimen is protected by a *Pectunculus* valve.

OXYSTOMATA.

Calappa lophos (Herbst), 1785—A.2, p. 144.

Localities :—Trincomalee, one specimen (*a*); Gulf of Manaar, one specimen (*b*).

Description :—

	(*a*) young female.	(*b*) young male.
C.l.	8·50	14·75
C.b. ÷ C.l.	1·26	1·36

Remarks.—Recorded as fossil by de Man from post-tertiary of Celebes ('Samm. Geol. Mus. Leiden,' (1), vii., p. 277, 1904).

Calappa philargius (Linnæus), 1764—A.2, p. 145.

Localities :—Gulf of Manaar, one specimen (*a*); Station I., off Negombo, one specimen (*b*); pearl banks, Gulf of Manaar, four specimens (*c*, *d*, *e*, *f*); Galle, one specimen (*g*).

Description:—

	(*a*).	(*b*).	(*c*).	(*d*) young ♀.	(*e*) young ♀.	(*f*) young ♀.	(*g*) adult ♂.
C.l. . .	12·75	12·75	13·50	21·00	22·00	30·00	37·50
C.b. ÷ C.l.	1·25	1·25	1·27	1·32	—	1·38	1·44

Specimens (*f*) young female and (*g*) male answer well to ALCOCK's description. In the young forms (*a* to *e*) the endostome septum is deeply concave anteriorly, and this is to be noted since the strongly *convex* character of this region is one of three characters by which ALCOCK distinguishes adults of *C. philargius* from those of *C. lophos*. A parasitic *Sacculina* is attached to the abdomen of (*g*) male ventrally, in the joint between somite VI. and the telson—it has not produced any obvious change of the secondary sexual characters.

Calappa gallus (HERBST), 1803—A.2, p. 146.

Localities:—Series (A)—Mutwal Island, Station LXVI., one specimen; south of Modragam, one specimen; Chilaw Paar, Station LXIX., one specimen; coral reefs, Gulf of Manaar, two specimens; pearl banks, Gulf of Manaar, six specimens. Series (B)—Coral reefs, Gulf of Manaar, two specimens; pearl banks, Gulf of Manaar, eleven specimens; Gulf of Manaar and Palk Straits, three specimens; off Kaltura, Station XLIII., 22 fathoms, one specimen; west of Periya Paar, Station LXIII., 17 to 24 fathoms, two specimens; ten miles north of Cheval, one specimen.

The specimens fall into two morphological series (A and B) which differ in certain particulars. Members of both series are often obtained from the same locality. The figures of HERBST and of KLUNZINGER (K., pl. ii., fig. 14) answer in general to (A), and that of BRITTO CAPELLO to (B). The differences are as follows:—

Rostrum.—(A) Anterior border blunt and not at all or but little emarginate; indications of two blunt longitudinal ridges on ventral surface.

(B) General appearance more elegant; anterior border sharper and more definitely emarginate; longitudinal ridges of under surface are fairly sharp compared with (A).

Teeth of hepatic region of antero-lateral border small in (A); obsolescent in (B).

Tubercles of Carapace.—(A) The rounded tubercles tend to be rough and fairly prominent; the beaded squamiform tubercles occupy a good deal of posterior half of carapace, and they form lines which curve forward on the clypeiform expansions.

(B) Rounded tubercles smoother and more flattened; the beaded tubercles occupy a more limited region, and form lines which are approximately straight on the clypeiform expansions.

Hepatic region strongly concave in (A); slightly concave in (B).

Hair.—(A) Posterior border of carapace and of clypeiform expansions sparsely fringed; three characteristic tufts placed transversely on abdominal tergum II.; a fringe on under surface of meropodite of walking leg 4. In (B) hair is absent in these regions.

Post-cardiac transverse groove slight but distinct in (A); absent in (B).

Third tooth of clypeiform expansion.—(A) Less acute than in (B); points obliquely forward; has anterior border ÷ posterior border = 0·54 (average of eight specimens).

(B) Acute; points laterally; has anterior border ÷ posterior border = 0·90 (average of nine specimens).

I do not suggest that the above distinctions would be absolute or their correlation perfect for a large series. This would be to separate series (B) as a species apart from *C. gallus*.

In the British Museum is a specimen (adult female, Philippine Islands, 43.6) which combines the (A)-type of front with the (B)-type of the other characters. Another unites the deep hepatic concavity of (A)-type with a more (B)-like front. BRITTO CAPELLO'S figure suggests that his specimen had rougher, more prominent tubercles than (B).

One of present series (B) has a line of hairs posteriorly as in (A) and traces of the same occur in three others.

It is best, I think, for the present, to consider the two groups as varieties which one may call :—(A), var. *gallus*, and (B), var. *capellonis*.

The best distinction between them is perhaps the shape and direction of the 3rd tooth of the clypeiform expansion, which may be expressed by index anterior border ÷ posterior border. Examination of this character in our series shows :—

Var. *gallus* . .	Mean = 0·54;	range of variation = 0·50–0·55 (8 examples).
,, *capellonis* .	,, = 0·90;	,, ,, = 0·83–1·07 (9 ,,).

Growth changes do not affect correlation much in these specimens :—

In var. *gallus*, 10 specimens considered (6 young + 4 adult).

	6 females (1 adult).	4 males (3 adult).
C.l.	9·00–31·50	10·25–33·25
$C.b._1 \div C.l.$.	0·95– 0·98	0·95– 0·96
$C.b._2 \div C.l.$.	0·81– 0·86	0·78– 0·85 (Index decreases with size).

Var. *capellonis*, 19 specimens (1 adult male).

	10 females.	9 males.
C.l.	7·25–25·75	8–33·25
$C.b._1 \div C.l.$ ..	0·98– 1·00	0·95–1
$C.b._2 \div C.l.$.	0·79– 0·88	0·74–0·90 (Index decreases with size).

($C.b._1$ = in front of clypeiform expansions. $C.b._2$ = across 3rd tooth of clypeiform expansions.)

Mursia bicristimana, ALCOCK & AND., 1894—A.2, p. 150; A.Invest., pl. xxiv., fig. 5.

Locality :—Gulf of Manaar and Palk Straits, two specimens.

Description :—	C.l.	C.b. (in front of lateral spines) ÷ C.l.	Lateral spine l. (anterior border) ÷ C.l.
(*a*) Ovigerous ♀ . .	17·00	1·21	0·22
(*b*) Adult ♂. . . .	17·25	1·22	0·22

The specimens are about one-third the size given by ALCOCK.

The hairs on outer parts of pterygostomian and subhepatic regions are not long, nor do they form a dense felt.

Length ÷ breadth of meropods of walking legs 1, 2 and 3 is only about 0·33 (*e.g.*, meropod W.L. 3 of (*a*) ovigerous female = 9·5 ÷ 3·15).

Cryptosoma granulosum (DE HAAN), 1835—A.2, p. 152.

Locality :—Aripu coral reefs, Gulf of Manaar, two specimens.

Description :—(*a*) Adult male, C.l. = 19·50 ; C.b. ÷ C.l. = 0·92.

The granular transverse ridge at distal end of arm bears 2 spines only.

Remarks :—Genus is new to Ceylon fauna.

Matuta lunaris (FORSK.), 1775—A.2, p. 160 (under *M. victor*, FABR.).

Locality :—Galle, one specimen.

Description :—Young female, C.l. = 38·50 ; C.b. (without spines) ÷ C.l. = 1·05 ; lat. spine l. (ant. border) ÷ C.l. = 0·28 ; frontal b. ÷ orbital b. = 1·10.

Remarks :—The *M. lunaris* of ALCOCK (A.2, p. 161) = *M. planipes*, FABR., 1798 (STEBBING, in 'Mar. Inv. S. Africa,' iv., 1905).

Matuta miersi, HENDERSON, 1886–87—A.2, p. 163.

Locality :—Gulf of Manaar and Palk Straits, two specimens (*a*, *b*) ; pearl banks, Gulf of Manaar, three specimens (*c*, *d*, *e*).

Description :—	(*a*) Young ♀.	(*b*) ad. ♀.	(*c*) ad. ♂.	(*d*) ad. ♂.	(*e*) ad. ♂.
C.l.	17·50	20·75	23·75	26·50	27·50
C.b. (without spines) ÷ C.l. .	1·03	1·04	1·03	1·01	1·02
Front. b. ÷ orbit. b. . . .	1·15	1·12	1·11	1·10	1·10
Lat. spine l. ÷ C.l.	0·17	0·14	0·11	0·17	0·12

Cryptocnemus holdsworthi, MIERS ('Trans. Linn. Soc.,' 1877, p. 241).

Locality :—Gulf of Manaar, two specimens.

Description :—	(*a*) ovigerous female.	(*b*) female.
C.l.	7·25	7·25
C.b. ÷ C.l.	1·38	1·48

The carapace outline of this species is subject to some variation. MIERS' specimen and the present ones are the only three recorded so far as I am aware. In treating this genus as non-Indian, ALCOCK overlooks MIERS' locality—Ceylon.

Tlos havelocki, n. sp.—Plate I., fig. 2, and text-fig. 1.

Locality:—Coral reefs, Gulf of Manaar, one specimen.

Description:—An adult male. C.l. = 5·75; C.b. ÷ C.l. = 1·48; Ch.l. ÷ C.l. = 1·09; arm l. (inner border of under surface) ÷ C.l. = 0·48; propus l. (lower border) ÷ C.l. = 0·61; F.l. ÷ H.l. (upper border) = 1·14. (Ch.l. is the sum of arm l. and propus l.)

Carapace broadly pentagonal—the front produced and strongly upturned and having its anterior border flattened and a little emarginate in the middle line—the antero-lateral and postero-lateral angles of the pentagon are rounded—the anterior sides concave—the lateral sides converge posteriorly a little—the posterior side is divided by two deep notches into three lobes which all project backwards to approximately the same level. The branchio-hepatic regions are concave and the post-cardiac region deeply so. There are two marginal sutures on each side—one supra-orbital, the other about midway between this and the antero-lateral angle. The margins of the carapace are a little thickened, a little upturned and bordered by enlarged granules as far forward as the more posterior pair of sutures—between the latter and the supra-orbital pair they are rounded and less distinctly granulated—the frontal margin is merely roughened. The true posterior border of the carapace and the surface rising vertically above it are covered with enlarged granules. A longitudinal ridge runs backward from the front to the cardiac region. The latter is prominent and is crowned by a transverse ridge uniting the anterior ends of a pair of very strongly developed, broad topped, granular ridges which run obliquely backward to be continued into the lateral margins at the postero-lateral angles of the pentagon. The rest of the dorsum of the carapace is smooth to the naked eye (seen under lens to be uniformly covered by obsolescent granules).

Fig. 1. *Tlos havelocki*, n. sp.

The pterygostomian region is prominent, its summit is forwardly directed and surmounted by a couple of granules. The exposed portions of the thoracic sterna are covered with enlarged granules—the rest of the under surface of the body, *i.e.*, pterygostomian, sub-hepatic, and sub-branchial regions, is smooth to the naked eye (obsolescently granular under lens).

The orbits are largely ventral. The eyes are visible in part only, in a dorsal view.

Antennules not remarkable.

External maxillipedes with exposed surface roughened; not remarkable in form.

Chelipeds—Ch.l. ÷ C.l. = 1·48. The distal end of the arm is seen beyond the carapace (arm l. ÷ C.l. = 0·47). The arm is trigonal, with enlarged granules along its borders—its surfaces are smooth to naked eye (obsolescently granular under lens). Wrist rounded—its borders and much of its surfaces granular. Hand with outer and inner borders granular—under surface rounded and bearing granules which tend to run in rows, of which one curves downwards and outwards from the inner side of the proximal end to be continued along the whole under surface of the propus to the tip of the fixed finger. The horizontal upper surface of the hand meets the oblique antero-inner surface at an angle, forming an oblique ridge crowned by a characteristic row of enlarged granules (six in this specimen). The inner surfaces of hand and fingers form together a hollowed area. The fixed finger is not constricted off from the hand and is much more massive than the dactylus. The upper surface of the dactylus is fluted—three granular ridges defining two grooves. There are two longitudinal rows of granules on the fixed finger. The distal two-thirds of the apposed border of either finger is flattened to form a facet which is bordered by a few very sharp denticles; the tip of each finger forms a curved tooth—that of the dactylus closes to the inner side of that of the fixed finger.

The meropodites of walking legs 2, 3, and 4 are concealed by the carapace; the succeeding three segments are short, so that by folding the legs at the joint between meropodite and carpopodite they may be entirely concealed from dorsal view. [The first walking legs are lost.] The basipodites and the three distal segments are granular. The meropodites are trigonal, their borders tend to be granular, and their surfaces smooth (obsolescently granular under lens)—the proximal one-third of the under surface occupies a different plane from the distal two-thirds, and is granular.

Remarks.—The new species is closely related to *Tlos petræus*, A. Milne-Edwards, 1874 (A.2, p. 176), but may be easily distinguished from it by the unbroken character of the oblique post-cardiac ridges. It differs further from *T. petræus* in the following particulars:—(1) The front is more produced and more upturned; (2) the true posterior border of the carapace does not project further backward than the lobe on either side of it; (3) there are two marginal sutures only on each side; (4) there is a stronger contrast between the obsolescent granules of the general surface and the enlarged granules of special areas; (5) in the prominence of the pterygostomian region; (6) the orbits are less ventral; (7) sculpture of cheliped—in particular the presence of the oblique row of granules on the upper surface of the hand; (8) the facets on the apposed borders of the fingers.

Tlos latus, Borradaile, 1903 (B.VI., p. 437), differs in—(1) Absence of marginal sutures of carapace; (2) absence of oblique line of granules on upper surface of hand; and (3) isolation of lateral cardiac hump.

Lithadia sculpta, Haswell, var. **aglypha,** nov.—Text-fig. 2.

Locality:—Coral reefs, Gulf of Manaar, one specimen.

Description:—An immature individual. C.l. = 8·5.

It bears a considerable general resemblance to the already described form of *L. sculpta*, but differs from it in the following particulars:—(1) The carapace is broader in proportion to its length—C.b. ÷ C.l. = 1·26; (2) the two grooves which border the cardiac region laterally are not continued forward until they meet, but terminate apart in the middle region of the carapace; (3) there is a mere trace of an intestino-cardiac groove, quite different from the well-cut channels which the other grooves present; (4) the granules on the arm and hand are not so sharp; (5) the strip of carapace cut off laterally by the skirting channel is narrower; between the slightly broadened portions which lie above the bases of cheliped and walking legs 1 and 3 it forms a quite thin ledge; (6) the sub-hepatic region is swollen, much as in *L. sculptus*, and the small tubercle at point of union of antero-lateral and postero-lateral borders is not double.

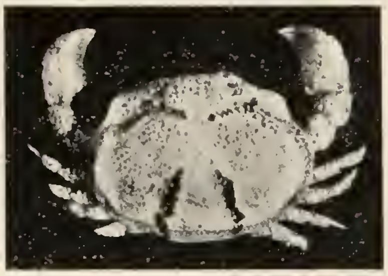


Fig. 2. *Lithadia sculpta*, var. *aglypha*, nov.

Remarks.—The single specimen is immature, but its order of size is much the same as that of a British Museum specimen of *L. sculpta*. This species is of rare occurrence. Only two other examples are known to me, from two localities (Arafura Sea and Eastern seas), but closely resembling each other, suggesting that variability may be low. The present form may turn out to be the representative of a new species.

Nursia plicata (Herbst), 1804, nec auctorum—A.2, p. 180.

Localities:—Adam's Bridge, one specimen (*a*); pearl banks, Gulf of Manaar, one specimen (*b*).

Description:—	C.l.	C.b. ÷ C.l.	Ch.l. ÷ C.l.	F.l. ÷ H.l.
(*a*) adult ♂ . .	10·25	1·27	1·63	0·55
(*b*) adult ♂ . .	12·50	1·20	1·72	0·54

In carapace length the posterior point is the indentation between the two posterior lobes. Carapace breadth measured by straight line uniting indentations between 2nd and 3rd lateral teeth of either side. In both specimens the greatest carapace breadth is given by a straight line uniting tips of 2nd lateral teeth of carapace—not 3rd pair as in *N. hardwicki*.

Nursia hardwicki, Leach, 1817—A.2, p. 181.

Localities:—Pearl banks, Gulf of Manaar, one specimen (*a*); Aripu Reef, one specimen (*b*); coral reefs, Gulf of Manaar, one specimen (*c*).

Description (C.l. and C.b. measured as in *N. plicata*):—

	C.l.	C.b. ÷ C.l.	Ch.l. ÷ C.l.	F.l. ÷ H.l.
(*a*) ♀ . . .	10·25	1·15	1·51	0·61
(*b*) ♀ . . .	10·75	1·12	1·49	0·56
(*c*) ♀ . . .	11·00	1·11	1·50	0·55

The most anterior of the four antero-lateral teeth, just behind the marginal nodule, is quite conspicuous in (*a*), but only slightly developed in the other examples. In all the greatest carapace breadth is given by a straight line uniting tips of 3rd lateral teeth—not 2nd as in *N. plicata*.

Ebalia diadumena, Alcock, 1896—A.2, p. 187.

Locality :—Galle, two specimens.

Description :—	(*a*) young ♀.	(*b*) ♂.		(*a*)	(*b*)
C.l.	4·75	6·50	Ch.l. ÷ C.l. . . .	1·37	2·00
C.b. ÷ C.l. . .	1·05	0·96	F.l. ÷ H.l. . . .	0·83	0·77
			H.b. ÷ H.l. . . .	0·83	0·69

This is first record of male. It differs from Alcock's female (Palk Straits) in a few respects :—(1) the gastro-cardiac groove is hardly to be distinguished ; (2) the cheliped granulation is not so extensive ; (3) about middle of striation on upper surface of immobile finger is a prominent elongated laterally compressed granule ; (4) abdominal tergum VI. is armed with strong terminal tooth.

Ebalia maldivensis, Borradaile, 1903—B.VI., p. 437, fig. 116.

Locality :—Gulf of Manaar, one specimen.

Description :—Ovigerous female, C.l. = 5·75 ; C.b. ÷ C.l. = 1·13 ; Ch.l. ÷ C.l. = 1·22 ; F.l. ÷ H.l. = 0·75. The mounds on dorsum of carapace are all distinct.

Myra* fugax (Fabricius), 1798—A.2, p. 202.

Locality :—Aripu coral reefs, Gulf of Manaar, three specimens (*b*, *d*, *f*) ; Trincomalee, five specimens (*a*, *c*, *e*, *g*, *h*) ; Galle, three specimens (*j*, *k*, *l*) ; off Manaar Island, one specimen (*i*).

Description :—*a–h*, young.

						ovig.	ad.				ad.	ad.
	b (♀).	*d* (♀).	*e* (♀).	*f* (♀).	*h* (♀).	*i* (♀).	*l* (♀).	*a* (♂).	*c* (♂).	*g* (♂).	*j* (♂).	*k* (♂).
C.l. . . : .	9·00	12·00	12·25	12·50	17·00	18·00	26·00	8·75	11·50	16·50	19·00	24·75
C.b. ÷ C.l. .	0·86	0·87	0·88	0·86	0·88	0·86	0·85	0·89	0·87	0·82	0·87	0·86
Ch.l. ÷ C.l. .	1·69	1·79	1·79	1·76	1·98	1·86	2·12	1·83	1·85	1·95	2·33	2·38
H.l. ÷ C.l. .	0·39	0·44	0·47	0·42	0·51	0·47	0·58	0·46	0·46	0·51	0·62	0·65
F.l. ÷ H.l. .	0·93	0·86	0·78	0·90	0·80	0·79	0·77	0·81	0·86	0·68	0·74	0·72
H.l. ÷ H.b. .	2·29	2·50	2·87	2·50	2·69	2·67	3·16	2·09	2·62	2·83	3·36	3·56

Ch.l. is the sum of lengths of its segments, measured along median line of posterior surface. C.l. is without the spine.

Among the adult specimens considered to be mature, the sexual dimorphism in regard to cheliped length is by no means so marked as Alcock records.

In one specimen the more acutely bidentate and upturned front is somewhat reminiscent of *M. brevimana*. It has also a well-marked median longitudinal carina.

Specimen (*i*), an ovigerous female, is an interesting form which deserves note. It tends to combine characters of *M. fugax*, *M. affinis*, and *M. brevimana*. In slender build of chelipeds and in index F.l. ÷ H.l. it resembles *M. fugax*. In indices Ch.l. ÷ C.l. and H.l. ÷ C.l. it more nearly approaches *M. affinis* and *M. brevimana*. The prominence

* Miss Rathbun unites this genus with the older genus *Persephona*, Leach, 1817.

of the upper hepatic tooth is much as in *M. affinis* ; the *Leucosia*-like front approximates to that of *M. brevimana*. The specimen is conveniently put under *M. fugax*.

Specimens (*d*) and (*f*) are young forms which may perhaps be put with specimen (*i*).

Myra affinis, Bell, 1855—A.2, p. 205.

Locality :—Pearl banks, Gulf of Manaar, five specimens (*g*, *h*, *i*, *j*, *l*) ; Coral reefs, Gulf of Manaar, four specimens (*a*, *d*, *f*, *k*) ; Trincomalee, three specimens (*b*, *c*, *e*) ; off Mutwal Island, one specimen (*m*).

Description :—*a–k*, young.

	a (♀).	c (♀).	d (♀).	f (♀).	h (♀).	i (♀).	j (♀).	k (♀).	ad. l (♀).	b (♂).	g (♂).	ad. m (♂).
C.l. (spine).	7·50	11·25	11·50	12·50	16·50	18·75	19·00	19·75	24·00	8·00	15·75	26·75
C.b. ÷ C.l.	0·93	0·89	0·87	0·88	0·84	0·88	0·86	0·86	0·87	0·91	0·86	0·86
Ch.l. ÷ C.l.	1·50	1·49	1·46	1·50	1·51	1·56	1·53	1·57	1·74	1·53	1·54	1·91
H.l. ÷ C.l.	0·40	0·40	0·39	0·40	0·42	0·44	0·42	0·43	0·49	0·41	0·45	0·56
F.l. ÷ H.l.	0·67	0·67	0·67	0·65	0·61	0·61	0·62	0·65	0·60	0·69	0·57	0·53
H.l. ÷ H.b.	2·00	2·00	2·00	2·00	2·15	2·20	2·13	2·12	2·14	2·17	2·34	2·50

Among the small specimens there is a marked tendency to possession of an additional postero-lateral pair of small spicules, a carina, an intestinal granule, and several enlarged antero-lateral denticles. A similar tendency is found in the small young placed under *M. fugax* and *M. brevimana*.

Specimen (*m*) male is large. Its C.l. is only 0·25 millim. less than that of Nobili's (p. 95) large specimen, but it by no means approaches the latter in cheliped length or in length of hand. It is indeed but little different from Alcock's smaller specimens in Ch.l. ÷ C.l., though in H.l. ÷ C.l. it exceeds his measurement (Nobili's specimen, C.l. = 27·0 ; Ch.l. = 70·0 ; H.l. = 20·0). Measurements taken as in *M. fugax*.

Myra brevimana, Alcock, 1896—A.2, p. 206 ; A. Invest., pl. xxix., fig. 8.

Locality :—Aripu coral reefs, Gulf of Manaar, four specimens (*a*, *b*, *d*, *h*) ; off Kaltura, four specimens (*c*, *e*, *f*, *i*) ; off Galle, two specimens (*g*, *j*). ; Trincomalee, one specimen.

Description :—

	yg. b (♀).	yg. c (♀).	ad. d (♀).	ov. h (♀)	ad. i (♀).	ad. j (♀).	ad. e (♂).	ad. f (♂).	ad. g (♂).
C.l. (spine).	9·50	12·50	16·50	18·50	22·00	25·50	16·00	17·75	18·25
C.b. ÷ C.l.	0·87	0·84	0·83	0·84	0·84	0·84	0·84	0·85	0·79
Ch.l. ÷ C.l.	1·53	1·60	1·67	1·70	1·76	1·75	1·91	1·85	1·88
H.l. ÷ C.l.	0·34	0·38	0·41	0·43	0·43	0·43	0·48	0·45	0·47
F.l. ÷ H.l.	1·00	0·95	0·89	0·84	0·89	0·86	0·77	0·84	0·82
H.l. ÷ H.b.	1·86	1·90	2·08	2·14	1·89	1·84	2·21	2·00	2·00

Variability in size of adults is high. The two smallest specimens have a few scattered hairs. There is a suggestion in the adults of sexual dimorphism as regards cheliped length. Specimen (*h*), though female, has well-marked spinule on penultimate abdominal tergum. Measurements taken as in *M. fugax*.

Myra darnleyensis, HASWELL, 1879—A.2, p. 207.

Localities:—Aripu coral reefs, Gulf of Manaar, four specimens; pearl banks, three specimens.

Description:—There are in all considerable traces of the "cruciform constellation" of five enlarged granules on centre of dorsum of carapace. This is evidently not confined to females and young males, as it occurs in an adult male from "pearl banks."

Leucosia obtusifrons, DE HAAN, 1841—A.2, p. 216.

Localities:—Aripu coral reefs, Gulf of Manaar, two specimens (*a*, *b*); off Kaltura, one specimen (*c*).

Description:—

	(*a*) young ♂.	(*b*) young ♂.	(*c*) adult ♂.
C.l.	12·75	17·25	25·00
C.b. ÷ C.l.	0·90	0·91	0·92
Ch.l. ÷ C.l.	1·10	1·20	1·45

In addition to the two pairs of white gastric spots characteristic of the species there is a third pair of quite small but otherwise similar ones, anteriorly. In specimen (*a*) young male all these spots are faintly ringed and a pair of postero-lateral orange spots is present also.

Leucosia longifrons, DE HAAN, 1841—A.2, p. 217.

Localities:—Trincomalee, two specimens (*a*, *b*); pearl banks, Gulf of Manaar, one specimen (*d*); Station I., off Negombo, one specimen (*c*); Aripu Reef, one specimen (*e*).

Description:—

	(*a*) young ♀.	(*b*) young ♂.	(*c*) young ♀.	(*d*) young ♀.	(*e*) adult ♀.
C.l.	17·00	17·50	17·50	17·75	26·00
C.b. ÷ C.l. . .	0·85	0·87	0·87	0·87	0·87

Specimen (*c*) young female comes under var. *pulcherrima*. Specimens (*a*) young female and (*b*) young male show some tendency to vary in the direction of the same variety (anterior half of carapace is slightly punctate); propodites of walking legs carinate dorsally and tend to be so ventrally also, each of the posterior two of the six spots of gastric shoe is surrounded by red rings.

On the other hand, var. *neocalidonica* characters are hinted at in specimens (*d*) young female and (*e*) adult female, where in addition to dorsal and ventral carination of propodites of the walking legs, common to *pulcherrima* and *neocalidonica*, the chelæ and walking legs have a tendency to the granulation of the latter variety. Thus in (*e*) adult female the wrist has trace of the three granules, the meropodite of walking leg 1 has traces of one dorsal and one ventral row, and that of walking leg 2 has traces of one dorsal row of granules.

Leucosia urania, Herbst, 1801—A.2, p. 220.

Locality :—Galle, one specimen.

Description :—Young male, C.l. = 17·00 ; C.b. ÷ C.l. = 0·84.

A series in the British Museum links this specimen with the adult form, from which latter it differs in certain points :—(1) fingers are crenulate in their distal half only ; (2) hand is cristate on both borders (the lower crest is crenulate—the crenulations swollen into granules).

Leucosia cumingi, Bell, 1855—A.2, p. 226.

Locality :—Coral reefs, Gulf of Manaar, one specimen.

Description :—Ovigerous female, C.l. = 13·00 ; C.b. ÷ C.l. = 1·04.

Leucosia hæmatosticta, Adams and White, 1848—A.2, p. 229.

Localities :—Aripu coral reefs, Gulf of Manaar, two specimens (*b*, *c*) ; Station I., off Negombo, one specimen (*a*).

Description :—	(*a*) male.	(*b*) ovigerous female.	(*c*) ovigerous female.
C.l.	9·75	13·00	13·50
C.b. ÷ C.l. . . .	0·97	1·00	0·98

Leucosia pubescens, Miers, 1877—A.2, p. 233.

Localities :—Galle, one specimen ; pearl banks, Gulf of Manaar, three specimens ; coral reefs, Gulf of Manaar, three specimens.

In an ovigerous female, C.l. = 18·50.

Philyra platychira, de Haan, 1841—A.2, p. 242.

Localities :—Coral reefs, Gulf of Manaar, four specimens ; pearl banks, three specimens ; Trincomalee, three specimens ; Welligam Bay, two specimens ; Galle, six specimens.

An indication of sexual dimorphism is given by index Ch.l. ÷ C.l. :—

For 12 adult males this has mean value 2·32 and range of variation 2·23–2·40.

,, 4 ,, females ,, ,, . 1·83 ,, ,, 1·67–1·92.

To this difference all the segments of the cheliped contribute. Thus

	Arm l. ÷ C.l.	Wrist l. ÷ C.l.	H.l. ÷ C.l.	F.l. ÷ C.l.
Male means	0·93	0·32	0·60	0·47
Female means . . .	0·71	0·26	0·51	0·35

All have some very fine granulation on the posterior and lateral regions of the dorsum of the carapace—the specimens from "Coral reefs, Gulf of Manaar," have in addition some rather large scattered granules on the lateral region.

Some of the specimens fall under Klunzinger's var. *bidentata* (K., p. 72).

Philyra adamsi, Bell, 1855 ('Trans. Linn. Soc.,' xxi., p. 301)—Plate I., fig. 1.

Localities:—Pearl banks, Gulf of Manaar, two specimens; coral reefs, Gulf of Manaar, four specimens, including (*b*); Galle, seven specimens, including (*a*).

Description:—	C.l.	C.b. ÷ C.l.	Ch.l. ÷ C.l.	H.l. (upper border) ÷ C.l.	Fixed finger (inner border) ÷ C.l.
(*a*) Ovigerous ♀	8·00	1·02	1·60	0·34	0·26
(*b*) Adult ♂	9·00	1·03	2·10	0·46	0·36
(*c*) Bell's "type," ♂ .	9·00	1·03	2·25	0·50	0·39

I have compared the specimens with Bell's "type" preserved in the British Museum, and they agree well with it.

Bell's figure gives an inadequate, and in some respects erroneous, idea of his specimen. Henderson amends Bell's description (H., p. 400), but omits reference to any hepatic facet, the presumed *absence* of which has been lately emphasised by Nobili (N., p. 104). In re-figuring Bell's specimen I emphasise (1) general shape of front; (2) presence of a small median frontal tooth, at lower level than rest of front; (3) details of hepatic facet; (4) two tubercles on hand at base of fixed finger; (5) proportions of buccal cavern; (6) exognath of external maxilliped.

Remarks:—Alcock omits this species from his key, observing that it appears to him to be rather a *Pseudophilyra*. It is indeed intermediate in many ways, *e.g.*: (1) production of front; (2) general proportions of buccal cavern; (3) shape of exognath of external maxilliped. But in all these particulars it bears considerable resemblance to *Philyra platychira* and to *Ph. granigera*, Nobili, 1906 (N., p. 102, pl. vi., fig. 30), both of which it further resembles in the presence of the hepatic facet and of the longitudinal grooves of the carapace (the latter more as *P. granigera* than *P. platychira*). It must be placed in the same genus with these, and all three fall under section I.2.1 of Alcock's key of *Philyra*.

Ph. adamsi is at once distinguished from *Ph. platychira* by the entire sub-orbital border of the endostome and by the characters of hand and fingers.

It is more closely allied to *Philyra granigera* than Nobili imagined, since it has in reality a hepatic facet. It differs from *Ph. granigera* in possessing:—(1) line of granules on upper border of inner surface of hand and wrist; (2) the distinct granule on upper surface of hand proximal to base of fixed finger (tendency for a second, less distinct granule just distal to the distinct one); (3) the small median frontal tooth.

Philyra globosa (Fabr.), 1787—A.2, p. 243.

Localities:—Trincomalee, one specimen (immature male); Galle, two specimens (adult females).

Pseudophilyra tridentata, Miers, 1879—A.2, p. 250.

Locality:—Pearl banks, Gulf of Manaar, five specimens (*a*, *b*, *c*, *d*, *e*).

Description :—	(*a*) ad. ♂.	(*b*) ad. ♂.	(*c*) ad. non.-ov. ♀.	(*d*) ovig. ♀.	(*e*) ovig. ♀.
C.l.	5·00	5·00	5·50	6·00	6·00
C.b. ÷ C.l. . .	0·85	0·90	0·86	0·92	0·92
Ch.l. ÷ C.l. . .	1·60	1·60	1·45	1·50	1·46
F.l. ÷ H.l. . .	0·50	0·50	0·50	0·54	0·54
H.b. ÷ H.l. . .	0·50	0·50	0·50	0·54	0·54

The specimens are much smaller than those in the Indian Museum from Persian Gulf. The length of the first pair of walking legs exceeds that of the arms by about the last segment only, as NOBILI (N., p. 105) found in his Persian Gulf specimens. H.b. ÷ H.l. is of same order as ratio recorded by NOBILI and by CALMAN (C., p. 28).

There is no distinct abdominal tooth in the males; just a slight convexity in (*a*) adult male, more marked in (*b*) adult male.

Pseudophilyra melita, DE MAN, 1888—A.2, p. 253.

Localities :—Trincomalee, six specimens; coral reefs. Gulf of Manaar, one specimen; pearl banks, Gulf of Manaar, four specimens.

Description :—*d*, *g*, *h*, *j*, adult.

	(*a*) yg. ♂.	(*c*) yg. ♂.	(*d*) ♂.	(*g*) ♂.	(*h*) ♂.	(*j*) ♂.	(*b*) yg. ♀.	(*e*) ♀ ov.	(*f*) ♀ ov.	(*i*) ♀ ov.	(*k*) ♀ ov.
C.l. . . .	8·75	9·50	9·75	10·25	12·75	13·50	9·00	9·75	10·00	13·00	13·75
C.b. ÷ C.l.	0·88	0·89	0·87	0·88	0·90	0·89	0·92	0·90	0·92	0·88	0·91
Ch.l. ÷ C.l.	1·94	1·89	1·87	1·93	1·90	1·96	1·67	1·67	1·67	1·71	1·71
H.b. ÷ H.l.	0·50	0·48	0·50	0·50	0·52	0·50	0·53	0·53	0·50	0·52	0·50

Sex difference negligible in C.b. and in H.b., but marked in Ch.l.

C.b. ÷ C.l. . . .	Mean adult	♂ = 0·89;	range of variation		♂ = 0·87–0·91
	,,	♀ = 0·90;	,,	,,	♀ = 0·88–0·92
H.b. ÷ H.l. . .	,,	♂ = 0·50;	,,	,,	♂ = 0·50–0·52
	,,	♀ = 0·51;	,,	,,	♀ = 0·50–0·53
Ch.l. ÷ C.l. . .	,,	♂ = 1·91;	,,	,,	♂ = 1·87–1·96
	,,	♀ = 1·69;	,,	,,	♀ = 1·67–1·71

Heterolithadia fallax (HENDERSON), 1893—A.2, p. 261.

Localities :—Pearl banks, Gulf of Manaar, two specimens (*a*, *e*); coral reefs, Gulf of Manaar, two specimens (*b*, *d*); Trincomalee, one specimen (*c*).

Description :—	(*a*) young ♂.	(*b*) young ♂.	(*c*) ovigerous ♀.	(*d*) ♀.	(*e*) ovigerous ♀.
C.l. . . .	9·00	11·25	13·00	15·00	17·50
C.b. ÷ C.l. .	1·06	1·02	1·04	1·03	1·03
Ch.l. ÷ C.l.	1·58	1·53	1·50	1·43	1·44
F.l. ÷ H.l. .	1·50	1·47	1·45	1·40	1·48
H.b. ÷ H.l.	0·75	0·73	0·66	0·70	0·70

The gastro-cardiac groove is very inconspicuous in all.

Arcania quinquespinosa, Alcock and Anderson, 1894—A.2, p. 266.

Locality :—West of Periya Paar, 17 to 24 fathoms, one specimen.

Description :—Adult female, C.l. = 11·00 (includes frontal lobes, but not posterior spine) ; C.b. (without spines) ÷ C.l. = 1·05 ; lateral spine l. ÷ C.l. = 3·41 ; Ch.l. ÷ C.l. = 2·23 ; F.l. ÷ H.l. = 1·50. The pair of postero-lateral granules is present.

Arcania erinaceus (Fabricius), 1787—A.2, p. 268.

Localities :—Pearl banks, Gulf of Manaar, two specimens (*a*, *c*) ; coral reefs, Gulf of Manaar, one specimen (*b*).

Description (measurements as in *A. quinquespinosa*) :—

	(*a*) young ♀.	(*b*) ad. ♂.	(*c*) ad. ♀.
C.l.	13·25	18·50	18·75
C.b. ÷ C.l.	0·87	0·84	0·88
Ch.l. ÷ C.l.	1·55	1·57	1·49
F.l. ÷ H.l.	0·73	0·59	0·61

A difference between the adult male and the adult female above is the presence in the latter of a median longitudinal line of hair on the ischium of the external maxilliped.

Arcania tuberculata, Bell, 1855—A.2, p. 268.

Locality :—Pearl banks, Gulf of Manaar, two specimens (*a*, *b*).

Description :—	C.l.	C.b. ÷ C.l.	Ch.l. ÷ C.l.	F.l. ÷ H.l.
(*a*) ovigerous ♀ . . .	9·50	0·89	1·18	0·77
(*b*) ovigerous ♀ . . .	10·25	0·88	1·17	0·85

Arcania pulcherrima, Haswell, 1879—A.2, p. 269.

Localities :—Trincomalee, one specimen (*a*) ; coral reefs, Gulf of Manaar, one specimen (*b*).

Description :—	C.l.	C.b. ÷ C.l.	Ch.l. ÷ C.l.	F.l. ÷ H.l.
(*a*) young ♂	8·00	1·09	2·06	0·82
(*b*) ovigerous ♀ . . .	10·75	1·09	2·16	0·77

There are in both specimens 14 tubercles on the dorsal surface of the carapace in addition to the 10 marginal prominences.

Ixa cylindrus (Fabricius), 1787—A.2, p. 271.

Localities :—Aripu Reef, one specimen (*a*) ; pearl banks, Gulf of Manaar, one specimen (*b*).

Description (lateral spines included in C.b.) :—	(*a*) ad. ♂.	(*b*) ad. non-ov. ♀.
C.l.	14·50	16·75
C.b. ÷ C.l.	2·83	2·88

Dorippe dorsipes (Linnæus), 1764—A.2, p. 277.

Localities :—South end of Cheval Paar, two specimens ; Pearl banks, Gulf of Manaar, six specimens ; Coral reefs, Gulf of Manaar, five specimens ; Galle, one specimen.

Description :—There are no ovigerous females ; probably none of the females are adult. Of the males perhaps two or three of the largest specimens are adult. The largest male has C.l. = 23·50, *i.e.*, two-thirds measurement given by Alcock for large male. In the smallest specimens (C.l. = 8·50 and 9·00) the spine at outer angle of orbit falls far short of level of frontal teeth ; it nearly reaches it in larger specimens ; in the largest of all (C.l. = 23·50) it quite does so. In Alcock's still larger specimens it projects beyond the frontal teeth. In an immature male (C.l. = 12·00) from "Pearl Banks, Gulf of Manaar," there is on abdominal tergum IV. a small acute tubercle on either side of the larger median tubercle. The hands are still symmetrical in a male whose C.l. = 18·00.

Dorippe facchino (Herbst), 1785—A.2, p. 278.

Locality :—Pearl banks, Gulf of Manaar, two specimens.

Description :—	C.l.	C.b. ÷ C.l.	2nd W.L. ÷ C.l.	2nd W.L. ÷ 4th W.L.
(*a*) Young male . .	10·25	1·10	3·25 (approx.)	2·50 (approx.)
(*b*) ,, ,, . .	10·25	1·12	—	—

In neither does the spine at the external orbital angle project so far forward as the level of the frontal teeth. They are less hairy than Alcock describes for the adult ; hair is entirely absent from walking legs 1 and 2. In this respect they suggest the specimens included by Alcock as "? *D. granulata*, de Haan" (A.2, p. 279).

Raninoides serratifrons, Henderson, 1893—A.2, p. 293.

Localities :—South of Galle, deep water, three specimens ; west of Periya Paar, 17 to 24 fathoms, four specimens.

Description :—All are apparently immature. C.l. ranges from 6·50 to 15·25.

OXYRHYNCHA.

Achæus lacertosus, Stimpson, 1857—A.1, p. 172.

Localities :—Aripu coral reefs, Gulf of Manaar, two specimens (adult ♂) ; pearl banks, Gulf of Manaar, one specimen (adult ♂).

Description :—C.l. (exclusive of rostrum) of an adult male = 11·00.

Achæus dubia, n. sp.—Text-fig. 3.

Localities :—Pearl banks, Gulf of Manaar, four specimens (*a*, *d*, *f*, *g*) ; Chilaw Paar, one specimen (*e*) ; west of Periya Paar, 17 to 24 fathoms, one specimen (*b*) ; off Negombo, Gulf of Manaar, one specimen (*c*).

Description :—	(*a*) ad. ♂.	(*b*) ov. ♀.	(*c*) ov. ♀.	(*d*) ov. ♀.	(*e*) ov. ♀.	(*f*) ov. ♀.	mean ov. ♀.
C.l.	10·25	8·75	9·00	10·00	10·00	11·00	9·75
Rostrum l. ÷ C.l.	0·20	0·17	0·14	0·15	0·19	0·18	0·19
C.b. ÷ C.l.	0·78	0·86	0·75	0·82	0·87	0·84	0·83
Anten.flag.l. ÷ C.l.	0·83	—	0·67	—	0·75	0·75	0·72
Post.bord.C. ÷ C.l.	0·32	0·46	0·42	0·45	0·45	0·45	0·45
Arm.l. ÷ C.l.	0·78	0·51	0·44	0·50	0·55	0·50	0·50
Wrist.l. ÷ C.l.	0·59	0·37	0·32	0·37	0·40	0·36	0·37
H.l. (up. bord.) ÷ C.l.	0·73	0·37	0·33	0·37	0·40	0·36	0·37
H.b. ÷ C.l.	0·36	0·11	—	0·11	0·12	0·11	0·11
F.l. ÷ C.l.	0·54	0·40	0·36	0·42	0·47	0·41	0·41
W.L.1.Isch.l. ÷ C.l.	0·39	0·34	0·31	0·30	0·35	0·32	0·32
,, Merop.l. ÷ C.l.	2·10	1·46	1·31	1·47	1·70	1·36	1·46
,, Carp.l. ÷ C.l.	0·93	0·70	0·61	0·70	0·75	0·64	0·68
,, Prop.l. ÷ C.l.	2·00	1·49	1·39	1·42	1·72	1·45	1·49
,, dact.l. ÷ C.l.	—	—	0·97	—	—	1·05	1·01

The division between carapace and rostrum is taken to be a line uniting the anterior borders of the orbits; C.b. = a straight line uniting points above base of W.L.1 of either side, which is the region of greatest breadth; posterior border of carapace = a straight line uniting points behind the lateral tubercles of the posterior border; cheliped segments and segments of W.L.2 are measured along upper edge.

Description of Ovigerous Female (*f*).—Carapace sub-triangular, the postero-lateral angles well rounded, and the posterior border concave. The rostral lobes appear to the naked eye to be united to form a single short median dorsally grooved and bluntly pointed projection which reaches forward about as far as the distal end of the first joint of the antennal flagellum. The carapace is narrowed laterally behind the eyes. There is a post-hepatic constriction due to the branchio-cardiac groove. The greatest breadth is in the region above the first pair of walking legs. The regions of the carapace are distinct. The carapace armature consists of (1) tubercles, (2) straight hairs, (3) hooked hairs. The general surface beneath the hairs is smooth; of the tubercles two at once attract the eye—a large conical gastric one and a still larger one on the cardiac region. The tubercles are in detail:—3 gastric, arranged in form of a triangle, of which the two anterior ones, forming the base, are inconspicuous, while the median posterior one is that already mentioned—1 cardiac (median), the

Fig. 3. *Achaeus dubia*, n. sp.

largest on the animal and already mentioned—3 branchial (paired), of which one is lateral while the other two are dorsal, and so placed that a straight line uniting them would on being produced anteriorly pass between the antero-lateral gastric tubercle of the same side and the median gastric tubercle—2 hepatic tubercles (paired), a larger one below and to the outer side of a smaller—1 sub-hepatic (paired)—1 buccal, *i.e.*, the produced antero-external angle of the buccal cavern (paired)—1 pre-buccal tubercle (paired), quite small, just anterior to and a little above the buccal tubercle, its apex points downwards and outwards—finally, 1 at either end of posterior margin of the carapace. The buccal, the sub-hepatic, and the lateral branchial tubercles on either side are united by a low ridge forming an approximately straight line.

The upper margin of the orbit is smooth, there is no dorsal spine in this region.

The sternal surface is devoid of spinules.

Each tubercle tends to be crowned by one or two hairs of the straight variety. A dorso-lateral longitudinal row of hooked hairs is conspicuous on the branchial regions of either side; it commences on the region above the base of walking leg 3 and runs forward below the two dorsal branchial tubercles. On the anterior half of the carapace the hooked hairs are numerous and tend to run in lines which converge anteriorly.

The abdomen has in both sexes six divisions, somite VI. and telson being as usual fused. On its tergal surface are both straight and hooked hairs.

The basal antennal joint is smooth and fixed, being fused distally to the front. The antennal flagellum is fringed feather-wise with long straight hairs.

In the external maxillipeds the inner edge of the ischium and of the merus is fringed with long straight hairs. The inner edge of the ischium is finely toothed and its exposed surface tends to be roughened (under lens); the roughening is most marked along two slight longitudinal carinæ which border a somewhat V-shaped median longitudinal depression. The merus also is grooved longitudinally.

In the chelipeds the under border of the ischium and of the merus, and the upper and under borders of the laterally compressed hand, are carinate and finely denticulate; the denticulation is continued along the proximal half of the under border of the fixed finger. The rest of the cheliped is smooth. The fingers are strongly incurved and are apposable throughout their length. Long straight hairs fringe the upper and under borders of all the cheliped segments. Hooked hairs are arranged in a median longitudinal row on the outer surface of the arm; they occur also on the lower part of the outer surface of the wrist and on the upper portion of the outer surface of the hand.

The dactylopodites of walking legs 3 and 4 are slightly falciform, the curve strongest proximally. The walking legs possess some long scattered straight hairs. A row of hooked hairs is present on the upper border of all the segments of all the walking legs except the dactylopodites of the last two pairs.

Variation among the ovigerous females concerns (1) the size but not the number of the tubercles of the carapace; (2) the measurements, as given above; (3) the extent to which, if at all, the rostral lobes are apposed. Though all appear apposed to the naked eye, variation is seen by aid of a lens. In (*a*) and (*c*) they are apposed throughout their length, in (*d*) and (*f*) they are apposed distally, but are separated proximally by a narrow space, and in (*b*) and (*e*) they are separate throughout their whole length.

In the single male specimen the cardiac tubercle is, as in the females, the largest; but the median gastric and the posterior branchial tubercle of either side are all of approximately the same size, the former being relatively smaller and the latter relatively larger than in the female specimens. All the segments of the cheliped are longer and more swollen than in the females; their denticles are present, very small and set well apart. The fingers are apposable distally for rather less than half their length, a hiatus being left proximally, which is more or less bridged by a couple of blunt teeth, one near the base of each finger, that of dactylus distal to the one on the fixed finger.

I judge *Achæus dubia* to be closely allied to *A. tenuicollis*, differing from it mainly in the following particulars:—(1) Neither tubercles, rostral lobes, chelipeds, nor sternal surface bear spinules; and (2) Character of rostral lobes.

The rostral lobes are noteworthy. They are more sharply pointed than one expects in *Achæus*, making an approach thus to *Stenorhynchus*, *e.g.*, *S. rostratus*, where they are shorter than usual. The essential distinction hitherto recognised between *Achæus* and *Stenorhynchus* has been that in the former the rostrum consists of two short lobes, and in the latter of two long spines.

Paratymolus hastatus, ALCOCK, 1895—A.1, p. 174; A.Invest., pl. xviii., fig. 4.

Locality:—Gulf of Manaar, six specimens (three adult males, one young male, and two adult females, one ovigerous).

Description:—C.l. (exclusive of rostrum) of an ovigerous female = 5·25.

In the above females the genital orifices are, as in ALCOCK's specimen, on the sternum, not on the bases of the 3rd pair of walking legs.

Remarks.—ALCOCK observes that the position of the genital orifices of the female as above confirms ORTMANN's view that the correct place for this genus is among the *Achæus*-like Maiidæ.

Oncinopus aranea, DE HAAN, 1837—A.1, p. 183.

Localities:—Trincomalee, one specimen (ovigerous ♀); pearl banks, two specimens (adult ♂ and ovigerous ♀); coral reefs, Gulf of Manaar, three specimens (ovigerous ♀, adult ♂, and young ♂); south of Galle, deep water, one specimen (with *Sacculina*).

Description:—C.l. (including rostrum) of an ovigerous female = 8·50.

Remarks.—One of the ovigerous females which bears a parasitic *Sacculina* retains the usual broad female type of abdomen, and its abdominal appendages are also well developed.

Camposcia retusa, LATREILLE, 1829—A.1, p. 184.

Locality :—Pearl banks, Gulf of Manaar, one specimen.

Description :—Male, apparently adult, C.l. = 23·50. It has the broad sternum (KLUNZINGER, pl. i., fig. 1) and slender cheliped described for males of this species, giving them a curiously female appearance. The sternum, though broad in the male of this species, is not so broad as in the female.

Apocremnus indicus, ALCOCK, 1895—A.1, p. 188; A.Invest., pl. xx., fig. 1.

Localities :—Coral reefs, Gulf of Manaar, sixteen specimens; south of Galle, deep water, six specimens; Gulf of Manaar, deep water, three specimens.

Description :—In an ovigerous female C.l. (excluding rostrum) = 7·00. A gastric spinule is present—this is figured by ALCOCK, but omitted from his description.

A post-ocular spinule is figured by ALCOCK in his ventral view of the male, but is said by him in his description to be absent. The description—not the figure—is correct for the present specimens.

There is evidence in the present specimens that the male of this species is facultatively dimorphic. The series includes what I believe to be examples of young, non-breeding, and breeding males—the latter I judge to be of the "low" type.

Xenocarcinus tuberculatus, WHITE, 1847, var. **alcocki**, nov.—A.1, p. 192.

Locality :—Dutch Modragam Paar, one specimen.

Description :—An ovigerous female. C.l. (excluding rostrum) = 12·50; Rost.l. ÷ C.l. = 0·32. The present specimen agrees with A. MILNE-EDWARDS' fig. 1 ('Archiv. du. Mus.,' viii., 1872, p. 253, pl. xii., figs. 1 to 1*g*) in character of its legs, and is fairly intermediate in carapace-character between this and WHITE'S "type"-specimen in British Museum which is figured by MIERS ('Zool. Erebus and Terror,' Crust., p. 1, pl. ii., figs. 1 to 1*e*). It thus agrees in general appearance with ALCOCK'S figure of a specimen from Andamans or from Ceylon, but the rostrum is narrower anteriorly and so more conical. A close examination of the carapace surface reveals some obsolescent tubercles in the position of those seen in A. MILNE-EDWARDS' fig. 1, but are not sufficiently developed to affect the general appearance, which is due rather to nine swellings as in WHITE'S "type"-specimen; they are not, however, so strongly developed, so conical, nor so pointed as in the latter, and in particular the gastric and cardiac eminences are very ill-developed.

Remarks.—No second example seems to have been described which is in agreement with WHITE'S "type"-specimen (female) of *X. tuberculatus*. I have examined the five British Museum specimens from Cape Howe, for which MIERS created *X. depressus* in 1874 (reference as above), and find that they come into the series figured by A. MILNE-EDWARDS; one of them in particular is well represented by his fig. 1. CALMAN states (p. 34) that his Murray Island male is in fair agreement with the same figure.

I should recognise a single species within which are (1) a group including specimens figured by A. MILNE-EDWARDS, MIERS' five *X. depressus* specimens from Cape Howe, and CALMAN'S male from Murray Island. This I name var. *depressus*. (2) A group including ALCOCK'S two female examples from Ceylon and Andamans (A. Invest., pl. xxxiii., fig. 3), and the present specimen, also a female. This group is intermediate between (1) and (3). I name it var. *alcocki*. (3) WHITE'S female "type"-specimen figured by MIERS, which stands alone. It is characterised among other ways by having its gastric tubercle transversely divided. This I name var. *tuberculatus*.

Huenia proteus, DE HAAN, 1837—A. 1, p. 195.

Localities:—Aripu coral reef, two specimens (*g*, *m*); Chilaw Paar, one specimen (*a*); Cheval Paar, Gulf of Manaar, nine specimens (*h*, *e*, *d*, *b*, *i*, *l*, *n*, *o*, *k*); Jokkenpiddi, three specimens (*c*, *f*, *j*); Navakaddu Paar, one specimen (*p*). (*o* and *p* adult.)

Description:— Males.	(*k*).	(*l*).	(*m*).	(*n*).	(*o*).	(*p*).
C.l.	12·50	14·00	14·75	18·75	20·50	24·75
R.l. ÷ C.l.	0·36	0·43	0·41	0·40	0·45	0·41
Ch.l. ÷ C.l. . . .	—	0·82	—	—	1·14	1·05
Propus l. ÷ C.l. . .	—	0·36	—	—	0·50	0·46

Females.	yg. (*a*).	ov. (*b*).	yg. (*c*).	ov. (*d*).	ov. (*e*).	ov. (*f*)	ov. (*g*).	ad. (*h*).	ov. (*i*)	ov. (*j*).
C.l. . . .	13·25	14·25	14·50	14·50	16·50	20·00	20·50	21·25	21·25	21·50
R.l. ÷ C.l. .	0·32	0·32	0·33	0·29	0·32	0·32	0·33	0·31	0·33	0·30
Ch.l. ÷ C.l. .	—	0·81	—	0·79	0·77	0·76	0·79	0·79	0·78	0·82

The kind of alga carried by the animal varies. In (*a*), which is described by a label as a "green crab tinted similarly to the green alga on which it was found," it is a large piece of foliaceous Halimeda, while in (*e*) it is a branch of filamentous alga.

The hepatic lobes of the female may be horizontal as in (*e*), or they may curve considerably upward as in (*h*). Between these limits the other specimens may be arranged in a good connecting series.

The border of the hepatic lobe of the female is in some entire, in others irregular.

In all the males there is a pair of small transversely placed tubercles in front of the anterior median elevation. This is present also in ovigerous female (*f*), and a trace appears in ovigerous female (*i*).

The carapace-outline of all the males except (*p*) agrees with ADAMS and WHITE'S fig. 4 ('"Samarang" Crust.,' pl. iv., fig. 4). Specimen (*p*), which is the largest male in the collection, more resembles DE HAAN'S fig. 5 of the larger form (Crust. in 'Faun. Japon.,' pl. xxiii., fig. 5), but the anterior border of the epibranchial lobe slopes obliquely backwards, and in the same crab the upper border of the hand and wrist is strongly carinate, and on the upper, under, and outer surfaces of the arm are a few distinct short blunt spines.

In the two largest males Ch.l. ÷ C.l. is rather more than 1, instead of rather less as

ALCOCK describes. There is a difference between the sexes in rostral length. Thus the measurements show that for 6 males the mean value of R.l. ÷ C.l. = 0·41, and range of variation = 0·36–0·45. For 10 females the corresponding figures are 0·32 and 0·29–0·33. Neither the slight variation among the female nor the considerable variation among the male specimens seems to be particularly associated with growth.

Simocarcinus simplex (DANA), 1852, var. **pyramidatus**, nov.—A.1. p. 196.

[**Huenia hellerii**, PAULSON, 'Crustacea of the Red Sea' (Russian), Kiev, 1875, p. 8, pl. iii., figs. 2*a* to *c*.] **Trigonothir pyramidatus**, KLUNZINGER, p. 19, pl. i., figs. 3 to 3*g*.

Localities:—Jokkenpiddi Paar, three specimens (*a*, *b*, *d*); south end of Cheval Paar, one specimen (*e*); coral reefs, Gulf of Manaar, one specimen (*f*); pearl banks, Gulf of Manaar, four specimens (*g*, *h*, *i*, *j*); off Mutwal Island, one specimen (*c*).

Description:—	In present collection.				*S. simplex* in British Mus.				
	(*a*) ad. ♂.	(*b*) ad. ♂.	(*c*) ad. ♂.	(*e*).	(*m*) ♂.	(*n*) ♂.	(*o*) ad. ♀.	(*p*) ad. ♀.	(*q*) ad. ♀.
C.l.	16·00	16·00	12·25	14·00	15·50	13·50	14·75	12·00	12·00
R.l. ÷ C.l.	0·95	0·87	0·98	0·57	0·32	0·41	0·20	0·33	0·31
C.b. ÷ C.l.	0·86	0·91	0·82·	0·89	0·97	0·93	0·95	1·00	1·00
Inter-orb.b. ÷ C.l.	0·25	0·25	0·29	0·30	0·26	0·30	0·27	0·29	0·29
Ch.l. ÷ C.l.	1·97	1·95	1·65	1·19	1·68	1·43	—	1·19	1·12
W.L.1.l. ÷ C.l.	2·42	—	2·27	2·05	1·94	1·87	—	—	1·75
W.L.2.l. ÷ C.l.	1·12	—	1·12	—	1·16	1·09	1·00	1·12	1·17
W.L.4.l. ÷ C.l.	0·83	0·95	—	—	0·85	0·85	0·86	0·98	0·96

All the specimens have three tubercles on the gastric region of the carapace; they are somewhat blunter in the female than in the male.

The rostrum exhibits variability in several respects: (1) In its length, as above; (2) it may be straight or curved, in the latter case the concavity is below; (3) it may arise from the front of the carapace in such a way as to continue the general horizontal plane of the dorsal surface of the carapace, or it may rise upwards somewhat and make an obtuse angle with that plane. In one male the rostrum is straight and its plane horizontal; in two males it is curved and makes an obtuse angle with the post-rostral carapace.

The hands of one male are massive, with fingers which are only apposable at their tips, and which are, when so apposed, separated at the base by a considerable space; in two other males the hands are slender and the fingers when apposed distally are almost in contact basally.

A lobe is present in all the specimens on either side of the posterior border of the carapace. The size of the lobes is intermediate between those of dried specimens of *S. simplex* in the British Museum and HELLER's figure of *pyramidatus*.

The eye is much as in the British Museum specimens of *simplex*, *i.e.*, less prominent than in DANA's figure. In each of the three females which I place with the above males there is a pair of hepatic lobes, *Remarks.*—The present specimens form a group which I believe breaks down the distinction between *Simocarcinus simplex* (DANA), 1852, and *S. pyramidatus* (HELLER), 1861. As set forth by ALCOCK, the characters by which the former is distinguished from the latter are (1) the much shorter rostrum of the male; (2) the presence of three tubercles, disposed in a triangle, on the gastric region; (3) the larger and more prominent eyes; (4) the absence of the lobule on either side of the posterior border of the carapace; (5) the much more massive chelipeds of the male.

In the first place, I may remark that the only other specimen which appears to agree with the single one for which HELLER created *pyramidatus* is the male described by ALCOCK. I have examined MIERS' specimens of *S. simplex* in the British Museum and find that, though they are evidently *S. simplex* in the narrower sense of the term, they show two points of difference from DANA's figure which diminish the value of distinctions (3) and (4) above. There is in each of them a lobe at either end of the posterior border (it is distinct, though not so large as in HELLER's figure of *S. pyramidatus*), and in all the males the eyes are less prominent than in DANA's figure. This doubt cast upon the value of distinctions (3) and (4) is confirmed by the present specimens (see description above). The fifth distinction seems, in view of the evidence of the specimens in the present collection, to be one between young and adult males or between non-breeding and breeding adults. There is, however, some difference between the massive chela of male specimens (*a*) and (*b*) of the present examples and that of the British Museum male (*m*); this may or may not be a difference associated with high and low males respectively. Of ALCOCK's two remaining distinctions, (1) and (2), each specimen of the present group unites the three gastric tubercles of *S. simplex* with the long rostrum of *S. pyramidatus*. CANO ('Boll. Soc. Nat. Napol.,' iii., 1889, p. 173) describes an animal with a similar combination and unites the two species. More recent writers have not followed him, and KLUNZINGER (p. 19) describes a similar male as *pyramidatus*. The additional evidence confirms CANO.

It is difficult to estimate the value of the character rostrum-length referred to above. It holds excellently as between the present individuals and the specimens labelled *S. simplex* in the British Museum (see measurements above); but in KLUNZINGER's figure the index R.l. ÷ C.l. seems to be about 0·62, and HENDERSON describes his specimens as *simplex*, but with longer rostrum. The high variability of this character in *S. camelus*, KLUNZINGER (1906, pl. i., figs. 2*a*–*g*), is to be borne in mind. A further point of difference between my specimens and the British Museum examples of *S. simplex* is the greater length of the first pair of walking legs in the former (see measurements above, under W.L.1.l. ÷ C.l.). The present forms and all those with the three gastric tubercles I name var. *pyramidatus*.

I consider that MIERS' distinction between *Simocarcinus* and *Trigonothir* (the latter genus formed for a single male specimen) must be given up. The slender cheliped of the latter is better considered as the character of a young or of a non-breeding individual. The rostrum is stouter, more swollen and more clumsy in *Trigonothir* than in *Simocarcinus simplex* (includes *S. pyramidatus*) and *S. camelus*, but it is essentially the same otherwise. In all these its under surface is flattened proximally, while distally it is concave and produced into lateral carinæ; and its apex tends to be three-lobed, the lobes set at angles of 120° (very approximately) to each other. I have seen no specimens of *Simocarcinus* with the laterally compressed acute rostrum given by MIERS as a generic character. KLUNZINGER (p. 18) revises MIERS' definition of *Trigonothir*, transferring to it the species *pyramidatus*. As a new generic character he gives the absence of hepatic lobes in the female. The evidence of the present specimens confirms me in doubting the validity of this. As another new generic distinction he points out that in *Trigonothir* the chelipeds of the adult male are unequal. With the additional evidence available to me, I would suggest that this inequality—observed only in a single example (KLUNZINGER, pl. i., fig. 3)—is due to regeneration. I unite *Simocarcinus* and *Trigonothir* under the name of the former and for the present distinguish this genus from *Huenia* by two characters:—

(1) Pre-ocular spine. This is present in *Huenia*, absent in *Simocarcinus*. (2) Rostrum. In *Huenia* this is sharp-edged below and has an acute tip; in *Simocarcinus* it has a flattened under surface which tends to be concave distally, where its lateral edges are produced—the tip of the rostrum tends to be trilobed.

Menæthius monoceros (LATREILLE), 1825—A.1, p. 197.

Localities:—Cheval Paar, Gulf of Manaar, seven specimens (*h*, *f*, *g*, &c.); Aripu coral reefs, ten specimens (*c*, *a*, *e*, *i*, &c.); off Mutwal Island, eight specimens (*j*); Jokkenpiddi Paar, two specimens (*b*, *d*); Navakaddu Paar, one specimen.

Description:—

Males.	(*a*).	(*b*).	(*c*).	(*d*).	(*e*).	(*f*).	(*g*).	(*h*).	(*i*).	(*j*).
C.l. . . .	6·00	7·00	7·50	9·25	9·50	9·75	10·25	12·00	14·25	15·00
R.l. ÷ C.l. .	0·58	0·50	0·37	0·49	0·55	0·51	0·51	0·66	0·72	0·77

Ovig. females.	(*k*).	(*l*).	(*m*).	(*n*).	(*o*).	(*p*).	(*q*).	(*r*).	(*s*).
C.l.	9·75	9·75	9·75	10·25	10·75	12·00	12·25	13·25	13·50
R.l. ÷ C.l. . . .	0·32	0·49	0·51	0·59	0·44	0·50	0·43	0·43	0·50

The first three of the above males are young; there is evidence in the collection that this is a species showing facultative dimorphism.

The specimens show considerable variation in number of tubercles on dorsal surface of the carapace and in the teeth of the lateral border. The majority resemble the variety figured by DANA as *Menæthius sub-serratus* rather than any other variety. Some tend to combine the characters of two or more of DANA's figures, *e.g.*, of the three specimens from Cheval Paar, one agrees fairly with the figure of *M. sub-serratus*, while the other two agree with this figure in character of lateral teeth, but more resemble that of *M. angustatus* in tuberculation. The two specimens from Jokkenpiddi agree fairly with DANA's figure of *M. tuberculatus*.

Variability of rostrum-length is high. Thus for eight ovigerous females the index R.l. ÷ C.l. has mean value = 0·47, and range of variation from 0·32 to 0·59. For the ten males of various ages the corresponding figures are 0·57 and 0·37–0·77.

Specimen *s* (female) stands apart from the others and makes some approach to *Huenia proteus* in the character of its last pair of walking legs. These are comparatively smooth and expanded, and obvious teeth are absent from the dactylopodite. This specimen also has dorso-lateral hepatic swellings.

Acanthonyx macleayi, Krauss, 1843—A. 1, p. 199.

Locality:—Cheval Paar, Gulf of Manaar, one ovigerous female. C.l. = 12·50.

Halimus pleione (Herbst), 1803—A. 1, p. 208.

Localities:—Pearl banks, Gulf of Manaar, two specimens (ovigerous ♀ *a*, *c*); off Mutwal Island, two specimens (ovigerous ♀ *b* and young ♂ *d*).

Description:—	(*a*) ovigerous ♀.	(*b*) ovigerous ♀.	(*c*) ovigerous ♀.	(*d*) young ♂.
C.l.	17·00	20·00	23·00	11·00
C.b. ÷ C.l. . . .	0·75	0·75	0·78	0·80
R.l. ÷ C.l. . . .	[ ]	0·37	0·31	0·41

In the immature male the rostral spines lie in an approximately horizontal plane; in the three ovigerous females they continue the downward anterior slope of the gastric region of the carapace.

Halimus hilgendorfi (de Man), 1888—A. 1, p. 209.

Localities:—Pearl banks, Gulf of Manaar, sixteen specimens (including *d* and *f*); Aripu coral reefs, Gulf of Manaar, eighteen specimens (including *a*, *b*, *c*, *g*, and *e*); off Mutwal Island, two specimens (*h*, *i*).

Description:—	(*a*) ov. ♀.	(*b*) ov. ♀.	(*c*) ov. ♀.	(*d*) ov. ♀.	(*e*) ad. ♂.	(*f*) ad. ♂.	(*g*) ad. ♂.	(*h*) ad. ♂.	(*i*) ad. ♂.
C.l.	11·50	13·50	14·00	16·50	12·50	12·50	13·50	14·50	15·00
Rost.spine l. ÷ C.l. .	0·32	0·44	0·41	0·25	0·52	0·56	0·52	0·52	0·55
D. tips R.sp. ÷ C.l.	0·20	0·33	0·30	0·23	0·42	0·28	0·40	0·34	0·47

The above measurements give an indication of the high variability of the length, and degree of divergence, of the rostral spines. Both the characters named are sexually dimorphic.

A sexual difference is also shown in carapace length.

Halimus spinosus (A. Milne-Edwards), 1872—A. 1, p. 211.

Locality:—Aripu coral reefs, Gulf of Manaar, three specimens (two young ♀ and young ♂).

Remarks.—I unite *H. consobrinus*, A. Milne-Edwards, and *H. spinosus* specifically. The slight points of difference are that in the former (1) the anterior angle of the supra-ocular eave is hardly so much produced; (2) the two gastric spines are not so long: (3) the intestinal tubercle is but slightly represented. The present examples belong to the *consobrinus* variety.

Halimus convexus (MIERS), var. **hendersoni,** nov.

Localities:—Coral reefs, Gulf of Manaar, two specimens (ovigerous ♀ and young ♂); west of Cheval Paar, two specimens (young ♂); Cheval Paar, three specimens (young ♀).

Description:—C.l. of the ovigerous female = 10·50.

They differ from MIERS' form ('"Alert" Expedition,' p. 196 and figure) in having (1) an epibranchial tubercle on either side; (2) the carapace regions less strongly demarkated and less convex; (3) the rostral spines less divergent, straighter and shorter.

Remarks.—The specimens agree with the two dried ovigerous females from Penang in the British Museum, with which HENDERSON (p. 344) describes his Martaban example as almost identical. There is thus a group with a fairly wide distribution which differs from MIERS' form in certain definite respects: I call it var. *hendersoni.*

This variety bears a suspiciously close resemblance to descriptions and figures of *Halimus sub-inermis* (ZEHNTNER) ('Revue Suisse de Zool.,' ii., p. 136, pl. vii., figs. 2, 2*a*), and to *Halimus espinosus*, BORRADAILE (p. 688, pl. xlvii., fig. 4). I have not seen specimens of either of these species. The main difference from *Halimus espinosus* seems to be the form of the rostral spines. I should be inclined to merge both in *Halimus convexus* (MIERS).

Halimus brocki (DE MAN), 1887 ('Arch. f. Naturges.,' liii., p. 22).

Locality:—Off Mutwal Island, one specimen.

Description:—A male, perhaps adult. C.l. (measured anteriorly to the angle between the rostral spines) = 9·50; rostral spine l. ÷ C.l. = 1·0.

The rostral spines diverge less in their distal than in their proximal portions.

Halimus agassizi, RATHBUN, 1902—'Bull. Mus. Comp. Zool.' xxxix., p. 133, fig. 6.

Localities:—Pearl banks, Gulf of Manaar, one specimen (*a*); off Mutwal Island, one specimen (*b*); pearl banks, off Manaar, one specimen (*c*).

Description:—	(*a*) ovig. ♀.	(*b*) ovig. ♀.	(*c*) ad. ♀.
C.l.	8·50	6·00	6·50
R.l. ÷ C.l.	—	0·58	0·54

In specimen (*a*) there are a few inconspicuous hooked hairs, in no way hiding from view the tuberculation of the carapace, which I find to agree with Miss RATHBUN'S description of the male. The walking legs have a smooth appearance. In specimens (*b*) and (*c*) hooked hairs are numerous, obscuring the tuberculation of the carapace and giving the legs a roughened appearance.

As a point of distribution I may note that I found a specimen of this species (an ovigerous female) in the bottle which contains POCOCK'S "type" specimen of *Hyastenus* (*Chorilia*) *tenuicornis*, labelled "China Sea."

The interesting little tooth of the supra-orbital margin is referred to under *H. irami*, n. sp.

Halimus pehlevi, n. sp.—Plate I, fig. 3, 3*a*.

Localities:—Coral reefs, Gulf of Manaar, two specimens (*f*, *g*); pearl banks, Gulf of Manaar, 15 specimens. One is a young female; six are adult females (five are ovigerous); five are young males; five are adult males.

Description of Adult Male (*g*).—Carapace sub-triangular, globular behind the lateral post-hepatic groove. The regions are distinctly defined, and are convex independently of the general convexity of the carapace, and bear certain granules:—a pair at the anterior border of the gastric region internal to the bases of the supra-ocular eaves; 13 posterior to these on the gastric region, of which three are median; one (median) between the gastric and cardiac regions; three on the cardiac region arranged as a triangle with its base turned forward; one (median) intestinal; one in the posterior portion of the groove on either side of the cardiac region; two on each branchial region. The true posterior border of the carapace is convex apart from the general outline of the carapace. The rostral spines are divergent, the distance between their tips divided by the length of one of them = 1·11. Length of rostral spine (inner border) ÷ carapace length = 0·39. The spines are bordered laterally with hooked hairs. The supra-ocular eave is strongly bilobed; the post-ocular tooth has a denticle about the middle of its anterior border. The pterygostomian region bears a couple of tubercles, one to outer side of and behind the other.

The antero-external angle of the basal antennal joint is produced into a stout tooth which is just concealed in a dorsal view of the animal. Behind it the outer border of the basal joint of the antenna presents a slight convexity which is produced ventrally a little. Posterior to this and external to the opening of the green gland is a prominent laterally compressed tubercle, and posterior to this again the antero-external angle of the buccal cavern forms a prominence. The four prominences just named form a longitudinal row. The antennal flagellum does not reach so far forward as the tip of the rostral spine; it is stout and bears a few thick hairs averaging somewhat more than 0·5 millim. in length.

The merus of the external maxilliped has its antero-external angle produced, and its inner border indented by two notches. The inner border of the ischium of the same appendage is serrated.

Chelipeds are smooth beneath the hairs. In this adult male they are a little stouter than the walking legs and 1·2 times as long as the carapace (excluding rostral spines). The fingers gape proximally for about two-thirds of their length, a tooth on the proximal portion of the mobile finger projecting into the hiatus. The distal, apposable portion of the fingers is denticulate.

Walking legs are smooth beneath the hairs. W.L.1.l. ÷ C.l. = 1·74; W.L.2.l. ÷ C.l. = 1·17; W.L.3.l. ÷ C.l. = 1·00; W.L.4.l. ÷ C.l. = 0·91. The dactylopodite of walking leg 1 is almost straight, denticulate, and about half as long as the propodite. The dactylopodites of walking legs 2, 3, and 4 are curved, spinulous, and about the same length as the propodites of the same appendages.

C.l.	C.b. ÷ C.l.	Ch.l. ÷ C.l.	Propus l. ÷ C.l.	Arm l. ÷ C.l.	H.l. (up. bord.) ÷ C.l.	F.l. (up. bord.) ÷ C.l.
11·5	0·78	1·20	0·59	0·52	0·33	0·22

Arm length is measured along under surface from proximal end of ischium to tip of outer distal tubercle. Ch.l. = sum of arm l. and a line uniting outer distal tubercle of arm to tip of fixed finger when elbow is bent at a right angle. Propus l. is measured along lower border by a straight line uniting the proximal tubercle to the tip of the fixed finger.

Remarks.—This species may be recognised by the character of its orbital border.

The bilobed character of its supra-ocular eave is a point of resemblance to *Halimus verrucosipes* and *Halimus gracilirostris*.

The denticle on the anterior border of the post-ocular tooth is referred to under *H. irami*, n. sp.

Halimus irami, n. sp.—Plate I., figs. 4, 4*a*.

Locality :—Muttuvaratu Paar, two specimens—an ovigerous ♀ (*a*) and a *Sacculina*-infested male (*b*).

Description of Ovigerous Female.—Body and legs tomentose. Carapace sub-pyriform; the regions are defined, not very distinctly, by shallow grooves; the grooves defining the hepatic region are well marked; the gastric region shows a fairly prominent convexity. The denuded carapace is seen to be pitted, the pits well apart. The only protuberance on the carapace is a small epibranchial tubercle near the hinder limit of either branchial region. The rostral spines are 0·50 the length of the carapace (0·60 in the male example), fringed with a row of hairs on either side; the distance between their tips is 0·90 the length of one of them; though sloping obliquely downward, their slope is less inclined than that of the anterior surface of the carapace (in the male their slope is more oblique, in the same plane as that of the carapace).

The supra-ocular eave is produced anteriorly into a strong triangular tooth; at the base of the post-orbital tooth, between it and the supra-ocular eave, is a small tooth (it varies in position in the two specimens, as will be remarked later).

The antennal flagellum consists of about eight elongated segments, from the joints between which arise a few isolated stout hairs; it is damaged in this specimen, in the male it just falls short anteriorly of the tip of the rostral spine.

The outer anterior angle of the basal antennal segment is produced anteriorly into a stout tooth, visible from dorsal view, the outer border is a little convex; to the outer side of the aperture of the green gland is a compressed tubercle; behind the latter the antero-external angle of the buccal cavern is produced as a petaloid projection; on the pterygostomial ridge running obliquely backward from this there are two tubercles, and a third still further back just above the base of the cheliped.

The chelipeds are rather more slender than the walking legs. Ch.l. ÷ C.l. = 0·91. The dactylopodites of the walking legs are roughened, hardly denticulate, on their lower borders. Carapace length is 8·75.

The general form of the carapace and of the rostral spines, together with the slight epibranchial tubercle, suggest alliance with the *H. convexus* group. The small but distinct supra-ocular tooth is interesting. It occurs in *H. agassizi*; in *H. pehleri* there is no isolated tooth, but the lower half of the upper anterior border of the large post-ocular tooth bears a smaller tooth, which is perhaps its representative. At all events, the two examples of *H. irami* enable one to make a very pretty series; in specimen (*a*) there is on the right an isolated supra-orbital tooth well separated from both supra-ocular eave and large post-ocular tooth, on the left side it is at the base of the latter, though distinct from it, in (*b*) it is on either side hardly separated from the post-ocular tooth and might be described as situated upon it: this leads to the condition seen in *H. pehleri*.

For purposes of key this new species comes under section II.2.ii.*b*. of ALCOCK's arrangement (A.1, p. 208) with *H. planasius*; from the latter it is easily to be distinguished by its supra-ocular tooth.

The male example of the new species is of interest as exhibiting a condition of abdomen and chelipeds evidently due to the presence of the parasitic *Sacculina*. The chelipeds are much as in the female, the abdomen is much broadened, resembling that of a half-grown female; the larger pair of copulatory appendages reach back about half way along the abdomen.

Naxia investigatoris, ALCOCK, 1895—A.1, p. 218; A.Invest., pl. xxi., fig. 6.

Localities:—Coral reefs, Gulf of Manaar, one specimen (ovigerous ♀); pearl banks, Gulf of Manaar, one specimen (ovigerous ♀); off Mutwal Island, one specimen (♂).

Description:—	C.l.	Rost.sp.l. ÷ C.l.	Ch.l. ÷ C.l.
(*a*) ovigerous ♀ . . .	16·00	0·25	1·00
(*c*) adult ♂	16·00	0·37	1·19

The present male example suggests that facultative dimorphism occurs in the species. It has a well-grown appearance. In spite of its "non-breeding" type of cheliped, it is larger than a male specimen of ALCOCK's in the British Museum, which has chelipeds of "breeding" type; it is perhaps a "middle" male.

Naxia hirta (A. MILNE-EDWARDS), 1865—A.1, p. 218.

Localities:—Aripu coral reefs, Gulf of Manaar, nine specimens; Chilaw Paar, one specimen; pearl banks, Gulf of Manaar, seven specimens; off Mutwal Island, two specimens.

Description :—	C.l.	Rost.spine l. ÷ C.l.	Ch.l. ÷ C.l.
(*a*) adult ♂	35·50	0·30	1·31
(*b*) ovigerous ♀ . . .	31·25	0·24	0·94
(*c*) adult ♂	18·25	0·22	0·88

In adult male (*a*) one notes: (1) The cheliped length exceeds considerably the length of the carapace, whereas ALCOCK describes his specimens as having these measurements equal; (2) the fingers are considerably arched and so are well separated at the base when clenched—again contrasting with ALCOCK's description. ALCOCK does not give the size of his specimens, they are evidently either young or "non-breeding" forms. In the present collection males agreeing with ALCOCK's description in characters of cheliped have C.l. from 18·00 to 21·00.

Doclea gracilipes, STIMPSON, 1857—A.1, p. 229.

Localities:—Trincomalee, three specimens; pearl banks, Gulf of Manaar, two specimens.

Description:—All the examples are young—three are males and two females. They fall under ALCOCK's general description of the species, and are in fairly close agreement with the *Doclea* sp. of DE MAN, from Mergui. The smaller of his two specimens I have seen in the British Museum.

Doclea alcocki, n. sp.—Plate I., fig. 5, Plate II., fig. 2.

Locality:—Pearl banks, Gulf of Manaar, one specimen.

Description:—A female, non-ovigerous, but, judging from the broad abdomen, it is adult. C.l. (a straight line uniting base of posterior spine to posterior end of rostral groove) = 44·5. Body and legs, except the hands and dactylopodites, are covered with velvet.

Carapace sub-pyriform rather than sub-globular (Pl. II., fig. 2); the posterior part of the margin is semicircular, the anterior part (rostrum included) is triangular. Rostrum bifid; its length (a straight line uniting the tip of a rostral spine to the posterior end of the longitudinal dorsal rostral groove) is 0·25 the carapace length; the length of the free portion of a rostral spine is 0·55 the rostrum length; the rostral spines are compressed in an oblique plane and curve a little downwards distally. Inter-orbital breadth (a straight line uniting the fissures between the supra-ocular eave and post-ocular tooth of either side) is 0·25 the carapace length. The anterior angle of the supra-orbital eave is produced obliquely forward and outward as a tubercle. There are numerous tubercles (say 56). Of these, eight are in the median longitudinal line and increase in size from before backwards (four gastric, of which the most anterior is about one-third the size of the other three, one between gastric and cardiac region, one cardiac, one on posterior border; the last named is a good deal larger than any of the others (at its base on either side is a smaller tubercle, that on the right quite minute, that on the left strongly developed). Just anterior to this median dorsal row is a pair of small tubercles, one on either side of the posterior limit of the median longitudinal rostral groove; these and the small anterior one of the median dorsal row form a triangle; the three are sub-equal in size and are roughly one-third the size of the second member of the median dorsal row. The antero-external angle of the buccal cavern is produced into a tubercle, and this is the most anterior member of a row of four, of which the second is on the sub-hepatic region and the third and fourth are on the lateral border of the carapace. Parallel to this a row of four tubercles runs obliquely backwards and outwards from the posterior angle of the orbit; of these, the first is hepatic and the rest branchial. On either side between this row and the mid-dorsal row are twelve tubercles, four gastric and eight branchial. The gastric ones are small and occupy the corners of an antero-posterior oblong, of the branchial ones five follow the groove separating branchial from middle regions (second and sixth well developed, rest small), the remaining three lie to outer side, the posterior one being well developed, and the two anterior very close together. The middle regions of the carapace are separated from the lateral ones by distinct sinuous grooves; the branchio-hepatic groove also is distinct. In addition to the tubercles described above, the basal antennal segment is produced into one, there is another just behind this to the outer side of the opening of the green gland and just in front of the tubercle at the antero-external angle of the buccal cavern, already described. The interantennulary septum is produced ventrally in the middle region to form a much compressed tooth.

The merus of the external maxilliped has a very distinct notch in the anterior part of its inner border, its anterior border is oblique and a little convex, its outer angle rounded and slightly produced, its exposed surface concave; the ischium has its inner border obviously dentate. The length of the buccal cavern (a straight line uniting the inner base of the antero-external tubercle to the outer posterior angle) is 0·98, its breadth (across region of the two antero-external tubercles); outer border of merus ÷ breadth of buccal cavern = 0·48; outer border of ischium ÷ breadth of buccal cavern = 0·60.

Chelipeds slender, about the same degree of stoutness as the 2nd pair of walking legs, but a good deal shorter. Ch.l. ÷ C.l. = 1·15. W.L.1.l. ÷ C.l. = 2·37; W.L.2.l. ÷ C.l. = 1·98; W.L.3.l. ÷ C.l. = 1·64; W.L.4.l. ÷ C.l. = 1·37.

Abdominal segments IV. to VI. are fused (the specimen is female), but grooves representing joints remain very distinct.

Egeria arachnoides (Rumphius)—A.1, p. 223.

Localities:—Coral reefs, Gulf of Manaar, one specimen; south-east of Ceylon, 18 fathoms, one specimen.

Description:—Males—both probably immature.

Tylocarcinus styx (Herbst), 1803—A.1, p. 235.

Locality:—Cheval Paar, two specimens (ovigerous ♀ and young ♀).

Description:—C.l. of the ovigerous female = 16·5.

Paramithrax (Chlorinoides) longispinus (DE HAAN), var. **bispinosus**, nov.

Localities:—Pearl banks, two specimens; coral reefs, Gulf of Manaar, three specimens; off Kaltura, one specimen; Trincomalee, one specimen; south-east of Ceylon, 18 fathoms, one specimen; deep water, off Galle, two specimens.

Description:—C.l. of an ovigerous female = 12·00 (posterior and rostral spines excluded). For characters of the species see A.1, p. 242.

The examples include two ovigerous females, one adult non-ovigerous female, five adult males, one doubtfully adult male, and one young male.

They all differ from DE HAAN's figure ("F. Japon. Cr.," pl. xxiii., fig. 2) in the absence of the most anterior of the three supra-ocular spines. I name them var. *bispinosus*. The "Challenger" specimens included by MIERS under *Paramithrax coppingeri* illustrate a parallel variation in that closely allied species; the *P. coppingeri* specimens of HASWELL have three supra-ocular spines—the "Challenger" examples have two only.

Schizophrys aspera (H. MILNE-EDWARDS, 1834)—A.1, p. 243, pl. XXXV., fig. 1.

Localities:—Off Mutwal Island, two specimens (young ♀ and adult ♂); Jokkenpiddi Paar, one specimen (young ♂); pearl banks, one specimen (young ♂); coral reefs, Gulf of Manaar, one specimen (young ♀).

Description:—C.l. of the adult male = 29.

Cyclax suborbicularis (STIMPSON), 1857—A.1, p. 245.

Locality:—Galle, lagoon, one specimen.

Description:—A young male. It agrees in many points with A. MILNE-EDWARDS' fig. 2 of a young form ('Nouv. Archiv. du Mus.,' viii., p. 236, pl. x., 1872). The orbit, however, is different from his figures, both of young and adult, but as growth-changes are very considerable in this species, I do not exclude my specimen from it.

Stenocionops cervicornis (HERBST), 1803—A.1, p. 248.

Localities:—Jokkenpiddi Paar, one specimen (*b*); Cheval Paar, two specimens (*a*, *c*); pearl banks, Gulf of Manaar, three specimens; Chilaw Paar, three specimens; coral reefs, Gulf of Manaar, four specimens.

Description:—Among the specimens is one ovigerous female, one adult non-ovigerous female, and at least one adult male.

	C.l.	C.b. ÷ C.l.	Rost.spine ÷ C.l.	Sup.-oc.spine ÷ C.l.	Eye stalk ÷ C.l.
(*a*) ovigerous ♀ . . .	34·50	—	0·42	0·41	0·34
(*b*) adult ♀	25·00	0·71	0·35	0·37	0·34
(*c*) adult ♂	42·00	—	—	—	—

The posterior projection is, in all the specimens, blunter and more broadly triangular than in CUVIER's figure in the "Règne Animal" (pl. xxxi., fig. 1), *i.e.*, it is to some extent intermediate between that figure and A. MILNE-EDWARDS' figure of *Stenocionops curvirostris.* Among the present specimens there is nothing further to minimise the somewhat slender specific distinction between *S. cervicornis* and *S. curvirostris.*

In the young examples the tuberculation is less distinct than in the adult, and also the posterior projection of the carapace is less prominent. HENDERSON (p. 343) found in his specimens that the posterior projection was narrower and more upturned in the male than in the female; this does not hold as a distinction between the ovigerous female and the adult male of the present collection.

It would be of interest to re-examine A. MILNE-EDWARDS' "type"-specimens of *Stilbognathus* for the purpose of verifying the generic distinction between that genus and *Stenocionops.*

Pseudomicippa nodosa, HELLER, 1861—'S.B. Ak. Wien,' xliii., p. 303, pl. i., fig. 3.

Locality:—Muttuvaratu Paar, Gulf of Manaar, one specimen.

Description:—An ovigerous female. C.l. (without front) = 9·50. It is labelled "crab with black sponge." The sponge completely covers the dorsum of the carapace.

Remarks.—For remarks on the limits and affinities of the genus, see CALMAN (p. 40). He favours the generic separation of *P. nodosa* and *P. varians* on the grounds that (1) the rostrum is very strongly deflexed in *P. nodosa*—not so in *P. varians*; (2) the anterior angle of the orbit is produced into a long spine in *P. nodosa*—not so in *P. varians*; (3) the distal tooth of the basal antennal joint is directed obliquely forwards in *P. nodosa*—outwards in *P. varians.* With the additional evidence of the present specimen and of some specimens in the British Museum, I find it inadvisable to separate the species generically. Thus the present example combines the strongly deflexed rostrum of *P. nodosa* with an anterior orbital angle which is only drawn out a little more than in *P. varians.* In the British Museum I find specimens which show some variation in the degree to which the rostrum is deflexed. The third distinction does not appear to me to be one of generic value. In the present specimen the antennal angle is *nodosa*-like in pointing obliquely forwards, though it differs from HELLER's figure—the latter agreeing with dried Red Sea specimens in the British Museum. This genus is new to the Indian fauna.

Micippa philyra (HERBST), 1803—A.1, p. 249.

Localities:—Coral reefs, Gulf of Manaar, four specimens (*a*, *b*, *d*, *e*); off Mutwal Island, one specimen (*c*).

Description:—

	C.l.	C.b. ÷ C.l.	Antenn.l. ÷ C.l.	2nd sgt.ant.l. ÷ R.b.	Arm.l. ÷ C.l.	H.l. ÷ C.l.	H.b. ÷ H.l.
(*a*) ovig. ♀.	23·00	0·87	0·43	0·25	0·33	0·24	0·36
(*b*) adult ♂.	20·00	0·87	0·50	0·34	0·39	0·35	0·61
(*c*) adult ♂.	22·50	0·87	0·51	0·28	0·37	0·29	0·46

ALCOCK records a male dimorphism in this species, believing it to be comparable with the phenomenon recorded among the beetles. Dimorphism is illustrated by the males (*b*) and (*c*) above, but it is noteworthy that it is the larger example (*c*) which has the more female-like form of cheliped, while the smaller one (*b*) has a cheliped of strongly marked male character. This seems to be a case of facultative dimorphism, specimens (*b*) and (*c*) being respectively "breeding" (perhaps "low") and "non-breeding" ("middle") forms.

In length of mobile portion of the antenna, the two adult males come under var. *mascarena*. In the ovigerous female this measurement is larger than in females of the species as described by ALCOCK.

The surface of the post-cardiac region of the carapace varies in character. It is smooth in (*b*), it has a trace of granulation in (*a*) which is rather more obvious in (*c*) and (*d*) and quite fairly developed in (*e*). The vertical portion of the carapace plus the rostrum has in (*a*) and (*b*) a flattened surface, in (*c*) the lateral pair of lobes curve forward somewhat, so that the anterior surface is concave from side to side. Example (*d*) is intermediate.

All the specimens possess the following spines on the lateral margins of the carapace:—Three spines on hepatic border, one (a small tubercle) on the antero-lateral branchial border, three on branchial border in the region of the epibranchial angle. In addition, the two males (*b*) and (*c*) have two spines, both obsolescent in (*c*), and anterior one so in (*b*), on the border between the epibranchial angle and the true posterior margin of the carapace, just above the granular ridge.

Micippa thalia (HERBST), 1803—A.1, p. 251.

Localities:—Off Mutwal Island, two specimens; coral reefs, Gulf of Manaar, seven specimens; Cheval Paar, two specimens; pearl banks, Gulf of Manaar, 18 specimens.

Description:—The specimens fall into two groups, corresponding with the figures of A. MILNE-EDWARDS ('Nouv. Archiv. du. Mus.,' viii., p. 238, pl. xi., fig. 1, 1872) and of HERBST ('Krabben,' iii., pl. lviii., 3) respectively. Twenty-eight of them agree very fairly with the former and one with the latter. It may be noted that forms resembling the "type"-specimen of this species have been seldom recorded.

A. The following is the arrangement of the spines in 20 adult individuals of the first variety. The number which occurs in each region with maximum frequency is printed in heavy type.

Dorsal Surface of Supra-ocular Hood.—Fourteen specimens have a mere indication of one granule on each hood, three have a more obvious granule, and three have a small blunt spinule.

Dorsal Surface of Branchial Region.—Nineteen specimens have two spines on each side (may be written **2·2**), one specimen has one on the left side and two on the right side (may be written 1·2).

Gastric Region.—Nineteen specimens have **2** median spines (reduced in one specimen), and one has a spine and a granule.

Upper Margin of the Orbit behind the Supra-ocular Spine.—All have **3·3**, of which the third is the largest.

Hepatic Margin.—All have **3·3**.

Branchial Margin.—Fifteen specimens have **5·5**; one has 4·5; one has 5·6; one has 5·7; one has 6·6; one has 6·7.

B. Specimen (*a*), an ovigerous female, differs from the other examples in the collection in various ways, as set forth below, and goes with HERBST's "type"-specimen of the species:—

(1) The rostral spines are more strongly curved outwards at their tips (see HERBST's figure).

(2) The hepatic regions are not so much pinched in dorsally.

(3) The under surface of the basal antennal segment is smooth and its antero-lateral angle is produced into a longer, more definite spine, the border of which is entire (in the A-specimens the outer half of the under surface of the basal antennal segment is more or less granular, and its antero-lateral angle is produced to form a triangular and less spiniform infra-orbital projection with a crenulate border).

(4) The arrangement of spines is different.

Dorsal surface of the supra-ocular hood of either side has a definite blunt spine. The anterior and posterior angles of the eave form blunt projections.

Dorsal surface of branchial region of each side has three arranged in a longitudinal row; of each row the two anterior members are spinules merely, the posterior one is a well-developed spine. There is also a denticle on the branchial region which would lie about one-third way along a line drawn from the large spine just named to the middle point of the gastro-cardiac groove.

Gastric Region.—Two not very obvious median tubercles.

Upper margin of orbit behind the supra-ocular eave of either side has three spines, the middle one much the strongest.

Hepatic Margin, 0.

Branchial Margin, 7 8 (on the left side the anterior four are granules, the three posterior are larger; on the right side the anterior five and the seventh are granules; the sixth and eighth are larger).

Posterior Border of Carapace.—A pair of spines close together, one on either side of middle point.

Of the above particulars the form of the rostral lobes, the strong development of the middle one of the three supra-orbital spines, the presence of the two spines of the posterior border, and the crenulate margin of the antero-lateral spiniform production of the basal antennal segment, are conveniently conspicuous characters.

Micippa margaritifera, HENDERSON, 1893—A.1, p. 253; A.Invest., pl. xxxv., fig. 3.

Localities:—Jokkenpiddi Paar, two specimens (ovigerous ♀); Aripu coral reef, one specimen (ovigerous ♀); Gulf of Manaar, three specimens (one adult ♂ and two young ♂).

Description:—All the specimens have their walking legs folded beneath them, in which position the expanded meropodites, together with the retroflected tip of the rostrum, enclose a space beneath the body and help to give the animal a rounded ball-like appearance. The space referred to is widely open posteriorly, where a considerable squarish gap is left between the members of the last pair of walking legs. Slits remaining between the successive legs of either side are more or less occluded by fringes of hair which border the appendages.

A variable character to note is the size of the innermost of the three branchial tubercles; in none of the specimens, however, does this exceed two-thirds of the size of the two outer tubercles.

Micippa parca, Alcock, 1895—A.1, p. 253; A.Invest., pl. xxxv., fig. 4.

Locality:—Coral reefs, Gulf of Manaar, one specimen.

Description:—C.l. = 11·25 (a straight line uniting base of the median posterior spinule with the middle point of a faint inter-ocular groove); C.b. ÷ C.l. = 0·98; Inter-orbital b. ÷ C.l. = 0·58 (inter-orbital breadth is measured by a straight line uniting the notches made by the junction of pre-ocular spinule with supra-ocular eave of either side); breadth between the bases of the mobile portions of the antennæ ÷ C.l. = 0·36; Arm l. ÷ C.l. = 0·42; H.l. ÷ C.l. = 0·38.

The present specimen of *M. parca* differs from *Micippa margaritifera*, to which it is closely allied, in the following particulars:—

(1) The median region of the posterior border of the carapace is occupied by a group of spinules (three in a transverse row) instead of by a single pearl-like tubercle; (2) the post-cardiac cluster of granules and the cluster on either side of it are but slightly indicated; (3) the gastro-cardiac groove is more distinct; (4) the difference in size between the inner branchial spinule (a mere rudiment—not a real spinule) and the two outer ones (well developed) is more marked; (5) the meropodites of the walking legs are still more expanded, which is largely due to the greater foliation of their posterior borders; their distal borders are finely and fairly regularly toothed; (6) the walking legs are less hairy; (7) the upper portion of the outer surface of the hand is granular.

Lambrus (Lambrus) longimanus, Leach, 1815—A.1, p. 260.

Localities:—Galle, three specimens (*c*, *e*, *g*); pearl banks, Gulf of Manaar, four specimens (*a*, *b*, *d*, *f*).

Description:—	(*a*) young ♀.	(*b*) young ♀.	(*c*) young ♂.	(*d*) young ♂.	(*e*) young ♂.	(*f*) adult ♂.
C.l. (rost. included)	11·50	17·50	9·75	12·00	17·50	25·50
C.b. ÷ C.l. . . .	1·04	1·01	1·50	1·00	1·11	1·12
Ch.l. ÷ C.l. . . .	3·22	3·31	3·10	3·25	3·64	4·40

In the young male (*e*) the median lobe of the rostrum is reduced to a declivous denticle of approximately the same length as the denticular lateral lobes, which are in this example more strongly developed than usual. Considerable growth-changes in cheliped length for males are indicated by the measurements given above.

Lambrus (Platylambrus) carinatus, H. M.-Edw., 1834—A.1, p. 263.

Localities:—Coral reefs, Gulf of Manaar, four specimens; off Mutwal Island, one specimen; pearl banks, Gulf of Manaar, nine specimens.

Description:—The specimens include four ovigerous females (incl. *f–h*), six non-ovigerous females (incl. *a–e*), and four adult males.

	(*a*) ♀.	(*b*) ♀.	(*c*) ♀.	(*d*) ♀.	(*e*) ♀.	(*f*) ♀.	(*g*) ♀.	(*h*) ♀.	(*i*) ♂.	(*j*) ♂.	(*k*) ♂.	(*l*) ♂.
C.l. . . .	8·75	11·00	11·25	13·00	13·00	9·25	11·25	11·50	9·25	9·25	11·25	11·25
Arm.l. ÷ C.l.	0·80	0·77	0·82	0·65	0·73	0·73	0·73	0·72	0·89	0·86	0·84	1·02
H.l. ÷ C.l. .	0·94	0·93	1·02	0·83	0·92	0·94	0·87	0·83	0·94	0·95	0·96	1·11

Some characters exhibit high variability:—

(1) The mid-dorsal teeth may be large and laterally compressed, or they may be smaller and peg-like. In one example the most anterior of the three is obsolescent.

(2) The branchial ridges vary in number and in character. There may be on each side a single sharp carina, a single granular ridge, a pair of granular ridges, or a pair of smooth ridges; the second ridge may be very inconspicuous, and there may be a granule or two in the middle of such a faint ridge.

(3) The carapace may be free from granules, or granules may be present, but confined to the depression on either side of the cardiac region, or a few may extend over the branchial region also.

Remarks.—I include *Lambrus holdsworthi*, Miers, as a synonym. A. Milne-Edwards' brief diagnosis of *L. carinatus* applies to Miers' "type"-specimens of *L. holdsworthi* in the British Museum. Some of my specimens, which I group as var. *holdsworthi*, agree with the latter; others agree with Alcock's description of his examples of *L. carinatus*—I call these var. *alcocki*.

In var. *alcocki* there is a single carinate ridge on each branchial region; in var. *holdsworthi* there are two low granular ridges.

In var. *alcocki* the mid-dorsal tubercles are more prominent and are laterally compressed; in var. *holdsworthi* they are more peg-like and less prominent.

In var. *alcocki* the carapace tends to be free from granules; a fair number of granules are present in var. *holdsworthi*.

The variations presented by the present forms in regard to median dorsal teeth and branchial ridges—which I have referred to above—minimise or break down two of the distinctions which Alcock draws between his specimens of *L. carinatus* and of *L. prensor*. All my specimens agree with those described by Alcock in the character of the sub-orbital lobe (bilobed, the inner lobe rounded and not produced into spine nor seen in dorsal view) and of the anterior borders of the meropodites of the walking legs (serrate).

Lambrus (Rhinolambrus) contrarius (HERBST), 1804—A.1, p. 266.

Localities:—Coral reefs, Gulf of Manaar, four specimens (*b*, *c*, *g*, *h*); pearl banks, Gulf of Manaar, four specimens (*a*, *e*, *i*, *d*); Chilaw Paar, one specimen (*f*).

Description:—	(*a*) yg. ♀.	(*b*) yg ♀.	(*c*) yg. ♂.	(*d*) yg. ♂.	(*e*) yg. ♂.	(*f*) yg. ♂.	(*g*) ad. ♂.
C.l. (rost. included) .	11·50	24·00	9·50	18·00	19·75	22·75	38·75
C.b. ÷ C.l.	0·89	0·92	0·84	0·92	0·90	0·89	0·93
Ch.l. ÷ C.l.	2·17	2·30	2·18	2·36	2·34	2·58	2·86

The growth-changes in ratio Ch.l. ÷ C.l. will be noted.

Lambrus (Rhinolambrus) longispinis, MIERS, 1879—A.1, p. 266.

Localities:—Pearl banks, Gulf of Manaar, eight specimens; coral reefs, Gulf of Manaar, three specimens.

Description:—The specimens are all young—four of them males. The C.l. of the latter varies from 10·5 to 16; the scanty evidence suggests that no great change in the ratio Ch.l. ÷ C.l. accompanies this growth. There is at this size no very obvious establishment of sexual dimorphism.

	(*a*) yg. ♀.	(*b*) yg. ♀.	(*c*) yg. ♀.	(*d*) yg. ♀.	(*e*) yg. ♂.	(*f*) yg. ♂.	(*g*) yg. ♂.	(*h*) yg. ♂.
C.l. (rost. included) .	12·25	12·25	12·50	19·25	10·50	11·25	12·50	16·00
C.b. ÷ C.l.	0·94	0·98	0·92	1·00	0·98	0·94	0·92	0·97
Ch.l. ÷ C.l. . . .	2·14	2·16	2·06	2·39	2·24	2·11	2·08	2·22

The present specimens agree closely with ALCOCK's example and confirm his belief that the species is more nearly related to *L. contrarius*, HERBST, than to *L. validus*, DE HAAN. Variability is low among the above examples for most characters; the shape of the rostrum is an exception. The latter is acutely pointed in most of the examples, narrowing rather suddenly a short distance in front of the eyes; in one specimen no such sudden narrowing occurs; in another there are two small lateral lobes near the apex; other examples are intermediate.

Lambrus (Rhinolambrus) pelagicus, RÜPPELL, 1830—A.1, p. 267.

Localities:—Coral reefs, Gulf of Manaar, one specimen (young ♀); off Mutwal Island, one specimen (adult ♂).

Description:—

Young ♀ . . . . C.l. = 7·50; C.b. ÷ C.l. = 1·00; Ch.l. ÷ C.l. = 2·63.
Adult ♂ . . . . C.l. = 16·00; C.b. ÷ C.l. = 1·02; Ch.l. ÷ C.l. = 3·16.

Lambrus (Aulacolambrus) hoplonotus, ADAMS and WHITE, 1848—A.1, p. 273.

Localities:—Pearl banks, Gulf of Manaar, four specimens (*a*, *b*, *e*, *g*); coral reefs, Gulf of Manaar, three specimens (*c*, *d*, *f*).

Description :—	(*a*) young ♀.	(*b*) young ♀.	(*c*) adult ♀.	(*d*) young ♂.	(*e*) young ♂.	(*f*) adult ♂.
C.l. . . .	7·00	13·00	15·00	8·50	9·25	13·25
Ch.l. ÷ C.l. .	2·75	2·62	2·77	2·71	2·65	2·57

The above series present but little variation among themselves. They come under var. *planifrons*, with some approach also to var. *granulosus*. Thus adult female (*c*) bears considerable resemblance to MIERS' specimen of var. *planifrons* in the British Museum, excepting that the spines of the posterior border of the hand are neither so flattened nor so broad, *i.e.*, more as in var. *granulosus*, and in the same example the apex of the rostrum is a further point of resemblance to the latter variety.

The number of spines on the outer border of the hand is fairly constant, that of the teeth of the inner border more variable. Thus in all the specimens there are on the outer border of the hand six large smooth spines and four smaller alternating ones (the most distal of the alternating spines is in (*b*) larger than in the others, and in (*f*) it is almost the size of the larger ones); the inner border bears from eleven to thirteen teeth.

Lambrus (Aulacolambrus) curvispinis, MIERS, 1879—A.1, p. 274.

Localities :—Galle, one specimen (adult ♀); Trincomalee, one specimen (ovigerous ♀).

Description :— Adult ♀ . . . . . . C.l. = 21·00; Ch.l. ÷ C.l. = 3·07.
Ovigerous ♀ . . . . C.l. = 24·00; Ch.l. ÷ C.l. = 3·15.

Lambrus (Parthenolambrus) calappoides (ADAMS and WHITE), 1847—A.1, p. 275.

Localities :—Coral reefs, Gulf of Manaar, nine specimens (*a* to *i*); Trincomalee, one specimen (*j*).

Description :—

	(*a*) yg. ♀.	(*b*) yg. ♀.	(*c*) yg. ♀.	(*d*) ad. ♀.	(*e*) ♂.	(*h*) ♀.	(*i*) ♀.	(*f*) ♂.	(*g*) ♂.	(*j*) ♂.
C.l. . . .	9·50	14·50	15·75	19·25	19·00	14·50	17·50	8·00	14·00	16·75
Ch.l. ÷ C.l. .	1·84	1·84	—	—	2·09	1·66	1·71	1·97	1·96	2·04

The present examples show a good deal of variation about two centres; the two groups I call var. *alcocki* (corresponding more or less with ALCOCK'S description of *L. calappoides*) and var. *confragosus* (= *L. confragosus*, CALMAN).

I have seen the "type"-specimens of *L. confragosus* in the British Museum, and find that with the aid of the present forms and of the British Museum examples of *L. calappoides* I can arrange a transitional series which unites the two forms named.

Differences between the two varieties are :—(1) The post-ocular notch is well indicated in var. *confragosus*; absent in var. *calappoides*. (2) The lateral hepatic region is prominent, dentiform and compressed in var. *confragosus*; little prominent and rounded in var. *calappoides*. (3) The post-hepatic notch is well indicated in var. *confragosus*; slightly so in var. *calappoides*. (4) The median dorsal spines are prominent and pointed backward in var. *confragosus*; in var. *calappoides* they are represented by inconspicuous tubercles. (5) The tubercles of the carapace are granulated in var. *confragosus*; in var. *calappoides* they are more or less smooth, low and obsolescent and the general surface of the carapace tends to be pitted and uneven, producing what Alcock aptly terms a "boiled" appearance. (6) The postero-lateral angles are angular and spine-bearing in var. *confragosus*; rounded in var. *calappoides*. (7) The greatest carapace-breadth is in var. *confragosus*, across the region of the postero-lateral angle; in var. *calappoides* it is anterior to this region. (8) There are two large tubercles on the inner border of the arm in var. *confragosus*, one about one-third from its distal end and the other about one-third from its proximal end. The latter is the larger, a good deal compressed from above downwards, and has a small tubercle at its base; in var. *calappoides* there are traces only of both. (9) The rostrum is obliquely deflexed in var. *confragosus*; vertically deflexed in var. *calappoides*.

The above characters show a fair degree of correlation; the transitional forms tend to combine intermediate conditions of most of them. The correlation is, however, by no means perfect, *e.g.*, a "Challenger" female from "off Tongatabu," in the British Museum, combines with most characters of var. *calappoides* a considerable development of the median dorsal spines.

Lambrus (Parthenolambrus) beaumonti, Alcock, 1895—A.1, p. 276.

Localities:—Coral reefs, Gulf of Manaar, three specimens (*a*, *d*, *e*); south of Galle, deep water, one specimen (*b*); Gulf of Manaar, deep water, one specimen (*c*).

Description:—	(*a*) young ♀.	(*b*) ovigerous ♀.	(*c*) ovigerous ♀.	(*d*) adult ♂.	(*e*) adult ♂.
C.l.	6·75	7·75	8·00	9·25	10·00
C.b. ÷ C.l. . . .	1·11	1·06	1·09	1·00	1·07
Ch.l. ÷ C.l. . . .	1·74	—	1·91	2·46	2·90

The difference in ratio Ch.l. ÷ C.l. between the two males—both apparently adult—is interesting. In the present forms there is much variation in the size of gastric and cardiac tubercles. They are both absent in the young female example (*a*), they are both rudimentary in the larger of the two males (*e*), there is a blunt tubercle on each of these regions in ovigerous female (*b*), finally, in the smaller male (*d*), there is a stout spine on the gastric eminence, and a still stouter one on the cardiac.

Lambrus (Parthenolambrus) harpax, Adams and White, 1848—A.1, p. 278.

Locality:—Pearl banks, one specimen.

Description:—A male, apparently young. C.l. = 14·25; Ch.l. ÷ C.l. = 2·79. This individual, belonging to a highly variable species, agrees with Alcock's description of the Indian Museum specimen from the Andamans, excepting that the index Ch.l. ÷ C.l. is considerably higher.

Cryptopodia fornicata (Fabricius), 1793—A.1, p. 282.

Locality:—Pearl banks, Gulf of Manaar, one specimen.

Description:—A young male, C.l. (rostrum included) = 18·0; C.b. ÷ C.l. = 1·46.

Cryptopodia pan, n. sp.—Plate I., fig. 6, and text-fig. 4.

Localities :—Coral reefs, Gulf of Manaar, one specimen (adult ♀ = *a*) ; west of Periya Paar, 17 to 24 fathoms, two specimens (young ♀ = *b* ; young ♂ = *c*).

Description of female (*a*) :—C.l. (rostrum included) = 22·5. Carapace broadly triangular ; antero-lateral margin slightly sinuous, smooth in its anterior third and lacinated in its posterior two-thirds ; the posterior and postero-lateral margins form a single strong curve, the edge of which shows faint traces of crenulation ; the surface of the carapace is fairly smooth to the naked eye, but some obsolescent granules crown the prominences, and there are a few also scattered on the posterior slope ; there are some

Fig. 4. *Cryptopodia pan*, n. sp.

pits, obvious to the naked eye, on the cardiac prominence and on the prominence on either side of it ; the whole surface (as also that of the chelipeds) is dull, which is seen under lens to be due to a fine pitting which covers it ; the triangular depression is shallow ; the oblique branchial ridge of either side is much swollen and rounded ; the rostrum is prominent, obtusely pointed, rather longer than broad, and has the anterior part of the edge faintly crenulate. The carapace is produced beyond the abdomen posteriorly for a distance equal to 0·08 the carapace length. C.b. ÷ C.l. = 1·43.

The third pair of maxillipeds form together a striking bulge. This is due in part to curvature of the appendage, but the most important factor is an actual thickening of the substance of the ischium. The exposed surface of the ischium is glazed, its outer two-thirds particularly are thickened, its inner one-third is ornamented with a double row of granules. The merus is granular on its proximal portion ; distally it is smooth beneath a pubescence. The exopodite is, for the most part, concealed in ventral view by the ischial bulge.

The chelipeds are much as in *Cryptopodia fornicata* (see A.1, p. 282), but the surface is dull, not glazed ; the armature is not so sharp ; the outer border of the wrist has no tooth, but its blunt outer angle is well developed, so that its outer border is made up of two borders of approximately equal length set at right angles to each other. The meropodites of all the walking legs have their upper border, and those of the 1st and 4th pairs their lower border also, armed with a spiniform crest ; the other segments are a little compressed from side to side, but not carinate.

Differences from *Cryptopodia fornicata* are :—(1) The duller surface of the carapace and chelipeds (due largely to fine pitting); (2) the more rounded surfaces of the prominences, and less sharply cut armature ; (3) the angular wrist ; (4) form of rostrum ; and (5) the swollen external maxillipeds. The last-named particular separates the new species at a glance from any other member of the genus known to me.

Heterocrypta petrosa, KLUNZINGER, 1906—(K., p. 53, pl. ii., figs. 9*a*, *b*).

Locality :—Gulf of Manaar, one specimen (*a*) ; off Mutwal Island, one specimen (*b*).

Description :—	C.l.	C.b. ÷ C.l.	Ch.l. ÷ C.l.	Rt.H.b. ÷ Lt.H.b.
(*a*) Ovigerous ♀. . .	13·25	1·47	2·00	1·50
(*b*) Adult ♂	18·00	1·57	2·44	1·35

In the female specimen the true posterior border of the carapace forms a convex bulge. The carapace regions are more rounded in the male specimen than in the female. The latter variation is probably not concerned with sex, for KLUNZINGER's figure of a male bears a stronger resemblance to my female than to my male example in this respect.

Remarks.—This species falls decidedly into the genus *Heterocrypta*, as defined by ALCOCK, but, having conformed so far, its further resemblances are rather to *Cryptopodia spatulifrons* than to any *Heterocrypta*. Such resemblances concern (1) general appearance of cheliped (no crest, however, on outer surface of wrist); (2) general shape of posterior border of the animal (*i.e.*, true posterior border of carapace together with posterior border of clypeiform expansions); (3) sculpture of exposed surface of the external maxillipeds, of uncovered portions of thoracic sterna, and of the abdominal terga.

On its part, *Cryptopodia spatulifrons* (as also *C. dorsalis*) makes some approach to *Heterocrypta* in the slight posterior expansion of its carapace—much slighter, for example, than in *Cryptopodia fornicata*.

Zebrida adamsi, WHITE, 1847—A. 1, p. 287.

Localities :—Gulf of Manaar, one specimen ; south of Manaar Island, two specimens.
Description :—C.l. of an adult male (rostral lobes included) = 8·0.

Harrovia albolineata, ADAMS & WHITE, 1848—(' "Samarang" Zool.,' Crust., p. 56).

Localities :—South of Manaar Island, hauls 3, 4 and 5, two specimens (adult ♂, adult ♀) ; pearl banks, Gulf of Manaar, one specimen (young ♀) ; coral reefs, Gulf of Manaar, one specimen (ovigerous ♀).

Description :—C.l. of ovigerous female = 7·00.

CYCLOMETOPA.

Carpilodes tristis, DANA, 1852—A.3, p. 82.

Locality :—Galle, lagoon, three specimens (one adult ♂, two young ♂).
Description :—C.l. of adult male = 10·0.

Carpilodes pediger, ALCOCK, 1898—A.3, p. 83 ; A.Invest., pl. xxxvi., fig. 4, ♀.

Localities :—Off Mutwal Island, two specimens (one adult ♂ = *a*, one young ♂ = *b*) ; west of Periya Paar, 17 to 24 fathoms, one specimen (adult ♀ = *c*) ; pearl banks, Gulf of Manaar, three specimens (adult ♂ = *d*, ovigerous ♀ = *f*, young ♀ = *e*).
Description :—C.l. of ovigerous female = 5·25.

The third of the four antero-lateral teeth of the carapace may be continuous with the lobe 4L of DANA's nomenclature as in (*b*), it may be separated therefrom by a faint groove as in (*a*), (*d*), and (*e*), or by a more evident groove, agreeing with ALCOCK's figure, as in (*f*).

Carpilodes cariosus, ALCOCK, 1898—A.3, p. 86 ; A.Invest., pl. xxxvi., fig. 7, ♀.

Localities :—Muttuvaratu Paar, 6 to 9 fathoms, one specimen (adult ♂ = *a*) ; Gulf of Manaar, three specimens (young ♂ = *b*, two adult ♀ = *c*, *d*) ; Jokkenpiddi Paar, one specimen (adult ♀ = *e*).
Description :—C.l. of an adult female = 4·50.

There is variation in lobulation of carapace. The lobe 3M (DANA's nomenclature) is entire in all except the young male (*d*), where a groove separates the narrow anterior limb from the posterior broad part. Lobe 2M is completely divided by a longitudinal groove in all except the adult female (*b*), in which the groove is incomplete posteriorly. The outer division of 2M is entire in adult females (*b*) and (*e*) ; its inner border is notched in adult male (*a*) on both right and left sides of the animal ; in adult female (*c*) its inner border is notched on the lobe of the right side of the animal, while on the lobe of the left side there is an indication of a transverse groove ; finally, in young male (*d*) a distinct transverse groove divides the lobe of each side. Lobe 5L is entire in all except adult male (*a*), in which it is divided obliquely. Lobes 2R, 1R, and S are fused in adult male (*a*) and adult females (*b*, *c*) ; in young male (*d*) and in adult female (*e*) there is an indication of their separation by grooves. Variation is not always bilaterally symmetrical. The degree of sub-division of the lobules is the most apparent difference between the present species and *C. monticulosus*. The variations above noted are within the limits allowed to the species by ALCOCK.

Atergatis integerrimus (LAMARCK), 1818—A.3, p. 95.

Locality :—Galle, lagoon, one specimen (very small young).

Lophactæa anaglypta (HELLER), 1861—A.3, p. 102.

Locality :—Gulf of Manaar, two specimens (both males). C.l. = 16·0.

(See RATHBUN, 'Proc. Biol. Soc. Wash.,' xi., p. 159, for *Platypodia* as generic name.)

Zozymus gemmula, DANA, var. **ceylonica**, nov.—Plate I., fig. 7.

Locality :—Trincomalee, three specimens (*a*, *b*, *c*).

Description :—Two males, one of which appears to be adult, and one female, which, though non-ovigerous, has a broad abdomen loosely applied to the sternum and may well be adult. Except in regard to the walking legs, the specimens show a very close similarity in most respects to those described and figured by DE MAN under *Zozymus gemmula*, DANA (DE MAN, 'Abh. Senck. Ges.,' xxv., p. 588). However, the walking legs show considerable differences. The following is a description of these appendages in my specimens :—The four pairs of the same individual are very similar. Dorsal border of the meropodite faintly denticulated. Carpopodite and propodite have well-developed dorsal crests ; that of the carpopodite is deeply fissured about the middle of its extent (a little more distal than the middle). The carpopodite has a longitudinal groove on its posterior surface ; a transverse groove crosses this, continuing the line of the incision of the crest, and marking off a more or less triangular distal area of the segment. The joint between carpopodite and propodite is markedly oblique. The lower border of the propodite curves upward obliquely, approaching the upper border, so that the segment is more or less triangular in shape. The upper part of the flattened posterior surface of the propodite presents a triangular excavation filled with hair. The dactylopodite is narrow and slightly curved, terminating in a dark brown spinule.

The points in which the walking legs differ from DE MAN'S description and figure of those of *Z. gemmula* concern : (*a*) the similarity of the members of the four pairs—in DE MAN'S specimens they show considerable differences ; (*b*) the upper border of the meropodites ; (*c*) the free edges of the dorsal crests of carpopodite and propodite form a continuous even line ; (*d*) the position of the fissure of the upper crest of the carpopodite ; (*e*) the transverse grooves of the posterior face of the carpopodite ; (*f*) the dorsal border of the propodite (for detail compare with DE MAN'S figure).

Further differences from DE MAN'S specimens are :—(1) The most posterior tubercle on the dorsal border of the hand is more prominent, it attracts notice with its flattened surface and its backwardly and inwardly projecting sharpened edge ; (2) the anterior border of the front is a little more horizontal (see figures)—DE MAN found that the front was more prominent in the male than in the female, this does not hold for my specimens ; (3) the ratio of fronto-orbital breadth divided by carapace length is greater in both sexes ; (4) the granules of the outer surface of the fixed finger are more definitely arranged in two longitudinal rows ; (5) they are smaller : it is possible, however, that they are not fully grown.

The value of distinctions (2), (3), and (4) appears to me very doubtful. I only emphasise particularly (1) above, together with the condition of the walking legs, and for the present consider this form a variety of *Z. gemmula*.

I may note that 2M is completely divided into two by a longitudinal groove both in DE MAN'S *Z. gemmula* and in the new variety, while DANA describes it as only partly divided. Another point is that in the present specimens the hollowing of the finger tips is not obvious; I should describe the fingers as blunt merely, DE MAN'S figure indeed represents them very well. A point in the present specimens not mentioned by DE MAN is the presence of a curious little tuft of brown hair (seen well with a lens) which rises from a groove running along the inner surface of the fixed finger.

	(*a*) adult ♂.	(*b*) young ♂.	DE MAN'S ♂.	(*c*) adult ♀.	DE MAN'S ♀.
C.l.	7·25	5·50	14·25	6·25	10·00
C.b. ÷ C.l.	1·48	1·45	1·47	1·48	1·53
Fronto-orbital b. ÷ C.l.	0·93	1·00	0·81	1·00	0·90

Demania, n. gen.

Carapace pentagonal, moderately convex antero-posteriorly, flattened from side to side in its posterior half; the regions well delimited and subdivided into numerous lobules, the surface of which is smooth. The antero-lateral borders are blunt, cut by shallow grooves into four lobes: the border is faintly continued below the eye to the antero-lateral angle of the buccal cavern; the postero-lateral borders are straight and strongly convergent.

Front prominently bilobed, its breadth about one-third the greatest carapace-breadth, its plane is a continuance of the postero-anterior curve of the dorsum of the carapace. Orbits large, the three suture lines near the outer angles distinct; eyes on short thick stalks.

The antennules fold in a transversely oblique direction, making an angle of 40° (approximately) with a transverse line; the inter-antennulary septum is broad. Basal joint of antenna not quite as long as the posterior border of one of the antennulary fossæ; as a whole it stops short of the orbital hiatus, but its antero-external angle is produced into the latter; its antero-internal angle touches a downward projection of the front; the flagellum is short (less than major diameter of orbit), lodged in the orbital hiatus.

No ridges define efferent branchial channels in anterior portion of buccal cavern.

Merus of external maxillipeds pointed anteriorly, its borders sloping obliquely backwards, making together an angle of 90° (approximately). Chelipeds equal in female (male not known); fingers not hollowed at tips. Walking legs with the upper border of the merus, carpus and propus and the lower border of merus and propus cristate.

Abdomen of male not known.

Carapace length (including rostral lobes) of only specimen known is 32·50 millims.

This new genus bears considerable resemblance in general appearance to the genus *Zozymus*; the sculpture of its carapace and chelipeds, and its cristate walking legs, are reminiscent of *Zozymus æneus*. It presents, however, many points of difference from that genus.

These differences concern :—(1) Plane of the posterior half of the dorsal surface of the carapace; (2) antero-lateral borders of the carapace; (3) direction in which the folded antennules lie; (4) antero-external angle of the basal antennal segment; (5) shape of anterior part of merus of external maxillipeds; and (6) finger tips.

The form of the antero-lateral borders of the carapace is, moreover, a point of difference from ALCOCK's description of the Alliance in which he places *Zozymus, i.e.*, Alliance Zozymoida (see A.3, p. 77); the character of the walking legs is a link with this Alliance. The sub-orbital continuation of the antero-lateral borders of the carapace, and the production of the outer angle of the basal antennal joint into the orbital hiatus, are links with the Alliance Euxanthoida. The pentagonal form of the carapace is a point of similarity to the Alliance Halimedoida. (See NOBILI for figure of *Halimede hendersoni*—N., p. 123, pl. vi., fig. 31.)

Demania splendida, n. sp.—Plate I., fig. 8, and Plate II., fig. 1.

Locality :—Trincomalee, a single non-ovigerous, but probably adult, female.

Description :—Carapace roughly pentagonal, with prominent deeply notched front and rounded epibranchial angles; the antero-lateral borders are convex, the postero-lateral borders concave, the posterior border slightly concave.

The general surface is convex fore and aft; it is also convex from side to side —quite obviously so in the hepatic regions, only slightly so in the branchial regions. The regions are well delimited by pubescent grooves, and are themselves broken by similar grooves into numerous lobules; the latter are more numerous and more distinctly demarcated in the posterior half; in the anterior half they are often more or less confluent, the separating grooves dying away. The lobules are all smooth and polished, and the grooves are found on removal of the pubescence to be smooth. The carapace has thus a general resemblance to that of *Zozymus æneus*.

The front is considerably produced and deeply divided to form two prominent bluntly pointed lobes: at the base of the outer border of each of the latter the outer angle of the front is produced as a distinct, blunt, forwardly directed tooth. Frontal breadth $\div$ C.l. = 0·31; length of frontal lobe (inner border) $\div$ frontal breadth = 0·27.

Orbital border smooth. Upper border has tumid inner portion. There are three fissures—one a little to outer side of the middle point of the upper border, the other two are in the neighbourhood of the outer angle, one above and one below. The inner orbital angles, both upper and lower (the latter a blunt tooth), are prominent; the intervening hiatus receives only a narrow projection of the outer angle of the basal antennal segment.

Antero-lateral border of carapace rounded; the actual edge shows a slight sharpening, and there is a suggestion of its continuance anteriorly below the orbit to the antero-external angle of the buccal cavern. It is divided by grooves into four sufficiently distinct, but little-prominent, lobes; the groove between the 1st and 2nd lobe is the least distinct.

Under surface of carapace smooth and polished, and lobulated as dorsal surface. A distinct groove runs obliquely backward from the region of the green gland aperture, to end at the border of the carapace just above the base of walking leg 4. There is a patch of hair above the base of the chelipeds, and a fringe follows the edge of the carapace above the bases of the walking legs, and skirts abdomen.

Thoracic sternal region is in its exposed portion broken by transverse pubescent grooves into regions appropriate to the segments bearing chelipeds and four walking legs. There is some tendency to subdivision of these regions (see figure), and the surfaces are polished and show some dimples.

Abdomen.—The seven abdominal terga are separate. Tergum VI. is about twice as long as any of the first five (which are subequal in length) and of approximately the same length as tergum VII. In addition to a little dimpling, each tergum is traversed by a pubescent transverse groove, before and behind which, in the case of VI., is a slightly marked additional groove. The abdomen is well fringed with hair.

Antennules fold obliquely—making an angle of 40° (approximately) with a horizontal line.

Antennæ.—Basal antennal segment, as a whole, falls short of the inner orbital angles: its outer angle, however, is produced into the hiatus; its inner angle touches a downgrowth of the front. The orbital hiatus thus remains open for the most part, and in it is seen the short antennal flagellum (flagellum length ÷ C.l. = 0·11).

External Maxillipeds.—See figure. The merus is of approximately the same breadth as the ischium and about one half as long; it is pointed anteriorly, its borders sloping obliquely backwards and making together an angle of 90° approximately. The flagellum arises from the inner side of the apex. A longitudinal groove traverses both merus and ischium. The surface of the external maxilliped is polished.

Chelipeds of equal size. The upper, outer, and under surfaces of the arm, wrist, and hand are subdivided by pubescent grooves into polished lobes somewhat reminiscent of brain convolutions. The inner surface of the arm is smooth, and is concave in correlation with the convex under surface of the carapace; on the sharp inner border of the merus are three blunt teeth (exclusive of the distal angle), the same border has a fringe of hair; the upper border is also sharp; the inner border is well rounded. The length and breadth of the upper surface of the wrist are equal, its inner anterior angle is produced into a tooth, to the inner side of which is a much smaller one; the upper and outer surfaces form a continuous curve. The upper border of the hand is armed with a row of six or seven blunt teeth, or tubercles (six on right hand, seven on left hand); the grooves of the hand, transverse in the main, are crossed by two which are longitudinal (one running to the outer side of the base of the dactylus, the other to the base of the inter-digital cleft). The fingers have pointed tips, they meet throughout their length; apposed borders are toothed throughout, the distal teeth being the larger; when clenched, the inner surfaces of the fingers taken together are concave; an irregular pubescent groove runs along the proximal portion of the upper surface of the dactylus.

Walking legs flattened laterally, the dorsal border of meropodite, carpopodite, and propodite in each is expanded as a considerable crest; the ventral border of the meropodite of each has distally two ridges, the anterior of which extends the whole length of the segment, and is more prominent proximally, particularly in walking leg 4; in walking leg 4, also, the ventral border of the propodite is expanded, so that the segment is foliaceous; there are traces of transverse grooves on the posterior surfaces of the meropodites of all the walking legs; the posterior surface of the propodite is dimpled.

The dactylopodites of the first three pairs are fairly similar, somewhat compressed antero-posteriorly, both anterior and posterior surfaces with a longitudinal groove, dorsal border flattened and bearing a mat of short hairs. The dactylopodite of walking leg 4 is foliaceous, but its flattened surface is only 0·36 as broad as that of the propodite of the same appendage. There is a tuft of hair on the dorsal border of the proximal portion of the meropodite of each walking leg.

C.b. (rostral lobes included) = 32·50; Front.b. ÷ C.l. = 0·31; Fronto-orb.b. ÷ C.l. = 0·58. C.b. ÷ C.l. = 1·11; Front.b. ÷ C.b. = 0·32; Fronto-orb.b. ÷ C.b. = 0·50. Ant.lat.bord.C. ÷ C.l. = 0·43; Post-lat.bord.C. ÷ C.l. = 0·58; Post.bord.C. ÷ C.l. = 0·52. Ch.l. (*i.e.*, Arm l. + Propus l.) ÷ C.l. = 1·30; Arm l. (lower border, condyle of basal joint included) ÷ C.l. = 0·58; Propus l. (lower border) ÷ C.l. = 0·72.

Lophozozymus incisus (H. Milne-Edwards, 1834)—A.3, p. 107.

Locality:—Gulf of Manaar, one specimen.

Description:—An adult male. C.l. = 15·0.

Lophozozymus dodone (Herbst, 1801)—A.3, p. 108.

Localities:—Off Mutwal Island, two specimens (adult ♂, adult ♀); coral reefs, Gulf of Manaar, two specimens (adult ♂); pearl banks, Gulf of Manaar, two specimens (♂, ? young); Trincomalee, two specimens (young ♂, young ♀).

Description:—Variability among the specimens concerns:—(1) Index C.b. ÷ C.l.; and (2) the fact that most are somewhat concave laterally, but an adult male has approximately straight sides.

Lophozozymus pulchellus, A. Milne-Edwards, 1867—('Nouv. Arch. Mus.,' ix., p. 205).

Locality:—Galle, one specimen.

Description:—Adult female. C.l. = 10·5. It is covered with a pubescence. The most anterior of the three antero-lateral teeth is obsolescent. Traces of the network of red lines are seen in the posterior and postero-lateral regions with a lens.

Remarks.—This species is new to the Indian fauna. It may conveniently be separated from all other Indian forms by having the edge of the antero-lateral border of the carapace rounded in its anterior portion.

Euxanthus herdmani, n. sp.—Plate I., figs. 9, 9*a*.

Locality :—Pearl banks, Gulf of Manaar, one specimen.

Description :—An adult male. C.l. (including frontal lobes) = 23·00.

The lobules of the carapace are strongly convex, 2L more prominent than the others; they are dimpled, but 3M very slightly so: there is a fine pitting on the anterior part of the surface of the carapace, producing a dull appearance; the posterior part is glazed. The antero-lateral border is cut into four blunt tubercular teeth, the hindermost of which is smaller than the other three, which are of sub-equal size; the sub-orbital continuation of the border is indistinct. The curve of the orbit is unbroken by any denticle at the outer angle, and is seen by the lens to be finely granular.

The exopodite of the external maxilliped is granular, so is the outer proximal part of the ischium and the free border of the merus. The longitudinal groove of the ischium and that of the merus are both deep. The outer surfaces of the wrist and hand, as of the corresponding segments of the legs, are nodular, both nodules and the hollows between them being smooth. The outer surface of the wrist is rounded, with the nodules faintly marked (by no means so obvious as in *E. melissa* or *E. sculptilis*). The inner surface of hand, wrist, and arm is flattened and smooth; the upper surface of the hand has two nodules distally behind the finger joint, and a third posteriorly just in front of the wrist joint. Running obliquely backward and outward from the outer of the two distal nodules is a series of three others, from each of the first and third of which runs forward a wrinkled non-granulated line. The fingers have strongly toothed cutting edges, the distal end of the fixed finger is hollowed on the inner side of the teeth; the proximal portion of the upper surface of the dactylus is granular.

The upper and lower borders of the walking legs and the upper border of the arms are fringed with hair; the fringe is replaced on the upper border of the dactylopodites of the walking legs by a close-set covering of short hairs.

C.l. (rostral lobes included) = 23·00; C.b. ÷ C.l. = 1·33; Fronto-orbital b. ÷ C.l. = 0·71; Antero-lateral border (a straight line uniting the outer angle of orbit with the tip of the 4th antero-lateral tooth) ÷ C.l. = 0·62; Postero-lateral border (a straight line uniting the tip of the 4th antero-lateral tooth with the point at which the carapace border meets the 1st abdominal tergum) ÷ C.l. = 0·53; Posterior border of carapace (line of junction with abdominal tergum 1) ÷ C.l. = 3·04.

Remarks.—Among forms hitherto described the new species comes nearest to *E. melissa* in general character of the lobules of the carapace and in the absence of the denticle at the outer angle of the orbit. It is somewhat intermediate in the sculpture of its hands and fingers, between *E. melissa* and *E. sculptilis*. It differs from forms hitherto described in:—(1) Ratio of C.b.÷C.l.; (2) the more produced frontal lobes (see figure); (3) the antero-lateral border of the carapace has only four tubercles. The latter point is useful for purposes of key. The anterior of the antero-lateral teeth seems to take the place of the first two antero-lateral tubercles of *E. melissa* or of *E. sculptilis* and of a third tubercle to the inner side of these on the dorsal surface of the carapace, which is distinct in both the species named. Correlated with this arrangement is the more regular curve made by the front and the antero-lateral borders.

The form of the front is not unlike that of a specimen of *Hypocolpus rugosus* in the British Museum, in which, moreover, there are only four indistinct lobes on the antero-lateral border. There is a faint depression on the ventral surface behind the orbit and to inner side of 1st antero-lateral tooth. This does not represent the curious deep cavity found in *Hypocolpus*, for both are present in *H. sculptus* (*i.e.*, in British Museum specimen from Mauritius 84.8).

Hypocolpus [= Hypocœlus] rugosus, Henderson, 1893—A.3, p. 111.

Locality:—Coral reef, Gulf of Manaar, two specimens (ovigerous ♀ and adult ♂).

I note (1) granules of carapace are larger than in a specimen of *H. granulatus* in the British Museum instead of smaller as in Henderson's description; (2) the three teeth of the antero-lateral border of the carapace are not so obvious as in Henderson's figure, and in the adult ♂ (*b*) an additional small tooth occurs between the 2nd and 3rd larger ones counting from before backwards. In the adult ♀ (*a*) there is a mere trace of this additional tooth.

A point of difference between the present specimen of *H. rugosus* and the British Museum specimen of *H. granulatus* is that in the former the sternal area on either side of the flexed abdomen has an eroded appearance, while in the latter it is covered irregularly by distinct granules.

Xantho distinguendus, de Haan, 1835—A.3, p. 113.

Localities:—Coral reefs, Gulf of Manaar, one specimen (*a*); south of Galle, deep water, three specimens (*b*, *c*, *d*).

Description:—Specimen (*a*) is an adult male, C.l. = 6·0; specimens (*c*) and (*d*) are non-ovigerous adult females; specimen (*b*) is male, with a parasitic *Sacculina*.

Remarks.—On comparing with de Haan's example, one notes (1) the much smaller size, and (2) that the posterior surface of the meropodite of the walking leg 4 is smooth instead of granulated. They thus tend to agree with Miers' "Challenger" specimens which he called *Lophozozymus bellus*, var. *leucomanus*, but are still smaller. This species is the *L.* (*Lophoxanthus*) *leucomanus* of Lanchester. The *Sacculina* attached to the male specimen (*b*) does not seem to have affected the sexual characters of its host; the male appendages and the general shape of the abdomen are much as in specimen (*a*), and no abdominal appendages appropriate to the female are developed.

Xantho (Leptodius) exaratus (H. M.-Edw., 1834)—A.3, p. 118.

Locality :—Trincomalee, one specimen (female, doubtfully adult).

Description :—It answers to Alcock's description. Comparing with Kossmann's figures, its greatest carapace-breadth is across the region of the 3rd, not the 4th, lateral teeth.

Cycloxanthops [= Cycloxanthus] lineatus, A. M.-Edw., 1867—A.3, p. 124.

Localities : Coral reef, Gulf of Manaar, three specimens (*a*, *b*, *c*) ; Cheval Paar, one specimen (*d*) ; off Kaltura, one specimen (*e*).

Description :—All are males, apparently adult. The spirit has removed the colour, but the specimens give evidence (under lens) that there are colour varieties within the species.

A. In specimens (*b*) and (*d*) there are faint whitish lines on the carapace in the positions represented in A. Milne-Edwards' figure.

B. In specimens (*a*) and (*e*) the carapace is covered with large spots a little darker than the general surface, each of which is surrounded by a whitish ring.

C. Specimen (*c*) has neither lines nor spots.

Polycremnus ochtodes (Herbst, 1783)—A.3, p. 135.

Localities :—Pearl banks, six specimens (three ♂, probably adult, two ♀, one young ♀) ; coral reefs, Gulf of Manaar, three specimens (two ♂, probably adult, and one ♀, probably adult).

Actæa speciosa (Dana, 1852)—A.3, p. 143.

Locality :—Gulf of Manaar, one specimen.

Description :—Female, adult, but non-ovigerous. C.l. = 6·25. It agrees with Kossmann's description and photograph of *Psaumis glabra*. It also agrees with Dana's description, but differs from his figure in some points. In mine (1) the lobe 2M is more deeply subdivided ; (2) though in the posterior portion of the carapace the grooves are very shallow and partly obliterated by granules, it is still possible to distinguish, somewhat indefinitely, the lobes 1R, 2R, 1P and 2P. There is a distinct fissure between the outer angle of the orbit and the sub-orbital border, stated by Alcock to be absent in his specimens (three, from the Persian Gulf, Ceylon, and Andamans). de Man finds this fissure in his specimen ('Abh. Senckb. Ges.,' xxv., 609).

Differences between my specimen of *A. speciosa* and the descriptions of the closely allied *A. rufopunctata* are that in the former :—(1) Carapace is relatively longer and narrower ; (2) carapace, chelipeds, and walking legs devoid of hair ; (3) lobulation of carapace much less complete and bold except on antero-lateral regions, that of chelipeds and walking legs is much as in *A. rufopunctata* ; (4) the anterior tongue of 3M reaches farther forward ; (5) the longitudinal division of 2M is hardly complete posteriorly ; (6) the groove separating 2M from 2L diverges a good deal anteriorly from its fellow of the opposite side; (7) lobe 1P is not subdivided by a longitudinal groove and is more or less top-shaped, an anterior strip being marked off.

Actæa ruppelli (KRAUSS), 1843—A.3, p. 144.

Locality :—Navakaddu Paar, Gulf of Manaar, three specimens.

Actæa alcocki, n. sp.—Text-fig. 5.

Locality :—Gulf of Manaar.

Description :—An adult male. C.l. = 16·5.

The breadth of the carapace across region of last pair of antero-lateral teeth is 1·53 its length; breadth across region of next to last pair of antero-lateral teeth is 1·48 its length; frontal b. ÷ C.l. = 0·36; fronto-orbital b. ÷ C.l. = 0·64; antero-lateral border l. ÷ C.l. = 0·71; postero-lateral border l. ÷ C.l. = 0·60; posterior border l. ÷ C.l. = 0·60 (the junction of the posterior and postero-lat. border is the posterior end of a finely marked groove). The carapace and exposed surfaces of chelipeds and walking legs are covered with a short down which does not conceal the lobulation or granulation: the anterior two-thirds of the carapace are lobulated, the lobules are distinctly though not strongly demarcated by shallow grooves; on the posterior one-

Fig. 5. *Actæa alcocki*, n. sp.

third of the carapace the lobulation is obsolete. The whole dorsal surface of the carapace, grooves and lobules, and the exposed surfaces of chelipeds and walking legs, are covered with crisp, not particularly strong, granules. The lobes of the antero-lateral border are bluntly pointed, increasing in size from before backward; the first is obsolescent. The front is vertically deflexed, continuing the curve of the anterior part of the carapace; it is quite obviously bilobed; at the outer base of each lobe the inner supra-orbital angle is produced vertically downwards to form a distinct tooth. Supra-orbital margin moderately tumid, cut by two fissures in its outer portion and separated from the lower border by a third fissure.

Basal antennal segment does not quite reach the inner orbital angles.

The surfaces of the arm are smooth, a row of small sharp granules borders its lower edge. The upper and lower borders and the outer surfaces of hand and wrist (*i.e.*, the "exposed surfaces") are granular as the carapace; the granules of the hand are the larger and are arranged in longitudinal rows on the lower half of the outer surface; the other surfaces are smooth. There is a slight transverse groove on the outer surface of the wrist behind the joint with the hand. The proximal part of the upper border of the mobile finger is roughened; there is a tooth on the biting border of each finger about one-third of its length from the base; the fingers are grooved and pointed. Distally the upper border of the hand turns abruptly downward at a right angle to the point where the mobile finger is hinged.

There is a longitudinal groove to the outer side of the upper border of the carpopodites of the walking legs. Colours in spirit ($4\frac{1}{2}$ years), yellowish, with a circular brown patch on the gastric region, and brown fingers.

The new species comes most easily into section I.I.2 of ALCOCK's key, A.3, p. 139, though carapace length = 0·66 the breadth. It is distinguished by absence of shaggy hair, the shallow nature of its grooves, the festooned appearance of its antero-lateral borders, and by its general facies.

Actæa variolosa, BORRADAILE, 1902—B.III., p. 256, fig. 54.

Localities:—Jokkenpiddi Paar, one specimen (adult ♂); Navakaddu Paar, three specimens (one adult ♂, two adult ♀).

Description:—The grooves which delimit the cardiac region laterally agree in the adult male (*b*) with their condition in BORRADAILE's figure, but in the other specimens they are more obvious—running back to a slightly indicated transverse groove parallel to and just in front of the posterior border of the carapace.

The tooth on the base of the dactylus is quite small; that on the base of the fixed finger is stout. On either side of the base of each of these teeth is a curious little tuft of dark brown hair.

Actæa peroni (H. M.-EDW.), var. **squamosa**, HENDERSON, 1893 (H., p. 357).

Localities:—Coral reefs, Gulf of Manaar, one specimen (adult ♀); Navakaddu Paar, two specimens (adult ♀ and young ♀).

Description:—Add to HENDERSON's description that there are tubercles on the front and on the antero-lateral border.

Remarks.—These specimens, from two localities, fall under HENDERSON's description of var. *squamosa*—*i.e.*, the only specimens recorded from India fall into a group having varietal distinction from ALCOCK's description (A.3, p. 150). The latter applies to the Australian variety, of which I have seen 13 specimens in the British Museum from various parts of the coast of Australia.

Actæa calculosa (H. M.-EDW., 1834)—A.3, p. 152.

Localities:—Pearl banks, Gulf of Manaar, nine specimens; off Kaltura, one specimen; Galle coral reef, one specimen; Navakaddu Paar, two specimens.

Remarks.—I consider *A. calculosa* and *A. granulata* to be distinct species. Comparing the present series of the former with a series of over 20 specimens of the latter in the British Museum, I find that though the differences are individually slight, they are numerous, constant and highly correlated. A series of differences between the two species has been set forth by CALMAN (C., p. 8).

I have seen MIERS' specimens in the British Museum, for the reception of which he made *Euxanthus tuberculosus*; as CALMAN points out, they certainly = *A. calculosa.*

Actæa granulata (AUDOUIN, 1826)—A.3, p. 151.

Localities:—Off Negombo, Gulf of Manaar, two specimens; coral reefs, Gulf of Manaar, one specimen.

Xanthias [= Xanthodes] lamarcki (H. M.-EDW., 1834)—A.3, p. 157.

Locality:—Galle, lagoon, four specimens (two adult ♂, two young ♀).

Xanthias [= Xanthodes] notatus, DANA, 1852—A.3, p. 158.

Locality:—Chilaw Paar, one specimen.

Description:—Adult male; agrees well with ALCOCK'S description. In comparing with DANA'S figure it may be noted that, both in ALCOCK'S description and in the present specimen, the last two antero-lateral teeth are procurved and spine-like. The 3rd tooth is in this specimen the longest.

Chlorodiella [= Chlorodius] niger (FORSKÅL, 1755)—A.3, p. 160.

Localities:—Trincomalee, one specimen (*a*); Palk Bay, one specimen (*b*).

Description:—Specimen (*a*) is a small male (? immature), C.l. = 6·50; specimen (*b*) is an ovigerous female, C.l. = 9·25. In both examples the last two antero-lateral prominences are blunt teeth (sharper than the 1st and 2nd teeth of the series in (*a*), much as 2nd tooth in (*b*)). They do not terminate in "procurved spine-like points" as in the examples described by ALCOCK. In specimen (*a*) there is neither spine nor tubercle on the anterior border of the arm.

Phymodius sculptus (A. M.-EDW., 1873)—A.3, p. 164.

Locality:—Coral reef, Galle, two small males.

Chlorodopsis areolata (H. M.-EDW., 1834)—A.3, p. 166.

Localities:—Galle, two specimens (adult ♀ and adult ♂); Galle, lagoon, one specimen (young ♀).

Description:—In the adult female, C.l. = 9·50; C.b. ÷ C.l. = 1·42; Frontal b. ÷ C.l. = 0·66; Frontal l. ÷ C.b. = 0·46.

The female of this species is figured by DANA under the name *Etisodes cœlatus.*

Chlorodopsis pilumnoides (White, 1847)—A. 3, p. 167.

Localities:—Coral reefs, Gulf of Manaar, six specimens; Navakaddu Paar, four specimens; Jokkenpiddi Paar, two specimens; Muttuvaratu Paar, six specimens.

Description:—The above include six adult males, one young male, three ovigerous females, six adult non-ovigerous females, and two young females. C.l.ovig. ♀ = 9·5.

Pilodius pugil, Dana, 1852—('U.S. Expl. Exp.,' Crust., I., 1852, p. 219, pl. xii., fig. 8.)

Locality:—Gulf of Manaar, one specimen.

Description:—An adult male. C.l. = 10·0.

Cymo andreossyi (Audouin), 1826—A. 3, p. 173.

Locality:—Gulf of Manaar, one specimen.

Description:—Adult male, C.l. = 6·50.

Calmania, n. gen.

Carapace subcircular, its length and breadth about equal; it is convex antero-posteriorly, less so from side to side; the only region distinctly indicated is the cardiac, which is delimited anteriorly and antero-laterally by an obvious groove. The antero-lateral border is indistinctly four-lobed.

Fronto-orbital breadth about two-thirds the greatest carapace breadth. Frontal breadth about one-third the greatest carapace breadth. The front is rounded anteriorly, continuing the general antero-lateral curve of the carapace: it is very distinctly bilobed; the lobe of either side is not separated by notch or groove from the orbital border. One of the two supra-orbital grooves is present, the other indicated merely. Eyes on short thick stalks.

The fold of the antennules is longitudinally oblique, making an angle of a little less than 45° with a perpendicular line.

The basal antennal segment falls short of the orbital hiatus, into which its outer angle is not produced. The antennal flagellum slender and naked; it is about $\frac{1}{4}$ C.l.

No ridges define efferent branchial channel in anterior portion of buccal cavern.

The merus of the external maxillipeds is broader than long. The ischium is slightly longer than broad. The outer angle of the merus is rounded.

Chelipeds equal (a non-ovigerous, but quite probably mature, female only known), not long, but very massive, the fingers remarkably large, gaping proximally, their tips pointed; the upper border of the hand bears two prominences—the distal of the two is particularly enlarged. The walking legs are approximately the same length as the cheliped; they are fringed with silky hair.

It is a little difficult to find relatives for the new genus. I place it among the Xanthidæ, as having the anterior epistomial margin of the buccal cavity well defined and not overlapped by the external maxillipeds, and the antennal flagellum slender; it differs, however, from the usual Xanthid form in the greater length of its antennal flagellum and in the longitudinally oblique fold of the antennules. The latter characters and the general *Kraussia*-like shape of the carapace suggest Cancrid affinities. It may possibly fall into the sub-family Chlorodinæ (A.3, p. 78); but it does not agree with any of the three Alliances into which ALCOCK divides the sub-family, but the obliquely folding antennules of *Cymo* are to be remembered. From *Cymo*, however, the new genus presents many points of difference.

Calmania prima, n. sp.—Plate I., fig. 12, *a–c*.

Locality :—Gulf of Manaar, one specimen.

Description :—A female, non-ovigerous, but quite probably adult.

C.l. = 7·0 ; C.l. ÷ C.b. = 0·93 ; the only region distinctly indicated is the cardiac, which is delimited anteriorly and antero-laterally by a well-marked groove ; a fainter groove completes the isolation of the branchial regions anteriorly, a groove runs back in the middle line from the notch between the frontal lobes. There are four tufts of hair on the dorsal surface of the carapace, one on each side of the gastric region and one behind and to outer side of each of these. The antero-lateral border of the carapace is sharpened, almost cristate, and has three slight teeth behind the external orbital angle, which faintly indicate a division into four lobes.

Fronto-orbital b. ÷ C.b. = 0·71 ; frontal b. ÷ C.b. = 0·46. For further description of front see generic description ; it is fringed by long silky hairs.

The folded antennule makes an angle of 40° approximately with a perpendicular line. The antennal flagellum is slender and naked. Ant.flag.l. ÷ C.l. = 0·25, approx.

For external maxillipeds, see description of genus. The ischia do not quite meet.

Ch.l. ÷ C.l. = 1·22 ; the massive hand and fingers are remarkable ; the fingers are bent on the hand somewhat as in *Lambrus* ; when closed, the distal halves of the fingers meet, but between the proximal halves there is a rounded gap left ; the distal apposable part of both fingers is dentate. The inner surface of the hand is smooth and polished ; the outer surface of hand and fingers is richly sculptured ; both above and below an intermediate region of outer surface of hand is a groove bordered on both edges by a granular line. On the upper border of the wrist is a row of granules. The sculpture of the hand and fingers is hidden a good deal by hair ; long silky hairs are found also on the upper border of the hand, and a tuft on the outer surface of the wrist.

The walking legs are of approximately equal length, 2nd walking leg l. ÷ C.l. = 1·20 ; they are a little compressed laterally ; their surface is smooth and glazed ; their borders are fringed with silky hair.

Ozius rugulosus, STIMPSON, 1858—A.3, p. 182.

Locality :—Galle, one specimen (adult ♀).

Ozius tuberculosus, H. M.-EDW., 1834—A.3, p. 183.

Locality :—Trincomalee, one specimen.

Description :—An adult male. The central part of the carapace is smooth, *i.e.*, the pearly tubercles are here absent.

Epixanthus frontalis (H. M.-Edw., 1834)—A.3, p. 185.

Locality :—Trincomalee, two specimens (*a*, *b*).

Description :—	C.l.	C.b. ÷ C.l.	Frontal b. ÷ C.l.	Frontal b. ÷ C.b.
(*a*) adult ♂ . . .	13·25	1·64	0·57	0·34
(*b*) ovigerous ♀ . .	16·00	1·62	0·56	0·35

Pilumnus vespertilio (Fabricius), 1793—A.3, p. 192.

Locality :—Trincomalee, one specimen.

Description :—An adult male, C.l. = 19·0. The sub-hepatic denticle of the right side is double, and that of the left side is represented by a group of three granules.

Pilumnus longicornis, Hilgendorf, 1878—A.3, p. 193.

Locality :—Gulf of Manaar, two specimens.

Description :—Both adult males.

Pilumnus cursor, A. M.-Edw., 1873—A.3, p. 195.

Locality :—Gulf of Manaar, one specimen.

Description :—Female, probably adult. C.l. = 8·00.

This specimen agrees very fairly with Alcock's description of the samples which he puts with a query under this species. However, an area occupying the distal part of the lower portion of the outer surface of its larger chela (say one-third of whole outer surface) is naked and polished. Its fingers are dark brown.

Actumnus setifer (de Haan), var. **tomentosus** (Dana), Miers—A.3, p. 202.

Locality :—Pearl banks, Gulf of Manaar, four specimens (including *a*); off Mutwal Island, two specimens (*b*, *c*); south of Modragam, one specimen.

Description :—The series includes six males—all perhaps adult—and one ovigerous female. C.l. of the latter = 5·5.

In male specimen (*a*) the denuded carapace appears smooth to the naked eye, but fine granules are revealed by the lens. A similar fine granulation occupies the central part of the carapace of males (*b*) and (*c*), in both of which an antero-lateral strip is granular to the unaided eye. Distinctness of areolæ possesses high variability; specimens (*c*), (*a*), and (*b*), together with a Torres Straits specimen in the British Museum, form a series linking *tomentosus* and *setifer* in respect of this character.

Remarks.—The evidence of the British Museum specimens and of those before me compels me to consider, with Miers ("Alert," p. 225), that *tomentosus* and *setifer* are a single species. Alcock kept them apart, however, and in so doing he had before him 32 specimens of the former and 53 of the latter. It would be interesting to have some exact knowledge of variability within such considerable samples.

Actumnus setifer (DE HAAN), var. **setifer**—A.3, p. 202.

Localities:—Pearl banks, Gulf of Manaar, one specimen (adult ♀); deep water off Galle, one specimen (ovigerous ♀); Trincomalee, one specimen (ovigerous ♀).

Description:—In these specimens the areolæ are more distinct than in the figures of either DE HAAN or of A. MILNE-EDWARDS. Moreover, the tomentum gives place to a slight pubescence, and the general appearance is reminiscent of *A. verrucosus*, HENDERSON, from which the specimens may, however, be distinguished as in ALCOCK's key by having the lobule of the lateral gastric region semicircular instead of ω-shaped.

Remarks.—The specimens suggest that an examination into the specific distinctness of *A. setifer*, *A. bonnieri*, and *A. verrucosus* is desirable.

Actumnus verrucosus, HENDERSON, 1893—A.3, p. 203.

Localities:—Pearl banks, Gulf of Manaar, 25 specimens; coral reefs, Gulf of Manaar, five specimens; Muttuvaratu Paar, one specimen.

Remarks.—There is in the British Museum a single adult male specimen of this species labelled in MIERS' (?) writing "*Actumnus ceylonicus*, MIERS—Ceylon. Presented by E. W. H. HOLDSWORTH, Esq.—1875." I am not aware that he published any description of the crab.

A. verrucosus is very closely allied to *A. setifer* on the one hand and to *A. bonnieri*, NOBILI, 1905, on the other.

Actumnus bonnieri, NOBILI, 1905—(N., p. 132, pl. vi., fig. 32).

Localities:—Pearl banks, Gulf of Manaar, two specimens (one adult ♀); deep water off Galle, one specimen (ovigerous ♀).

The present examples of *A. bonnieri* agree well with NOBILI's description and photograph. They are smaller than the average of *verrucosus* specimens known to me. The difference between the two species in question is mainly a difference in the form of the lateral gastric lobe. A similar distinction does not separate it from *A. setifer*, though other differences hold here.

Apart from the characteristic ω-shaped lateral gastric lobe of *A. verrucosus*, the characters which separate *A. setifer* var. *tomentosus*, *A. setifer* var. *setifer*, *A. verrucosus*, and *A. bonnieri* from each other are highly variable. An exact knowledge of the variation within large samples is very desirable. Such variable characters are:—(1) C.b.÷C.l., (2) convexity of carapace, (3) distinctness of areolæ, (4) hairiness of carapace, (5) condition of outer angles of front, (6) condition of fissure in lower orbital margin (?), (7) granulation of wrist.

Actumnus fissifrons, ALCOCK, 1898—A.3, p. 204; A. Invest., pl. xxxvii., fig. 5.

Locality:—Deep water off Galle, one specimen (adult ♂).

Trapezia cymodoce (HERBST, 1801)—A.3, p. 219.

Localities :—Muttuvaratu Paar, four specimens (*e*, *f*, *g*, *h*); Jokkenpiddi Paar, one specimen (*k*); coral reef, Galle, twelve specimens (*m*, *n*, *p*, *q*, *r*, *s*, *t*, *u*, *v*, *w*, *x*, *y*); pearl banks, Gulf of Manaar, eight specimens (*a*, *b*, *c*, *d*, *i*, *j*, *k*, *o*).

Description :—ALCOCK'S observation, that the carapace of the adult female is more curved than that of the male, is reversed in the present series. Variation concerns—(1) size : the size of adult specimens varies a good deal, *e.g.*, two adult males C.l. = 6·25 and 16·0, and two ovigerous females C.l. = 5·75 and 10·75; (2) the outer angles of the frontal lobes : these are entire in most, but crenulate in adult male (*i*) and in ovigerous female (*b*), and they tend to be so also in (*j*) young ♀, (*m*) ovigerous ♀, and (*n*) adult ♂; (3) the outer orbital angle is in most cases produced and pointed, but in the adult male (*k*) and also in (*p*), (*q*), and (*r*) it is blunt, in ovigerous ♀ (*v*), ovigerous ♀ (*x*), and adult ♂ (*y*) it is only slightly produced, and in adult ♂ (*w*) it is not produced; (4) the lateral epibranchial spine is quite obvious and sharp in most cases, but in (*k*), (*p*), (*q*), and (*r*) it is blunt, while in (*v*), (*x*), and (*y*) it is obsolescent. It will be noted that variation of outer orbital angle and of lateral epibranchial spine are correlated.

A specimen (*z*) from "Lagoon, Galle, 1903," may be conveniently included here as a variety. In it the lateral epibranchial tooth of the carapace is absent, the antero-lateral borders diverging posteriorly to form a continuous curve with the anteriorly divergent postero-lateral borders. The hand is naked. The front agrees fairly with that of *T. ferruginea* or *T. cymodoce*. I would name it var. *edentula*.

Another specimen (*z''*), a doubtfully mature male, has the merest trace of a lateral epibranchial tooth and a rather strongly reflected front.

Remarks.—The specimens (*p*), (*q*), and (*r*) combine the outer orbital angle, the lateral epibranchial tooth, and the inner sub-orbital tooth of *ferruginea* with the hand of *cymodoce*. The front is intermediate in character. The specific distinction between the two species is thus minimised. Judging from my specimens and from those in the British Museum, the best distinction is the hair of the hand.

Trapezia ferruginea, LATREILLE, var. **areolata,** DANA, 1852—A.3, p. 221.

Localities :—Coral reef, Galle, two specimens; Trincomalee, one specimen; Cheval Paar, two specimens; Jokkenpiddi Paar, two specimens.

Description :—C.l. of an ovigerous female = 12.

Trapezia maculata (MACLEAY, 1838)—A.3, p. 221.

Locality :—Jokkenpiddi Paar, two specimens (young ♂ and young ♀).

Trapezia rufopunctata (HERBST, 1799)—A.3, p. 222.

Locality :—Jokkenpiddi Paar, one specimen.

Description :—An ovigerous female, C.l. = 13.

Tetralia glaberrima (Herbst, 1790)—A.3, p. 223.

Localities :—Galle, one specimen ; pearl banks, Gulf of Manaar, two specimens ; Navakaddu Paar, two specimens ; Muttuvaratu Paar, one specimen ; off Mutwal Island, one specimen.

Description :—The above include three ovigerous females, one young female, one adult male, and two doubtfully young males.

Quadrella coronata, Dana, var. **granulosa,** Borradaile, 1902 (B.III., p. 266).

Locality :—Gulf of Manaar, six specimens ; Galle, deep water, three specimens.

Description :—C.l. of two ovigerous females = 7·0 and 13·75.

Portunus tuberculatus, Roux, 1830.

Locality :—Deep water off Galle and onwards, one specimen.

Remarks.—This genus (*i.e.*, the *Portunus* of Fabricius) is new to the Indian fauna.

Lissocarcinus polybioides, Adams and White, 1848—A.4., p. 19.

Localities :—South-east of Modragam, on weed-bearing oyster spat, one specimen (adult ♂) ; Gulf of Manaar, two specimens (ovigerous ♀ and young ♂).

Description :—C.l. of ovigerous female = 9·5.

Lissocarcinus orbicularis, Dana, 1852—A.4, p. 20.

Localities :—Negombo, one specimen (ov. ♀ *a*) ; Galle, lagoon, one specimen (adult ♀ *b*).

Description :—C.l. of ovigerous female = 12·00.

Specimen (*a*) is labelled "black crab from mouth of Trepang," and specimen (*b*), which is wound about with Holothurian threads, bears the label "black and white crab from rectum of black Holothurian."

Lissocarcinus lævis, Miers, 1886—A.4, p. 21.

Localities :—Pearl banks, Gulf of Manaar, ten specimens (*a* to *g* and *n* to *p*) ; coral reefs, Gulf of Manaar, six specimens (*h* to *m*).

Description :—The difference in size between (*a*) and (*b*), both adult females (the latter ovigerous), is to be noted. C.l. of (*a*) = 11·00 ; C.l. of (*b*) = 7·00. Apart from this, variability is low in the above series.

Lupocyclus rotundatus, Adams and White, 1848—A.4, p. 23.

Localities :—Off Kaltura, two specimens (*a*, *b*) ; deep water off Galle, four specimens ; coral reef, Gulf of Manaar, ten specimens (including *c*).

Description:—The series includes three ovigerous females, three adult non-ovigerous females, three young females, five adult males, and two young males. C.l. of an ovigerous female = 10·00.

In the above specimens there are indications of ridges in similar positions to those of *Neptunus* (*Lupocycloporus*) *whitei*, except that the anterior gastric ridge of the latter is not represented.

In ovigerous female (*c*) and in adult male (*a*) the three posterior of the interdental denticles are excessively rudimentary; a character described by ALCOCK for the young (*i.e.*, the absence of these denticles) tends thus to survive in the adult.

Lupocyclus strigosus, ALCOCK, 1899—A.4, p. 24.

Locality:—Gulf of Manaar, three specimens (2 adult ♂ and 1 young ♀).

Description:—C.l. of an adult male (front included) = 12·00. The present examples have only five teeth on the antero-lateral margin of the carapace (outer orbital angle included) instead of six. It is the second tooth which is absent.

Neptunus (Neptunus) sanguinolentus (HERBST, 1783)—A.4, p. 32.

Localities:—Gulf of Manaar, one specimen; Trincomalee, two specimens.

Description:—Two females and a male—all young.

Neptunus (Neptunus) pelagicus (LINN.), 1764—A.4, p. 34.

Locality:—Off Chilaw, $2\frac{1}{2}$ to 4 miles off shore, one specimen (adult non-ovigerous ♀). (RATHBUN, 'Proc. Biol. Soc. Wash.,' xi., for genera of this and last species.)

ALCOCK unites *N. pelagicus* and *N. trituberculatus*. Miss RATHBUN keeps them apart ('Proc. U.S. Nat. Mus.,' vol. xxvi., p. 26, 1902). The present specimen comes under *N. pelagicus* in Miss RATHBUN'S sense. WHITELEGGE'S notes on variability should be consulted ('Mem. Austral. Mus.,' iv., p. 154, 1900). He concludes, after an examination of some hundreds of examples from Port Jackson, that the character of the median tooth is not to be used as a specific distinction between the two species. Perhaps the granulation of the carapace is much a matter of sex. This character is in the present specimen of the type described by WHITELEGGE as essentially female. ORTMANN and CALMAN have cast doubt upon the specific distinctness of *N. armatus* from the present species (C., p. 21).

Neptunus (Amphitrite) gladiator (FABRICIUS, 1798)—A.4, p. 35.

Localities:—Off Negombo, Gulf of Manaar, one specimen; off Kaltura, two specimens; Galle, one specimen; pearl banks, Gulf of Manaar, thirty specimens; coral reefs, Gulf of Manaar, four specimens; Chilaw Paar, one specimen.

Description:—There are five ovigerous females, six adult but non-ovigerous females, fifteen young females, one adult male, and twelve young males.

The present specimens are small compared with some I have seen from Madras. I give some measurements of three of the ovigerous females:—

C.l.	22·00	20·00	20·00
C.b. ÷ C.l.	1·45	1·46	1·49
Rt. lat. spine l. (anterior border) ÷ C.l. . . .	0·12	0·17	0·17

C.b. is measured by a straight line uniting the notches between teeth 8 and 9.

Neptunus (Amphitrite) argentatus, WHITE, 1847—A.4, p. 36.

Localities:—Deep water off Galle, one specimen (ovigerous ♀); coral reefs, Gulf of Manaar, two specimens (adult ♀, adult ♂); off Kaltura, five specimens (one ovigerous ♀, one adult non-ovigerous ♀, and three adult ♂).

Description:—C.l. of an ovigerous female = 15·50.

Neptunus (Amphitrite) petreus, ALCOCK, 1899—A.4, p. 37.

Locality:—Gulf of Manaar.

Description:—A young specimen (C.l. = 5·00) which I put a little doubtfully in this species. Its wrist has the strikingly elongated inner spine. A point in which it differs from ALCOCK'S figure (A. Invest., pl. xlvi., fig. 2) is the still more blunt nature of the frontal lobes, the notches between them being wider and shallower.

Neptunus (Amphitrite) euglyphus, n. sp.—Text-figs. 6 and 7.

Localities:—Pearl banks, Gulf of Manaar, 13 specimens (*a* to *e* and *m* to *t*); coral reefs, Gulf of Manaar, four specimens (*f* to *i*); off Negombo, three specimens (*j*, *k*, *l*).

Description:—The association of a strong lateral production of the antero-external angle of the merus of the external maxilliped with rounded posterior carapace angles, and a much enlarged last spine of the antero-lateral series, show *N. euglyphus* to be a member of the sub-genus *Amphitrite* (*i.e.*, I.A.1.ii. of ALCOCK'S key. A.4, p. 31).

Fig. 6. *Neptunus euglyphus*, n. sp.

Fig. 7. Ventral view, external maxilliped and cheliped.

It differs from *Neptunus* (*Amphitrite*) *gladiator* in the following particulars:—(1) The grooves which delimit the several regions of the carapace are more strongly marked; (2) the two median frontal teeth are closer together: they meet the dentiform process of the epistome, so producing an appearance not unlike a single dorsally grooved median tooth; (3) the large last spine of the antero-lateral series has a very characteristic appearance: it is very broad proximally, flattened dorso-ventrally, and its posterior border is strongly recurved downwards and forwards;

(4) correlated with (3) is the short postero-lateral border of the carapace; (5) the middle region of the posterior border of the arm is considerably expanded—the inner surface of the hand and of the fixed finger is granular, and the under surfaces of all segments of the cheliped have a glazed appearance; (6) walking legs 1, 2, and 3 are, as a whole, glazed, there are a few hairs along the upper border, walking leg 4 is more or less tomentose.

Remarks.—The new species is distinguished at a glance from all other members of the sub-genus by its very characteristic last pair of lateral spines. It will be noted from (5) above that the cheliped bears a considerable resemblance to that of *Neptunus* (*Achelous*) *granulatus* (H. MILNE-EDWARDS).

I append the measurements of three adult males:—

	C.l.	C.b. ÷ C.l.	Lat. sp. (post. bord.) ÷ C.l.	Front. b. ÷ C.l.	Front.orb. b. ÷ C.l.	Ant.lat. bord. ÷ C.l.	Post.lat. bord. ÷ C.l.	Post. bord. ÷ C.l.
(*a*) . .	12·50	1·64	0·46	0·36	0·88	0·68	0·32	0·56
(*n*) . .	13·00	1·58	0·54	0·38	0·85	0·73	0·37	0·58
(*o*) . .	13·00	1·58	0·50	0·37	0·85	0·73	0·33	0·58

Antero-lateral border is from outer angle of orbit to notch between teeth 8 and 9.

Postero-lateral border is from base of posterior border of large spine to point of junction with abdomen.

Neptunus (Hellenus) hastatoides (FABRICIUS, 1798)—A.4, p. 38. Text-fig. 8.

Localities:—Galle, one specimen; pearl banks, Gulf of Manaar, nine specimens; off Mutwal Island, two specimens; coral reefs, Gulf of Manaar, twelve specimens; Palk Bay, two specimens.

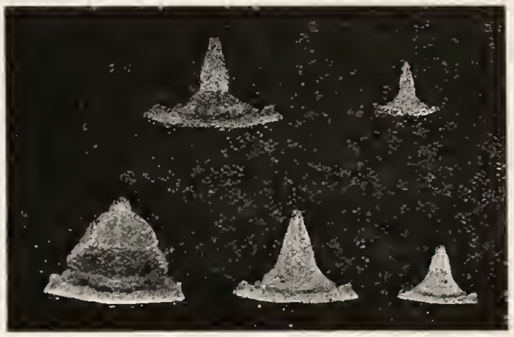


Fig. 8. Growth stages in abdomen of *Neptunus hastatoides*—upper row males, lower three females.

Description:—C.l. of an ovigerous female = 18·0.

Remarks.—LANCHESTER gives some account of sexual differences obtaining in this species. In view of the specimens before me I judge his figure ('Proc. Zool. Soc.,' 1900, p. 745, pl. xlv., figs. 7*a*, 7*b*) of a female abdomen to be evidently that of a young example. It agrees well with that of the young males of the present collection (see text-fig. 8).

Neptunus (Hellenus) hastatoides (FABRICIUS), var. **unidens**, nov.

Locality:—Coral reefs, Gulf of Manaar, one specimen.

Description:—A male, doubtfully adult, both chelipeds missing; C.l. = 12·25.

This specimen differs from other specimens of *N. hastatoides* known to me in the following particulars:—

(1) It possesses a single median frontal tooth instead of a pair, so that the front is cut into three teeth only. (This median tooth is somewhat smaller and less prominent than the lateral teeth, and its apex is flattened.)

(2) The tip of the dactylopodite of walking leg 4 is not darkened in colour (one must, of course, not overlook the possible agency of the spirit in producing this appearance).

(3) The carina of abdominal segment III. is more prominent in its middle portion and its median notch is deeper, approaching in appearance that of *N. macrophthalmus*, RATHBUN, 1903 (R., p. 871, fig. 31).

The granulation of the sternum of this male closely resembles that of the adult male of *N. hastatoides*.

Remarks.—I call attention to the absence of both chelipeds. It is therefore impossible to ascertain various essential characters. Leaving these necessarily out of consideration, the specimen is so closely similar to *N. hastatoides* (except in particulars given above) that it may be conveniently included as a varietal example of that species, in which the pair of narrow median frontal teeth have coalesced. This latter particular seems of sufficient interest to warrant my putting the specimen on record. I append the following measurements :—

$C.b._1$ (a straight line uniting the notches between the 8th and 9th antero-lateral teeth of either side)÷C.l. = 1·51 ; $C.b._2$ (a straight line uniting points immediately behind the great lateral spines)÷C.l. = 1·10 ; Posterior border of C.÷C.l. = 0·65 ; Frontal b.÷C.l. = 0·41 ; Fronto-orb.b.÷C.l. = 0·82 ; lateral spine l. (posterior border) ÷C.l. = 0·49 ; antero-lateral border of C. (a straight line uniting outer orbital angle with notch between the great lateral spine and the tooth in front of it)÷C.l. = 0·69 ; postero-lateral border of C. (a straight line uniting base of great lateral spine with postero-lateral angle)÷C.l. = 0·39.

Neptunus (Hellenus) spinipes, MIERS, 1886—A.4, p. 39.

Locality :—Galle, one specimen.

Description :—An adult male, C.l. = 11·00.

Remarks.—I have examined the Martaban specimens placed by HENDERSON as *N. andersoni*, and which are preserved in the British Museum, and find that in reality they are *N. spinipes* of MIERS, whose "Challenger" specimens I have also consulted.

Neptunus (Hellenus) longispinosus (DANA), var. **bidens**, nov.—(See A.4, p. 40).

Localities :—Off Negombo, one specimen (adult ♂) ; off Mutwal Island, one specimen (adult ♂) ; Gulf of Manaar, one specimen (ovigerous ♀).

Description :—C.l. of an ovigerous female = 6·50.

In all three specimens the hand has only two spines, a point of resemblance to *Neptunus* (*Hellenus*) *tuberculosus*, A. MILNE-EDWARDS. I suggest for them the varietal name *bidens*.

The antero-external angle of the merus of the external maxillipeds and the shape of the male abdomen are evidently characters with high variability in this species if ALCOCK is correct in including both the forms figured by DANA. The present examples agree in combining a merus resembling DANA's fig. 2*c* with a male abdomen in which the borders are still more sinuous than in his fig. 3*b*—abdominal segment VI. being the one chiefly involved.

Neptunus (Hellenus) tenuipes (DE HAAN, 1835)—A.4, p. 42.

Locality :—Pearl banks, Gulf of Manaar, one specimen.

Description :—Adult male. C.l. = 16·00.

Behind the single distal spine of the outer border of the arm is a sub-terminal tubercle marking the position of the second spine of some allied species.

Neptunus (Lupocycloporus) whitei (A. M.-EDW., 1861)—A.4, p. 44.

Localities :—Coral reefs, Gulf of Manaar, two specimens (adult ♂ and adult ♀); pearl banks, Gulf of Manaar, one specimen (young ♀); off Mutwal Island (young ♀).

Description :—C.l. of adult female = 18·00.

In both the adult specimens (a ♂ and a ♀) one notes :—(1) The cardiac ridge is broken in the middle line so that it takes the form of two low broad tubercles, granulated on their posterior slope; (2) there is a small granulated protuberance on the post-gastric region; (3) there is a longitudinal row of granules on the middle line of the carapace; its anterior commencement is just in front of the break in the anterior gastric ridge, and runs back across the second gastric ridge, to terminate posteriorly between this and the third gastric ridge.

Neptunus (Achelous) granulatus (H. M.-EDW., 1834)—A.4, p. 45.

Localities :—Off Negombo, one specimen; Gulf of Manaar, 17 specimens; off Mutwal Island, one specimen.

Description :—The above specimens include four ovigerous females, five adult females, seven adult males and three young males. C.l. of an ovigerous female = 13.

There is a pearly sheen, much as in *N. argentatus,* on the crests of abdominal terga II. and III., the terminal spine of the arm, the crest of the outer surface of wrist, and the upper surface of the dactylus.

The spinule on the hand, in front of the apex of the wrist, is said by ALCOCK to be blunt. Among the present examples it is sharp, except on the left hand of two and the right hand of three specimens.

Neptunus (Achelous) dubia, n. sp.—Text-fig. 9.

Localities :—Coral reefs, Gulf of Manaar, one specimen; oft Negombo, one specimen.

Description :—Adult ♂ C.l., 13; C.b. ÷ C.l., 1·31; front.b. ÷ C.l., 3·85; front.-orb.b. ÷ C.l., 0·85; ant.lat.bord. C. ÷ C.l., 0·54; post.bord. C. ÷ C.l., 0·62; post.lat.bord. C. ÷ C.l., 0·58; Ch.l. ÷ C.l., 2·00.

It differs from *Neptunus* (*Achelous*) *granulatus* in the following characters:—(1) The outer fissure of the supra-orbital margin is obsolete; (2) the nine teeth of the antero-lateral border gradually decrease in size from before backwards; (3) the antero-lateral angle of the merus of the external maxillipeds is rounded and but slightly produced in a lateral direction; (4) the chelipeds in the male are about twice the length of the carapace, the posterior border of the arm is more expanded than in *N. granulatus*, the anterior border of the arm bears three well-developed spines and a fourth inconspicuous one posterior to these, the posterior border bears one spine only in the position of the distal one of *N. granulatus*; (5) the outline of the abdomen of the male is triangular, abdominal terga II. and III. both have well-marked carinæ, across abdominal tergum V. runs a transverse ridge just anterior to the joint between terga V. and VI.—this is correlated with the form of the copulatory appendages; (6) the form of the male copulatory appendages is characteristic.

Fig. 9. *Neptunus dubia*, n. sp., adult male.

It will be noted that in characters (1), (2) and cheliped-length the new species agrees with *Neptunus* (*Achelous*) *orbicularis*, but it differs from the latter and resembles *N. granulatus* in the granulation of its carapace and chelipeds, in the open character of the inner fissure of the supra-orbital margin, and in ratio C.b. ÷ C.l. I have not seen any specimen of *N. orbicularis*, but as points (3), (5), (6) and spines of hand, *i.e.*, part of (4), are not specified by Alcock as differences from *N. granulatus* in his description of *N. orbicularis* (A.4, p. 47), I conclude that the new species is sufficiently distinct from the latter.

The characters of the antero-lateral angle of the merus of the external maxilliped may be conveniently used to separate *N. dubia* from the other two members of the sub-genus given in Alcock's key (A.4, p. 32).

I may note here that I judge *Achelous rubro-marginatus*, Lanchester ('Proc. Zool. Soc.,' 1900, p. 746, pl. xlvi., fig. 8), to belong to the sub-genus *Amphitrite*, linked to the *gladiator* group by *Neptunus* (*Amphitrite*) *petreus* (A.4, p. 37). The latter species may have been unknown to Lanchester: its description did not long precede that of *rubro-marginatus*.

Neptunus (Pontus) convexus, de Haan, 1833.

Localities:—South of Modragam, one specimen; off Mutwal Island, two specimens; coral reefs, Gulf of Manaar, nine specimens; pearl banks, eleven specimens.

Description :—The above include one ovigerous female, six adult non-ovigerous females, nine young females, five adult males, and two young males. The specimens from "Coral reefs, Gulf of Manaar," are larger than those from the other localities.

Neptunus convexus is not definitely included in the Indian fauna by ALCOCK (A.4, p. 32). He suggests that its affinities are with the sub-genus *Neptunus*. It seems advisable to keep it apart, however, as the single representative of *Pontus*, a sub-genus re-defined by DE MAN ('Abh. Senckenb. Ges.,' xxv., pt. iii., p. 643, pl. xxi., fig. 27, 1902).

Charybdis (Goniosoma) natator (HERBST, 1794)—A.4, p. 61.

Localities:—Off Mutwal Island, two specimens; pearl banks, Gulf of Manaar, thirteen specimens.

Description :—The above include four females and eleven males, all young.

Charybdis (Goniosoma) orientalis, DANA, 1852—A.4, p. 63.

Localities:—Coral reefs, Gulf of Manaar, five specimens; pearl banks, Gulf of Manaar, fifteen specimens; south of Galle, one specimen; off Mutwal Island, one specimen.

Description :—C.l. of ovigerous female = 9·50.

Charybdis (Goniohellenus) ornata, A. M.-EDW., 1861—A.4, p. 64.

Locality:—Coral reef, Galle, one specimen.

Description :—The specimen is a male, C.l. = 9·75.

The last of the antero-lateral teeth is a little larger than the others instead of smaller as in ALCOCK's description. A parasitic *Sacculina* is attached to the abdomen. On comparing the crab with one of similar size in the British Museum (ref. 73.28) I find that this has had little effect upon the form of the abdomen, but that the copulatory appendages are sensibly less developed.

Thalamita prymna (HERBST), var. **crenata** (= **T. crenata,** LATR.)—A.4, p. 76.

Locality:—Trincomalee, three male specimens.

Description :—

C.l.	29·00	38·00	41·00
C.b. ÷ C.l. . . .	1·47	1·49	1·50

The high variability in size is to be noted, as all three are possibly adult.

Thalamita prymna (HERBST), var. **annectans,** nov.

Locality:—Trincomalee, two specimens.

Description :—One is a small, but quite probably adult, male, C.l. = 16·00.

The following are its most interesting characters for systematic purposes:—(1) The fourth tooth of the antero-lateral margin of the carapace is rudimentary; (2) the ridge on the basal joint of the antenna bears spines; (3) the four middle lobes of the front are more or less squarely cut; (4) the transverse mid-gastric ridge is not continued to the notch between the first and second teeth of the antero-lateral border of the carapace; (5) there are four ridges on the hand: two of these are ill-defined and unite the two rows of spines on its upper surface—a third corresponds in position to the third ridge of var. *crenata* and is similarly continued on to the fixed finger—the fourth is smooth, runs above the third, and ends distally just behind the cleft between the fingers; (6) there are three spines in the upper row on the palm—the distal one is smaller than the other two; (7) there is a distal spine on the wrist, just behind the upper row of spines of the palm; (8) the lower border of the propodite of walking leg 4 bears obvious spines distally; these become smaller proximally and disappear on the proximal third.

The second specimen is an immature female (Cl. = 10) which may probably be correctly put with the above. The fourth tooth of the antero-lateral margin of the carapace is seen under the lens to be excessively minute—still more rudimentary than in the male. The ridges of the hand are granular, and there is a trace of an additional ridge above the position of the one which ends interdigitally in the male.

Remarks on the species *Thalamita prymna* (HERBST). ALCOCK (1899) supports KOSSMANN'S view of the specific identity of *T. prymna* (HERBST)—*T. crenata* (LATREILLE) (including *T. crassimana*, DANA)—*T. danæ*, STIMPSON—*T. stimpsoni*, A. MILNE-EDWARDS—and *T. picta*, STIMPSON—*i.e.*, those forms with an eight-lobed front combined with a very broad basal antennal joint. Material recently described tends to justify this view. Thus CALMAN describes three series of Torres Straits forms (C., p. 22), of which two at least evidently belong to the group, and tend to combine characters of the other members rather than to belong decidedly to any recognised division. The same kind of thing occurs in the specimen of the present collection described above. It is allied by characters (1), (2), and (3) to var. *prymna*, by (4) to var. *crenata* and var. *danæ*, while characters (6) and (7) separate it from varieties known to me. ALCOCK'S key brings the present variety under var. *prymna*, from which it may readily be distinguished by characters (6) and (7) above.

Thalamita chaptali, AUDOUIN and SAVIGNY, 1826—A.4, p. 80.

Localities:—Pearl banks, Gulf of Manaar, 23 specimens; coral reefs, Gulf of Manaar, 26 specimens; off Mutwal Island, one specimen; 10 miles north of Cheval, one specimen.

Description:—C.l. of an ovigerous female = 8·25.

Thalamita poissoni, AUDOUIN and SAVIGNY, 1826—A.4, p. 81.

Localities:—West of Periya Paar, one specimen (ovigerous ♀); pearl banks, Gulf of Manaar, one specimen (adult ♂).

Description:—C.l. of the ovigerous female = 7·50.

The fourth tooth of the antero-lateral border is very rudimentary in both examples.

Thalamita admeta (HERBST, 1803)—A.4, p. 83.

Localities :—Pearl banks, Gulf of Manaar, 58 specimens ; coral reefs, Gulf of Manaar, four specimens ; off Negombo, one specimen ; off Mutwal Island, four specimens ; Muttuvaratu Paar, two specimens.

All the above specimens come under var. *admeta* as defined by BORRADAILE (p. 202). The fourth tooth of the antero-lateral border of the carapace, considerably reduced in all, is very rudimentary in some—particularly among the females. It is, perhaps, most rudimentary, however, in one of the adult males.

Thalamita exetastica, ALCOCK, 1899—A.4, p. 86 ; A.Invest., pl. xlvii., figs. 2, 2*a*.

Localities :—Pearl banks, Gulf of Manaar, two specimens (adult ♀, one ovigerous) ; south of Galle, deep water, one specimen (adult ♀).

Description :—As in BORRADAILE'S specimens (p. 203), the squamiform markings of the cheliped are almost absent ; a trace only is present, on the upper distal portion of the arm. On the upper surface of the arm and on the upper portion of the outer surface there are more or less rounded granules ; the inner surface, the under surface, and the lower portion of the outer surface are smooth. The ridges of the carapace are well marked.

In the ovigerous female there are one or two spinules on the posterior border of the propodite of walking leg 4. This is an approach to *Charybdis orientalis*, DANA.

Thalamita integra, DANA, 1852—A.4, p. 85.

Locality :—Pearl banks, Gulf of Manaar, six specimens.

Thalamita investigatoris, ALCOCK, 1899—A.4, p. 85 ; A.Invest., pl. xlvii., fig. 1.

Localities :—Off Mutwal Island, one specimen ; Gulf of Manaar, deep water, three specimens ; deep water off Galle, four specimens ; coral reefs, Gulf of Manaar, one specimen (*a*).

Description :—There are five ovigerous females, one young female, one adult male, and two young males. C.l. of an ovigerous female = 7·00.

Spines are present on the propodite of walking leg 4 as described by ALCOCK, but omitted from his figure. As differences from ALCOCK'S description of the single male for which he creates the species one notes that the median lobes of the front tend to have a straight rather than a rounded anterior border, and are not obviously more prominent than the sub-median pair, the latter point agreeing with ALCOCK'S figure, however. I should not describe the fifth tooth of the antero-lateral margin of the carapace as "very" small. The wrist and hand bear more numerous spines.

The fourth tooth of the antero-lateral margin of the carapace is absent in one of the ovigerous females (*a*).

Thalamita sexlobata, MIERS, 1886—A.4, p. 87.

Localities :—Pearl banks, Gulf of Manaar, eight specimens ; coral reefs, Gulf of Manaar, four specimens ; off Mutwal Island, one specimen.

Thalamita wood-masoni, Alcock, 1899—A.4, p. 90.

Locality:—10 miles north of Cheval Paar, one specimen (young ♀).

Description:—The fourth tooth of the antero-lateral margin of the carapace, which Alcock describes and figures (A.Invest., pl. xlviii., figs. 1, 1*a*) as rudimentary, is absent in the present example.

Thalamita oculea, Alcock, 1899—A.4, p. 91.

Localities:—Coral reefs, Gulf of Manaar, 10 specimens; pearl banks, Gulf of Manaar, 19 specimens; off Mutwal Island, three specimens; deep water off Galle, two specimens; off Kaltura, one specimen; Trincomalee, one specimen.

Description:—C.l. of an ovigerous female = 10·00.

Kraussia nitida, Stimpson, 1858—A.4, p. 98 (*pars*).

Localities:—Off Mutwal Island, one specimen (*a*); pearl banks, one specimen (*b*); west of Periya Paar, 17 to 24 fathoms, one specimen (young ♀).

Description:—

	C.l.	C.b. ÷ C.l.	Fronto-orb.b. ÷ C.l.
(*a*) adult ♂	12·00	1·04	0·62
(*b*) adult ♀	10·00	1·10	0·62

Miss Rathbun ('Bull. Mus. Comp. Zool.,' Harvard, xxxix., No. 5, 1902, p. 132) separates Henderson's *nitida* from this species and makes for it a new species, *Kraussia hendersoni*. The specimens of the present collection come under *K. nitida* in Miss Rathbun's sense. They agree with her figure. Miss Rathbun's photographs of species of *Kraussia* are useful (*loc. cit.* and R., 1903).

This genus is new to the Ceylon fauna. The only other genus of the family Cancridæ which I know to have been recorded from Ceylon is *Trichopeltarium*, represented by a single species (? *T. ovale*, A.4, p. 99).

I may note here that I have seen in the British Museum the "type"-specimens described by Adams and White in the 'Voyage of the "Samarang"' (p. 59, 1850) as *Trichocera porcellana*, and find that the latter name is a synonym of *K. rugulosa*. Dana puts it as such with a query (Crust., 'U.S. Expl. Exped.,' I., p. 302, 1852).

Gomeza bicornis, Gray, 1831.

Localities:—Deep water, off Galle, one specimen (*a*); pearl banks, Gulf of Manaar, six specimens (*b* to *g*).

Description:—Examples (*b*), (*c*), and (*g*) are ovigerous females, (*a*) is an adult but non-ovigerous female, and (*d*) to (*f*) are adult males.

Variability is high within the species. The present specimens fall into three groups:—(1) The non-ovigerous female (*a*, C.l. = 20) approaches A. Milne-Edwards' figure under name *Gomeza viginti-spinosa* ('Nouv. Archiv. du Mus. Paris,' vol. x., p. 52, pl. iii., fig. 5, 1874); (2) examples (*b*, C.l. = 15·5) to (*f*) agree with de Haan's figure

(Crust. in 'Fauna Japonica,' p. 44, pl. ii., fig. 5, 1835); (3) the ovigerous female (*d*, C.l. = 23) goes with the "Challenger" specimens preserved in the British Museum.

Some variable characters of the species may be set forth in the form of a key.

I. Inner sub-orbital spine small . . . . var. A.

II. Inner sub-orbital spine large.

a. Carapace strongly pilose . . . . var. B.

b. Hairs on carapace few or absent.

i. Spiniform outer angle of orbit as well developed as first antero-lateral spine . . . . var. C.

ii. Spiniform outer angle of orbit much shorter than the first antero-lateral spine . . . . var. D.

The family Corystidæ is new to the Ceylon fauna.

CATOMETOPA.

Catoptrus nitidus, A. M.-Edw., 1870—A.6, p. 307.

Locality :—West of Periya Paar, 17 to 24 fathoms.

Description :—Male, apparently adult, C.l. = 3·80 ; Ch.l. (smaller) ÷ Ch.l. (larger) = 0·92 ; C.b. ÷ C.l. = 1·51 ; F.l. (larger) ÷ C.l. = 1·05 ; Ch.l. (larger) ÷ C.l. = 0·33 ; F.l. (smaller) ÷ F.l. (larger) = 0·75.

Remarks.—The small size of the specimen may be noted—Alcock refers to some

	G. inæqualis, Rath.	*C. nitidus* : A.6, p. 307.	Present specimen.	*C. nitidus* (= *G. truncatifrons*, de Man).
	♂.	(Sex ?)	♂, probably adult.	♂, young.
(1) C.l.	7·00	9·50	3·80	6·20
(2) C.b. ÷ C.l.	1·51	1·53	1·51	1·66
(3) Ant. lat. region. . .	Finely granular	Finely granular	Finely granular	Coarsely granular
(4) Denticle betw. ant. lat. teeth 1 and 2	Absent	(Not mentioned)	Absent	Present
(5) Ch.l. (larger) ÷ C.l. .	3·00	—	3·03	2·50
(6) Ch.l. (smaller) ÷ C.l. .	3·40	About 3·00	3·29	Much as larger Ch.l. ÷ C.l.
(7) Ant. border arm . .	"Coarsely granulous," no spines.	Finely serrulate, one serration at either or both ends enlarged and spiniform.	Finely serrulate, one serration at prox. end enlarged and spiniform.	Granular, a spine distally in larger Ch. In smaller Ch. one behind middle also.

similarly small examples. *Goniocaphyra inæqualis*, RATHBUN, is, I believe, a synonym—her photograph gives an excellent impression of the present specimen. The preceding table shows comparative characters in these forms. ALCOCK'S description was based on 19 specimens from various localities. His measurements refer to Mauritius specimens in particular. A. MILNE-EDWARDS' "type"- specimen was large (C.b. = 23·00).

Goniocaphyra inæqualis comes under *Catoptrus nitidus* as described by ALCOCK except as regards characters (6) and (7) of table, and of these (7) is admittedly variable (even in Miss RATHBUN'S photograph there seems to be some indication of a proximal tubercle). My specimen is intermediate in regard to character 6.

Dr. DE MAN points out ('Notes, Leyden Mus.,' xii., p. 67, 1890) that his *Goniocaphyra truncatifrons* is young and = *Catoptrus nitidus*. The evidence suggests a single species for the forms included in the table, within which DE MAN'S *truncatifrons* specimen stands somewhat apart.

Mertonia, n. gen.

Description :—Carapace rudely semicircular in outline, the posterior border being the longest, and the postero-lateral borders anteriorly convergent, to form a common curve with the well-arched antero-lateral and anterior borders; it is but little broader than long, is convex fore and aft, and strongly declivous anteriorly. Regional distinctions are almost imperceptible. Fronto-orbital border more than one-half (about 0·6 in the two specimens), and front one-quarter, the greatest breadth of the carapace; front is prominent and bilobed.

Orbits somewhat ventral, completely filled by immovable elongated eye-stalks; eyes small.

Antennules small; they fold obliquely into proper pits.

Basal antennal segment fairly long, its antero-external angle stands well in the orbital hiatus; the anterior portion of the hiatus is occupied by the flagellum, which is stout and markedly plumed and half the carapace length.

The epistomial wall of the buccal cavern is well formed and prominent; the buccal cavern is not completely closed by the external maxillipeds, a considerable space being left between their inner borders, particularly those of the meri; the flagellum articulates with the antero-internal angle of the merus; the antero-external angle of the merus is produced.

Chelipeds a little unequal, much more massive than, but about the same length as, the 3rd pair of walking legs; palm short, deep, and compressed, with sharp edges.

Walking legs slender, unarmed; dactylopodites styliform: the 3rd and 4th pair of approximately equal length (the 2nd pair missing).

For key purposes *Mertonia* comes under division I.1.ii.b. of ALCOCK'S key to the Indian genera of the Rhizopinæ (A.6, p. 317). The other occupant of the same division is *Xenophthalmodes*, from which the new genus is distinguished readily by the lateral production of the outer angle of the merus of the external maxillipeds; additional differences from the same genus concern: (1) ratio of fronto-orbital breadth ÷ C.b.; (2) ratio of frontal b. ÷ C.b.; (3) the more ventral position of the orbits: (4) eyes, though very small, are distinct; (5) direction of fold of antennules; (6) relations of basal antennal segment and orbital hiatus (associated, no doubt, with more ventral position of orbit); (7) the markedly plumed antennal flagellum. Characters (4) and (5) approach the condition found in *Typhlocarcinus*: (2) and (3) are intermediate between the latter genus and *Xenophthalmodes*.

Mertonia lanka, n. sp.—Plate I., fig. 11, *a*, *b*.

Locality:—Gulf of Manaar, two specimens (♀ and ♂).

Description:—C.l. = 4 in ♂, 4·5 in ♀; C.b. = 5·5 in ♂, 6 in ♀.

Carapace has practically smooth surface, polished, with some irregular dimpling; its free edges fringed with longish silky hairs; C.b. ÷ C.l. = 1·37 in ♂, 1·33 in ♀: frontal b. ÷ C.b. = 0·27 in ♂, 0·28 in ♀; fronto-orbital b. ÷ C.b. = 0·64 in ♂, 0·58 in ♀: front strongly declivous and decidedly bilobed.

Orbits elongated; long diameter of orbit ÷ C.l. = 0·25 in ♂, 0·28 in ♀.

The antennal hairs are numerous and long; antennal flagellum l. ÷ C.l. = 0·5 in ♂.

The buccal cavern increases slightly in breadth anteriorly; the merus of the external maxilliped has its length and breadth about equal (the measurements taken along the middle line in each case); its outer border somewhat convex; its antero-lateral angle produced and rounded; the ischium is not much longer than broad; its breadth is as that of the merus; a space is left between the ischia and a larger one between the meri (see Pl. I., fig. 11, *a*).

Chelipeds about same length as walking leg 4; hands sub-equal; inner angle of wrist acuminate; upper and lower edges of hand sharpened, its surfaces polished, with some dimpling; the edges of the chelipeds are fringed with silky hairs, these are long on the wrist, shorter on the hand. Walking legs fringed with silky hairs.

Scalopidia spinosipes, Stimpson, 1858—A.6, p. 325.

Locality:—Gulf of Manaar, one specimen.

Description:—A young male, C.l. = 5·75; C.b. ÷ C.l. = 1·30.

Pinnoteres margaritiferæ, n. sp.—Text-fig. 10, 10 *a*.

Locality:—Pearl banks, Gulf of Manaar, one specimen.

Description:—An adult male. C.l. = 5·25.

Carapace well calcified, circular, smooth, and polished; seen under lens to be pitted, more markedly so towards the margins; it is flattened a good deal, though a little convex; its margins are rounded and ill-defined. Front produced, with straight anterior border in dorsal view; its tip is really, however, deflexed acutely, and its true anterior border, seen in anterior view, is obtusely pointed. Eyes small, well pigmented; not entirely visible in a dorsal view of the animal. Propus of external maxilliped spathulate; dactylus slender and inconspicuous, arising from about the middle of the flexor surface of the propus, which arises before the termination of the carpus, and the latter before the termination of the merus. Cheliped slightly longer than the carapace (Ch.l. ÷ C.l. = 1·12); two or three times as stout as walking leg 1, but rather shorter (Ch.l. ÷ W.L.1.l. = 0·86); the segments inflated, smooth, and

Fig. 10. *Pinnoteres margaritiferæ*, n. sp. × 3.

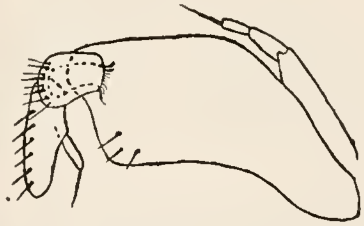


Fig. 10A. External maxilliped.

polished; dactylus is about two-thirds as long as the upper border of the hand; its tip is strongly bent down; there is a stout tooth near its base, on its apposable border.

Walking legs slender; lower borders fringed sparsely with hair. W.L.1 ÷ C.l. = 1·33; W.L.2 ÷ C.l. = 1·38; W.L.3 ÷ C.l. = 1·38; W.L.4 ÷ C.l. = 1·05. The dactyli of walking legs 1, 2, and 3 are sub-equal in length (about 0·2 of C.l.); that of walking leg 4 is about one-half as long again.

Gelasimus* annulipes, Latreille—A.6, p. 353—Text-fig. 11.

Locality:—Off Mutwal Island, two specimens (*a*, *b*).

Description:—	C.l.	C.b. ÷ C.l.	Post. bord. C. ÷ C.l.	Front bord ÷ C.l.	Larger propus l. ÷ C.l.
(*a*) ♂ . . .	8·75	1·66	0·91	0·29	2·17
(*b*) ♀ . . .	9·25	1·62	0·95	0·28	—

C.b. is measured by a straight line uniting produced post-orbital angles.

Posterior border C. is measured by a straight line uniting points just above and to inner side of bases of 4th pair of walking legs.

Propus length is measured along lower border.

Nobili (in 'Boll. Mus. Torino,' xvi., No. 397, p. 13, figs. A, B, 1901) has distinguished two varieties of the species—differentiated by presence or absence of a large triangular tooth at distal end of fixed finger.

A, var. *orientalis*, Nobili, 1901. Large tooth present.

B, var. = *Gelasimus perplexus*, A. M.-Edw., 1852. Large tooth absent.

Fig. 11. *Gelasimus annulipes*, the larger chela × 2.

* I retain the generic name *Gelasimus*—sanctioned by tradition—to avoid confusion with the distinct group of land crabs known as *Uca*.

The photograph (fig. 11) should be compared with NOBILI's figures. It might conceivably be included under var. *orientalis*, but does not agree well with either.

Length of large propus is in adult male (*a*) much less than that given by ALCOCK, who had before him 300 Indian specimens (ALCOCK's index, large propus l. ÷ C.l. = 3·00).

Ocypoda ceratophthalma (PALLAS, 1772)—A.6, p. 345.

Localities:—Trincomalee, mangrove swamps, two specimens (*b*, *c*); Galle, one specimen (*a*).

Description:—	(*a*) ad. ♀.	(*b*) ad. ♀.	(*c*) ad. ♂.
C.l.	13·50	30·00	36·50
C.b. ÷ C.l.	1·02	1·13	1·07
Projection of eye stalk beyond eye (lower border) ÷ C.l.	0·0	0·10	0·29

C.b. is a straight line uniting points of lateral borders where the serrulate line forks.

In adult female (*b*) the outer band of granules of the ischium of external maxillipeds is somewhat obsolescent, tending, in conjunction with a specimen of *O. platyarsis* in the present collection, to cast doubt upon granulation of this region as a character of specific value.

Ocypoda platyarsis, H. M.-EDW., 1852—A.6, p. 348.

Localities:—Gulf of Manaar, one specimen (*d*); Trincomalee, mangrove swamps, three specimens (*a*, *b*, *c*).

Description:—	(*b*) young ♀.	(*c*) young ♀.	(*d*) adult ♂.
C.l.	15·00	24·00	50·00
C.b. ÷ C.l.	1·27	1·34	1·26
Projection of eye stalk beyond eye (lower bord.) ÷ C.l.	0·10	0·19	—

The distinction between this species and *O. ceratophthalma* in regard to C.b. ÷ C.l. holds, in the present specimens, for both adult and young. In adult male (*d*) the granulation of ischium of external maxillipeds approaches the condition recorded above for an adult female specimen of *O. ceratophthalma*.

Dotilla myctiroides (H. M.-EDW., 1852)—A.6, p. 368.

Localities:—Off Mutwal Island, three specimens; coral reefs, Gulf of Manaar, three specimens; Galle, twenty-three specimens.

Description:—C.l. of an adult male = 8·50.

All the specimens are males except a single immature female from "Coral Reefs, Gulf of Manaar." All the males are mature save one, or perhaps two.

The immature female has seven separate abdominal terga.

Remarks.—Is the striking preponderance of males over females in the collection correlated with a difference in habit, the latter staying at home in the mud?

DE HAAN'S use of the division of the female abdomen into five movable parts only, as a generic character, is not to be considered as contradicted by the present specimen, as the latter is immature (C.l. = 5·50).

Macrophthalmus latreillei (DESMAREST), 1822—Plate II., fig. 3, text-fig. 12.

Locality:—Gulf of Manaar, one specimen.

Description:—Ovigerous female. C.l. (front included) = 21·00; C.b. ÷ C.l. = 1·33; front.b. ÷ C.l. = 0·13. (C.b. = straight line uniting points where the granulated line which borders the carapace bends above the bases of walking legs 1. Front.b. is measured across the "neck.")

The carapace, particularly in its grooves, has traces of hair, but there is by no means a hairy covering such as ORTMANN describes for *M. laniger*. The lateral teeth of the carapace are both in flatness and in outline more as ORTMANN'S description and figure of *M. laniger* than as MIERS' figure of *M. serratus* (= *latreillei*).

Remarks.—I agree with DE MAN in uniting *M. polleni*, HOFFMANN, 1874, with *M. latreillei*—also with ORTMANN in adding *M. serratus*, ADAMS and WHITE, to the union. I believe further that *M. laniger*, ORTMANN, 1894, is not specifically distinct. The main characters in which ORTMANN describes *M. laniger* as differing from *M. latreillei* (= *serratus*) are that the former has:—(1) Well-developed hairy covering of carapace; (2) flat, not thorn-like, teeth of lateral margin of carapace; (3) almost straight under border of chela; (4) cheliped of male not very strongly developed.

I have before me a series which makes it difficult to accept these as distinctions of specific value. Another male B.M. specimen (D) is figured (pl. ii., fig. 3).

	A. ♂ (dry). "Challeng." *serratus.* B. Mus. 43–6. Phil. Isds.	C. ♂ (dry). B. M. 83–24. Singapore.	B. ♂ (dry). B. M. 43–6. Phil. Isds.	C'. ♂ (dry). B. M. 83–24. Singapore.	E. ♀ (spirit). Present form. Ceylon.	F. ♂. *laniger* (ORT.'s descr. and figure).
C.l.	41·50	29·00	30·25	27·50	21·00	small
C.hair	absent	much	absent	much	little	much
Arm l. ÷ C.l. . .	0·84	0·74	[0·45]	0·71	0·45	—
P.l. ÷ C.l. . . .	1·37	1·28	[0·65]	1·20	0·62	—
H.l. ÷ C.l. . . .	1·00	0·88	[0·36]	0·82	0·32	—
H.height ÷ C.l. .	0·46	0·47	[0·22]	0·45	0·14	—
F.l. ÷ C.l. . . .	0·54	0·56	[0·31]	0·53	0·35	—
F.l. ÷ H.l. . . .	0·54	0·64	[0·86]	0·64	1·07	—

P.l. = Propus length (under border). H.l. is measured along upper border. Specimen (B) has only one cheliped, and that is a regenerated one.

Examining the above table and the plate one notes that a hairy type of carapace is associated indifferently either with "flat, not thorn-like" carapace-teeth (F), or with acute upturned carapace-teeth (C), or with a somewhat intermediate form (C'). On the other hand, the character of the marginal teeth of the carapace, the male cheliped measurements and the size of the crab (measured by C.l.), are correlated.

The cheliped differences in the males have the appearance of being growth-changes. The appearance of regenerated cheliped of (B) is suggestive (Pl. II., fig. 3, B). Possibly the differences in the character of the marginal teeth are also growth-changes; one

D. C.

A.

Fig. 12. *Macrophthalmus latreillei*—growth stages of male chela.

requires more evidence. It may be noted that in all the males the copulatory appendages appear to be well developed; it would be difficult to say that the smaller specimens are not sexually mature.

I have seen MIERS' small "Challenger" specimens from Japan, referred to by ORTMANN, and put them with the example in the present collection. In one of them the degree of development of hair on the carapace is much as in my specimen. Specimens of this variable species are often found as sub-fossils (HENDERSON, p. 389).

Elamena truncata, A. M.-EDW., 1873—A.6, p. 386.

Locality:—Galle Bay, "From bags hung from buoy," three specimens.

Description:—	(*a*) young ♀.	(*b*) young ♀.	(*c*) adult ♀.
C.l.	5·00	5·25	6·25
C.b. ÷ C.l.	0·95	0·95	1·00

The front is "broadly truncated," but its anterior border cannot be described as "quite straight." BORRADAILE (B.X., p. 682) follows ORTMANN in placing the Hymenosomidæ among the Oxyrhyncha.

Geograpsus crinipes (DANA, 1851)—A.6, p. 396.

Locality:—Galle, in tow-net, one specimen.

Description:—An adult male, C.l. = 32·00. The label gives colours in life:—"Dorsum of carapace very dark purplish-red, ventral surface red (except dactylopodites of walking legs—which are nearly white), eye stalks dark purplish-red (as dorsum of carapace), lens black."

The exopodite of external maxilliped bears a slender flagellum—a point which is to be noted, for ALCOCK uses the absence of a flagellum as a generic character, speaking of it in his key as present in *Grapsus* and absent in *Geograpsus*. The two genera are, however, distinguished at once by the very striking fringe of hair on the apposed borders of the coxæ of walking legs 2 and 3—present in *Geograpsus*, absent in *Grapsus*.

Metopograpsus messor (FORSKÅL, 1775)—A.6, p. 397.

Locality :—Trincomalee, four specimens.

Description :—C.l. of an ovigerous female = 16·00.

Sesarma edwardsi, var. **brevipes,** DE MAN, 1889 ('Zool. Jahrb. Syst.,' iv., p. 425).

Locality :—Mouth of a stream near Galle, one specimen.

Description :—An adult male, C.l. = 9·50.

Leiolophus planissimus (HERBST, 1804)—A.6, p. 439.

Locality :—Galle, lagoon, two specimens (small, immature).

Plagusia depressa (FABR.), var. **immaculata,** LAMK., 1818.

Localities :—Cheval Paar. four specimens (*a*, *b*, *c*, *d*); Navakaddu Paar, one specimen (*e*).

Description :—	C.l.	C.b. ÷ C.l.	Post.bord.C. ÷ C.l.	Fronto-orb.b. ÷ C.l.
(*a*) ovigerous ♀ . .	29·00	1·09	0·59	0·66
(*b*) ovigerous ♀ . .	24·25	1·08	0·58	0·70

All come definitely under *P. immaculata* of MIERS' revision ('Ann. Mag. Nat. Hist.,' (5), i., p. 150, 1878). The tubercles are naked in all.

Remarks.—There is some confusion of terminology in regard to this and allied forms. ALCOCK writes "*Plagusia depressa*, var. *squamosa* (HERBST)," which is interpreted by BORRADAILE as "*Plagusia depressa* (HERBST), 1783 [misprinted as 1793], var. *squamosa*, HERBST, 1790." This can hardly be ALCOCK's meaning, for then (1) *squamosa* would = *depressa* and (2) FABRICIUS had already used *depressa* in a different sense. I take ALCOCK to mean "*Plagusia depressa* (FABR.), 1775, var. *squamosa*, HERBST, 1790," which implies two things: (1) a development of MIERS' views in bringing together under one species the three (*P. depressa* (FABR.), 1775, *P. tuberculata*, LAMARCK, 1818, and *P. immaculata*, LAMARCK, 1818) recognised by the latter in his excellent revision of the Plagusiidæ; (2) a union of the *P. tuberculata* and *P. immaculata* as a single variety within the species so formed. I agree with the first suggestion, but cannot accept the second.

Plagusia depressa (FABRICIUS), 1775, may be divided as follows :—

1. Carapace covered by numerous—often more or less squamiform—tubercles, each bordered by a fringe of short stiff hairs :
   - *a.* Posterior coxal process of 2nd and 3rd walking legs entire . . . . var. *tuberculata.*
   - *b.* Posterior coxal process of 2nd and 3rd walking legs dentate . . . . var. *depressa.*
2. Carapace tubercles more depressed—those on gastric region obsolescent :
   - *a.* Posterior coxal process of 2nd and 3rd walking legs entire . . . . var. *immaculata.*

The few specimens hitherto described show that the above distinctions are average, not absolute, *e.g.*, MIERS' "Challenger" specimen of *depressa* is hardly dentate, and DE MAN describes an example of *immaculata* which has a few hairs on some tubercles. The amount of material is not sufficient to enable one to estimate the exact degree of overlapping.

Additional differentia requiring investigation are :—

1. MIERS points out that carapace is more convex in *immaculata* than in *depressa* or *tuberculata.* This holds in general, but is broken in two instances known to me among the collections of the British Museum, in which *tuberculata* shows approximately same degree of convexity as *immaculata.*

2. Degree of fusion of abdominal terga 3, 4, 5 and 6. I have before me only 4 males (1 *immaculata* + 2 *depressa* + 1 *tuberculata*), which suggest that the tendency for such fusion may be found to be greater in *depressa* and *immaculata* than in *tuberculata.*

3. Shape of abdomen.

4. Size of carapace—*immaculata* being smaller than the others.

Of the above, the first at least is of value—possibly all are so. I retain for the varieties the names used by MIERS, entirely avoiding *squamosa.* If used, the latter should apply to the *tuberculata* series only, but it has the grave disadvantage of having been used by HERBST to denote in the text a form with entire coxal process, and in his figure one with coxal process dentate.

Palicus jukesi (WHITE, 1847)—A.6, p. 451—Plate I., fig. 12.

Locality :—Coral reefs, Gulf of Manaar, one specimen.

Description :—An adult male. C.l. = 14·25 (frontal lobes included). C.b. ÷ C.l. = 1·11.

Remarks.—This specimen confirms CALMAN'S inclusion of *Cymopolia carinipes,* PAULSON, 1875, in the synonymy of the species—for, while answering to ALCOCK'S description, it has, instead of the sub-hepatic tubercle described by CALMAN for his

Torres Straits specimen, a transverse row of four granules (*cf.* PAULSON's ridge), from outer end of which a row of granules runs backward for a short distance parallel to the lateral margin of the carapace. With my figure should be compared that of Dr. CALMAN (C., pl. i., fig. 10).

I follow ALCOCK in emphasising the probably catometope affinities of the genus *Palicus.* On this matter see CALMAN, p. 29.

Palicus serripes (ALCOCK and AND., 1894)—A.6, p. 454 ; A.Invest., pl. lxvii., fig. 1.

Localities :—Trincomalee, one specimen (*a*) ; Gulf of Manaar, deep water, one specimen (*b*).

Description :—(*a*) ovigerous ♀ . . C.l. = 10·50 ; C.b. : C.l. = 1·10
(*b*) ovigerous ♀ . . C.l. = 9·00 ; C.b. ÷ C.l. = 1·11

NOTE.—In the above pages 196 species are named. There remain 12 undetermined forms in the collection, making 208 in all. Of these 12, one is an Oxystome, one an Oxyrhynch, seven are Xanthids, one is a Portunid, and the remaining two are Catametopes.

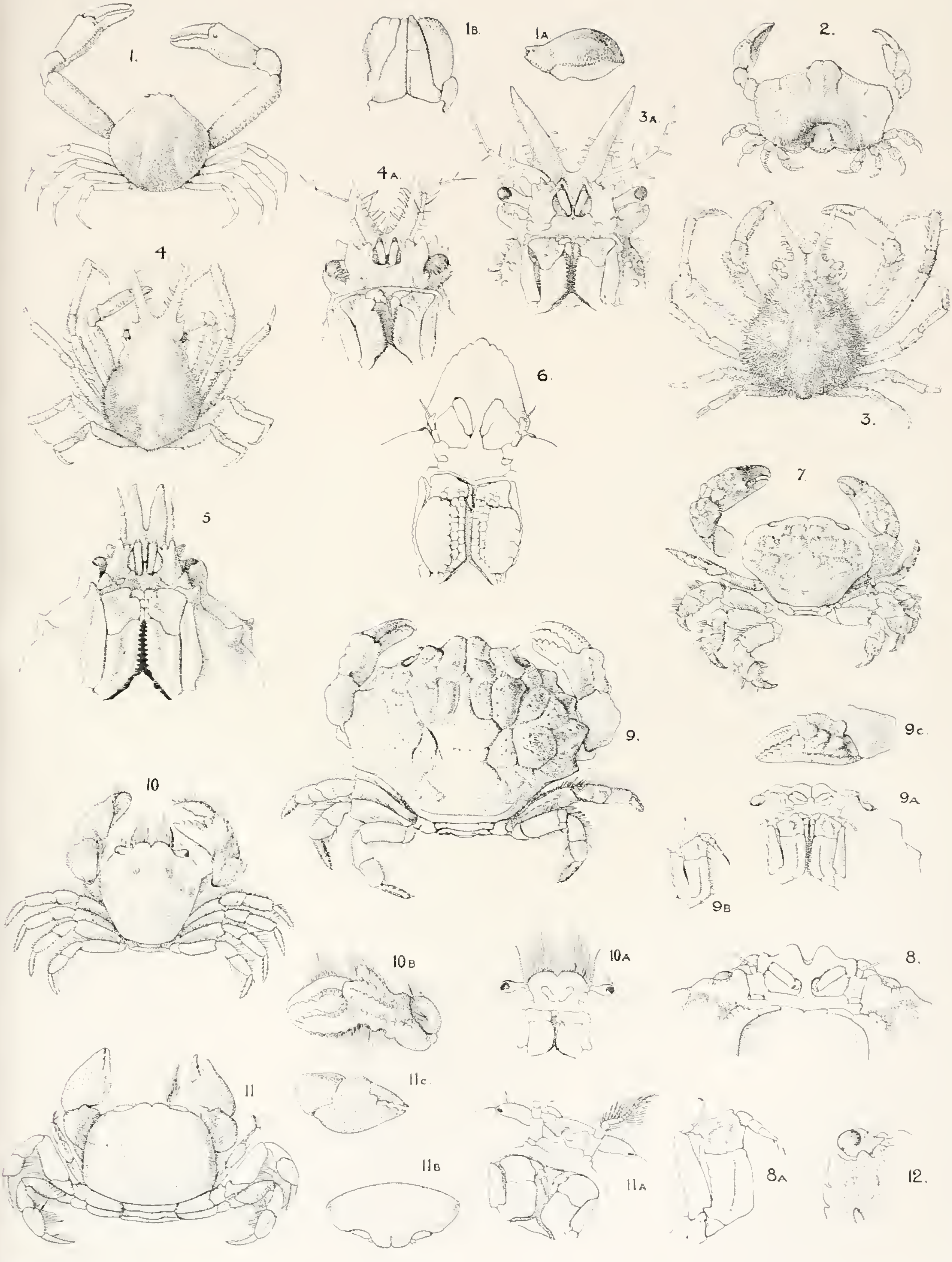
EXPLANATION OF PLATES.

PLATE I.

Fig. 1. *Philyra adamsi*, BELL. ♂. (BELL'S "type"-specimen refigured.) × 2.
a, hepatic facet, &c. × 2; *b*, buccal region with external maxilliped of one side removed. × 5.
,, 2. *Tlos havelocki*, n. sp. × 3.
,, 3. *Halimus pehleri*, n. sp. × 2.
a, ventral view of anterior region. × 5.
,, 4. *Halimus irami*, n. sp. × $2\frac{1}{2}$.
a, ventral view of anterior region. × 5.
,, 5. *Doclea alcocki*, n. sp., ♀, ventral view of anterior region. × $1\frac{1}{2}$.
,, 6. *Cryptopodia pan*, n. sp., ventral view of anterior region. × 4.
,, 7. *Zozymus gemmula*, var. *ceylonica*, nov. × 2.
,, 8. *Demania splendida*, n. gen. et sp., ventral view of anterior region. × 2.
a, external maxilliped. × 2.
,, 9. *Euxanthus herdmani*, n. sp. × $1\frac{1}{2}$.
a, ventral view of anterior region. × $1\frac{1}{2}$; outer surface of wrist, hand and fingers. × $1\frac{1}{2}$.
,, 10. *Calmania prima*, n. sp. × 3.
a, ventral view of anterior region. × 2. *b*, outer surface of hand. × 3.
,, 11. *Mertonia lanka*, n. sp. × 4.
a, ventral view of anterior region. × 8. *b*, anterior view. × 4. *c*, outer surface of hand. × 4.
,, 12. *Palicus jukesi* (WHITE), sub-hepatic region. × 2.

PLATE II.

Fig. 1. *Demania splendida*, dorsal and ventral views. Nat. size.
,, 2. *Doclea alcocki*, dorsal and ventral views. × $\frac{3}{4}$.
,, 3. *Macrophthalmus latreillei* (DESM.)—A–E, five specimens illustrating the characters given in the text. B shows regenerated cheliped; opposite surface in small figure alongside.



G. M. W. del.

Fig. 1.

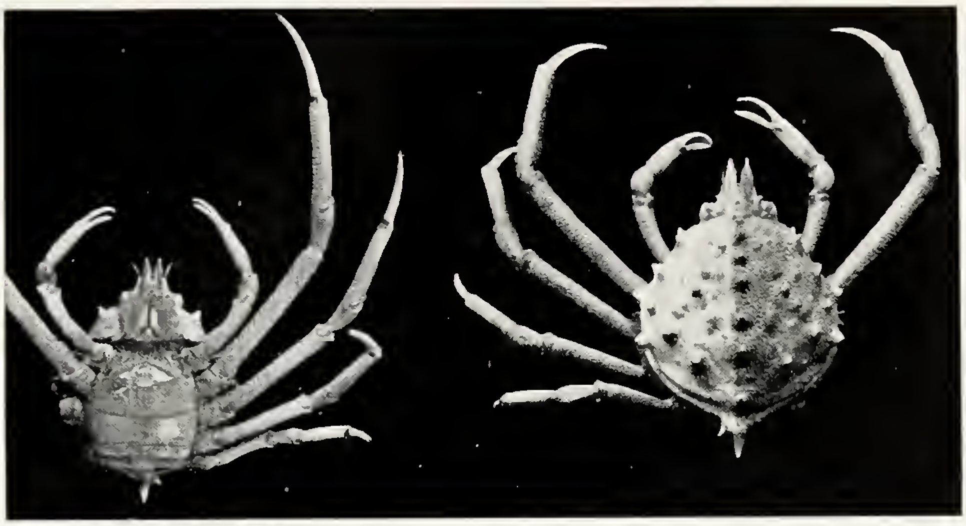


Fig 2.

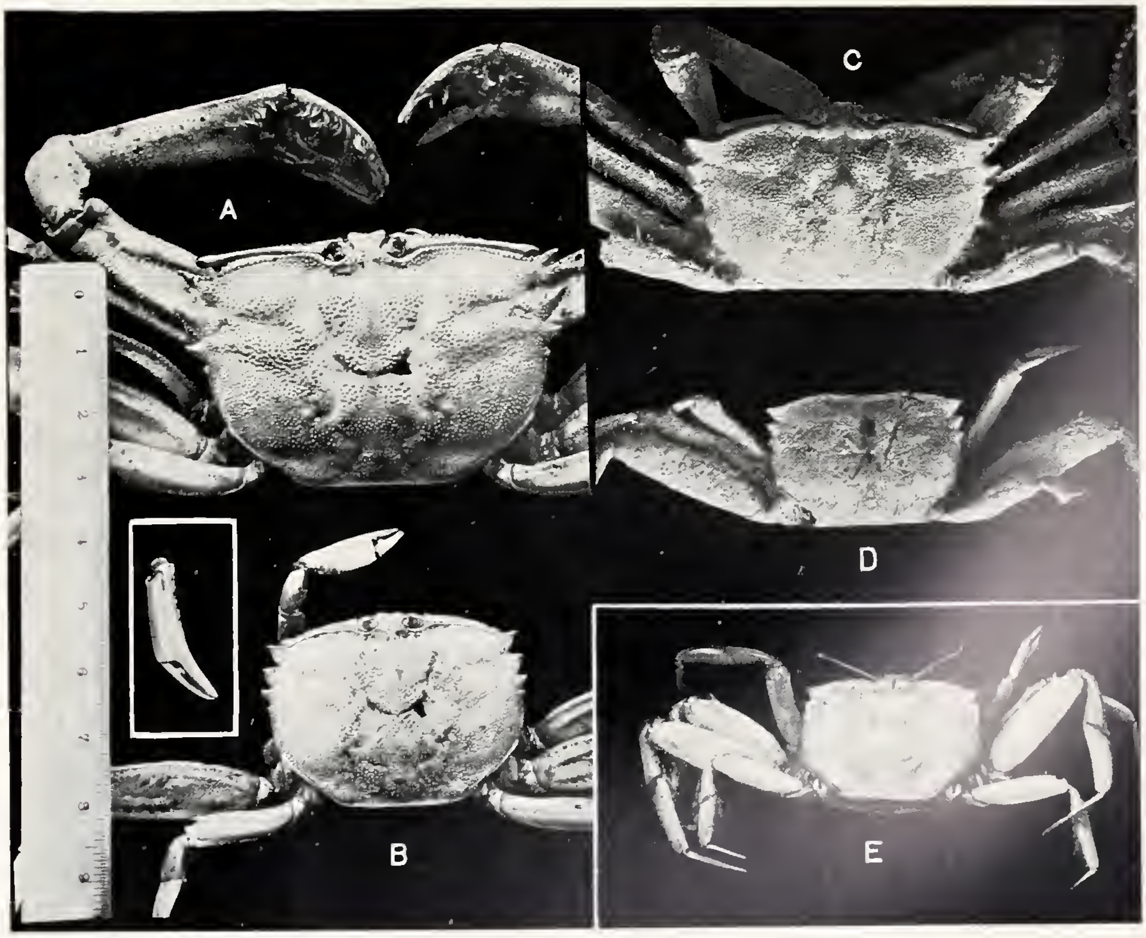


Fig. 3.

DISCUSSION OF FAUNISTIC RESULTS.

BY

W. A. HERDMAN, F.R.S.

[WITH TWO PLATES AND TEXT-FIGURES.]

THE preceding forty Supplementary Reports, along with the four upon Parasites, have made known 2615 species of marine animals from the coasts of Ceylon. Of these, 575 species are described as new to science, and have required the formation of 65 new genera and three new families. The distribution of these species in the chief groups of animals is shown in the following table :—

Group.	Number of species.	New species.	New genera.	Group.	Number of species.	New species.	New genera.
Foraminifera . . .	130	3	—	Brought forward	1436	449	58
Sponges	146	77	11				
Hydroids	43	13	1	Isopoda	34	14	3
Medusæ	29	12	—	Cumacea	16	9	1
Alcyonaria	120	47	2	Leptostraca, Stomatopoda, and Schizopoda	18	2	—
Antipatharia . . .	13	10	—	Macrura	53	3	—
Actiniaria	14	?	—	Anomura	48	2	—
Corals (Solitary and Reef)	51	5	2	Brachyura	208	15	3
Echinodermata . .	109	8	1	Pantopoda	2	2	—
Platyelmia	74	65	20	Hemiptera	1	1	—
Nematoda	7	3	—	Polyplacophora . .	9	5	—
Gephyrea	10	1	1	Molluscan Shells . .	530	10 (?)	—
Polychæta	112	36	2	Opisthobranchia . .	50	16	—
Polyzoa	116	16	—	Cephalopoda . . .	20	2	—
Cirripedia	11	1	—	Tunicata	66	44	—
Copepoda	289	80	12	Cephalochorda . .	7	—	—
Ostracoda	77	35	—	Pisces	117	1	—
Amphipoda . . .	85	37	6				
Carried forward	1436	449	58	Totals . . .	2615	575	65

The majority of the previously known species are new records for the Ceylon fauna and a large number of them are new to the fauna of the Indian Ocean, and, consequently, the Reports have added considerably to the recorded distribution of many of the older species. It is almost impossible to get exact numbers in such a case, but it is probably fairly correct to say that 1500 species have been added to the

Ceylon list and about 900 to that of the Indian Ocean. Such information, although, perhaps, as uninteresting as the description of new species, is of real importance in science, as it is impossible to draw conclusions as to geographical distribution, and the origin and past history of faunas, until we have a detailed knowledge of the animals now present in many different localities.

In comparing with other seas, we find that about 250 of our species* extend into the Malay region and 300 on into the Pacific. At least 240 are known from the Red Sea and 130 from the Mediterranean. About 280 species extend southwards to the Australian coasts, and a few are found elsewhere in southern latitudes. Finally, 90 Ceylon species are found also in the West Indian region, and may indicate a closer connection by sea in a former period than exists at the present day. This interesting relation between these two far-distant regions—the East and the West Indies—has been pointed out by several writers, and in 1899, ALCOCK† published an interesting chart (after E. KOKEN) showing a direct connection by means of a great inland basin stretching east and west from the Gulf of Mexico to the Arabian Sea. This indicated the supposed relations of land and water in Tertiary times, and was put forward by Dr. ALCOCK to elucidate the theory he advanced as to the origin of a considerable part of the Fish fauna of India from a Tertiary extended Mediterranean stretching across the present mid-Atlantic to the West Indies.

Fig. 1. Map to show the equatorial seas and the relative positions of: I. Gulf of Manaar, II. Mergui Archipelago, and III. the Maldives.

Restricting our attention now to the northern part of the Indian Ocean, there are three recent series of faunistic explorations with which we may compare our results, viz., (1) the Reports on the Mergui Archipelago, off the coast of Lower Burma (see

* Possibly a good many more. These numbers are all minimum estimates.

† Descriptive Catalogue of Indian Deep Sea Fishes in the Indian Museum, Calcutta.

'Journ. Linnean Soc., Zool.,' vols. xxi. and xxii.), (2) the series of Reports and "Illustrations" issued from the Calcutta Museum as the result of work by Colonel ALCOCK and others in the "Investigator," and (3) Mr. STANLEY GARDINER'S series dealing with "The Fauna and Geography of the Maldive and Laccadive Archipelagoes." The map (fig. 1) will serve to recall relative positions and distances.

The Mergui marine fauna is, as might be expected, not unlike that of Ceylon, but differs in the details of the species that occur. It is, however, if we may judge from the published records, not so rich a fauna, as the following summary will show—using only those groups which are common to the two reports. The predominance of Actinozoa, in the case of Mergui, is due to the large number of species of Corals described by Professor MARTIN DUNCAN. The other groups of fixed organisms—Sponges, Hydroids, Alcyonaria and Polyzoa—show markedly in favour of Ceylon.

	Sponges.	Hydroida.	Alcyonaria.	Actinozoa.	Echinodermata.	Gephyrea.	Polychæta.	Polyzoa.	Stomatopoda.	Macrura.	Anomura.	Brachyura.	Marine shells.	Totals.
Mergui.	30	6	23	86	48	4	5	21	4	19	26	116	328	716
Ceylon.	146	43	120	78	109	10	112	116	12	53	48	208	530	1585

As an indication that the fauna of the Indian Ocean is gradually becoming known, in, at least, some groups, it may be noted that in Dr. DE MAN'S account of the Mergui Podophthalmata (1888) out of 166 species, 38 (about 23 per cent.) were new to science, while 18 years later, in the present report, out of the much larger number (321) of Ceylon Podophthalmata, only 22 (less than 7 per cent.) were previously unknown. In Brachyura, 39 species (nearly $\frac{1}{5}$) are common to the two lists.

Colonel ALCOCK'S magnificent series of monographs and the accompanying fasciculi of "Illustrations," have done much to elucidate the fauna of the northern part of the Indian Ocean, but they deal largely with deep-water forms, and I find it difficult to make any comparison between my restricted, but, perhaps, more intensive, study of a small shallow-water area (the Gulf of Manaar) and his extended gleanings all over the three seas of India. Perhaps the most important conclusion to be drawn is the extreme richness of the fauna, since so little is common to the two series of results. Some groups have not yet appeared in the "Investigator" series, but even in the case of those that have been monographed, the shallow waters of Ceylon have here and there added something to the list. These reports cannot be compared in number of novelties with the "Investigator" monographs, but they may be regarded as in some respects supplementing them.

The comparison with the Maldive fauna ought to be more satisfactory and interesting:—first, because STANLEY GARDINER'S reports are almost as recent as these, and are therefore presumably done on very much the same lines, so as to be fairly comparable with ours; and, secondly, because the Maldives are a group of Coral-formed oceanic islands in contrast to Ceylon, which is continental and geologically a part of India. The comparison between a shallow-water (under 100 fathoms), continental-coast fauna and that of a group of oceanic coral islands, only, on the average, some 400 miles apart, in the same latitudes and the same sea, but separated by deep water, ought to be instructive.

The following table shows the number of species in the chief groups which are recorded in both series of Reports :—

	Hydroida.	Medusæ.	Alcyonaria.	Actinozoa.	Echinodermata.	Platyelmia.	Gephyrea.	Cirripedia.	Copepoda.	Amphipoda.	Isopoda.	Stomatopoda.	Macrura.	Anomura.	Brachyura.	Mollusca.	Cephalochorda.	Pisces.	Totals.
Maldives . . .	23	44	39	112	49	28	25	16	120	19	14	6	79	34	189	431	4	65	1297
Ceylon . . .	43	29	120	78	109	74	10	11	289	85	34	12	53	48	208	530	7	117	1857

There are evidently marked differences here, and some of them at least seem susceptible of explanation. A group of oceanic coral islands must clearly have been populated from some of the surrounding older continental coasts,* and the nearest of these to the Maldives are Ceylon and the southern end of India, some three to five hundred miles distant.† There are two dominant factors that will play an important part in determining which animals from the neighbouring continent will form part of the new population, viz :—(1) The means of transport possessed by the animals either in the adult or the larval condition, and (2) whether or not the conditions existing on the island are sufficiently favourable to the migrating animal on its arrival either as an adult or a larva.

Looking at the table we find that the total number of animals is much greater in the recorded Ceylon fauna than in that of the Maldives, but that in certain groups —the Medusæ, Actinozoa, Gephyrea, Cirripedia, and Macrura—the Maldivian numbers are the greater; while in other groups—such as Hydroida, Alcyonaria, Echinodermata, Platyelmia, Copepoda, Amphipoda. Isopoda, and Mollusca—the Ceylon list markedly predominates.

Oceanic or pelagic groups, as would be expected, and coastal animals of active

* We may assume that even if Mr. Gardiner's view is correct, that the Maldives are based upon an old continental platform cut down by currents to a depth of some 2000 fathoms, none of the original continental animals have lived on to appear amongst the inhabitants of the coral reefs.

† Of course, some species may have come from the much more distant African coast.

habit, possessing the necessary means of transport in the adult condition, are well represented in the Maldive fauna. For example, Fishes, Medusæ, and Chætognatha are all fairly abundant. The Cirripedia also, some of which are almost cosmopolitan in their distribution on the high seas, are more numerous than in Ceylon. The Copepoda might be expected to bulk larger than they do. The pelagic and more active forms are, however, present, and the deficiency is in the bottom-living species, many of which are associated with Sponges, Tunicates, and other fixed colonies which are probably much more abundant at Ceylon than in the Maldives. The high number in the case of Actinozoa is due to species of Madreporaria which are, of course, abundant in a Coral archipelago, and the species of which were especially studied by Mr. STANLEY GARDINER. In the case of Macrura the 79 species includes 76 Alpheidæ, and the species of *Alpheus* being closely associated in habitat with Corals would naturally be obtained in abundance amongst the reefs.

Turning now to the groups of animals which are more abundant at Ceylon, we find that it is the fixed and the more or less sedentary, bottom-living forms that are poorly represented in the Maldivian fauna—*e.g.*, Hydroida, Alcyonaria, Echinoderma, and Mollusca. I should expect this result to apply also to Sponges, Polyzoa, and Tunicata, and I have little doubt that it does, but these groups in the case of the Maldivian fauna have not yet been reported on. Most of these groups are dependent for dispersal upon minute, feeble, and short-lived embryos or larvæ to which 400 miles of open sea may be a formidable obstacle. In marked contrast to some of these groups there is the case of the Brachyura, where the numbers in the two faunas (Maldives 189 and Ceylon 208) are not very different. The probable explanation is that the larvæ of the crabs are powerful, locomotory, comparatively long-lived animals which are frequently taken in the tow-net in the open sea, and are therefore much better fitted to survive the journey from the continental coast. The most feebly represented of Crustacean groups are the Amphipoda and Isopoda, and I would suggest that the explanation is to be found in the unsuitability of their young stages for distribution to oceanic islands. Those that do cross in safety are probably carried accidentally on larger objects. It may conceivably be easier for a shallow-water species, which neither in the adult nor in larval life is adapted to a prolonged pelagic existence, to spread in the course of ages from India to Australia along the stepping-stones of Malaysia than to cross the stretch of open sea from Ceylon to the Maldives.

There is, however, not only the numerical but also the specific constitution of the two faunas to be considered, and, undoubtedly, many species are common to the Maldives and Ceylon. Probably all the Corals collected in the Gulf of Manaar have been recorded in Mr. STANLEY GARDINER'S reports, and nearly all their associated Alpheidæ. The Foraminifera seem to be very much the same in the two localities, at corresponding depths. Out of 131 species found at Ceylon, 68 occur in CHAPMAN'S list from the Laccadives, and the latter collection was mainly, if not wholly, a deep-water one. An analysis of the recorded Echinoderms gives us the following result :—

Crinoidea . .	10 Maldivian species,	16 Ceylon species,	5 in common	
Asteroidea . .	13 ,, ,,	25 ,, ,,	8 ,,	
Ophiuroidea .	12 ,, ,,	13 ,, ,,	5 ,,	
Echinoidea . .	15 ,, ,,	28 ,, ,,	12 ,,	

In the Amphipoda 11 species out of the 19 found in the Maldives occur also in Ceylon. Even in the Isopoda a few species, such as *Cirolana sulcaticauda*, *Lanocira gardineri*, and *Cymodoce inornata*, are common to both faunas. Mr. LAURIE considers that the Ceylon crabs show a marked resemblance to those of the Maldives, over 70 of the species being identical.

In some groups little relationship is shown. In the Nudibranchiata only one Ceylon species extends to the Maldives; amongst the Hydroids there are two, but in addition we find several pairs of representative or closely allied species which might by some be regarded as identical forms. The Maldive Cephalopoda, according to Dr. HOYLE, exhibit a "remarkable likeness" to those of Ceylon, and several species are identical. Mr. BROWNE, on the other hand, calls attention to the dissimilarity of the Medusæ, but we must remember that two successive collections of Medusæ (GARDINER'S and AGASSIZ'S) made in the Maldives were also very dissimilar.

Confining our attention now to the Ceylon marine fauna, we may conveniently divide our records into three sets of localities :—

1. Trincomalee and the north-east coast (Stations XX. to XXXI.*).
2. Galle and the south end of the island up to Colombo (Stations XXXII. to XLVI.).
3. The Gulf of Manaar and around Adam's Bridge, from Colombo to Palk Bay (Stations I. to XIX. and XLVII. to LXIX.).

Of these three regions of the coast, the first two have deeper water and a more varied fauna than is found in the pearl-bank region of the Gulf of Manaar. But, on the other hand, we have more stations in the third district, where much more time was spent and where the fauna, on the pearl banks, was consequently studied much more closely than elsewhere. The following table gives the number of species in each group of animals found in each of the three districts :—

* See "Narrative," in Part I. (1903), for details as to the Stations.

Group.	Trincomalee.	Galle.	Gulf of Manaar.	Group.	Trincomalee.	Galle.	Gulf of Manaar.
Foraminifera	11	15	130	Brought forward	133	408	1147
Sponges	11	65	105				
Hydroids	1	18	38	Isopoda	1	10	28
Medusæ	1	13	22	Cumacea	—	1	15
Alcyonaria	15	29	91	Leptostraca, Stomatopoda, and Schizopoda	2	1	17
Antipatharia	4	6	5	Macrura	4	17	43
Actiniaria	3	5	7	Anomura	9	22	36
Corals (Solitary and Reef)	16	33	35	Brachyura	35	60	170
Echinodermata	19	45	74	Pantopoda	—	1	2
Platyelmia	1	4	67	Hemiptera	—	1	1
Nematoda	—	—	7	Polyplacophora	1	3	7
Gephyrea	2	5	8	Molluscan Shells	175	145	357
Polychæta	4	28	81	Opisthobranchia	3	6	44
Polyzoa	9	50	107	Cephalopoda	1	3	18
Cirripedia	1	2	13	Tunicata	7	14	59
Copepoda	18	63	214	Cephalochorda	—	2	4
Ostracoda	1	4	67	Pisces	5	23	95
Amphipoda	16	23	76				
Carried forward	133	408	1147	Totals	376	717	2043

The great majority of the shallow-water forms have spread all round the island. To take the pearl oyster as an index, while its home may be said to be the Gulf of Manaar, it occurs in fair quantity in shallow water at Trincomalee, and sparingly at Galle. In regard to the rarer and finer things, such as Solitary Corals, branched Alcyonaria, Antipatharia, and some Echinoderms, Crustacea and Mollusca, I am inclined to think the distribution is a question of depth rather than locality. They have been found at Trincomalee and off Galle where rather deeper water was obtained, but probably occur also in the depths outside the pearl bank plateau in the Gulf of Manaar.

Let us now pass the various groups in review so as to ascertain the general impression given by the fauna in each case; and I desire here to acknowledge that, while I am alone responsible for any opinions that are not quoted from others, I am indebted directly or indirectly to my friends the authors of the special Reports for most of the facts upon which these opinions are founded.

The Foraminifera figure largely in the deposits round the Ceylon coast. Two extreme examples may be given. At the 100-fathom line, south of Galle, the bottom seems to be practically composed of masses of the new species *Ramulina herdmani*, Dakin; and at several points in the Gulf of Manaar up to 40 per cent. of the deposit is formed of *Heterostegina depressa*. Other species, such as *Amphistegina lessoni*, *Orbitolites marginalis*, and *Alveolina melo*, are also so abundant that to the eye the deposit, when it comes up in the dredge, appears to be formed mainly of Foraminifera. *Polytrema miniaceum* is also of very frequent occurrence, and grows to a large size.

But beyond this abundance of certain species there is no special feature to be noted. The collection is an ordinary assemblage of shallow-water tropical forms, including a few rare species and three new to science—the most remarkable of which is the *Ramulina* found in such abundance in deep water off Galle. Most of the species are new records to Ceylon, and 50 are new to the Indian Ocean. Many of them have a wide distribution in other seas, and at least 57 species are common to Ceylon and the West Indies.

Fig. 2. *Ramulina herdmani*, DAKIN. Nat. size.

The collection of SPONGES is a very large one, containing about 150 species, nearly 80 of which are new to science. Moreover, the individuals of some of these species are numerous, so that sponges bulk large in the fauna, especially in the Gulf of Manaar. The Calcarea are few and small and the Hexactinellida not represented, but the Tetractinellida, the Monaxonellida, and the Euceratosa present a rich and varied assemblage of forms. Some of the species are cosmopolitan, many are common Indo-Pacific forms; only a few extend to the Red Sea, a few more to the Mediterranean, and as many to the North Atlantic (Azores and even the British seas), half-a-dozen are represented in the West Indies, and a dozen extend eastwards through the Malay Archipelago. But much the closest affinity is shown with the fauna of Australia, as no less than 30 of the species in our collection are found also on the Australian coast. Adding to this the other known Ceylonese species, Professor DENDY finds that 47 in all out of the 75 species of sponges whose range is known to extend beyond Ceylon seas are found in the Indo-Australian region. About two-thirds of the total number of species are, however, peculiar to the Ceylon area which Professor DENDY speaks of as "an extremely rich centre of sponge distribution." Some of the most notable species from the Gulf of Manaar are shown on Plate II., figs. 1 to 4.

The Ceylon MEDUSÆ comprise 29 species, 12 of which were new to science. They are represented sparingly in all the other seas of the world, including the West Indies, and rather more fully in the Malay archipelago. But there is no indication of marked affinity with any other fauna. In fact, the differences are more evident than the resemblances. Even in the case of two such neighbouring localities as the Maldives and Ceylon, Mr. E. T. Browne, after considering the figures, writes: "the Medusoid fauna of Ceylon is quite distinct from that of the Maldives." But the fact that the genera and species of Gardiner's and Agassiz's successive expeditions to the Maldives "were quite distinct," and that there is a well-marked difference between the two collections "which is quite as great as if they had come from localities a thousand miles apart" (Browne) shows that we must not attach too much importance to such differences. Seasons and methods of collecting must be taken into account, and we have probably still much to learn in regard to each of these faunas.

The Hydroida are fairly abundant at Ceylon, and some of them are of large size (see Plate II., figs. 5 and 6). Outside the Indian Ocean the affinities of the Ceylon forms are distinctly with those of Australian seas—out of 43 species, 11 extend to Australia, and only nine of the other species are found beyond the Ceylon seas; four of these occur in the West Indies, and only one in the Mediterranean.

The Alcyonaria form a rich collection, dealt with in three reports (Nos. XIX., XX., and XXVIII.). Miss Pratt points out the similarity with the Maldive fauna, nine species of the fleshy forms, out of 17, being common to the two districts; but Professor Arthur Thomson, dealing with the Gorgonoid, Pennatulid, and other non-fleshy forms, lays stress upon the great difference between the present collection and those from Zanzibar (Crossland), Maldives (Gardiner), New Britain (Willey), and the deeper waters of the Indian Ocean (Alcock). I believe this merely indicates that the Alcyonarian fauna of these regions is so rich that we are still far from having completed the survey. Each new expedition brings in an abundant harvest, and in our present state of knowledge it is probably more profitable to base any tentative conclusions upon resemblances in the fauna rather than upon differences which may merely be due to negative evidence.

Many of the species are familiar Indo-Pacific forms, a few are represented in the Malay region; but perhaps the closest affinity is with the Red Sea fauna, on the one hand, and with that of Australian seas on the other. As in the case of so many other groups, at least one species is represented in the West Indies.

Corals are, of course, exceedingly abundant round the coast of Ceylon. The reef-building forms were not specially collected and have not been reported on, but over 30 common species have been brought home. There are in the collection about 21 species of Solitary Corals, five of which are described as new, along with two new genera—*Rhodocyathus* and *Cyathotrochus*.

The Actiniaria, although not reported on, have been examined by Mr. Southwell, who finds about 14 species, of which several are probably undescribed forms. A beautiful green, colonial form, *Zoanthus shackletoni*, is very abundant on the reef at Galle and in some parts of the Gulf of Manaar. A species of *Palythoa* (*P. tuber-*

culosa) is also common at Galle. But, perhaps, the most noteworthy form is the remarkable, free, sand-encrusted anemone *Sphenopus marsupialis*, which is apparently abundant at several localities in the Gulf of Manaar.

ANTIPATHARIA are amongst the most striking forms brought up from the deeper water outside the pearl banks or at Trincomalee and Galle. Most of the smaller colonies obtained were new species; but the finest belonged to the well-known *Antipathes abies*. Several of our Ceylon species occur in the Maldives.

The ECHINODERMATA are an ordinary Indo-Pacific series presenting a few rarities, a few novelties, and some extensions of distribution, but no other notable features. It may be of interest to show the numbers of the orders separately in the case of several allied Indian Ocean faunas :—

	Mergui.	Maldives.	THURSTON (Manaar).	Ceylon collection.	ALCOCK (deep-sea).
Crinoidea	6	10	4	13	(?) few
Asteroidea.	9	13	18	25	60
Ophiuroidea	13	12	12	14	56
Echinoidea	6	15	21	28	(?) 60
Holothuroidea	14	—	10	30	(?) 20

Probably, on the whole, the Echinodermata of Ceylon present most affinity with those of the Malay region and of the Pacific, but they also show resemblances to the Australian fauna.

In turning to the VERMES, it is found impracticable to institute any comparisons with other faunas in the case of the lower parasitic groups, since, in the first place, from the nature of our enquiry on the Ceylon expedition it was clearly of importance to collect and identify such forms as Cestode, Trematode, and Nematode parasites which are very usually neglected by the general zoologist; and, in the second place, these worms seem in many cases to be confined to particular hosts, and their distribution will therefore be determined by that of the Fishes and Molluscs they infest. Consequently the fact that 54 Cestoda are recorded from Ceylon seas and none from the Mergui or from the Maldives, must not be taken to indicate that parasitic worms are more abundant in the one locality than in the others. That these Platyelmian groups yielded a very large proportion of new species, no less than 17 new genera and one new family, is due first to our comparative ignorance of the fish Cestodes and Trematodes from tropical waters, and, secondly, to the special attention paid to them during our expedition on account of their possible bearing upon the problem of pearl production.

The 10 species of GEPHYREA, one new and the type of a new genus, are nearly all additional records for Ceylon, and half of them are new to the Indian Ocean. Their affinities seem mainly with those of the Malaysian seas to the East.

The POLYCHÆTA comprise over 112 species, of which at least 36 are new to science. In regard to these higher worms, Dr. WILLEY writes that the Polychæte fauna of Ceylon bears a circumtropical stamp in contrast, for example, with the northern and the southern faunas: a good many of the species are identical with Philippine forms. The occurrence of a species of *Grymæa* (a characteristic Scandinavian genus) is rather singular. Perhaps the most remarkable form of all is the new *Thalenessa stylolepis* obtained from coral masses in the Gulf of Manaar.

The POLYZOA form a large collection with a comparatively small proportion of novelties, 16 species out of 116. Some are cosmopolitan, and a considerable number extend into other seas, no less than 19 being British species. The chief indication of affinity is, however, with the Australian fauna, as 32 species are in common. Seven species are West Indian forms, and at least 85 are new records to the Indian Ocean, and probably about 100 are new to Ceylon.

Minute CRUSTACEA, such as Copepods and Ostracods, swarm both on the surface and in the deposits at the bottom.

The COPEPODA fauna is enormous, and the collection contained many novelties. Nearly 300 species (289 have been identified) were collected; 80 of these are new to science, and 12 new genera have been required. Nearly all the species found were additions to the known fauna of Ceylon and of the Indian Ocean. The majority (over two-thirds) of the species are from the Gulf of Manaar, about one-fourth are from Galle, and a few only from Trincomalee.

It is difficult to institute any comparisons with other faunas, as in most seas the more minute Copepods are still very imperfectly known. There was no report on Copepoda in the case of the Mergui Archipelago, and in respect of some expeditions it is known that while free-swimming Copepoda were collected in tow-nets from the surface and intermediate waters, no steps were taken to explore the very abundant fauna living in the bottom-deposits or in and upon the dredged larger animals, or to secure the parasitic forms attached to fish. In the case of the Gulf of Manaar these two last faunas yielded a rich harvest of unknown forms.

The results brought out by our records that the Ceylon Copepod fauna shows most affinity with that of the Red Sea and of the Mediterranean is largely due to the fact that we have a better knowledge of these regions than, for example, we have in the case of the Malaysian or Australian seas. Dr. NORRIS WOLFENDEN* has recently remarked upon the very striking difference in the Copepod fauna between Ceylon and the Maldives. This difference, however, seems to be chiefly confined to the littoral Harpacticidæ, which are only represented by five or six species from the Maldives, while in the Ceylon collections they are very abundant.

In the case of the Ceylon OSTRACODA, out of 77 species 35 were new to science, and nearly all were obtained from the Gulf of Manaar. The majority of the species are new to the Ceylon fauna and that of the Indian Ocean. There is no clear indication

* "Fauna and Geogr., Maldive," &c., vol. II., suppl., 1, p. 989.

of affinity with other regions. The CIRRIPEDIA are a somewhat cosmopolitan group, but our Ceylon assemblage shows some affinity with the Red Sea and the Australian faunas.

The AMPHIPODA and ISOPODA were both large collections containing a number of new forms. The individual animals in both were of small size compared with those from temperate and polar seas. In the Amphipoda 85 species gave 37 new to science, requiring the formation of six new genera. A few of the species extend to the Red Sea, the West Indies, the Malay Archipelago, and the Pacific, seven are found in the Australian fauna, and ten in the Mediterranean. In the case of the Isopoda, out of 34 species 14 proved to be new, requiring three new genera and two new families. Here, also, there is indication of Australian affinities, and two species extend to the West Indies.

The CUMACEA, being a comparatively unknown group, are all new records for the Indian Ocean, and out of the 16 species nine are new and one has required a new genus. We do not know enough of the distribution in this case, or in that of the STOMATOPODA and SCHIZOPODA, to make comparisons with other seas.

In the MACRURA, out of 53 species, three of which are new, a large proportion, 24, extend into the Pacific, 10 are common to the Malaysian fauna, and 10 also reach the Australian seas, nine are found in the Atlantic, four in the Red Sea, three in the Mediterranean, and one in the West Indies.

The ANOMURA, as a group, have, to the collector, the appearance of being very abundant, but that is due chiefly to great numbers of a few common species. At Galle, and at Trincomalee, ten times the present collection might easily have been made without adding to the number of species. Out of 48 species collected only two are new, and they present no features of special interest. ALCOCK has pointed out that the littoral Paguridæ of the Maldives and India are Indo-Pacific forms, while the sub-littoral forms of Indian seas are most closely related to those of the West Indies.

The BRACHYURA form a very large and interesting assemblage, in which only a comparatively small proportion, 15 out of 208 species, have proved to be unknown, but three of these are so remarkable as to require new genera. About 60 per cent. of the species are new to the Ceylon fauna, and 35 per cent. extend to the Maldives.

The PANTOPODA and HEMIPTERA both contain new forms that seem to be common at Ceylon, but call for no further remark.

The MOLLUSCA are an ordinary Indo-Pacific assemblage, most of which have been made known in the past from shell collections. The chief novelties are naturally in those divisions of the group which have not been studied by conchologists. The Nudibranchs present us with at least nine new species in 30 collected, and, in addition, there are some small Eolids and Dotos undetermined that show, at least, that these families are not so rare as was supposed in tropical seas. The Opisthobranchs, as a whole, show some affinity with Red Sea and Mediterranean forms, but still more with the Pacific and Australian faunas. Two new species of Pelecypoda, living with the *Aspidosiphon* in the basal cavities of Solitary Corals, are described by BOURNE under the new genus *Jousseaumia* (Report XXXVII.). The profusion of young Octopods, of undetermined species, on the pearl banks in the Gulf of Manaar was a notable feature during our exploration. Some of the same forms occur at the Maldives.

The TUNICATA are not numerous (66 species), although some of the commoner forms are so abundant that the group bulks large in the general fauna; 44 species are new to science, and nearly all the species (about 60) are new records for the Ceylon fauna. Calcareous and sandy genera, such as *Leptoclinum*, *Rhabdocynthia*, and *Psammaplidium*, are especially abundant and large. *Ecteinascidia*, *Rhodosoma*, *Hypurgon*, and the Polystyelidæ are other noteworthy forms. As is usual in tropical seas, the Cynthiidæ and Styelidæ are especially abundant, and the Ascidiidæ and Botryllidæ are few and of small size. Very few Molgulidæ were found, but several other kinds of Simple Ascidians belonging to other families have sandy coverings so as to look superficially like species of *Molgula*. *Pyrosoma*, though no doubt sometimes present, was not seen; and the Thaliacea were not especially abundant. The commonest genera are *Polycarpa* amongst the Simple Ascidians and *Leptoclinum* in the Compound forms. Although most of the species are peculiar to Ceylon or the Indian Ocean, there are allied forms elsewhere, and it may be said that the fauna shows affinity with that of the Malay Archipelago and that of the Australian seas.

Seven species of CEPHALOCHORDA were obtained, four of which are new to the Ceylon fauna. The collection of FISHES has added considerably to the Ceylon list, but does not call for any special remarks. Adding THURSTON's list to our own, the total number of fishes recorded from the Gulf of Manaar is over 226, but I do not doubt that even that could be largely added to by further work. The Maldive list is 57 named species, but of these only 17 extend to Ceylon. Thus the percentage of Ceylon fishes recorded from the Maldives is small. The Pleuronectidæ are well represented in both faunas, but there are no species common to the two lists.

On the whole it seems probable from this survey of the groups that the Ceylon marine fauna is more closely related to that of the Malay region and Australia than to that of the Maldives or the Red Sea.

THE FAUNISTIC CHARACTERS OF THE PEARL BANKS.

The physical and the leading biological characters of the individual paars were given in the section entitled "Description of the Pearl Oyster Banks of the Gulf of Manaar," in Part I. at p. 99, and it is only necessary now to point out the general faunistic features of the region as a whole. It will be remembered that it is a shallow plateau, lying for the most part between the contours of 5 and 10 fathoms, and having on the whole a sandy bottom. Where the ground is hard it is a modern calcrete formed by the cementing together of sand and shells, and where the sand is not derived from the disintegration of the granitoid rocks of Ceylon it is mainly Foraminifera and shell fragments. The large amount of a few species of Foraminifera in some deposits is a notable feature, which has been already discussed above. In some parts, as on the South Cheval, balls of *Lithothamnion fruticulosum*, large and small, are very abundant and are useful as cultch for the pearl oyster.

Sponges are a very dominant group, and probably exercise considerable influence upon the welfare of the oyster beds. The most important in this connection is *Cliona margaritiferæ*, the ravages of which have been described and figured in previous sections of this report. Other characteristic forms are the large black *Spongionella nigra* and the four species of Sponge shown on Plate II. Fig. 1 is the huge crater-like *Petrosia testudinaria* which occurs on the Cheval and especially on the Periya Paar. Fig. 2 shows the two characteristic forms, the cup-like and the flabellate, of *Phakellia donnani*, a brick-red Sponge found in great abundance on many parts of the pearl banks, but especially on the Modragams, the Cheval, and the Periya Paar. Fig. 3 is the scarlet spherical mass *Aulospongus tubulatus*, a Sponge in which the minute Polychæte worm *Polydora armata* lives as a commensal. Fig. 4 is the remarkable "umbrella" Sponge, *Phyllospongia holdsworthi*, which is said by the divers to be characteristic of the "Koddai Paar" to the west of the Cheval. It is, however, found also on various parts of the Cheval, Muttuvaratu, and Periya paars, and elsewhere.

Amongst Cœlenterates, corals are the most conspicuous and important forms. Living reefs composed of many common species compete successfully with the pearl oysters at many places and prevent the formation of beds, while solitary forms such as *Fungia* are found alive scattered over the sandy bottom on the Cheval and other paars. In some places there are great aggregations of *Heterocyathus aequicostatus* and *Heteropsammia michelini*, both of which have in their base commensal species of *Aspidosiphon* and of *Jousseaumia*. Many of the reef-building corals, such as species of *Madrepora*, *Porites*, *Pœcilopora*, *Montipora*, *Favia*, *Goniastrea*, *Galaxea*, and *Cœloria*, are also found growing over the shells of living oysters. This is especially the case on the Muttuvaratu Paar. *Turbinaria cinerascens* and *T. crater* are especially common on some parts of the northern paars.

Some of the fleshy Alcyoniidæ are very common on the coral reefs at the pearl banks, and form enormous colonies several feet in diameter. The Gorgonoid Alcyonaria are for the most part found in deeper water outside the pearl-bank plateau, but a few species such as *Juncella juncea* and *Suberogorgia suberosa* occur on the Cheval Paar.

One of the Hydroid Zoophytes, *Campanularia juncea*, Allm., which grows to a large size (Plate II., fig. 6), is especially characteristic of the East Cheval Paar. Another handsome species from the pearl banks is *Halicornaria insignis*, Allm. (Plate II., fig. 5).

Some of the Echinodermata are amongst the commonest and most conspicuous of animals both on the oyster beds and on the sandy stretches between. The huge black trepang, *Holothuria atra*, and the flat urchins, *Clypeaster humilis* and *Laganum depressum*, eat their way through the sand, and the star-fishes, *Pentaceros lincki* (Plate I., fig. 1), *Luidea maculata*, and *Astropecten hemprichi* prowl over the surface and devastate the pearl oysters.

Amongst the worms, in addition to the numerous parasites that infest the oyster, there are two abundant species of *Polydora* that call for special mention—*P. hornelli*, found burrowing in the oyster shells, and *P. armata*, a commensal in the globular scarlet sponge, *Aulospongus tubulatus* (Plate II., fig. 3). Polyzoa are especially abundant, and are a factor of importance in the building up of the calcareous masses on the reefs and the paars—*Schizoporella viridis* may extend for several feet, and *Lepralia cucullata* is abundant, encrusting oyster shells, ascidians, sponges, and almost all other objects with its dark purple spots and patches.

Crustacea of various kinds abound, but so many species are represented that there seem to be no specially notable ones. The Alpheidæ are common, Pagurids are very abundant, and crabs, mostly of small size and many of them inconspicuous from their protective shapes and colouration, are found in every haul of the dredge.

In addition to common Gastropod and Lamellibranch shell-fish, there are several Opisthobranchs—notably *Philine aperta* and *Aplysia cornigera*—that congregate in great numbers in some parts of the Gulf of Manaar. *Pinna* is abundant in places and of large size. Species of *Pinaxia*, *Sistrum*, *Nassa*, and *Purpura* are found boring into the smaller pearl oysters, and the large "Chanks" (see Plate I., fig. 3, A, B, C, D) are of importance both as damaging the large oysters and also as constituting a fishery themselves. *Modiolus barbatus* (Plate I., fig. 2), from its habit of weaving entanglements, is another molluscan enemy of the younger pearl oysters.

The large simple Ascidian *Rhabdocynthia pallida* is abundant on some parts of the Cheval Paar. Several species of Amphioxus burrow in sand, the commonest on the Cheval and Periya paars being *Branchiostoma lanceolatum*, var. *belcheri* and *Asymmetron cingalense*. Over 200 species of fishes frequent the pearl banks, and many of these are carnivorous, including especially the file and the trigger fishes and the gigantic rays. In addition to the species that have been mentioned as especially common, characteristic, or important, there are enormous numbers of the smaller organisms belonging to many invertebrate groups that are found encrusting and attached to the shells of the older pearl oysters. Fig. 7 on Plate II. shows a photograph of such a "microcosm" from the Cheval Paar.

Such are the animate surroundings, including both friends and foes, amid which the pearl oyster habitually lives in the Gulf of Manaar, and seems, if left in comparative peace, able to hold its own in the struggle for existence; but the balance, as we have shown in previous parts of this report, is liable to be seriously disturbed by three all-powerful factors: devastating hordes of voracious fishes which come up from the deeper waters and leave crunched shells and torn byssus in their wake; storms, currents, and over-washes of sand which may sweep away or bury a promising bed; and lastly man who comes periodically from above on his diving stones and clears the bank of its tens of millions of oysters, old and young. The carnivorous fishes and the monsoons cannot be controlled; but to show that much can be done by man to mitigate their influence, and to compensate for the decimation necessarily caused by his own operations, has been the chief object of the present Report.

EXPLANATION OF THE PLATES.

PLATE I.

Some Enemies of the Pearl Oyster.

Fig. 1. *Pentaceros lincki*, de Bl. Reduced to one-third natural size.
,, 2. *Modiolus barbatus*, Linn. The "Suran," in its nests or entanglements.
,, 3. A, B, C, D, the following four large Chanks, from left to right:—
A. *Murex ramosus*, Linn. The elephant chank.
B. *Fasciolaria trapezium* (Linn.). Chank.
C. *Turbinella pyrum*, Linn. The common chank.
D. *Turbinella rapa* (Linn.). The sacred chank—possibly only a form of the last species.

PLATE II.

Some Characteristic Animals of the Pearl Banks.

Fig. 1. *Petrosia testudinaria* (Lamk.). Reduced one-half.
,, 2. *Phakellia donnani* (Bowerb.). Nat. size. A, flabellate; B, cup-shaped form.
,, 3. *Aulospongus tubulatus* (Bowerb.). Nat size.
,, 4. *Phyllospongia holdsworthi* (Bowerb.). Reduced one-half.
,, 5. *Halicornaria insignis*, Allman. Reduced to one-fourth.
,, 6. *Campanularia juncea*, Allman. Reduced to one-third.
,, 7. A living pearl oyster, *Margaritifera vulgaris*, Schum., covered with many encrusting and adhering organisms; slightly reduced.

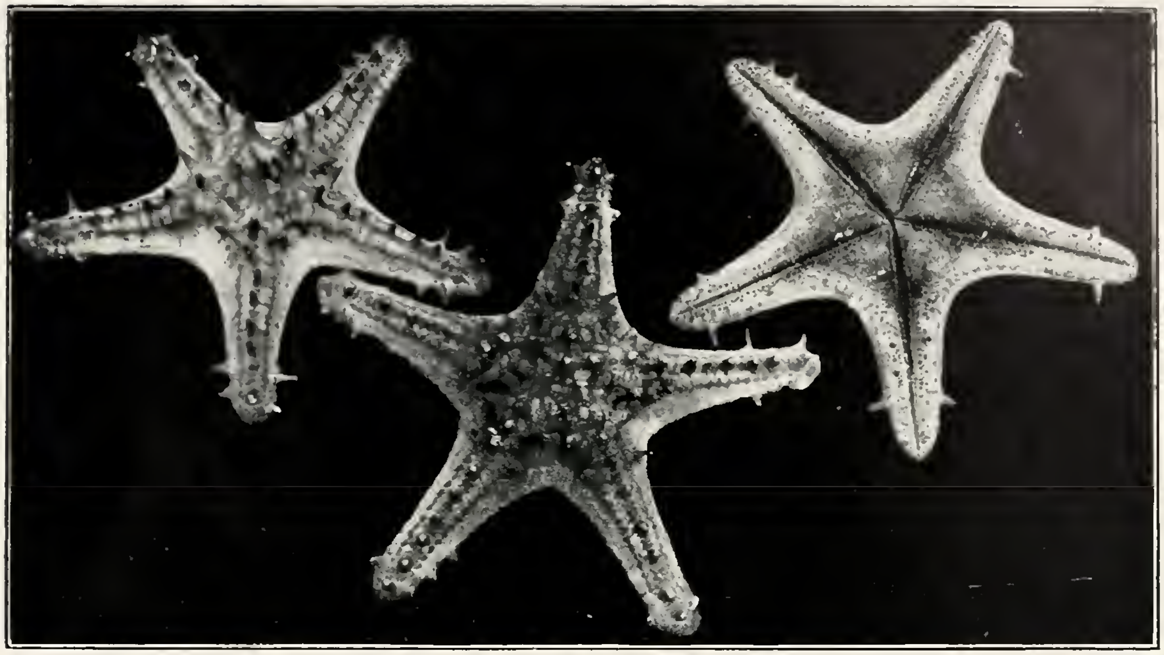


Fig. 1.

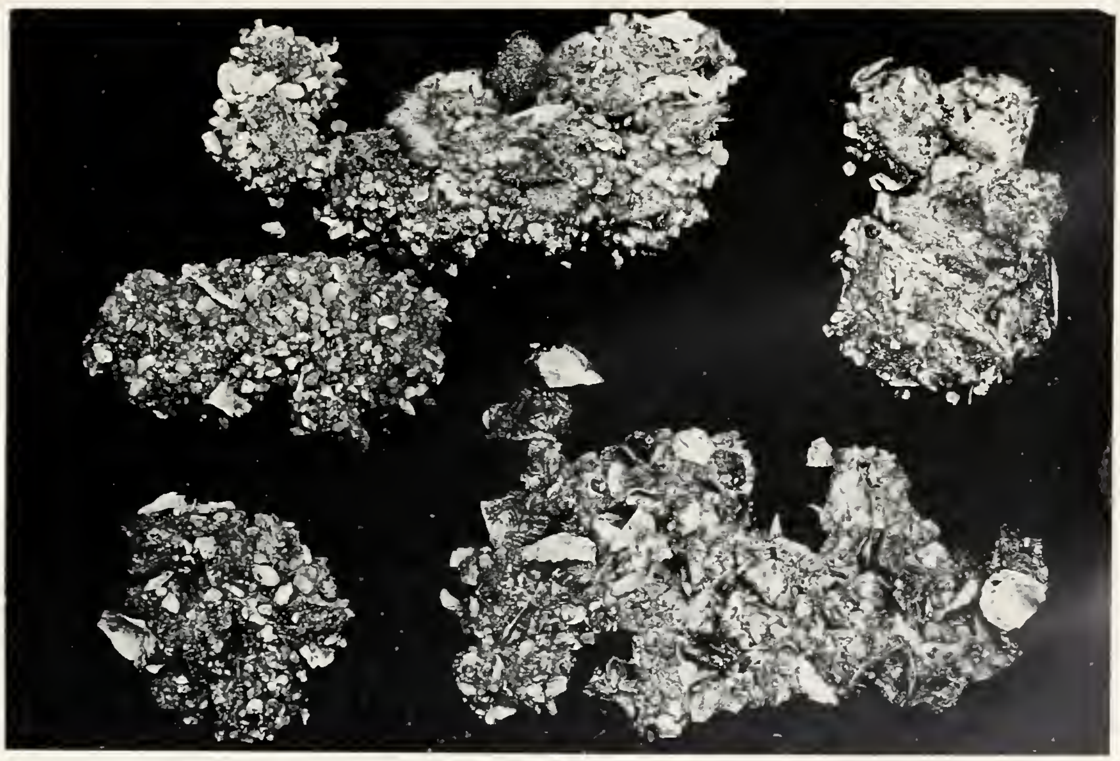


Fig. 2.

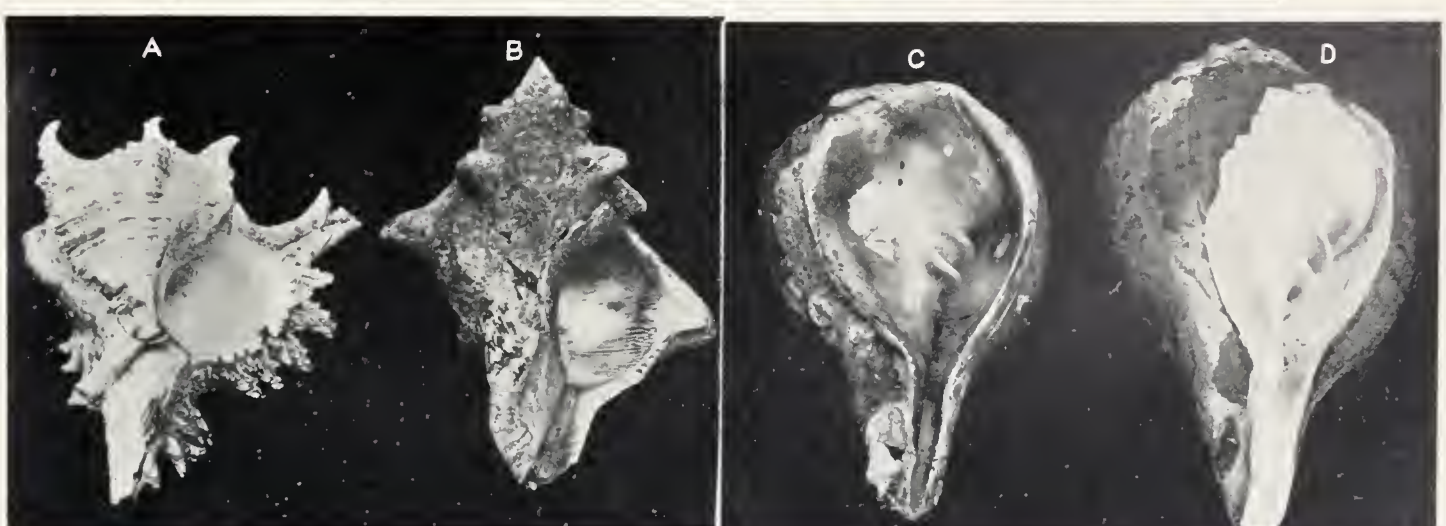


Fig. 3.

ENEMIES OF THE PEARL OYSTER.

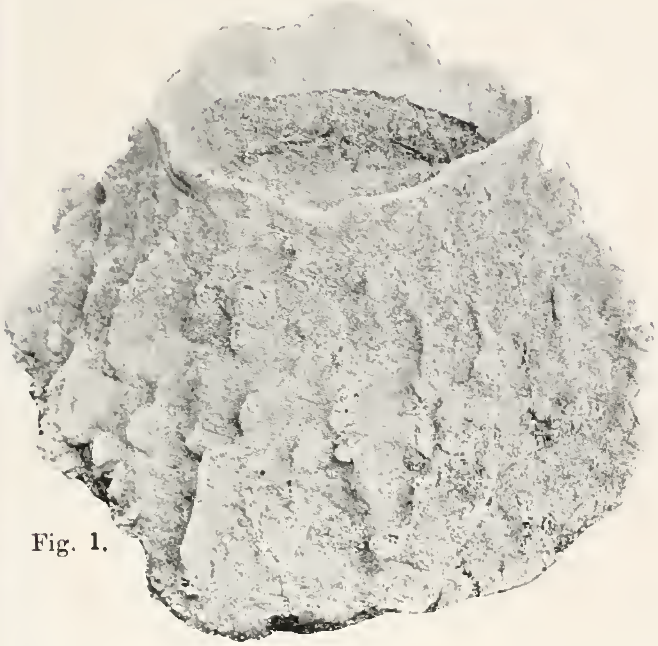


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 7.

Fig. 6.

CHARACTERISTIC ANIMALS OF THE PEARL BANKS.

CORRECTIONS AND ADDITIONS.

PART I.—(LIFE HISTORY, &c.), p. 142, ll. 30, 31, 33, *for* "acres" *read* "sq. yards."

,, II.—(HYDROIDA), p. 119, ll. 17, 30, *for* "*Desmoeyphus*" *read* "*Desmoseyphus.*"

,, II.—(CRINOIDEA), p. 157, l. 20, *for* "*Antedon anceps*, CARPENTER," *read* "*Antedon bengalensis*, HARTLAUB."

,, II.—(CUMACEA), p. 175, l. 22, *for* "exopod" *read* "endopod."

,, II.—(CEPHALOPODA), p. 186, *et seq.*, *for* "*Polypus aculeatus*" *read* "*Polypus horridus.*"

,, III.—(SPONGES), Professor DENDY adds the following records:—

(1) *Sycon raphanus*, var. *chevalensis*, n., characterised by spear-shaped ends to some of the dermal oxea. The species is recorded from Ceylon by HAECKEL.

(2) *Iotrochota baculifera*, RIDLEY.—Palk Bay.

(3) *Spongelia fragilis*, variety.—Reef, Galle; several large colonies.

(4) *Spirastrella tentorioides*, DENDY.—A second specimen, confirming the characters given on p. 126.

,, III.—(ALCYONARIA), p. 317, l. 4, *for* "Plate III." *read* "Plate IV."

,, III.—(ALCYONARIA), p. 325, l. 2, *for* "cylindrical" *read* "quadrangular."

,, III.—(ALCYONARIA), p. 325, l. 14, *for* "the axis is round not square" *read* "the axis is quadrangular not cylindrical."

,, IV.—(MACRURA), pp. 65, 67, 76, 92, *for* "*Caradina*" *read* "*Caridina.*"

,, IV.—(MACRURA), pp. 66, 67, 79, 92, *for* "*Nauticaris grandirostris*, n. sp." *read* "*Saron gibberosus* (M. EDW.)."

,, IV.—(POLYZOA), p. 108, l. 25, *for* "his private collections," &c., *read* "the collection in the Univ. of Cambridge Zool. Museum."

,, IV.—(POLYZOA), p. 110, l. 8, *for* "*Membranipora favus*, HINCKS," *read* "*Membranipora normaniana*, D'ORB."

,, IV.—(POLYZOA), p. 110, l. 14, *for* "*Membranipora hastilis*, KIRKPATRICK," *read* "*Membranipora coronata*, HINCKS."

,, IV.—(POLYZOA), p. 110, l. 16, *for* "*Amphiblestrum cervicorne*, BUSK," *read* "*Amphiblestrum radicifera*, var. *intermedia*, KIRKP."

PART IV.—(POLYZOA), p. 113, l. 3, *for* "*Bercnicea prominens*, LX. [= *Ch. brongniartii*]" *read* "*Chorizopora brongniartii* (AUD.)."

,, IV.—(POLYZOA), p. 114, l. 17, *for* "*ceeilia*" *read* "*cecilii*."

,, IV.—(POLYZOA), p. 116, l. 5, *for* "*avieularis*, n. sp.," *read* "*inelusa*, n. sp." [name changed to avoid possible confusion with *Cellepora avieularis*].

,, IV.—(POLYZOA), pp. 117, 118, *for* "*Rhyncopora*" *read* "*Rhynehozoön*."

,, IV.—(POLYZOA), p. 121, l. 6, *for* "*nitida*, n. sp." *read* "*adhaerens*, n. sp." [to avoid possible confusion with *Membraniporella nitida*, JOHNST.].

,, IV.—(POLYZOA), p. 122, l. 18, *for* "*fissa*, n. sp." *read* "*gallensis*, n. sp." [to avoid possible confusion with *Schizotheca fissa*, BK.].

,, IV.—Add to POLYZOA : *Alcyonidium mytili*, DALYELL.—Galle.

,, IV.—(SOLITARY CORALS), p. 192, Professor BOURNE adds :—

A fixed specimen of *Cyathotrochus herdmani* has been found (off Galle, 100 fathoms). This necessitates the following correction in the diagnosis of the genus :—*For* "Corallum simple, free, without a trace of adherence" *read* "Corallum simple, free or fixed by a narrow base, the basal scar completely filled up in the free forms so as to form a short laterally compressed cone."

PART IV.—(POLYCHÆTA), p. 248, l. 4, *for* "1887" *read* "1878."

,, IV.—(POLYCHÆTA), p. 281, l. 29, *for* "*acquabilis*" *read* "*aequabilis*."

,, IV.—(POLYCHÆTA), Plate VI., fig. 139.—An extra bundle of setæ has been inserted by the lithographer on the right side in front of the normal row of fascicles.

,, IV.—(POLYCHÆTA), add: A few additional forms have been examined by Mr. ARNOLD T. WATSON, who reports the following :—

(1) *Palmyra herdmani*, n. sp.—Found in the tube of the large Foraminifer, *Ramulina herdmani*, from Galle. The characters are: Head, darkish brown and iridescent, distinctly globular (instead of more or less rectangular, or an oval placed transversely to the body). Eye-spots four, light brown, oval; posterior pair contiguous and situate slightly behind apex of the head; anterior pair just beneath a very short, stumpy, cone-like, unpaired tentacle. (Immediately behind the head was a brown, oval capsule, or caruncle, which may possibly have been adventitious.) Head and caruncle almost completely hidden beneath the pale yellow paleæ. Back completely covered, the inner edges of opposite flabella overlapping in the middle. No elytra apparent. Dorsal paleæ serrated on edge, about 21 in the largest flabella, almost linear at the outer edge of flabellum, gradually becoming falciform towards the centre. Both dorsal paleæ and ventral serrated compound setæ somewhat similar to those of *Palmyra debilis*, GRUBE, but the appendix is slender and very much longer. Ventral cirri springing from a basal tubercle on neuropodial lobe and bearing a

reddish-brown band especially in the anterior segments. Cirri, both ventral and dorsal, tapering away to a slender filament. Specimen, a fragment 3·5 millims. long, 1 millim. broad over setæ, consisted of the anterior 17 pairs of parapodia only.

(2) *Ascidicolous Nereid from Galle.*—This worm, the identity of which has not yet been satisfactorily determined (though apparently allied to *Nereis vexillosa*, GRUBE), was found in the crevices of an Ascidian. The specimen is 22·5 millims. long, 3·5 millims. broad over the setæ, and consists of the head and anterior 64 segments only, the hinder part of the body being in course of regeneration. The head differs greatly from that of *N. vexillosa* and is very remarkable, being rather longer than broad and almost rectangular in form. It is dark brown and iridescent, as are also the succeeding 12 segments. Eyes large and black, the anterior pair before and the posterior pair just behind the bases of the longest cirri. Tentacles widely separated and half length of the head. Longest tentacular cirrus about twice as long as head, others much shorter. Palps large brown bases with pale tips. First four body segments twice as long as the succeeding ones. The proboscis being retracted, the paragnaths have not yet been examined. The setæ are somewhat similar to those of *Nereis melanocephala*, their general distribution being two slender spinigers in each dorsal lobe, and two or three spinigers, accompanied by five to seven stout setæ with pectinate falces, in each ventral lobe. The outline of the enlarged dorsal ligules of the posterior parapodia differs greatly from the figures of *N. vexillosa* given by GRUBE and EHLERS; the cirrus, moreover, is long and blade-like instead of filiform. This is probably a new species.

(3) *Brown, Parchment-like Branched Tube of one of the Eunieidæ.*—The main trunk 11 millims. calibre, 70 millims. long, with two short branches from one side. The terminal half of trunk sinuous, much like the tube of *Eunice tibiana*, EHLERS, with numerous openings in corresponding positions. The lower half of tube is partially enveloped by a compound Ascidian, *Leptoclinum* sp., the colony being perforated at intervals for openings into the tube. No worm accompanied the specimen.

PART V.—Add the following list of ACTINIARIA identified by Mr. T. SOUTHWELL:—

Cerianthus sp.—Tampalakam, Trincomalee.

Zoanthus shackletoni, HADD. and DUER.—Reef Galle and Gulf of Manaar.

Zoanthus (? n. sp.).—Reef Galle.

Isaurus duchassaigni (ANDRES).—Coral reef, Gulf of Manaar.

Gemmaria variabilis, DUERDEN.—Reef Galle.

Palythoa tuberculosa, KLUNZ.—Reef Galle.

Sphenopus marsupialis, STEENSTR.—Station LVIII., 9 to 26 fathoms, and elsewhere in Gulf of Manaar.

Halcampa sp.—Tampalakam, Trincomalee.

Sagartia sp.—Reef Galle.

Phellia sp.—Cheval Paar, Gulf of Manaar.

Calliactis sp.—Pearl banks, Gulf of Manaar.
Chondractinia digitata (MÜLLER).—Station XX., 11 to 13 fathoms, Trincomalee.
Actinauge sp. (? n. sp.).—West of Periya Paar.
Another form, not identified, from Gulf of Manaar, shallow water.

Several of the unidentified species in the above list are in all probability new to science. Out of these 14 species 11 are new records to Ceylon, those previously known being *Zoanthus shackletoni*, *Palythoa tuberculosa* and *Sphenopus marsupialis*.

The only specimens in the Ceylon Collection that now remain unidentified and unexamined, so far as I am aware, are about half a dozen ENTEROPNEUSTA, belonging apparently to three species.—W. A. H.

Our deck laboratory on the "Rangasami-Poravi."

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10