BIOLOGICAL ANOMALIES: MAMMALS I

Compiled by:

William R. Corliss

A CATALOG OF BIOLOGICAL ANOMALIES

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PREFACE

After more than twenty years of scouring the scientific and semiscientific literature for anomalies, my major conclusion is that this is a most fruitful activity. In fact, organized science should have been compiling such information over the past 200 years. It is surprising that a Catalog of Anomalies does not already exist to guide scientific thinking and research. It is at least as important to realize what is anomalous as it is to recognize the well-explained facts of nature. With this outlook, here is the fifteenth volume of such a Catalog. It is largely the product of one person's library research, carried forward entirely through the sale of these Catalogs, Handbooks, Sourcebooks, and related books on anomalies.

Under the aegis of the Sourcebook Project, I have already published 30 volumes, totalling roughly 12,000 pages of source material on scientific anomalies. (See page iv for the list of titles.) As of this moment, these 30 volumes represent only about 40% of my data base. New material is being added at the rate of about 1,200 new items per year, about 500 of which come from the current scientific literature. These acquisition rates could easily be multiplied several-fold simply by spending more time in libraries. Even after twenty years, only the English-language scientific journals have received my serious attention. The journals in other languages, government reports, conference papers, publications of scientific research facilities, untold thousands of books, and an absolutely immense reservoir of newspapers remain almost untouched. Every library foray uncovers new scientific anomalies; the world's libraries are bulging with them.

Given this rough assessment of the magnitude of the anomaly literature, one can understand why the Catalog of Anomalies will require at least 30 volumes, many of them larger than the one you now hold. I visualize a shelf of these 30 volumes, with master indexes, to be only the initial step in providing scientists with ready access to what, in my opinion, is not well-explained. The underlining of "my" is important because anomalousness is often in the eye of the beholder. It depends upon how well one is satisfied with explanations based upon currently popular theories. In the Catalog of Anomalies, the data rule; all theories and hypotheses are deemed tentative. The history of science demonstrates that this is a wise policy.

Will the Catalog of Anomalies revolutionize science? Probably not---at least not right away. Quite often the initial reaction to the volumes already published has been disbelief and even disdain. The data must be in error; the data are mainly testimonial; the data are too old; the purported anomaly was really explained long ago. Germs of truth reside in all these complaints. Some science and some observations are certainly bad. Also, the baseline of well-established theories, against which anomalousness is measured, is always shifting. But for every anomaly that can be legitimately demolished, a trip to the library will replace it with ten more from impeccable sources. In sum, Nature is very anomalous or, equivalently, Nature is not yet well-understood. Much remains to be done.

William R. Corliss

P.O. Box 107
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September 1, 1995.

"ROUND ABOUT THE ACCREDITED AND ORDERLY FACTS OF EVERY SCIENCE THERE EVER FLOATS A SORT OF DUST-CLOUD OF EXCEPTIONAL OBSERVATIONS, OF OCCURRENCES MINUTE AND IRREGULAR AND SELDOM MET WITH, WHICH IT ALWAYS PROVES MORE EASY TO IGNORE THAN TO ATTEND TO . . . . ANYONE WILL RENOVATE HIS SCIENCE WHO WILL STEADILY LOOK AFTER THE IRREGULAR PHENOMENA. AND WHEN THE SCIENCE IS RENEWED, ITS NEW FORMULAS OFTEN HAVE MORE OF THE VOICE OF THE EXCEPTIONS IN THEM THAN OF WHAT WERE SUPPOSED TO BE THE RULES."

William James

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HOW THE CATALOG IS ORGANIZED

Purpose of the Catalog

The Catalog of Anomalies is designed to collect and categorize all phenomena that cannot be explained readily by prevailing scientific theories. Following its definition, each Catalog anomaly is rated in terms of: (1) its substantiating data; and (2) the seriousness of the challenge the anomaly poses to mainstream scientific theories. Next, all examples of the anomaly discovered so far are recorded, some of the more interesting ones in more detail. Finally, all examined references are listed. Thus, the Catalog is a descriptive guide as well as a compendium of examples with supporting references. Scientific researchers thus have a substantial foundation for beginning further studies of these intriguing phenomena. This is the basic purpose of the Catalog: the collection and consolidation of the unknown and poorly explained in order to facilitate future research and explanation.

General Plan of the Catalog

It was tempting to organize this Catalog alphabetically, making it an "encyclopedia of anomalies". But many of the phenomena have obscure names or, even worse, no names at all. Under these circumstances, access to the data base would be difficult. Therefore, a system of classification was designed based upon readily recognized classes of phenomena and the means the observer uses to detect them. The universe of anomalies is first divided into nine general classes of scientific endeavor, as illustrated in the diagram on the following page. Few people would have difficulty classifying a phenomenon as biological, astronomical, geological, etc. The second, third, and fourth levels of classification are also based upon generally recognized attributes. The similarity of this kind of categorization to that employed in natural-history field guides is quite intentional. Like bird indentification, phenomenon classification soon becomes second nature. In fact, many of the phenomena described in this Catalog are accessible to anyone with normal senses and, especially in astronomy, a little optical help.

Most catalogs employ numbering systems, and this one is no exception. Rather than use a purely numerical system, the first three levels of classification are designated by letters. The triplets of letters selected have some mnemonic value. Thus, a BMA anomaly is easily recognized as belonging to the biology class (B), involving mammals (other than human) (M), and concerning external appearance and morphology (A). The number added to the triplet of letters marks the fourth classification level, so that BMA4 denotes the phenomenon of hybrids and mosaics in the other mammals, as indicated in the diagram on the next page. Every type of anomaly has such a unique alphanumeric code. All cross references and indexes are based on this system. Catalog additions and revisions are made easier with this approach.

The Catalog codes may seem cumbersome at first, but their mnemonic value to the compiler has been considerable. The codes are simple, yet they are flexible enough to encompass the several thousand types of anomalies identified so far in diverse scientific disciplines.

A glance through this volume will reveal that each entry for an anomaly type bears an X-number, and each reference an R-number. BMA4-X1 therefore specifies the first entry for mammalian hybrids and mosaics. BMA4-R1 is the first reference in this phenomenon's bibliography.

How the Catalog Is Organized

First-order classification	Second-order classification	Third-order classification	Fourth-order classification
A Astronomy	A Arthropods	A **Appearance & Morphology**	1 Parallelisms
B **Biology**	B Birds	B **Behavior**	2 Limits on Variability
C Chemistry & Physics	C Biochemistry	C Chemistry & Physics	3 Diverging Mammal Populations
E Earth Sciences	F Fish	E Bones & Artifacts	4 Hybrids and Mosaics
G Geophysics	G Genetics	F Bodily Functions	5 Mirror-Image Twins
L Logic & Math	H Humans	G Genetics	
M Archeology	I Animals without Skeletons	H Health	
P Psychology	L Microorganisms	I Internal Structure	Other BMA Entries
X Unclassified	**M Mammals**	O Organs	
	P Plants & Fungi	**T Talents and Faculties**	
	R Reptiles & Amphibians	U Unrecognized Species	
	X Life Processes	X Interactions with Other Life	
		Z Interactions with Other Entities	52 Mammal Vibrations

Bold-face subjects are covered in this volume

Catalog Coding Scheme

How Data and Anomalies Are Evaluated

Each anomaly type is rated twice on four-level scales for data "validity" and "anomalousness", as defined below. These evaluations represent only the opinion of the compiler and must be considered only rough guides.

Data Evaluation Scale

1 Many high-quality observations. Almost certainly a real phenomenon.

2 Several good observations or one or two high-quality observations. Probably real.

3 Only a few observations, some of doubtful quality. Phenomenon questionable.

4 Unacceptable, poor-quality data. Such entries are included only for purposes of comparison and amplification.

Anomaly Evaluation Scale

1 Anomaly cannot be explained by modifications of present laws. Revolutionary.

2 Can probably be explained through relatively minor modifications of present scientific laws.

3 Can probably be explained using currently popular theories. Primarily of curiosity value.

4 Well-explained. Included only for purposes of comparison and amplification.

Referring to the evaluation scales above, it should be remarked that anomalies that rate "1" on both scales are very rare. Such anomalies, however, are the most important because of their potential for forcing scientific revolutions.

Anomaly Examples

Examples of anomaly types and the entries discussing them are designated by the letter X in the body of the Catalog. Except in the cases of extremely common phenomena, such as ball lightning, all of the examples discovered so far are entered. If the example is of the "event" type, time and place are recorded if they are available. Such data are the basis of the Time-of-Event and Place-of-Event Indexes, which could in principle lead to the discovery of obscure cause-and-effect relationships. When library research has unearthed a great many examples of a specific anomaly, only the more interesting and instructive are treated in detail. In all examples and entries, direct quotations from eye-witnesses and scientific experts are employed to covey accurately the characteristics and significance of the phenomenon.

The References and Sources

Each anomaly type and the examples of it are buttressed by all references that have been collected and examined. Since some references deal with several examples, each reference includes the X-numbers of the examples mentioned. When a reference covers more than one type of anomaly, it is repeated in each anomaly bibliography. Actually, there is little repetition of this sort in the Catalog.

Perusal of the Source Index will demonstrate that the great majority of the references employed comes from the scientific literature. Heavily represented in this volume of the Catalog are such journals as: Nature, Science, and Journal of Mammalogy. Some less technical publications are also used fairly frequently, such as Science News and the New Scientist. All of the serials just mentioned are generally very reliable, although one must always be wary when dealing with anomalous phenomena. In addition to these often-referenced publications, a wide spectrum of other journals dealing with biology has been found useful here. In contrast to the preceding Catalog volumes, books, both scientific and popular, have played an important role here.

The sources consulted date from the beginning of organized science some 200 years ago. The great bulk of the references, however, comes from the past 80 years. In biology especially, the explosive growth of the data base is remarkable. Indeed, advances are being made so rapidly in natural history and biology that some things printed in the volume will be outdated before the books leave the bindery.

The Indexes

Most Catalog volumes conclude with five separate indexes. At first glance this may seem to be too much of a good thing, but in the context of a science-wide endeavor each index helps tie the whole together. It is quite apparent, though, that most biological phenomena are not of the "event" type. Therefore, the Time-of-Event and Place-of-Event Indexes in the Series-B volumes are very small compared to those in the Series-G and Series-A volumes.

The Source Index shows immediately the dependence of this Catalog upon the scientific literature rather than newspapers and other popular publications. Its real purpose, though, is the rapid checking of newly acquired references to determine whether they have already been caught in the fishing net of the library-research aspect of the Catalog effort. The Source Index is doubly valuable because many footnotes and bibliographies in the scientific literature omit article titles and, sometimes, even authors! The researcher also comes across vague references to such-and-such an article by so-and-so back in 1950 in Nature. In such cases, the rather ponderous Source and First-Author Indexes can help pin down references lacking in specifics.

The five indexes use the Catalog codes described above rather than page numbers. The codes are permanent whereas page numbers would change as volumes are revised. The mnemonic value of the Catalog codes is evident here, too, because the approximate nature of each index entry is readily apparent, while page numbers provide only location.

Supporting Publications of the Sourcebook Project

The Catalog volumes currently being published are actually distillations of huge quantities of source material. The Sourcebook Project has already published 30 volumes of such material, as detailed on p. iv. Phase I of the Sourcebook Project resulted in ten looseleaf notebooks called "sourcebooks". To meet the demands of libraries, Phase II supplanted the sourcebooks with a series of six "handbooks", which are casebound, much larger, and more comprehensive than the sourcebooks. Phase III, now in progress, is the cataloging phase. This consists of systematizing the data base, which now comprises some 40,000 articles, and the publication of the "catalogs".

Catalog Addenda and Revisions

Over 1200 new reports of anomalies are collected each year from current and older scientific journals. New anomaly types and additional examples of types already cataloged are accumulating rapidly. When sufficient new material has been assembled, Catalog volumes will be revised and expanded.

The Sourcebook Project welcomes reports of scientific anomalies not already registered in extant Catalog volumes. Reports from scientific journals are preferred, but everything is grist for the anomaly mill! Credit will be given to submitters in new and revised Catalog volumes. If the reports are from current literature they may be mentioned in Science Frontiers, the Project's newsletter. Send data to: Sourcebook Project, P.O. Box 107, Glen Arm, MD 21057.

BM INTRODUCTION: Volume I

This is the fifteenth volume in the Catalog of Anomalies. The preceeding three volumes are dedicated to human biological anomalies. Here, we begin a two-volume treatment the anomalies of the "other" mammals. After these two volumes, books on birds, reptiles and amphibians, fish, etc. will follow in due course. Originally, we opined that eight volumes would be sufficient for all of biology, but as any biologist could have warned us, biology is the most complex and anomaly-ridden of all the sciences. Our latest estimate is that fully ten volumes will be required to catalog just the most obvious and easily researched mysteries of life.

This first volume on mammalian biological anomalies focuses, as does Humans I, on "external attributes" of mammals; (1) their appearance to an observer in the field or at the zoo; (2) their anomalous modes of behavior; and (3) their unusual senses and faculties. Hopefully, we can fit everything else into Mammals II; that is, internal anatomy, biological functions, genetics, fossils, and unrecognized species.

As with Humans I, II, and III, catalog entries range from outrageous heresies to mere curiosities. Of course, the evolutionary paradigm, that great unifier of modern biology, receives most of the scrutiny. It is by far the biggest target for an anomalist. Not far behind is that dictum of the behaviorists that insists that nonhuman mammals are simply unreasoning, instinct-driven automatons. The iconoclastic approach of the Catalog of Anomalies may well offend those used to the reverent attitude adopted by most writers on biology, whether popular or professional. Anomalists are by definition confrontational; they dote on major and minor mysteries; they see problems everywhere.

Biologists should not feel singled out in all this. The preceeding eleven volumes on geophysics, astronomy, and geology treat those disciplines in the same doubting, suspicious way. Indeed, biological anomalies are often closely linked to phenomena from these other disciplines. Geology's fossil record is key to fleshing out the development of life, from its origin(s) through its radiations and extinctions. Astronomy, too, contributes with its inputs to climate changes, the biological devastation of asteroid/comet impacts, and, possibly, the synthesis of prebiotic chemicals, perhaps even life itself, in outer space. The attitude of the anomalist may seem "bad" to a mainstream scientist, but it is eclectic and ever-inquiring.

BMA EXTERNAL APPEARANCE AND MORPHOLOGY

Key to Phenomena

GENERAL ATTRIBUTES

SKIN AND FUR

LUMINOSITY

FACIAL FEATURES

TEETH AND TUSKS

HORNS AND ANTLERS

EXTREMITIES

TAILS

OTHER EXTERNAL FEATURES

MISCELLANEOUS TOPICS

BMA0 Introduction

When we first see a mammal in the field, we instinctively note its size, shape, color, markings. and the presence of horns, tail, and other extremities. These external characteristics are the subject of this chapter---but only if they are anomalous or at the very least very curious.

Often the external characteristics and general morphology of a mammal are enough to identify the species. Sometimes, though, gross appearance is not sufficient, for there are over 4,400 mammalian species recognized, and some of them do look very much alike. And herein lies an important class of anomalies: parallelisms or convergences of characters. Many distantly related species look so much alike that we wonder how evolution managed such near-duplication. In particular, several marsupial species closely mirror placental mammals. These parallelisms extend to the finer features of mammal morphology, such as the teeth, feet, and even behavior, as we shall see in the next chapter (BMB).

Mammalian parallelisms raise doubts---at least in the mind of the compiler---about the efficacy of evolution. In fact, most of the anomalies claimed in this volume question Darwinism. This is not surprising because of all biological theories, evolution is the one that ties together the entire discipline. When a mainstream biologist observes an anomaly or incongruity, he or she instinctively tries to think of explanations consistent with evolution. An anomalist, on the other hand, collects all deviant observations and wonders if the whole paradigm should be revised. Dedicated evolutionists are hereby warned that the compiler has a "bad attitude" about evolution and will repeatedly point out difficult-to-explain phenomena, such as those marsupial-placental parallelisms. Actually, this is not a vendetta against evolution per se, for this "bad attitude" also prevails in the case of the Big Bang theory, relativity theory, and all paradigms, as the other volumes in this series will attest.

Besides parallelisms or convergences of external attributes, two other classes of objections to evolution surface again and again: (1) Are random mutations and natural selection, working together, really innovative enough to account for the many remarkable features mammals have developed to survive in their diverse environments? (2) Can the accumulation of small mutations really answer the question: What good is half a wing? In other words, should evolutionary gradualism be replaced by saltations, as in "punctuated equilibrium"? The evolutionist must answer YES and NO, respectively; the anomalist responds MAYBE!

Beyond these apparent preoccupations with evolution are other anomalies; observations that have no explanation at all within our present theoretical framework. Then, there is the compiler's tendency to favor the curious and bizarre in nature, all the while recognizing that these are not necessarily anomalous.

GENERAL ATTRIBUTES

BMA1 Mammalian Morphological Parallelisms: Convergence and Mimicry

Description. Striking morphological parallelisms between some mammals and: (1) other distantly related mammals; (2) other classes of animals; (3) plants; and (4) their own surroundings. Parallelisms that aid the mammal's concealment or warn or discourage predators are usually considered forms of mimicry.

Data Evaluation. Morphological parallelisms are common in the natural world. They are well recognized by biologists, who generally ascribe them to "convergent evolution." We record here only a few of the more interesting and significant mammalian parallelisms. The literature holds many others. Rating: 1.

Anomaly Evaluation. The currently accepted neo-Darwinian paradigm holds that random mutations guided by natural selection operating in similar environments can, given sufficient time, account for all parallelisms. Given that random mutations are nearly infinitely variable, this claim of the evolutionists is impossible to refute in principle. In this sense, no anomaly exists in the convergence of characteristics, since random mutation can explain virtually anything! However, the compiler and others, even some scientists, have reservations about the evolutionary paradigm. Some of the parallelisms among distantly related animals, as recorded below, are so remarkable that random mutation plus natural selection seem inadequate. In other words, a suspicion exists that other, yet unrecognized factors may be involved. In these situations, which occur frequently in this Catalog, no anomaly rating is attempted.

Possible Explanations. (1) Parallelism or convergence arises through separate, independent chains of random mutations modulated by natural selection. (2) So-called "morphic resonance," a radical concept proposed by R. Sheldrake (R17), may accelerate such processes. (3) Parallelisms may be the consequence of traits inherited from a distant common ancestor. (4) "Directed" or "adaptive" evolution, a highly controversial process, may greatly accelerate the evolutionary accommodation of an animals to new environmental conditions. (R24) If the environmental parameters are similar, parallelisms in different species may arise.

Similar and Related Phenomena. Morphological parallelisms are abundant throughout the earth's fauna and flora (BBA, BRA, BFA, etc.). See the Subject Index under Parallelisms for examples in this volume.

X0. Background. We split the subject of mammalian morphological parallelisms into four sections:

- The frequent parallelisms between marsupial and placental mammals that fill similar environmental niches. (X1-X5)
- The striking parallelisms between supposedly distantly related placental mammals that occupy similar environmental niches. (X5-X12)
- The morphological parallelisms between mammals that exist ostensibly for defensive purposes---that is, they are a form of mimicry. (X13)
- The morphological parallelisms between mammals and nonmammalian life forms and even inanimate objects ostensibly for purposes of camouflage. This is, of course, also a form of mimicry.

(X14-X16)

It stands to reason that animals occupying similar environmental niches would require similar attributes, even though they are far apart on the evolutionary tree. And no one can argue the utility of camouflage or the value of resembling a well known, fierce and feared member of another species. Regardless of the apparent purpose of a parallelism, the prevailing evolutionary paradigm insists that it must have been derived through random mutation as modulated by natural selection or somehow inherited from a commom though distant ancestor. Assuming that the random mutation process plus natural selection can be creative, why has it been creative in the same ways, so often, and so precisely? Actually, some parallelisms are so amazing that some scientists have proposed new theories for their evolution. Some of these will be treated in X17.

First, though, we present some of the basic data on parallelisms that must be explained, either by elucidating the detailed mechanisms of Darwinism or by entirely new approaches to the development of new species.

X1. Marsupial and placental mole parallelisms. The convergence of some marsupials and placental mammals is nowhere more apparent than in mole-like animals. Let us begin with the so-called marsupial mole:

> The discovery of this mole-like marsupial in 1888 created a stir among mammalogists comparable with the sensation that accompanied the discovery of the duck-billed platypus. The marsupial "mole" affords an interesting example of evolutionary parallelism between marsupial and placental mammals. Notoryctes resembles the golden moles (order Insectivora) in general body form, burrowing habits, texture of fur, and even external features of the brain. (R22)

J. Vandenbeld remarks on the mole convergences in his Nature of Australia:

> Perhaps the most remarkable of all marsupials is the marsupial mole (Notoryctes typhlops) It has become specialised to live in the desert sand, swimming through it in search of insects and their larvae, and small reptiles. It has evolved almost identical features to those of eutherian moles elsewhere in the world: it is blind, and the eyes are reduced to vestigial subcutaneous lenses, the ears have only holes, and the snout is protected by a bony shield. One feature that marks it very definitely as a marsupial: the backward opening pouch. (R16)

With its powerful forelimbs and burrowing habits, the marsupial mole closely parallels the placental mole. The horny nose shield protects its face.

We shall return to the golden moles mentioned in the first quotation in X8, because they demonstrate another, separate, convergence that took place entirely within the placentals.

X2. The thylacine-wolf parallelisms. The thylacine, also called the Tasmanian wolf or tiger, has long been held up by biologists as an excellent example of marsupial-placental mammal convergence. The thylacine certainly looks a lot like a placental wolf-like animal. M. Denton, however, points out that the parallelism is not complete---and he wonders why:

> A fascinating example of convergence is the similarity between the placental and marsupial dogs. The dog-like carnivore, the thylacine, known locally in Australia as the Tasmanian wolf, lived until recently in the remote rain forests of southwest Tasmania. Although as a marsupial the thylacine was quite unrelated to the placental dog, it was incredibly simi-

> lar in gross appearance and in skeletal structure, teeth, skull, etc., so similar in fact that only a skilled zoologist could distinguish them.
>
> Anyone who has been privileged to handle, as I have, both a marsupial and placental dog skull will attest to the almost eerie degree of convergence between the thylacine and placental dog. Yet in terms of the soft anatomy of their reproductive systems, there is an enormous difference between the two groups. (R9)

There are, nevertheless, so many parallelisms between the thylacines and the placental wolf family that at least one evolutionist is uncomfortable:

> The identity of their proportions extends from their general appearance, their skeletons and skulls, to the very sequence and particularities of their single teeth. Parallel environmental factors may account for most of these, but not very likely for all of them. The question remains the same: what makes features of independent genomes equally interdependent? (R5)

The thylacine is also convergent with an extinct group of large, predatory South American marsupials called borhyaenids:

> ...so great was the similarity that thylacines and borhyaenids were at one time thought to be closely related. In fact, each probably evolved independently and underwent similar adaptations to meet similar challenges in a phenomenon called convergence. (R16)

Despite its stripes and large gape, the marsupial thylacine closely resembles the placental wolf, both externally and internally.

Other scientists explain this convergence within the marsupial group in terms of both thylacines and the borhyaenids possessing a common ancestor prior to the drifting apart of South America, Antarctica, and Australia. In this view, the common ancestor already possessed the genes that "permitted" the convergence to develop. (R22)

Finally, the thylacine may not be extinct after all. See BMD in Mammals 11.

X3. Cat-like marsupials and placentals. Paralleling the marsupial wolf convergence is that of the Australian quoll, also called the "native cat" or "tiger cat." The quoll bears considerable resemblance to the placental cats in both appearance and habits. (R22) The Australian fossil record has also yielded a marsupial "lion." (R2)

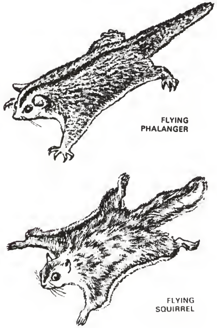
The marsupial quoll or "native cat" parallels placental cats.

X4. Other marsupial-placental convergences. We list below a few additional marsupial-placental parallelisms:

Marsupial	Placental
Marsupial mice	Mice
Spotted cuscos	Lemurs (primates!)
Flying phalanger	Flying squirrel
Wombat	Woodchuck
Numbat	Anteaters

It is fitting that we end this list with the anteaters because, like the porcupines (X6), they are involved in a wider parallelism.

Placental woodchucks (marmots) are paralleled by this marsupial wombat.



Flying phalangers are marsupials, but the resemblance to flying squirrels is striking.

X5. Anteater convergences. Although called "anteaters," these animals dine primarily on termites or "white ants." To efficiently collect and ingest termites, anteaters in Australia, South America, and the Old World have developed essentially the same suite of characteristics: powerful, clawed forefeet for opening termite mounds; long, pointed snouts; long, sticky tongues; plates instead of teeth for crushing their prey; and very low metabolic rates. Yet, all of these geographically separated anteaters come from quite different branches on the tree of life.

The South American giant anteater, with its immense tail, is perhaps the most familiar. It is one of four anteater species on that continent. There are two "lesser" anteaters and the strange silky anteater. In the Old World, the basic anteater characteristics are manifested in the pangolins or scaly anteaters, of which there are seven species. In Australia, the marsupial anteater is the numbat. However, Australia also boasts a monotreme anteater, the echidna or spiny anteater. This egg-laying mammal is not a marsupial but related instead to the platypus. (R11, R13, R22)

All of these anteaters---placental, marsupial, monotreme---share similar characteristics designed to capture and

On cold nights, the giant anteater wraps its huge tail around itself.

consume termites, but they are very, very distantly related. It is difficult to see how any ancestor common to them all could have the genes necessary to develop these unusual characteristics.

Note also in passing the unusual exteriors of some of the anteaters: "silky," "scaly," "spiny." Truly a strange group.

X6. Porcupine convergences. These heavy-set, slow-plodding mammals with their armories of needle-like quills inhabit both the New World (10 species) and the Old World (19 species). The New World and Old World porcupines are so much alike, even though now separated by thousands of miles of ocean, that some scientists have wondered whether some of these animals might have crossed the Atlantic on rafts of vegetation. (R8) Such seems unlikely however! Since the porcupine fossil record begins well after the separation of the New and Old Worlds via continental drift, convergent evolution seems indicated; that is, the porcupine characteristics evolved separately at least twice.

Why do the many species of porcupines the world over look so much alike? This is not an idle question. See text.

X7. The panda problem. Asian bamboo forests provide sustenance to two mammals bearing the panda name. More familiar is the black and white giant panda---the one sometimes seen in zoos. Less well known is the lesser or red panda. The two pandas are dissimilar in outward appearance. The giant panda looks like a cuddly bear, while the red panda is raccoon-like, with a bushy striped tail and mask-like markings on its face. Convergence in these two pandas is found in their habits and a peculiar paw adjunct resembling an extra thumb. Both pandas subsist almost exclusively on bamboo; and both possess this extra "thumb" specially designed for processing bamboo stalks for consumption. (See BMA39 for more on the so-called "thumb.") These common habits and thumbs have convinced some biologists that the two pandas are actually much more closely related than are bears and raccoons.

The panda debate has simmered for over a century. If both are bears or both are raccoons, their unusual habits and extra thumbs evolved only once. If the giant panda is really a bear and the lesser panda a raccoon, then the remarkable convergences are difficult-to-explain.

In anatomical details, the giant panda is most likely a bear. Also the fossil record shows no transitional forms linking raccoons to the giant panda. In addition, most biochemical and genetic com-

parisons conclude that bears and raccoons separated about 40 million years ago, while the giant panda split from the bear lineage only 20 million years ago. The case for the giant panda being a true bear and only distantly related to the lesser panda seems unassailable. Nevertheless, animal behaviorists still resist this conclusion. (R10) They can also point to hemoglobin studies that link the two pandas more closely than do the other biochemical data. (R20)

In 1991, the situation was complicated further by the publication of a new DNA analysis by Ya-ping Zhang and Li-ming Shi, who asserted:

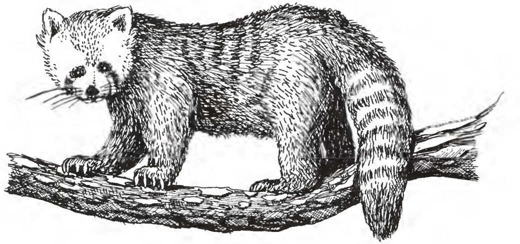
> In our phylogenetic tree, the giant panda is more closely related to the lesser panda than to the bears. Our results indicate that the two pandas are closely related on mitochondrial DNA RFLP. So, the key point of the controversy is whether the similarities between the two pandas are all caused by convergent evolution.
>
> .....
>
> If we accept that some similarities both between the two pandas and between the giant panda and the bears are due to common descent, it is certainly a fascinating evolutionary problem to determine the cause of these similarities. (R20)

In other words, no matter which way the pandas are classified, explanation of the panda affinities is challenging.

X8. Convergence among burrowing mammals. Many burrowing or "fossorial" mammals, such as moles and shrews, possess the same general morphology and suite of habits, regardless of where they sprout from the mammalian family tree. Again and again nature (i.e., the "forces" of convergence) home in on the same basic designs for certain environments.

One case in point is that of the golden moles, of which Africa boasts all of 18 species. Both the true moles and golden moles use strong forepaws for digging, have tough snouts for pushing through the soil, possess loose skins, and have reduced or vestigial eyes. Both belong to the order Insectivora, but are placed in entirely different families.

Even more distant taxonomically are some mice (Rodentia instead of Insectivora), which have also evolved the characteristics of true moles. Two examples of these burrowing mice are found in South America: the Brazilian shrew-mouse and the long-clawed mole mouse. (R22) Refer back to X1 for the marsu-



The giant panda (left) is bear-like and is probably not closely related to the raccoon-like lesser panda (above), but the two are remarkably alike in many ways.

pial mole-placental mole parallelisms.

X9. Bat convergence. Bats comprise the order Chiroptera, but they are split into two suborders: the so-called microbats and megabats. The former are generally on the small side, possess sophisticated echo-locating capabilities, and feed on insects, pollen, nectar, blood, and small animals. The much larger megabats eat mainly fruit. A few have developed rudimentary echo-locating talents. However, both suborders have membraneous wings and hang by their feet when resting; they both look like they came from the same mold. Actually, they are profoundly different, as R. Wesson describes:

> It is strong evidence of separate origins that the dentition of megachiropterans is quite different from that of microchiropterans and could not have been derived from their insectivore-like teeth. The brain and central nervous system and the circulatory and reproductive systems of the two suborders also differ importantly; in these respects the megachiropterans are more like primates. (R19)

Mammalogists have found it difficult to accept the width and depth of the chasm separating the microbats and megabats, particularly the suggestion that the latter may be closely related to primates. However, recent comparisons of the blood sera of primates and megabats have only strengthened the close connection. (R23)

It is hard to avoid the conclusion that mammalian flight and several other bat characteristics developed separately but converged on the same designs.

X10. Parallelisms among primates. Apparently, the New World and Old World monkeys, which are superficially so similar, owe their parallelisms to convergence, as explained by J.F. Eisenberg:

> The earliest representatives of the order Primates can be distinguished in the Paleocene, when the first fossils appear in North America. By the time of the Eocene, lemurlike primates are recognizable from North America and Europe. In some manner the early prosimians of the Eocene made their way to Asia and Africa, with one or two stocks transiting to Madagascar where they became isolated and underwent adaptive an radiation. The New World primates, the Ceboidea, had an independent origin from the Old World primates and became established on what was then the continent of South America, where they underwent extensive adaptive radiation. The earliest ceboid primates have been found in the Oligocene strata of South America. The Cereopithecoidea and the Hominoidea had an Old World origin and underwent an adaptive radiation roughly parallel to the radiations of South America. (R18)

Like the word "evolve," the phrase "underwent adaptive radiation" conveys no detailed "map" of what actually has happened at the molecular level.

X11. Parallelisms in Madagascar primates. As noted in X10, the Madagascar primates are believed to have become geographically isolated and then radiated independently into diverse forms. Some of the Madagascar primates, the lemurs, evolved body forms much like those of mammals on other continents.

One such lemur, now extinct, Megaladapis edwardsi, apparently looked very much like the Australian koala. Palaeopropithecus ingens seems to have been designed for a sloth-like existence, in which it clambered along tree branches upside down. (R15)

X12. Parallelisms in marine animals. It is too easy to gloss over the fact that the body shapes of whales, ichthyosaurs (extinct reptiles), and fish are much the same---all seemingly perfected for a marine existence. In fact, the bone structure of whale and ichthyosaur flippers are remarkably alike. (R9) To be sure, a marine environment favors such body plans, but the same old question arises here, too: Are these parallelisms the result of three separate series of random mutations converging, with the help of natural selection, on the same morphology, or were similar building instructions coded very long ago in an archaic genome, parts of which survive today in mammal, reptile, and fish genomes? Or, is there some unrecognized "force" or influence molding animal morphologies into similar designs?

X13. Mammals that mimic other animals. Mammal mimicry of different, more fearsome animals is rather rare. Yet, it does occur; and one is faced with the problem of ascertaining how a mammal's genome can be modified to mold the phenotype (the actual animal) to look and behave like a completely different animal. This seems a daunting task, particularly if the animal to be mimicked is taxonomically distant. The biologists' stock answer, of course, is that random mutation plus natural selection can in time accomplish the duplication. As often asserted in this Catalog, random mutation can, in principle, do the job; but one wonders how many precisely synchronized, coordinated mutations would be required to mimic body shape, coloration, even internal organs in some cases, and behavior to fool a predator. Are other factors involved? Unfortunately, very few are really looking for "other factors," because it is politically unwise to do so! Also, it is a formidable task, for the detailed mechanisms of the evolution of a mimic involve a host of complex genetic changes, differential changes in survivability, feedback loops, etc.

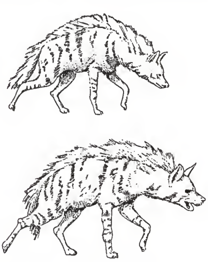
With these factors in mind, the following mammalian mimics pose problems that cannot be answered satisfactorily by just saying they "evolved" or "converged."

Maned rat/porcupine mimicry. The maned rat is a small rodent (590-920 grams) occupying central Africa.

> This rodent does not resemble a rat, as the head is similar to that of a guinea pig (Cavia) and the body, when viewed from a distance, looks like that of a small porcupine (Erethizon). When the animal becomes excited or frightened, its crest erects and it exposes a glandular area along its flanks. This trait may be a protective measure to frighten its enemies into mistaking it for a porcupine. (R22)

Undoubtedly, there are other cases of mimicry among the smaller mammals. But let us move on to larger, more impressive mimics.

Aardwolf/hyena mimicry. As the sketches show, the aardwolf certainly does resemble the striped hyena---an aggressive animal that most predators avoid. The look-alike aardwolf possesses an erectile mane along it back that makes it appear much larger than it really is and also enhances its resemblance to the striped hyena, so much so that potential aardwolf predators might well look elsewhere for a meal. Furthermore, the external similarities extend to the aardwolf's internal anatomy. P.D. Gingerich opined that the aardwolf/hyena mimcry might be unique among the larger mammals. (R3)

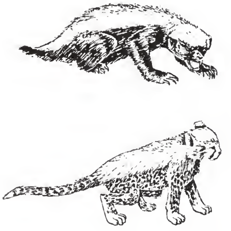


The aardwolf (top) mimics the formidable striped hyena (bottom).

Cheetah-kitten/ratel mimicry. R.L. Eaton has suggested a second possible case of mimicry among large mammals:

> Gingerich (R3) postulated mimicry of the striped hyena (Hyaena hyaena) by the aardwolf (Proteles). I discovered a second possible case of mimicry in larger mammals. Cheetah (Acinonyx jubatus) infants appear to mimic the honey badger or ratel (Mellivora capensis). The coloration of both ratels and cheetah kittens is the opposite of counter-shading, which is typical of the vast majority of mammals. While counter-shading disrupts three dimensional vision, patterns of light above, dark below actually increase conspicuousness. The ratel exemplified warning coloration; the cheetah kitten appears to mimic the ratel. (R4)

Ratels are fierce anough to discourage many would-be predators.



For protection, infant cheetahs mimic the fierce ratel (honey badger). The reverse counter-shading is unusual in mammals.

Pigmy sperm whale/shark mimicry. The head of the pigmy sperm whale resembles that of a shark. It has no beak. Beached specimens are, if fact, often misidentified as sharks. The feature that makes this mimicry more than usually interesting is the false gill on the side of the head, which greatly enhances its shark-like appearance. How did evolution contrive to put the false gill just there where it simulate the gills of a shark? (R7)

Spinner dolphin/shark mimicy. The overall appearance and behavior of a male spinner dolphin is definitely shark-like. In its threat posture, the male spinner dolphin arches his back and chatters his teeth just like the aggressive gray reef shark. Coloration of the two species is also similar. The mimicry is enhanced by the fact that the male dolphin's post-anal hump looks just like the shark's claspers. (R21)

X14. Mammalian mimicry of plants. Returning to the silky anteater (X5), we find that this strange mammal superficially resembles a seed pod!

The silky anteater looks very much like the silky mass of a freshly opened seed pod of the silk-cotton tree.

> It is said that the silky anteater frequents the silk-cotton tree (Ceiba), which has seed pods that are a massive ball of soft, silverish fibers. The sheen of this silky mass and that of the little anteater are so strikingly alike that when the animal is placed next to a freshly opened pod, a person can scarcely tell the difference. This protective coloration helps the silky anteater escape the keen eyes of its chief predators, the harpy eagle, various eagle-hawks, and the spectacled owl. (R22)

X15. Protective coloration and camouflage. Many mammals are colored and patterned so as to escape the attention of predators. We have only to mention the zebras, the sloths covered with green algae, and the dolphins with white undersides and dark backs. One example remarkable enough to catalog is the giant anteater of South America. Not only is the adult's black and white striping well designed to help conceal it in its habitat, but its young are patterned so that they blend in perfectly with the mother's camouflage when riding on her back.

> Baby anteaters ride on their mothers' backs, lying flat across the spine low down near the tail, clinging to the one spot there that makes the stripe on their own flank a perfect extension of the maternal sash. As they grow larger, and move further forward to distribute their weight more evenly, their growing stripes continue to make a seamless connection, joining mother and child invisibly by means of the only shape in the only place that would make such continuity possible. (R14)

X16. Is mimicry really useful? It is a sacrilege to make such an assertion, as mimicry is part of the evolution paradigm. Yet, some biologists have shown in field tests that mimicry may not be particularly effective and may not improve a species' survivability very much. Back in 1932, W.L. McAtee began the summary of his 145-page inquiry into the efficacy of mimicry with these two paragraphs:

> The hypotheses about protective and warning colors and mimicry are part of the Natural Selection group of theories. These coloration phenomena and other protective adaptations are supposed to have been developed and perpetuated by the selective value they had in shielding their possessors from attack by predators.
>
> Preceeding sections of this discussion call attention to the evidence that one group of predators after another is known either to prey habitually upon "specially protected" groups, or to be so largely guided in source of food by availability as practically to ignore protective adaptations. (R1)

If mimicry and protective coloration are next to worthless, as implied in McAtee's analysis, how could they have evolved if natural selection was incapable of guiding the process?

X17. Possible explanations of parallelisms. No biologist denies the existence of the remarkable parallelisms recorded above. But their explanations of these convergences are usually frustratingly short on detail. For example:

> Such close similarities in very unrelated groups are easily explained as a result of convergent evolution. The environment simply works with what it has, and in due course selects the most efficient design for the animal's lifestyle in the particular set of environmental circumstances. (R6)

Naming the phenomenon without providing the detailed mechanism for, say, creating the two pandas' extra thumbs, is not enough. It is, however, possible to go a bit further with the conventional evolutionary paradigm. Even with his theory for such amplification, R. Sheldrake finds the mainstream explanation still wanting in detail. He uses his dissatisfaction to launch his own theory:

> The standard neo-Darwinian explanation of such parallelisms and convergences is twofold: first, that they

> have evolved on the basis of random mutations that survived because of similar selection pressures; second, that such convergences on similar end-points occur because of similar structural constraints; there may be only a very limited number of ways of designing an eye, for example. As Dawkins has expressed it, such convergent resemblances "provide most impressive demonstrations of the power of natural selection to put together good designs...The basic rationale is that, if a design is good enough to evolve once, the same design principle is good enough to evolve twice, from different starting points, in different parts of the animal kingdom." But what are these "good designs" and what are the "design principles"---the "principles" of porcupines, for instance? They remain unexplained in mechanistic terms. (R17)

Sheldrake believes his theory of morphic resonance is applicable here. This principle asserts that once a particular morphology, living or nonliving, has been created, it generates a "field" that makes subsequent creations of the same morphology much easier.

The concept of morphic fields has been rejected resoundingly by mainstream science. No one can detect such fields, as they can in the cases of magnetic and gravitational fields. But, no one could measure magnetic fields either a few hundred years ago! Also pertinent here is the morphic field's lack of creativity---it makes replication easier but do not create the initial morphology.

A somewhat different explanation of parallelisms has been offered by R. Augros and G. Stanciu:

> Methodical diversification from within would account for the frequent parallelism found in plant and animal evolution, for example, the striking similarity in body plans between many Australian marsupials and their placental counterparts on other continents. If these animals shared a common ancestor whose genetic potential differentiated according to a fixed procedure we would expect the descendants to follow roughly the same morphological paths even in different environments. Hence, parallelism. (R12)

This unlocking or releasing of similar body plans locked up in the genomes of common ancestors obviates the need to create the same morphologies twice. Of course, morphic resonance does this, too.

Thus, we have at least three ways to account for morphological parallelisms:

1. Similar environmental constraints will channel the (supposed) creativity of random mutations so that similar end points (similar animals) are created. That so many, so precise, so remarkable parallelisms exist in nature makes this explanation intuitively doubtful---but not impossible in principle!
2. Morphic resonance could make the evolution of similar morphologies by random mutation and natural selection much more likely. It is in essence a mechanism for accelerating convergent evolution.
3. Morphological parallelisms could have been present in the genomes of common ancestors, say, of the marsupials and placental mammals, waiting only to be unlocked in parallel by similar environmental keys.

Are there additional mechanisms by which parallelisms can be created? Probably! After all, Darwinian evolution (random mutation plus natural selection) took hold intellectually only during the last century, and morphic resonance is little more than a decade old. Fresh ideas are bound to come along, no matter how certain mainstream scientists are today about the eternal truth of Darwinism.

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BMA2 Limits on the Variability of Domestic Animals

Description. The existence of limits to the amount of variation humans have been able to induce in domesticated mammals. Speciation has obviously occurred among wild populations, but within the time of humans it has not been observed among their domesticated animals, no matter how strong the applied selection pressures, so that there does seem to be a rather high barrier before one species transforms into another. For some reason, humans have not yet been able to force this species barrier, and they have not so far observed it being actively forced by nature herself among wild mammals.

Data Evaluation. Humans have experimented with breeding new varieties of mammals for millennia. These experiments are well-documented. Great variation is also observed in wild populations, but so far humans have not been able to prove that new mammalian species have developed while under their direct observation, either on the farm or in the wild. Rating: 2.

Anomaly Evaluation. Although creationists claim that the inability of humans to transform one species into another negates the evolutionary paradigm, it is obvious that speciation has occurred in wild mammal populations, although perhaps not within human history. The anomaly here is that nature can create new species but humans so far cannot. Humans, in fact, have not even observed speciation in real time among wild mammal populations. The reason for this is unknown. If it is only because humans have not observed nature long enough and carefully enough, no anomaly exists. Our anomaly rating, however, is based upon the premise that biological innovation, especially at the phylum and class levels, requires some still unrecognized "force." Rating: 1.

Possible Explanations. Humans may have not tried hard enough or long enough to create new species! This is an easy explanation. It is more likely that speciation requires an impetus we do not yet recognize. The "force" that causes speciation may not even be acting today in the wild, since bona fide speciation does not seem to have been observed. Yet, the fossil record is emphatic that great explosions of speciation have occurred in the past; i.e., the Cambrian Explosion and the lemur radiation in Madagascar. Speciation may require some ingredient that humans have not yet observed either in nature or laboratory.

Similar and Related Phenomena. The failures of breeding experiments to create new species of plants (BPA) and insects (BAA). Split mammal populations (BMA3); unusual mammal hybrids (BMA4); mammal atavism (BMA6). Other remarkab~~leradia~~tions at low taxonomic levels (i.e., "microevolution") among wild populations: Darwin's finches (BBA), Hawaiian fruit flies (BAA), etc.

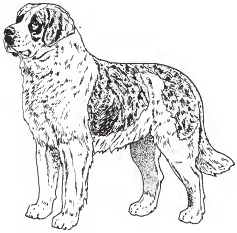
Entries

X1. Limits to the variation of domesticated mammals. For centuries, humans have been trying to alter their domesticated animals to enhance milk production, to improve hunting prowess, to increase wool production, and so on. Breeding experiments have been notably successful---up to a point. Sooner or later, animal breeders reach an impasse beyond which further variations seem impossible. Most significant is the fact that no breeding experiments have ever created a new species. The hand of man has never pushed an animal so far that a new twig commences to grow on its family tree.

Nowhere is this more apparent than in the canine clan, where the largest Saint Bernard is still the same species as the tiniest Pekingese. Antievolutionists make much of this species barrier. We quote now from D. Dewar's classic essay against evolution, The Transformist Illusion:

> As an example take the dogs. We know that men of the new stone age had domesticated dogs. The pictures on ancient Egyptian monuments show that men kept both house and hunting dogs and their breeds of dogs included the greyhound and the dachshund type and a breed that had hanging ears.
>
> Thanks to Dr. Caius we know that in England during the reign of Queen Elizabeth a number of breeds were popular. He classifies these dogs thus: 1. The Generous Kind. This consisted of the terrier, the harrier, the blood-hound, the gazehound, the greyhound, the leymmer and the tumbler, all used for hunting; the spaniel, the setter and the water-spaniel or finder, which were used for fowling, and the spaniel-gentle or lapdog for amusement. 2. The Farm Kind, consisting of the shepherd's dog and the mastiff. 3. The Mongrel Kind, consisting of the wappe, the turnspit and the dancer.
>
> Of the above several have become extinct, but a great number of new kinds have been imported, such as the Borzois, retriever, Alsatian, Schipperke, Pekingese, pugdog. Further new breeds have been produced by crossing existing breeds, such as Sealyham and the Yorkshire Terrier. But I cannot find any evidence of a

All domestic dogs, regardless of breed, are the same species.



> new type of dog having been bred by artificial selection for more than a century.
>
> It may be safely asserted that none of the existing breeds of animals will ever undergo extensive developments in the directions in which they have already been changed: any changes made in them will be in other directions.
>
> The fact that breeders are invariably brought to a standstill, no matter on what animal or plant they operate, or in what direction, is fatal to the evolution theory as enuciated by Darwin and developed by his successors, unless it can be explained away. (R1)

X2. Variation in wild mammals. In the wild, mammals show considerable variation in size, coloration, and behavior. Black, brown, and cinnamon bears, for example, are all of the same species and, as such, can freely interbreed.

Often the varieties or subspecies grade smoothly into one another. S.M. Stanley has described how the coloration of the water rat, Neofiber alleni, changes from very light, in the Florida panhandle, to a little darker in north central Florida, to very dark at the state's lower tip. (R3) This sort of variation is very common throughout nature.

Often, zoologists can classify such variants as subspecies. Of these there may be a great many, as related by F.L. Marsh:

> Examples in North America of polytypic species among larger mammals would be: (1) the red fox, Vulpes fulva, with its twelve subspecies distributed from Vancouver Island on the west to Newfoundland on the east, and (2) the coyote, Canis latrans, with its nineteen subspecies more or less isolated from one another in the western parts of the United States and Canada. However, according to Hall and Kelson, the greatest examples of subspeciation known in mammals are found among the small hairy animals of western United States. The southern pocket gopher, Thomomys umbrinus, leads the list with 214 subspecies, and the northern pocket gopher, T. taipoides,

Gophers are a highly variable species. There are over 200 recognized subspecies of pocket gophers.

ranks second with 66 subspecies. This high degree of subspeciation largely results from the isolation of groups because of the extreme lack of movement in the pocket gophers. The deer mouse, Peromuscus maniculatus, with its 66 subspecies ranges widely over the United States, and groups achieve isolation because they are so widely scattered geographically. (R2)

It should be pointed out that these many subspecies can interbreed and often differ from one another but slightly. Zoological "splitters" and "lumpers" are always adding to and subtracting from the mammalian family tree.

Thus, among wild populations, many distinct varieties may develop and morphologically drift away from one another. Since these populations of subspecies do mix somewhat and the hand of man is not present to direct the course of variation, the subspecies are usually not as sharply separated as the breeds of domestic dogs. The natural environment might favor a white coat on the polar bear but not the hairless dog!

Recognizing all of the above, the question is: Do some species, perhaps geographically isolated, really drift genetically so far that they are transformed into new species and so cannot interbreed any longer with other subspecies? Biologists and the evolutionary paradigm insist that the answer must be: YES. This answer seems reasonable, but so far, among the mammals, all the biologists have been able to see so far are trends but no sharply defined transformations.

X3. Adaptive radiations. Turning next to groups of closely related mammals that are definitely separated by the species barrier, mammalogists can point to several remarkable "radiations," or proliferations of species from one founder species. Madagascar's lemurs (BMA1-X11) are geographically isolated and probably radiated from one or a very few founder species. Dozens of lemur species now occupy many ecological niches on that island. It is easy and quite reasonable to imagine that the founder species drifted apart into subspecies and then into full species over the millennia. It is unreasonable to hold that these lemurs did not "radiate" into new species. But we do not know the details of the many transformations that must have occurred. Certainly, breeding experiments with domestic animals have not been able to bridge the species barrier, either because they are too narrowly focussed or because humans have not been trying for a long enough time.

One may make similar arguments with other groups of mammals that are obviously closely related. For example, there are about 986 species of bats. While the microbats and megabats may have evolved separately (BMA1-X9), the hundreds of species of microbats, some very much alike but not interbreeding, somehow drifted or saltated across the species barrier. Nature, it appears, can cause speciation but humans cannot. Why is this so?

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BMA3 Unusually Divergent Mammal Populations

Description. Mammals presently classified as being all of the same species that include populations with markedly different morphologies and habits. Since it is not known whether these populations interbreed, their species status is unclear. All we can tell is that they are strongly divergent.

Data Evaluation. The mammals involved in this phenomenon are well-known and frequently observed, but since they are all marine mammals it is difficult to ascertain their species status. Rating: 2.

Anomaly Evaluation. The evolution paradigm predicts that new species can be created through geographical and social isolation, just as seems to be happening with the species mentioned below. Therefore, no anomaly exists here. This entry is included only to amplify the material in BMA2 and for its curiosity value. Rating: 4.

Possible Explanations. None required.

Similar and Related Phenomena. Variation in mammals (BMA2).

Entries

X0. Introduction. The theory of evolution holds that speciation can occur when different populations of a species become geographically or socially isolated. It is difficult to observe this predicted phenomenon among mammals. Even the 214 subspecies of the southern pocket gopher (BMA2-X2) apparently interbreed and do not represent speciation. Yet, a few mammals do seem to be bridging that chasm separating species. A prime example is the killer whale or orca.

X1. Killer whales. The killer whales seen at the marine exhibits are, as far as we know, all members of permanent coastal populations of killer whales. These whales (really large dolphins) form tight social groups and dine just offshore almost exclusively on fish. Also well-observed is a second "transient" killer whale population, seemingly more rare, and with a taste for marine mammals, including whales and dolphins. Finally, there seems to be a mysterious, rarely seen, third variety of killer whale with even different habits and characteristics.

The "residents" and the "transients." These two populations of killer whales may not interbreed and may already be genetically isolated. M. Bright elaborates:

> The 'resident' kind of killer whales, characterized by a slender, rounded dorsal fin, travel in large groups, sometimes as many as fifty whales in the group, and appear around Vancouver during the summer months when the Pacific salmon is returning to its home river to spawn. "Residents" follow the salmon migration routes, so their movements are predictable. Their lifestyle seems to be determined by the behaviour of their prey.
>
> .....
>
> 'Transient' whales, characterized by a stubby, triangular dorsal fin, are less predictable and travel closer inshore to feed on more thinly dispersed and less abundant food sources. They take marine mammals, such as seals and sealions. In the Vancouver area there are only 50 'transient' whales, whereas there are 250 'residents'. There is some speculation that the two forms might repre-

> sent different species. Soviet workers have described similar characteristics in two distinct killer whale types in the Antarctic. That investigation is still going on, and is, as yet, unresolved. (R2)

The "residents" and "transients" also differ in loquaciousness. The former are always conversing with one another; the latter do not converse while hunting. They communicate only during the kill and when the spoils are being divided. (R3)

The "third" orca. Marine biologist K. Balcomb has been quoted as follows:

> About a year ago we discovered a group of orcas that weren't residents or transients---we'd never seen them before. Their language was different from any we've recorded, and they were farther offshore than orcas normally are---so we're calling them the 'offshore' orcas. We know absolutely nothing about them, they're a complete mystery. (R3)

X2. Spotted dolphins. A similar coastal-offshore split is apparent among the spotted dolphins:

> Whatever the names that may eventually be used for them, there appear to be two species of spotted dolphin in the Atlantic and Pacific oceans. The coastal forms in each species are larger and more robust, and have a greater fluke span. Offshore forms are more elongated, as is typical of other oceanic dolphins of the genera Delphinus and Stenella. (R1)

References

R1. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X2)
R2. Bright, Michael; The Living World, New York, 1987. (X1)
R3. Martin, Glen; "Killer Culture," Discover, 14:110, December 1993. (X1)

BMA4 Hybrids and Mosaics

Description. The existence of mammals with the characteristics of two different species. Hybrids are almost always the progeny of two closely related species. Mosaics, in the present context, are animals with characteristics of widely separated species. However, a genetic relationship is not usually implied, but could exist in principle. See X0 and X2, below, for a definition of "mosaicism."

Data Evaluation. Hybrids are common throughout the earth's fauna and flora, and much has been written about them, especially those involving domesticated mammals. The only so-called mosaic that has received much attention among the mammals has been the duck-billed platypus. Rating: 2.

Anomaly Evaluation. That some closely related mammals interbreed and produce fertile offspring is not considered anomalous. All biologists recognize that the definition of a species is not absolute; the species barrier is "leaky." The farther apart taxonomically the parents of a hybrid are genetically speaking, the more interesting and curious are the hybrids. When different genera are involved, as with domestic cattle and bison, a modicum of anomalousness begins to appear. Rating: 3.

Mosaics in mammals, as described in X2, are likewise curious, but it is not known for certain whether they are simply morphological coincidences or actual expressions of genetic instructions received from very distant common ancestors; that is, is the platypus's egg-laying really inherited from reptiles or a separate invention of this monotreme?

Possible Explanations. Species are not perfect taxonomic units.

Similar and Related Phenomena. Hybrids are common in most phyla, especially the "graft hybrids" in the plant kingdom. See the Subject Indexes in other volumes of this series under: Hybrids and Mosaics.

Entries

X0. Introduction. The human-defined species barrier used to classify living things is often breached in the wild and on the farm. Interspecies mating among mammals has produced many curious creatures displaying characteristics of both parents. Many, but not all, such hybrids are sterile. It is, therefore, possible that some of today's 4400+ mammalian species are actually fertile hybrids from interspecies unions of long ago.

In addition to observing hybridization in real time, one can study existing mammals and see the combined characteristics of other quite distant species. Animals possessing such amalgamations of diverse characteristics are called "mosaics" by some because of their pieced-together aspect. The implication is that they are the consequence of genes inherited from an ancient, common ancestor of the far-separated species suggested by their characteristics.This source of mammalian variability is, of course, largely surmise.

In this context, it is important to remark that the biologists usually define "mosaicism" to be the union of different tissues, each possessing different genetic complements. It is difficult to imagine natural situations in which mammalian mosaicism of this sort might arise, although "graft hybrids" are common in plants.

X1. Hybrid mammals. Some commonly recognized mammalian hybrids producing fertile offspring are:

Dog + wolf
Hare + rabbit
Goat + sheep = chabein
Camel + dromedary
Cow + buffalo = cattalo

The cattalo represents the union between two genera, Bos and Bison, respectively, and therefore breaches the much higher genus barrier. (R3)

Gibbon + siamang = siabon. The first reported viable ape hybrid was reported in 1975. This gibbon-siamang cross is remarkable because the gibbon has 44 chromosomes and the siamang 50. These two species are thought to have separated 15 million years ago. The authors of the report describing the hybrid, R.H. Myers and D.A. Shafer, were quick to point out that this hybridization undermines the theory that speciation occurs as a consequence of random mutation, natural selection, and geographical isolation.

> The hybrid ape brings into question both (i) the notion that geographic isolation is necessary for speciation and (ii) the form of the genetic barrier between gibbon and siamang. Since these species are geographically contiguous and since the viable hybrids indicate very similar, compatible genes, it appears that the multiple rearrangements rather than any

> accumulated point mutations may be the primary mechanism by which these species have diverged. (R2)

Cat + raccoon = coon-cat. One sometimes hears hunters talk of coon-cats, but the union of the domestic cat with the raccoon seems unlikely. Yet, the reputable journal American Naturalist reported on just such a hybrid in 1871. The observer was T.W. Higginson.

> I saw yesterday (May 2d, 1871) the most interesting hybrid animal I ever examined; and hasty as the examination was, it may be worth mentioning. Passing through Taunton, Mass., I saw in the doorway of Mr. Dunbar's bookstore what struck me, at first, as being the handsomest cat I had even beheld. The second glance revealed an unmistakable look of wildness; and, for a moment, it seemed to me that it must be some creature of the squirrel kind, at any rate something else than a cat. On inquiry, I found it to be the offspring of a domestic cat and a tame raccoon, kept in the same family in China, Maine. I was informed that there had been several litters of these hybrids, and Mr. Dunbar had before owned one of a previous litter. That had been stolen, and he had obtained this younger one, now seven months old, from Maine.
>
> She is larger than an average cat of that age, and is at once distinguishable both in shape and color. The color is a dark tawny, brindled with streaks that are almost black, on body and legs, and more obscurely on the tail. The under side of the body is lighter, as you will see from the matted hair which I enclose, and which was cut from the underside of one of the hind legs. (She is just now shedding her hair.) All the darker tints are quite unlike any that I ever saw in a cat. In shape she is somewhat slender, I should say, though this is concealed by the great length of the hair. The legs seem longer than a cat's, and there is something peculiar in her gait as if they were set on differently. Her walk is neither plantigrade nor yet quite feline, while it is easy and not ungraceful. I noticed no peculiarity in the paws. but the owner said she used them "unlike a cat, more like a squirrel." The head looks more triangular than a cat's, possibly, from the tufted ears, which are quite peculiar. (R1)

This "coon-cat" is said by some to be a cat-raccoon hybrid, but it looks to be mostly "cat."

Despite the foregoing, the so-called "coon-cat" is probably just an unusual breed of cat.

X2. Mosaics.

Duck-billed platypus. The classic example of an improbable union of animal characteristics is the platypus, which lays eggs like a reptile but is mammal-like in its possession of hair, mammary glands, and three ear ossicles. (R4) Although the platypus' bill resembles that of a duck, it is really a remarkable electrosensitive organ and (probably) genetically unrelated to the avian bill. (BMO in Mammals II)

Koala. Also found in Australia is the cuddly koala. A.A. Snelling sees in the koala possum-like habits, teeth, feet and diet; but its pouch and rudimentary tail are like those of the wombat. Curiously, the koala's pouch opens at the rear, which seems a poor design for a tree-climbing animal usually in an upright position. (R5) Marsupial pouches may open in either direction. (See BMA49.)

References

R1. Higginson, T.W.; "Hybrid between Cat and Raccoon," American Naturalist, 5:660, 1871. (X1)
R2. Myers, Richard H., and Shafer, David A.; "Hybrid Ape Offspring of a Mating of Gibbon and Siamang," Science, 205:308, 1979. (X1)
R3. Taylor, Ian T.; In the Minds of Men, Toronto, 1984. (X1)
R4. Denton, Michael; Evolution: A Theory in Crisis, London, 1985. (X2)
R5. Snelling, Andrew A.; "The Bear That Isn't," Creation/Ex Nihilo, 11:16, no. 4, 1989. (X2)

BMA5 Mirror-Image Twins in Mammals

Description. The mirror-imaging of asymmetric characteristics of some twin mammals; i.e., hair whorls, handedness, etc. Significantly, many such twins are not mirror images.

Data Evaluation. Only one reference on this phenomenon has been found for nonhuman mammals, and this deals primarily with cattle fetuses. Much more is known about human mirror-image twins. (BHA9 in Humans 1) Rating: 3.

Anomaly Evaluation. It is not known how mammal asymmetry originates in view of the fact that the genetic code for manufacturing proteins are identical on each side of the body. The situation becomes even more puzzling in mirror-image twins. The crucial question is why some twins are mirror images of each other while others are not. What genetic factor (or other influence) controls this? Rating: 2.

Possible Explanations. None offered.

Similar and Related Phenomena. Human asymmetry (BHA1); reversed internal organs (BHA9-X1); discordances in the appearances of human identical twins (BHA8); handedness in mammals (BHB20 in Humans 1, BMB11).

Entries

X1. General observations. In his 1940 survey of mirror imaging, H.H. Newman mentioned only one study of mirror imaging among twins of non-human mammals. This study involved the fetuses of double-monster calves; that is, calves with two heads, etc. Despite the very restricted nature of the evidence, Newman concluded:

> Double monsters in cattle show much abnormality and extensive mirror imaging. (R1)

The attributes most often mirror-imaged were hair whorls and color markings.

Reference

R1. Newman, H.H.; "The Question of Mirror Imaging in Human One-Egg Twins," Human Biology, 12:21, 1940. (X1)

BMA6 Atavism and Reversion in Mammals

Description. The appearance of "primitive" or "wild" traits in mammals, especially domesticated mammals bred to select characteristics favored by humans. This phenomenon is sometimes referred to as "the dominance of the wild type."

Data Evaluation. It is common knowledge that domesticated animals and plants quickly revert to their wild types when freed of artificial breeding pressures. Rating: 1.

Anomaly Evaluation. The anomaly here is not in explaining the genetics of atavism and reversion but rather in the doubt that the phenomenon casts upon the evolutionary concept that new species can be created by small, random mutations and natural selection. This mechanism seems no different in principle from that employed when human constraints are applied during artificial selective breeding. We have already seen in BMA2 that a limit seems to exist to the changes possible during breeding experiments, and they never breach the species barrier. In other words, both humans and nature can select for small, adaptive changes, but the wild type remains dominant and can reassert itself. Speciation both on the farm and in the wild would be impossible if this sort of stability always prevailed, but we know that it does not, because speciation has obviously occurred many, many times. Obviously, there is something about this barrier and its circumvention that we do not yet understand. Rating: 2.

Possible Explanations. Humans have not bred domesticated mammals through enough generations to realize speciation, whereas nature has had ample time over millions of years. On the other hand, speciation may actually require sharp, sudden environmental pressures---such as the natural catastrophism possible in the wild but not on the farm. Or, speciation may require some special, not-yet-recognized conditions.

Similar and Related Phenomena. Atavism in humans (BHA26, BHA40, BHA49, and BHA53 in Humans I); limits to mammalian variability (BMA2); horses with extra toes (BMA42); neoteny in humans (BHA10) and mammals (BMA7). See Series-B Subject indexes under: Atavism.

Entries

X1. The phenomenon of atavism or reversion. In his treatment of the limits of biological variability, R. Wesson also provided a useful capsule summary of the subject phenomenon:

> Despite their superficial diversity, domesticated animals have little genetic diversity, the reverse is true of the wild forms. And artificially selected traits are unstable. Domestic breeds, if allowed to reproduce without selection, revert in not many generations more or less to the wild type, as Darwin noted. Feral dogs lose the exquisite features of various breeds and tend to a nondescript brown or blackish, medium-sized mongrel type that is about the same the world around. Cats go feral much more readily than dogs and live much as their ancestors did. Domestic pigs also easily go wild, growing more bristles, recovering tusks, and having stripes when young. (R2)

Travellers in the poorer countries can readily observe that most dogs one sees there look about as Wesson described above.

X2. Explaining atavism and reversion. An attractive explanation of atavism and reversion holds that the genes defining the wild type are never destroyed by artificial breeding; they are just suppressed by the human-imposed selection criteria. When these strictures are removed and the primitive environmental forces restored, the "wild-type" genes are reactivated. R. Sheldrake quotes Darwin on this matter, and Darwin seems to have been very perceptive here:

> Darwin believed that atavism underlay many of the mysteries of spontaneous variation, and he concluded his discussion of the subject by reflecting that the germ "is crowded with invisible characters...separated by hundreds or even thousands of generations from the present time: and these characters, like those written on paper with invisible ink, lie ready to be evolved whenever the organization is disturbed by certain known or unknown conditions." (R1)

The way in which suppressed genes are "reactivated" by new external conditions is yet to be explained in detail. For example, how in a few generations can the increased survivability of young pigs with stripes be recognized by the genes, thus causing them to act?

Sheldrake explains atavism and reversion in terms of his own theory of morphic resonance:

> Such phenomena are closely related to what geneticists call the "dominance of the wild type"; in terms of morphic resonance, the ancestral wild-type [morphogenic] fields have been around much longer and are more strongly stabilized than those of the domesticated forms, and hence tend to predominate unless prevented from doing so by human activity and selection. (R1)

All of these explanations are well and good; but, to reiterate, the anomaly of this entry is not dismissed by identifying the basic mechanism of the phenomenon but lies instead in its implications for evolutionary theory.

References

R1. Sheldrake, Rupert; The Presence of the Past, New York, 1988. (X2)
R2. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X1)

BMA7 Neoteny in Mammals

Description. The appearance in non-human mammals of physical features that seem to be more juvenile than the same features in other mammals. This condition is labelled "neoteny." Example: hairlessness. Neoteny seems to be the handmaiden of high intelligence and other "advanced" biological features, despite its characterization as "juvenile."

Data Evaluation. Most treatments of neoteny relate only to humans, but a few references to neoteny in other mammals have been located. The file, however is rather skimpy. Rating: 2.

Anomaly Evaluation. Humans generally consider the other primates along with the whales and dolphins (the Cetacea) to be second only to themselves in intelligence and biological advance. The factors that impelled the cataloging of human neoteny (BHA10 in Humans I) are again operative here. It is considered incongruous that the level of evolutionary advance should be built upon the retardation of development rather than its acceleration! But this situation is really overshadowed by our nearly complete ignorance as to just how this claimed retardation of development is accomplished biologically and how these retardation mechanisms are triggered selectively. Then, too, the phenomenon of neoteny is unplumbed: what would be the effects of further retardation of human features already held back, or in the restraining of other human characteristics that are not now retarded? Rating: 1.

Possible Explanations. None offered.

Similar and Related Phenomena. Human neoteny (BHA10).

Entries

X0. Cross reference. This Catalog entry is a continuation of BHA10, "neoteny in humans," begun in Humans I. Important background is to be found in BHA10-X0. Here, we restrict the discussion to two non-human mammals that also seem to display neoteny; that is, juvenile characteristics. As in the case of humans, neoteny in the other mammals seems to be associated with traits humans consider to be "advanced." And, of course, humans are highly neotenous!

X1. Bonobos (pygmy chimpanzees). There are some primatologists who assert that bonobos represent a living missing link in human evolution. In refuting this claim, B.M. Latimer et al do identify several neotenous characteristics of the bonobos:

- Bonobos are more gracile (i.e., have a lighter frame) than the common chimpanzees. Gracilization of the human frame is considered to have been a big forward step in human evolution (BHE7 in Humans III).
- Bonobos have small dentition when compared to that of the common chimpanzees.
- The position of the foramen magnum in bonobos is more human-like than in the common chimps and, therefore, more "advanced."
- Facial prognathism is reduced in the bonobos when contrasted to the common chimpanzees.
- The bonobo's upper limbs are proportionally shorter than those of the common chimps and, therefore, more advanced.

Bonobo behavior is much more human-like (and therefore more advanced and neotenous) than that of the common chimpanzees:

> Supporters of the pygmy chimpanzee model observe that this animal "... acts more 'human' than other apes do. It walks upright more often, it is more social, and it copulates front to front." The bonobo is also considered "highly intelligent" and behaviorly "the more generalized species" of chimpanzee. (R1)

X2. Whales and dolphins. Scientists associate human neoteny with intelligence. Therefore, to find other neotenous mammals, it is logical to study other intelligent mammals. We are not surprised to find that whales and dolphins, rated highly intelligent, are also neotenous. E. Morgan in her The Scars of Evolution advances the observations of C.P. Groves on the subject of neoteny in the Cetacea:

> 'The most advanced example of neoteny among mammals appears to be the order Cetacea' (that is, whales and dolphins.) He cites a long list of resemblances between the general body form of an adult whale or dolphin and the form of the embryo of a land mammal such as a cow, pig or deer at the stage when the limb buds are forming. Like such an embryo, the dolphin has a hairless skin, a torpedo-shaped body with no neck, no external appendages such as ears, poorly formed ribs with no breast bone, hardly any hind-limb skeleton, and compared to most adult land mammals a very large brain in relation to body size---a characteristic of most mammal foetuses. (R2)

References

R1. Latimer, B.M., et al; "The Pygmy Chimpanzee Is Not a Living Missing Link in Human Evolution," Journal of Human Evolution, 10:475, 1981. (X1)
R2. Morgan, Elaine; The Scars of Evolution, London, 1990. (X2)

BMA8 Albino Populations of Mammals

Description. The existence of all-white herds of different species of mammals all within the same geographical region. It is presumed that these animals are albinos, but this has not been confirmed.

Data Evaluation. The only documentation of this phenomenon is a wire service account based on a Chinese news release. We should not place too much confidence in this report, intriguing though it may be. Rating: 3½.

Anomaly Evaluation. Albinism is a recognized genetic phenomenon that appears in many families of animals and, especially, plants. Among mammal populations, one usually finds just a sparse scattering of albinos. Sometimes a local deer population will include a couple albinos, but that is all. The incidence of albinism may be higher in some groups of mammals, as it is among the Zuni Indians. But all-white, presumably albino, herds of several *different* species have not been reported before to our knowledge. Given the *genetics* of albinism and the reduced "fitness" of albinos, total albinism in several geographically congruent populations constitutes a significant anomaly. Rating: 2.

Possible Explanations. The report is exaggerated or even totally false. The reported whiteness may not be due to albinism but rather some other unrecognized factors, such as diet.

Similar and Related Phenomena. Melanistic (dark-colored) races of mammals, such as squirrels, are well known and not considered anomalous.

Entries

X1. *General observations*. The following item was sent out by a wire service and must be viewed with caution.

> PEKING (UPI)---Explorers searching for China's version of the Abominable Snowman instead have discovered rare herds of mysterious all-white animals in the country's rugged central mountains, the official Xinhua news agency reported.
>
> The animals range from white squirrels to white vultures, musk deer, Asian deer, and huge lumbering white bears, the agency reported Wednesday. (R1)

Reference

R1. Anonymous; "Mysterious All-White Herds Found in China," Tulsa *Tribune*, July 31, 1980. (X1)

BMA9 Unusual Mammalian Sex Ratios

Description. Mammalian sex ratios that deviate significantly from 1:1, say, by 10% or more.

Data Evaluation. No systematic study of the phenomenon has been found. Instead, we have only a handful of cursory observations gleaned from the scientific literature. Rating: 2.

Anomaly Evaluation. Some of the deviant sex ratios collected below have convincing explanations. Others, though, remain mysterious. Nevertheless, the likelihood is that simple genetic, embryonic, and hormonal factors are responsible. Rating: 3.

Possible Explanations. See above and explanations in X1 and X2.

Similar and Related Phenomena. Unusual human sex ratios (BHA17).

Entries

X0. Cross reference. In BHA17, in Humans I, it is seen that the human sex ratio varies with geography, occupation, season of birth, and other factors. The sex ratios of the other mammals also show curious variations, some easily accounted for, others not readily explained. We present here, mainly as curiosities, some of the more interesting deviations from the expected 1:1, male:female ratio in mammalian populations.

X1. Lemmings. A genetic oddity seems to be responsible for the unusual sex ratio observed among some lemmings.

> Birth sex ratios not uncommonly differ from unity in mammals: female-biased ratios are uncommon while a considerable number of sexually dimorphic mammals, including man, show male-biased birth sex ratios which differ significantly from unity in large samples. Exceptions include two species of lemmings which produce around twice as many daughters as sons, apparently because a proportion of females are of XY karotype with an X chromosomes that causes its bearer to be a female and to produce mainly or exclusively X-bearing eggs. (R1)

X2. Mongolian gerbils. Here, we seem to have a case where the sex ratio is a bona fide Lamarckism:

> This conclusion derives from the finding that fetuses carried by mothers bearing multiple young experience an environment influenced by neighbouring fetuses. The mother and fetal neighbours affect the anatomical, physiological and behavioural development of the fetus. Clark et al show that female Mongolian gerbils produce litters containing more sons if the mother underwent gestation between male fetuses than if she had female 'wombmates'. Thus, brothers can beget nephews. (R4)

X3. Spider monkeys. In this species, as well as some other primates, low-ranking females give birth to many more females than males, whereas the situation is reversed among high-ranking females. Some pertinent statistics follow for a group of spider monkeys:

> Out of forty-six infants born between 1981 and 1986, twelve were male, thirty-two female, and two could not be accurately sexed. All of the twenty-one infants born to the lowest-ranking females were female. The probability that such a specialization in daughters could have occurred by chance was a staggering 1 in 10,000. Middle- and higher-ranking females produced equal numbers of sons and daughters. The highest-ranking females may have had a tendency to produce sons, but the sample size was too small to say for sure---six of eight were male. (R2)

The conventional explanation of this phenomenon is that the high-ranking females produce more sons because males have the ability to impregnate many females and thus spread the mother's genes more widely, whereas female progeny pass the mother's genes on to only one offspring per breeding season. On the other hand, the sons of low-ranking females would be unlikely to breed often, given their inherited low rank. Whereas low-ranking females will always breed and pass along their mother's genes. Just how the high- and low-ranking females skew the sex of their progeny to maximize the survival of the highest-quality genes and, as a consequence, the fitness of the species is unknown.

X4. Two-toed sloths. In the wild, 90% of adult Hoffmann's two-toed sloths captured are female. No explanation given. (R3)

These sex ratios are, obviously, not birth sex ratios.

X5. Spotted hyenas. A surprisingly robust change in the sex ratio of the offspring of a clan of this species occurred when a neighboring clan's territory suddenly became vacant, and new resources were available. The clan split up to take advantage of the situation. In the two years before the split, the clan produced 28 males and 20 females. In the three years afterward, female offspring were twice as numerous as males. (R5, R6)

References

R1. Chitton-Brock, T.H.; "Sons and Daughters," Nature, 298:11, 1982. (X1)

R2. Finnell, Rebecca B.; "Daughters or Sons," Natural History, 97:63, April 1988. (X3)

R3. Nowak, Ronald M.; Walker's Mammals of the World, 1:521, Baltimore, 1991. (X4)

R4. Vandenbergh, John G.; "And Brother Begat Nephew," Nature, 364: 671, 1993. (X2)

R5. Holekamp, Kay E., and Smale, Laura; "Rapid Change in Offspring Sex Ratios after Clan Fission in the Spotted Hyena," American Naturalist, 145:261, 1995. (X5)

R6. Mestel, Rosie; "Do Feasts Favor Female Hyenas?" New Scientist, p. 18, April 1, 1995. (X5)

BMA10 Wolves Defy Bergmann's Rule

Description. The decrease in the physical size of wolves with latitude at latitudes greater than 60° N.

Data Evaluation. Only one study of this anomaly has been uncovered. Rating: 2.

Anomaly Evaluation. Bergmann's Rule insists that the requirement to conserve body heat favors larger body sizes in colder climates. Although this rule is accurate for many mammals, the wolf (Canis lupus) is an exception. There may be other exceptions, but we have not run across them as yet. Even so, Bergmann's Rule is not threatened as a useful zoological generalization. However, the rationale behind it---body heat conservation---may be at risk due to the wolves, as mentioned next and in X1. Rating: 3.

Possible Explanations. The variation in animal size with latitude may actually be a consequence of the changes in seasonal biological productivity with latitude, rather than the need to conserve body heat in cold climates. See X1.

Similar and Related Phenomena. Sexual dimorphism in mammals (BMA11).

Entries

X0. Background. For over 140 years, zoologists have seen Bergmann's Rule confirmed again and again as they measured animal size as a function of latitude. Bergmann's Rule proclaims that animals of the same species are larger in northern climes than those farther south. And Bergmann's Rule does make sense physiologically. Larger animals conserve body heat better because of their lower area:volume ratio. They can survive the rigors of northern winters better because they lose less heat per unit weight to the environment.

Laboratory experiments neatly demonstrate the effect of cold on mammal physique. When pigs from the same litter are raised at different temperatures, those in the colder environments are stockier and hairier. (R1)

X1. Wolves (Canis lupus). Wolves roam North America from northern Mexico to the Canadian Arctic. As one studies these animals across this span of latitude, Bergmann's Rule holds until 60°N is reached, then the wolves become progressively smaller farther north---quite contrary to Bergmann's Rule.

V. Geist, who did such a study, doubts the rationale behind Bergmann's Rule. He asserts that if heat conservation were the prime reason for size increase at higher latitudes, size would have to increase much faster than it does in animals that have been measured ---up to a hundred times faster.

> Geist contends that the real cause of the link between body size and latitude is to be found elsewhere. Given the size variations of wolves, the ideal candidate would be an ecological factor that increases from the equator to temperate regions and then declines towards the poles. The burst of productivity that occurs each summer, and opportunity for growth, varies with latitude in just the right way, says Geist, to account for the facts. (R2)

Gray wolves defy Bergmann's Rule and are smaller the farther north one goes.

References

R1. Weaver, Morris E., amd Ingram, Douglas J.; "Morphological Changes in Swine Associated with Environmental Temperature," Ecology, 50:710, (X0)

R2. Anonymous; "Bergmann's Rule Thrown to the Wolves," New Scientist, p. 34, July 16. 1987. (X1)

BMA11 Unusual Sexual Dimorphism in Mammals

Description. Species where one sex is larger than the other but where the standard explanations for sexual dimorphism fail.

Data Evaluation. Sexual dimorphism has been thoroughly studied throughout the mammals, except for very rare and secretive species. Rating: 1.

Anomaly Evaluation. Many factors affect mammalian dimorphism (X0, below). It is, therefore, reasonable to expect that, in those few species where sexual dimorphism is presently recognized, reasonable explanations will eventually surface. Such rationalizations are deceptively easy to come by! Dimorphism is a tangled web to be sure! Indeed, the vast literature of biology that we have not yet had the opportunity to explore may already have disposed of the anomalies claimed below. Rating: 3.

Possible Explanations. None offered.

Similar and Related Phenomena. Mammal size variation with latitude (BMA10).

Entries

X0. Introduction. Sexual dimorphism is common throughout the Mammalia. One can make good cases for both larger females and larger males, depending upon several factors. Larger males are usual when males must fight one another for breeding rights, as in most of the deer family and elephant seals. On the other hand, the "fecundity-advantage model" states that large females can be advantageous to a species because they can produce and successfully nurture more offspring, as in rabbits and some baleen whales. About 25% of the mammal families contain species with larger females. (R1, R2, R4)

With good rationales for both types of sexual dimorphism, it is difficult to discern anomalies, but there are a few species that seem a bit mysterious in this regard.

X1. Weddell seals. Like other seals, the male Weddell fights for and maintains a large harem of up to twelve females. Unlike other seals, the Weddell male is significantly smaller than his females! (R3)

X2. Golden hamsters. Females are larger in this species, but not in the Chinese and European hamsters. All three hamster species are solitary with similar habits. Why the difference? (R1, R2)

X3. Marmosets. All marmoset species have large infants and similar social orders. The males all play a large parental role. Despite the strong similarities, females are much larger in some marmoset species. (R1. R2)

References

R1. Ralls, Katherine; "Mammals in Which Females Are Larger Than Males," Quarterly Review of Biology, 51:245, 1976. (X0, X1, X3)

R2. Anonymous; "Affirmative Evolution," Scientific American, 235:68, September 1976. (X0, X1, X3)

R3. Reiss, Michael; "Males Bigger, Females Biggest," New Scientist, 96: 226, 1982. (X2)

R4. Lewin, Roger; "Why Is the World Full of Large Females?" Science, 240: 884, 1988. (X0, X1, X3)

SKIN AND FUR

BMA12 Zebra Stripe Reversals

Description. The existence of zebras that seem to have white stripes on a dark background instead of the normal pattern. This is not a frivolous entry!

Data Evaluation. Although zebras with apparent stripe reversals are rare, this phenomenon has been well verified. Rating: 2.

Anomaly Evaluation. Developmental biologists have long puzzled over how mammal color patterns are created. (R3) How can the deposition and nondeposition of melanin (the black pigment in zebra stripes) be reversed? No one really knows how the instructions for this switch are marshalled in the embryo; and if color reversals are real the problem is aggravated. Some zoologists have even made a good case for normal zebras actually being black with white stripes! It is at once an amusing and perplexing problem. Rating: 2.

Possible Explanations. None offered.

Similar and Related Phenomena. Unknown purpose of the zebra's stripes (BMA13).

Entries

X0. Background. At first glance, the question of whether zebras have black stripes on a white background or the reverse sounds frivolous. Everyone knows that zebras are always white with black stripes! This, it seems is incorrect. Popular beliefs aside, a not insignificant biological problem is bound up in this "frivolous" question; namely, how is the melanin that creates the black stripes deposited and withheld in the zebra's striking pattern? This problem is certainly more serious if stripe reversals really do exist.

Reverting to the original question, we find two references that recognize the seriousness of the query.

X1. Observations of stripe reversals in zebras. The following is taken from Walker's Mammals of the World:

> There are various aberrations, including an almost entirely black coat and a reverse arrangement in which the ground color is dark and the stripes are white. (R2)

Although classed as "aberrant," the reversal phenomenon is obviously real. In fact, J.B.L. Bard has found an even more interesting deviation:

> Bard has uncovered an abnormal zebra whose "stripes" are rows of dots and discontinuous blotches, rather than coherent lines of color. The dots and blotches are white on a dark background. Bard writes: "It is only possible to understand this pattern if the white stripes had failed to form properly and that therefore the 'default' color is black. The role of the striping mechanism is thus to inhibit natural pigment formation rather than to stimulate it." The zebra, in other words, is a black animal with white stripes. (R1)

When it is argued that this cannot be the case because normal zebras have white bellies, Bard responds that many mammals otherwise fully colored have white bellies. The zebra's ground color could still be black, with the white belly appearing for the same purpose it does in many other mammals. (It is also unclear why so many mammals are white beneath. See BMA1 for countershading in the ratel, where the reverse is true.)

References

R1. Gould, Stephen Jay; Hen's Teeth and Horse's Toes, New York, 1983. (X1)
R2. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)
R3. Pool, Robert; "Did Turing Discover How the Leopard Got Its Spots?" Science, 251:627, 1991.

BMA13 The Existence of Zebras with Vivid Stripes

Description. All species of zebras exhibit striking black and white striping, but does the camouflage explanation suffice?

Data Evaluation. A trip to the zoo will confirm the reality of this phenomenon. Rating: 1.

Anomaly Evaluation. Over the years, zoologists have generated several theories that purport to explain the zebra's stripes. (See X1 below.) There is no scientific consensus, even though the camouflage theory is parceled out endlessly as the real reason for the stripes. Actually, so many theories are on the table---and none generally accepted---that we are justified in proclaiming a modest anomaly here. Rating: 3.

Possible Explanations. See X1 below for samples.

Similar and Related Phenomena. Zebra stripe reversals (BMA12); other strikingly striped mammals, such as the thylacine, the tiger, the okapi, and piglets.

Entries

X1. General observations. The widely promulgated explanation for the zebra's stripes parallels that for the tiger's stripes: they exist to camouflage their wearers. But zebras do not live in the tiger's shadowy woods; they inhabit the open plains where their vivid stripes attract attention rather than deflect it. All of the zebra's mammal companions on the plains generally blend in well with the landscape, although a few display minor striping on their shoulders and legs. Why have the zebras evolved such an attention-getting pattern? Biologists recognize the inadequacy of the camouflage theory and have devised several others:

> [J.] Kingdon rejected the hypotheses that stripes serve as camouflage for zebras, that they visually confuse predators and pests, and that they assist in regulating body temperature through heat absorption; instead, he suggested that stripes facilitate group cohesion and socialization. It may be that stripes developed originally as foci for grooming behavior and that the animals then came to associate this attractive tactile stimulus with a visual pattern. There is evidence that zebras, even unrelated individuals, are drawn closely to one another by such a pattern, whereas other equids maintain greater distance. (R1)

Though clever, these theories seem wanting and forced; so we are inclined to assert that the real reason for the zebra's stripes has not yet been discovered.

Reference

R1. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMA14 Land Mammal Hairlessness

Description. The existence of several large, nearly hairless, land mammals among a field of over 4000 fairly hirsute other land mammals. Most of the hairless land mammals have strong aquatic affinities.

Data Evaluation. The hairlessness of rhinos, elephants, hippos, etc. is well-known. Rating: 1.

Anomaly Evaluation. Science does not really know why some land mammals lost their hair (assuming they once had it). Cooling and parasite control in the tropics have been advanced as explanations, but these do not appear satisfactory because the overwhelming majority of tropical land mammals are heavily furred and nevertheless highly successful. A third explanation---that some of these hairless land mammals were once aquatic is both attractive and stimulating. Unfortunately, this extension of the "aquatic ape" theory is widely ridiculed by zoologists. Our anomaly rating is based upon this implication of aquatic evolution in some of these hairless land mammals. Rating: 1.

Possible Explanations. See X2 below.

Similar and Related Phenomena. Hairlessness in humans (BHA29).

Entries

X0. Cross reference. Human hairlessness is dealt with in BHA29, in Humans I. Readers interested in the several possible explanations for human hairlessness should consult BHA29.

X1. General observations. Humans certainly appear relatively hairless when compared to most other mammals. There are, however, some mammals with even less hair than our scanty inventory. Most of the other hairless mammals have aquatic affinities, as the following list demonstrates.

Cetaceans. Dolphins and whales still retain a few bristles where whiskers would normally appear. These totally aquatic mammals are well-insulated with thick subcutaneous fat and do not need hair for preserving body heat in cold marine waters. Besides, thick coats of hair would cause drag while swimming. Hairlessness among these animals seems a reasonable adaptation.

Hippopotomuses. Almost totally hairless. Fully aquatic during the day, but roams ashore at night.

Rhinoceroses. A trifling of hair. This land mammal is an inveterate wallower.

Pigs. Scant hair. Excellent swimmers and great wallowers.

Elephants. Virtually hairless. They have webbed toes and a built-in snorkel. The genitals of male elephants are enclosed just as they are in whales. Elephants have been know to swim 300 miles to offshore islands. (R1)

Naked mole rats. These fossorial mammals are naked and have no known water affinities. They obviously do not fit the trend we are seeing.

Only a few hairs sprout from the naked mole-rat's wrinkled skin.

Hairless dogs. Artificially bred, these land mammals are not pertinent here.

We have underscored the aquatic connections of hairless mammals, but such strongly aquatic mammals as seals, beavers, and otters possess dense coats of hair. Like the naked mole rats, these creatures do not fit the hairlessness-aquatic existence correlation. Even so, some hairless land mammals do, and we should inquire why.

X2. Explanations of hairlessness in land mammals. Two common explanations of hairlessness among land mammals are: (1) Body cooling is easier in tropical climes; and (2) Parasite control is much easier. Unfortunately for these theories, most tropical land mammals have thick coats of fur and cope quite well with the heat and pests.

A third explanation is implied by the aquatic connection we have been stressing: Hairless land mammals may have passed through an aquatic phase during their evolution---elephants and hippos, especially. (R1) Perhaps humans did, too. See BHA29.

Reference

R1. Morgan, Elaine; The Aquatic Ape, New York, 1982. (X1, X2)

BMA15 The Greening of Sloths

Description. The green tinging of sloth fur due to the presence of algae growing in the grooves of their guard hairs.

Data Evaluation. Grooved sloth hairs and the algae that grow upon them are well known to biologists and often mentioned in the literature. Rating: 1.

Anomaly Evaluation. Sloths are slow-moving animals inhabiting moist tropical environments. The growth of algae upon a sloth's hairy body is not unexpected. What is unusual is the grooved nature of sloth guard hairs---a feature unique to sloths. Since the sloths apparently derive some sustenance and camouflage value from the algae, there is evolutionary selection pressure to encourage the growth of algae on the hairs. So, sloth hair "evolved" grooves for the algae to adhere to and grow in. No other mammals have grooved hair, so evolution was innovative here---but how was it done? Random mutation must have produced a large number of unsuitable hairs before just the right sort was found. The problem here is that we have a good story, but no details. It was a "black box" process: normal, round mammal hair in one end of the black box and grooved sloth hair out the other end. The genome changes, the false tries, the transitional forms, and the feedback loops from natural selection forces are all a mystery. Given enough time, random mutations can do anything, but we really do not know if they were adequate. Where we have an irrefutable story minus convincing details, we do not attempt an anomaly rating. Dedicated evolutionists may be satisfied with the irrefutable story, but dedicated anomalists cannot be! They want the details, too, for there may be more to evolution than random mutations plus natural selection.

Possible Explanations. "Adaptive" or "directed" evolution or some other modification that accelerates or focusses the accepted evolutionary process. Yet unrecognized, scientifically acceptable processes that modify organisms. It is, of course, always possible that algae-friendly sloth hairs are only a lucky coincidence!

Similar and Related Phenomena. Polar-bear guard hairs as thermal diodes (BMA16).

Entries

X0. Background. Green is not a common color among the mammals. Where green is apparent, it is often due to the growth of green algae on the animals' fur. Monk seals, for example, may seem greenish due to alga colonies. Another curious case involves polar bears kept in zoos in the warmer climates. They sometimes turn green when algae invade and prosper inside their hollow guard hairs. (R1) Such colonies of algae seem to be simple opportunism on the part of the algae, but when we turn to the sloths the mammal-alga contract seems to approach symbiosis.

X1. The sloths. Some species of sloths, including members of both two- and three-toed types, have hair that seems to be specifically crafted to foster the growth of algae.

> According to Aiello, the hairs of both Choloepus and Bradypus differ in form and structure from those of all other mammals, apparently being specialized to encourage colonization by algae. Although sloths are usually said to benefit from this arrangement by being camouflaged, they actually may gain nutrients either by absorption through the skin or by licking the algae. (R2)

R.A. Lewin and P.T. Robinson provide some technical details for this arrangement:

> On two-toed and three-toed sloths (Bradypus and Choloepus) grooves on the outer surfaces of their guard hairs bear algae of two kinds; filamentous chlorophytes assigned to the genus Trichophilis (Chaetophorales) and purple cyanophytes which have been called Cyanoderma (Chamaesiphonales). (R1)

References

R1. Lewin, Ralph A., and Robinson, Phillip T.; "The Greening of Polar Bears in Zoos," Nature, 278:445, 1979. (X0, X1)

R2. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMA16 Polar Bear Hairs as Light Pipes

Description. The unique hollow guard hairs of polar bears that act as light pipes conducting solar energy to the bear's black skin for absorption.

Data Evaluation. This item is based on work done at Northeastern University by R. Grojean and reported in Science News. Grojean's observations appear reasonable, but more detailed studies must be done. Apparently, we have not yet uncovered all of the pertinent scientific literature. Rating: 2.

Anomaly Evaluation. We encounter again the "problem of perfection" in evolution. Evolution of a unique mammalian feature via random mutation and natural selection is difficult enough to believe for something as simple as the grooved sloth hairs of BMA15. When we aver that the same evolutionary process can lead to the vertebrate eye and the polar bear's high-tech light pipe, an anomalist is even more doubtful. This is particularly so here, because polar bears appeared on the evolutionary scene a scant 10,000 years or so ago. No other members of the bear family utilize hollow guard hairs as light pipes. It appears that a very clever solar energy collector appeared in a geological instant. There does not seem to have been enough time for random mutation and natural selection to "invent" the polar bear's light pipe! See the discussion on sloth hair evolution. (BMA15) We do not rate this type of evolutionary conundrum.

Possible Explanations. "Adaptive" or "directed" evolution, or some other as yet unrecognized accelerator of the evolutionary process.

Similar and Related Phenomena. The grooved hair of sloths (BMA15); the abundant examples of innovation and "perfection" in the development of life, such as the vertebrate eye---the most frequently cited example (BHO1 in Humans II).

Entries

X1. General observations. We have already encountered the polar bear's hollow guard hairs (BMA15), which can be home to algae in warm climates. What provides a curiosity in zoos greatly benefits the polar bears in their usual frigid environs. Their hollow guard hairs turn out to be analogous to light pipes or thermal diodes---high-tech inventions of modern humans!

> A polar bear's hairs are completely transparent. The bear appears white because visible light reflects from the rough inner surface of each hollow hair. However, the hairs are designed to trap ultraviolet light. Like light within an optical fiber, the radiation is conducted along the hairs to the skin. This summertime energy supplement provides up to a quarter of the bear's needs. (R1)
>
> Energy flows only in one direction in the hollow hairs. When it encounters the polar bear's black skin, it is almost completely absorbed. Truly a remarkable invention of nature.

Reference

R1. Anonymous; "Solar Bear Technology," Science News, 129:153, 1986. (X1)

BMA17 Sudden Blanching of Mammal Hair

Description. The sudden whitening of mammal hair, often within the space of a few hours. This phenomenon may be instigated by fright, injury, disease, etc.

Data Evaluation. This phenomenon has been widely discussed in the literature in connection with humans (BHA31 in Humans I). Records of the sudden blanching of other mammals are scarce; in fact, we have so far found only one! Rating: 3.

Anomaly Evaluation. Two unexplained aspects of this phenomenon are: (1) the unknown mechanism by which colored hair, supposedly an inert substance above the level of the skin, can suddenly be whitened; and (2) the unknown means by which mental and physiological states control the blanching mechanism. In short, we have a complex, bizarre phenomenon about which we know next to nothing. Rating: 2.

Possible Explanations. Hair above the skin level is not as inert as usually supposed. Several potential explanations for sudden whitening were advanced by A.F. Savill and C. Warren in their book The Hair and the Scalp. See details in BHA31-X10, in Humans I.

Similar and Related Phenomena. Blanching and color changes of human hair BHA31 and BHA32); blanching of bird feathers (BBA); the whitening of some arctic mammals in the winter (not considered pertinent to the present phenomenon because it involves molting).

Entries

X0. Cross reference. The sudden blanching of human hair is treated in BHA31, in Humans I. Considerable additional detail may be found there.

X1. Horses.

> In the Field for April 16, p. 582, Miss J. McAlpine gives an account of a bay horse the mane of which, black as usual in this colour, turned nearly white owing to a severe fright it received at six years of age when out at grass in a very long field. An aviator, in trying to land here, drove the horse the whole length of the field, and nearly alighted on it. No one saw the horse for three days afterwards, but it was then found to have lost the colour of its mane, as described, while the tail had also become quite grey. A photograph of the animal, now nine years old, accompanies the note, and shows the pale mane very plainly, so that the effect of the shock seems to have become permanent. (R1)

Reference

R1. Anonymous; "Blanching of a Bay Horse," Nature, 129:683, 1932. (X1)

BMA18 Mammalian Callosities

Description. The presence on some mammals of inherited callosities or areas of thickened skin. These callosities should not be confused with calluses acquired through use rather than inheritance.

Data Evaluation. All of the callosities described below are recognized in authoritative works on mammals. Rating: 1.

Anomaly Evaluation. Most inherited callosities have obvious value in protecting the animal against friction and pressure. Since callosities are normally acquired through use, it is presumed that the ancestors of present-day callosity-bearers developed them in the same way and, then, somehow, passed them on to their progeny. Such a development, however, can be interpreted as a clear example of Lamarckism or the "inheritance of acquired characters"---a paradigm at odds with Darwinism and therefore rejected by evolutionists. In this context, inherited characters that seem to have been acquired and subsequently inherited are highly anomalous. Those inherited callosities with no identifiable survival value (as in the right whales) are equally mysterious. Rating: 1.

Possible Explanations. Some acquired callosities, as well as other characteristics, can be inherited in opposition to prevailing evolutionary theory.

Similar and Related Phenomena. Several human characters are claimed to be examples of Lamarckism: ear pits (BHA39); foot injuries (BHA47); prehensile feet (BHA47); atrophied toes (BHA48); all in Humans I. See also the Subject Indexes of the Series-B Catalogs under: Lamarckism.

Entries

X1. Camels. Of all the mammals with callosities, camels are most frequently cited by writers seeking proof that acquired characters can be inherited or Lamarckism. We now quote R. Sheldrake and L. Watson, respectively, on this matter:

> The idea of Lamarckian inheritance has the great advantage of making sense of many of the evolutionary adaptations of organisms. For example, camels, like many other animals, develop thick calluses on their skin as a result of abrasion. They possess such calluses on their knees just where the skin is subject to abrasion as they kneel down. This could well be an acquired characteristic, but, as a matter of fact, baby camels are born with thick pads at exactly the right places on their knees. (R6)

And:

> The problem with the calluses on camels' knees is that they are inherited. They are visible on a baby camel long before it has ever had to kneel on stony ground. If the vital thickening of the skin occurred after birth, as a result of constant friction, there would be no problem. But it begins to take place in the embryo at precisely those places that the little camel's ancestors found to be vulnerable and in need of protection. It is hard to avoid the conclusion that the calluses represent a specific response to a particular environmental pressure experienced by the camel's ancestors. And it is impossible to explain this response in terms of orthodox evolution. (R5)

Watson goes on to promote Lamarckism

as a possible solution to this anomaly.

The camels also possess a patch of cornified skin on their chests that is useful when it kneels to rest or be loaded. This callosity is also of genetic origin and seems to have appeared as a consequence of domestication, since it is not found on wild camels! (R3) This would have to be a recent inherited characteristic.

X2. Guanacos. Guanacos are South American representives of the camel clan. Rather than the camel's knee pads, the guanacos display callosities on their forelimbs. (R8) Since these are mentioned in the same sentence as the camel's knee callosities, we assume that they are also inherited.

X3. Wart hogs.

> The African wart hog (Phacochoerus) has a peculiar habit of kneeling down on its forelimbs as it routs with its huge tusks in the ground and pushes itself forward with its hindlimbs. It has strong horny callosities protecting the surfaces on which it kneels and these are seen even in the embryos. This seems to some naturalists to be a satisfactory proof of the inheritance of an acquired character. It is to others simply an instance of an adaptive peculiarity of germinal origin wrought out by natural selection. (R2; R5, R6)

Note that any character can be explained by the final sentence above!

X4. Vampire bats. One would not expect bats to have developed callosities given their airborne habits, but the vampire bats of South America have padded thumbs.

> Vampire bats are agile quadrupedal runners and will readily run and hop on all fours, using the thickened thumb as a foot. (R7)
>
> Vampire bats often approach their prey by hopping along the ground as they attempt to make incisions in the feet of domestic livestock.

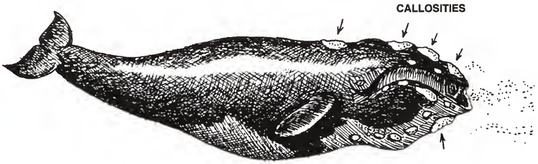
X5. Right whales. Right whales carry bizarre inherited callosities of unknown origin and purpose.

> Around the head are series of horny protuberances representing accumulations of cornified layers of skin and commonly infested with barnacles and parasitic crustaceans. The most conspicuous of these callosities is located on the tip of the upper jaw and is known as the bonnet. The callosities are present from the time of birth, but their exact function is unknown. Payne and Dorsey found that males have more and larger callosities than do females and suggested that they are used as weapons for intraspecific aggression. (R8; R4)

But the positions of many of the callosities would seem to have no value in combat.

X6. Horses. Horses possess curious warty structures on the inner sides of their limbs. These callosities are sometimes called "chestnuts." There has been much speculation (some of it wild) about these structures.

> It appears to be a very general belief that these structures are for the purpose of serving as cushions, or pads, to ease the pressure on the limbs when the animal is lying down. This, however, is obviously out of the question; and it is quite certain that the callosities are now useless remnants of structures that were once functional. The question is what those structures were. One theory is that they were footpads, or cushions, comparable to those on the foot of a dog or cat; and in order to support this hypothesis, it has been stated that they are situated much lower down on the foetus than in the adult, so as to be situated on what corresponds to the foot of other mammals. This, however, is not the case.



The arrows point to some of the strange callosities located around the head of the right whale.

A much more probable theory is that these callosities represent scent glands, comparable to those on the limbs of deer. Strong support to this is afforded by the fact (as I am informed) that the secretion which exudes from these callosities when cut will cause a horse to follow any substance anointed therewith; and also by the poacher's practice of carrying a fragment of one of them to keep his dog quiet. That a rudimentary footpad would have any effect of this kind is, of course, quite out of the question, although nothing is more likely than that such emanations should proceed from a decadent foot gland. (R1)

The preceding reference is almost a century old; and it is likely that more recent and more convincing explanations exist.

References

R1. Lydekker, R.; "Some Rudimentary Structures," Scientific American Supplement, 62:25648, 1906. (X6)

R2. Detlefsen, J.A.; "The Inheritance of Acquired Characters," Physiological Review, 5:244, 1925. (X3)

R3. Turner, C.E.A.; "The Camel: Created or Evolved?" Evolution Protest Movement Pamphlet No. 222, July 1979. (X1)

R4. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X5)

R5. Watson, Lyall; Beyond Supernature, New York, 1988. (X1, X3)

R6. Sheldrake, Rupert; The Presence of the Past, New York, 1988. (X1, X3)

R7. Emmons, Louise H.; Neotropical Rainforest Mammals, Chicago, 1990. (X4)

R8. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X2, X5)

BMA19 Skin Masks

Description. The presence on some bats of a fold of skin with two translucent spots that can be pulled up over the face, with the spots matching the locations of the bats' eyes. In essence, the bats have skin masks with eye spots. A similar situation exists with those bats that possess wings with transparent strips which allow the bat to view the environment while enveloped by wings.

Data Evaluation. These rather bizarre masks have been duly noted in New World mammal guides. Rating: 1.

Anomaly Evaluation. The spots on the skin masks are translucent rather than transparent, so that the bats can detect only the amount of light in their roost environment. The utility of these masks is puzzling because hundreds of other species of neotropical bats manage very well without them.

One has to ask what differential survival value the masks confer on these bats. It would seem to be slight. Would random mutation and natural selection be powerful enough to evolve such masks with such slight utility? Assuming that random mutation can create translucent spots in the first place, how many bat generations would be required to position the spots in just the right places? After all, random mutation would place them randomly! Biology seems to be lacking knowledge of the detailed mechanisms by which characteristics, with little differential survival value, can be evolved in a reasonable length of time. Rating: 1.

Possible Explanations. The masks and transparent wings might protect the bats' faces from vermin and parasites, confering some minimal differential survival value. This, of course, does not spell out the mechanisms involved in the evolution of these novel and intriguing features. "Directed" or "adaptive" evolution, a highly controversial concept, might be operative here.

Similar and Related Phenomena. Many mammals have skin flaps and/or musculature that can close off eyes, ears, mouths, and noses in difficult environments.

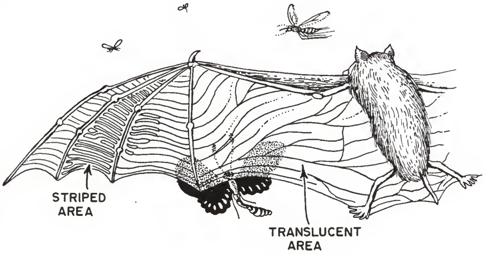
Entries

X1. Wrinkle-faced and visored bats. At least two species of New World bats possess a curious fold of skin which they can pull up over their faces. These species are: the wrinkle-faced bat (Centurio senex) and the visored bat (Sphaeronycteris toxophyllum). J.F. Eisenberg elaborates for the wrinkle-faced bat:

> This distinctive bat has many folds of skin on its face, and glands are associated with them. There is a fold of skin that forms a pouchlike structure on the throat when retracted. This skin can be drawn up over the face like a mask, and it has two spots that are generally devoid of hair, creating translucent areas so that the bat can distinguish light and dark while its face is covered. (R1)

L.H. Emmons adds in her field guide that the mask is better developed among the males in the wrinkled-face species. (R2)

These same two bats also display transparent strips in their wings. It is surmised that these clear areas are held in front of the eyes of the roosting bats. However, the bats do not always envelop themselves with their wings. (R3)



Wrinkle-faced and visored bats have translucent areas in their wings as well as "hoods."

References

R1. Eisenberg, John F.; Mammals of the Neotropics, Chicago, 1989. (X1)
R2. Emmons, Louise H.; Neotropical Rainforest Mammals, vol. 1, Chicago, 1990. (X1)
R3. Fenton, M. Brock; Bats, New York, 1992. (X1)

BMA20 Extensive Scarification of the Skin

Description. Extensive scarification of the skin seen on cetaceans, notably the grampus or Risso's dolphin.

Data Evaluation The scarification of the grampus is well known to marine biologists. Rating: 1.

Anomaly Evaluation. The anomaly of scarification of the grampus is not in the specific source of the scars but in the puzzling susceptibility of this single species to the phenomenon. What is different about the grampus physiologically or behavior-wise? Such extensive wounding would seem to have negative survival value. Of course, this is merely a minor mystery. Rating: 3.

Possible Explanations. See X1 below.

Similar and Related Phenomena. Sperm whales often bear the circular wounds made by the suckers of the large squid that they prey upon. In the category of genetic susceptibility to skin damage, we have the extreme sensitivity of humans and pigs to sunburn!

Entries

X1. Risso's dolphin or grey grampus. The grampus is a deep-water dolphin with a strange cleft head---the only dolphin with this feature. But this Catalog entry is actually concerned with the many, white, crisscross streaks seen on the body of the grampus. These streaks are actually believed to be healed scars, and their origin is debatable. Four possible sources of the wounds are:

- Fights between members of the same sex
- Overenthusiastic love play
- Wounds made by squid tentacles
- Scrapes made by underwater ledges during hunts for fish and crabs.

Any or all of the above may be involved in the scarification of the grampus. The puzzle of the scarification actually goes beyond simple identification of the source of the scars, as G. Reiger explains:

> The next logical question, however, is what evolutionary purpose is served by such extensive scarification? Why of all marine mammals is the grampus one of those most prone to crisscrossing cuts and abrasions? Or is no evolutionary purpose served at all, but merely a genetic quirk, like baldness among humans? Like so many secrets of the open ocean, the grampus will probably keep the answer to these questions for many years to come. (R1)

Some of the beaked whales also show heavy scarring on occasion. (BMA35-X4)

Reference

R1. Reiger, George; "The Mysterious Grampus," Sea Frontiers, 26:267, 1980. (X1)

LUMINOSITY

BMA21 Microwave Emmision from Mammals

Description. The direct measurement of microwave signals from mammals over and above those anticipated from blackbody radiation.

Data Evaluation. All we have at hand is a brief summary of experiments by one Canadian research group. Details are said to be available in a book entitled: Biologic and Clinical Effects of Low-Frequency Magnetic and Electric Fields, by J.G. Llaurado. This phenomenon is so unexpected and contrary to mainstream biology that independent confirmation is certainly essential. Rating: 2.

Anomaly Evaluation. The sources of microwaves emissions over and above the blackbody emissions from mammals are unknown. Nor is it understood how stress levels could affect microwave signal levels. Rating: 1.

Possible Explanations. None offered.

Similar and Related Phenomena. Telepathy claims relating to humans (Series-P Catalog volumes); possible telepathic rabbits (BMT4-X6); luminosity of the human body (BHA22, BHA23, in Humans I).

Entries

X1. Experimental measurements of microwave emissions from a rabbit.

J. Bigu del Blanco and Cesar Romero-Sierra of the anatomy department of Queens University, Ontario, working on a National Research Council of Canada grant, looked at the microwave emissions at 8.95 GHz from a man and a rabbit. They found that not only did both produce a natural microwave background expected from any radiating warm body, but also signals well above the background. Measurements were taken of signals from the abdomen of a man (with the antenna 4 m away) and from the man's hand and a rabbit's head (with the antenna 0.5 m away). Signals were found in all cases, and in the case of the rabbit, different size signals corresponded to different states of stress. (R1)

Del Blanco and Romero-Sierra speculated that microwave signals indicating stress might be perceived by some animals. They remarked that cats seem to be able to sense stress in other cats even though they are beyond the normal hearing range! (R1)

Comment. Literature research for this Catalog has never come across any confirmation of the claim for communication between stressed cats! However, telepathy claims relating to rabbits do exist. (BMT4-X6)

Reference

R1. Anonymous; "Do Animals Use Radio Telepathy?" New Scientist, 65:271, 1975. (X1)

FACIAL FEATURES

BMA22 Bat Faces: Remarkably Varied and Bizarre

Description. The incredible variety and the bizarre structures of many bat faces, including their noses, ears, wrinkles, and sundry projections. Bat faces are typical of a phenomenon in nature we choose to call "efflorescence" and/or "overshooting." These terms reflect nature's ability to create complex, bizarre, and/or beautiful structures far beyond the apparent need of the organisms thus adorned.

Data Evaluation. Many authoritative works on mammals and bats, specifically, provide sketches and photographs of the bat faces that stimulate this Catalog entry. See especially R2, R3, and the accompanying illustrations. Rating: 1.

Data Evaluation. Actually this phenomenon asserts itself throughout the natural world. Nature is exuberant in her designs: coral-reef fish, hummingbirds, fruit flies of Hawaii, etc. We catalog only the most interesting of these, and bat faces fit our criterion. The flanges, projections, ears, and noses are elaborate and bizarre far beyond the bats' need for sound-focussing structures. Of course, this is a judgment call, and we may be missing nature's purpose for these structures. We may also be underestimating the creativity of random mutations within complex biological systems. Nevertheless, superficially, bat faces appear to be examples of nature overshooting in the matter of design. The phenomenon of creating structures and talents beyond the present needs of life forms is considered highly anomalous because: (1) Subjectively, random mutation does not seem creative enough; and (2) Bizarreness and beauty, sans obvious utility, would not seem to be characteristics that natural selection would select for. Rating: 1.

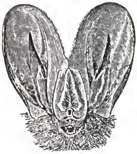
Possible Explanations. There is more to evolution that simple survival in the environment of the moment---real evolution, not Darwinian evolution, may be prescient and/or exuberantly creative!

Similar and Related Phenomena. Human overshoot phenomena: human culture (BHB14); perfect pitch (BHT14); both in Humans 1. The existence of almost a thousand species of bats---just short of one-fourth of all mammals---also demonstrates nature's efflorescent tendencies.

Entries

X1. General observations. In his insightful book Beyond Natural Selection, R. Wesson reproduces several drawings of bat faces that can only be called bizarre. His comments accompanying the drawings are apt here:

> What life has discovered is bewildering in its variety, complexity, and potency. Its fantasies are much more than can be attributed simply to



> organisms' fitting themselves, by a process of random variation, to the needs and opportunities of their world. There is not necessarily any adaptive meaning for patterns of butterfly wings, shapes of diatoms, songbird plumage, or the incredible variety of insect genitalia. The bizarrely varied flanges and projections of the many bats' noses, and also their faces and ears, cannot correspond to different needs of the many species making a living in about the same way. (R1)

Of course, Wesson's final sentence is presumptious.

References

R1. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X1)
R2. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991.
R3. Fenton, M. Brock; Bats, New York, 1992.

BMA23 Nictitating Membranes in Mammals

Description. The presence in a few mammals, including all of the monotremes, of nictitating membranes that can be drawn over the eyes for protection. This feature is also present in birds and reptiles.

Data Evaluation. The reality of this phenomenon can be easily verified by consulting standard works on mammals, although not all mention this mammalian aberration! Rating: 1.

Anomaly Evaluation. Mammalian nictitating membranes could be: (1) independent inventions by several distantly related mammals; or (2) atavisms derived genetically from distant reptilian ancestors. If independent inventions, we find it difficult to account for the parallel or convergent evolution in mammals as distantly related as the monotremes and the walrus. If the nictitating membranes in mammals are inherited from the reptiles, why are they expressed in rabbits, which would seem to have no use for them, and not in otters, which would find them useful just as the beaver does? Rating: 2.

Possible Explanations. Parallel evolution or atavism, as mentioned above. "Adaptive" or "directed" evolution may have occurred in the case of aquatic mammals where the nictitating membrane has survival value.

Similar and Related Phenomena. Nose- and ear-closing mechanisms in aquatic mammals (BMA26); skin masks in bats (BMA19).

Entries

X1. General observations. Nictitating membranes help protect the eyes of birds, reptiles, and some sharks. It is not widely appreciated that a few mammals also find these eye shields useful. The following list is doubtless incomplete:

- Monotremes, such as the platypus (R1, R3)
- Beavers (R1, R2, R4)
- Walruses (R1)
- Rabbits (R1)
- Badger (species not specified). This animal is said to have a second eyelid, which is transparent, for protection during burrowing operations. It may not be a true nictitating membrane. (R4)

The platypus, beaver, and walrus are primarily aquatic animals, and the nictitating membrane would be useful to them. The membrane's purpose in rabbits and the other monotremes (echidnas) is unknown. It should be remarked that many highly aquatic mammals, such as seals and otters, do not possess the nictitating membrane.

Of more than passing interest is the observation that the monotremes and the beaver have cloacas, just like the birds and reptiles. Cloacas are single, common openings for excretion and copulation.

References

R1. Brown, C.; "The Monotremes," Creation Science Movement Pamphlet No. 235, July 1983. (X1)

R2. Dunbar, Robin; Remarkable Animals, Enfield, 1987. (X1)

R3. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

R4. Thomas, Warren D., and Kaufman, Daniel; Dolphin Conferences, Elephant Midwives, and Other Astonishing Facts about Animals, Los Angeles, 1990. (X1)

BMA24 Eye Oddities among the Mammals

Description. Eye features that differ markedly from those of other mammals, particularly closely related ones. Several such curiosities are treated collectively here.

Data Evaluation. The quality of the data is merely satisfactory because the phenomenon is mentioned cursorily and sans details. The sources, though, are considered highly reliable. Rating: 2.

Anomaly Evaluation. Generally speaking, the vertebrate eye is fairly standardized throughout the mammals. In the susu eye, though, we see an organ apparently on its way to vestigial status. In the gorilla, red fox, and jaguarundi, we find curious departures from the eyes of very close relatives. The significance of these departures in not known. But, we rate them only as curiosities. Rating: 3.

Possible Explanations. None offered.

Similar and Related Phenomena. Anomalies of the human eye: the semi-lunar membrane (BHO6); imperfections of the human eye (BHO3); both in Humans II.

Entries

X1. General observations.

Susus. Some of the most unusual dolphins are the susus. There are two very similar species, one in the Indus, the other in the Ganges. These long-snouted river dolphins are sometimes called "blind" dolphins, for their eyes are not visible externally, but they do have eyes of a sort:

> The susu's eyes are surely its most intriguing feature, for it is the only cetacean (or marine mammal, for that matter) with eyes that lack a crystalline lens. The optic opening is scarcely as large as a pinhole, barely large enough to allow penetration by light. Although blind for all intents and purposes, the susu is probably able to detect the direction, and perhaps intensity of light in its environment. (R3)

Some naturalists suspect that the susu may be able to form an image when it lifts its head out of the water. (R5)

Since it inhabits murky waters, the sense of sight would not be of much use to the susus anyway. Perhaps their eyes are in the process of being lost, as has happened with the mole rats. Its sonar makes up for its poor eyesight.

Gorillas. A very old item from Scientific American states that the iris is missing entirely from gorilla eyes. (R1)

Red foxes.

> The pupil of the eye becomes elliptical when it contracts, instead of round, as with the other wild dogs. (R2)

Jaguarundis.

> Unlike other cats, it has a circular pupil, which may reflect its more diurnal habits. (R4)

References

R1. Anonymous; "A Hairy Child," Scientific American, 48:247, 1883. (X2)
R2. Rue, Leonard Lee, III; Pictorial Guide to the Mammals of North America, New York, 1967. (X3)
R3. Leatherwood, Stephen; Whales and Dolphins, San Francisco, 1983. (X1)
R4. Eisenberg, John F.; Mammals of the

Neotropics, vol. 1, Chicago, 1989. (X4)

R5. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMA25 The Inheritance of Eye Injuries

Description. The inheritance of eye injuries, deliberately induced in the case described here.

Data Evaluation. We have only a short letter to Nature mentioning the results of an experimentally induced eye injury. Without details and replication, we can accord only a low rating here. Rating: 3.

Anomaly Evaluation. Any experiment conclusively demonstrating the inheritance of acquired characteristics challenges the paradigm that evolution is the only way in which new characteristics can arise in a species. Rating: 1.

Possible Explanations. Both Darwinisn and Lamarckism may be valid, separately, in some circumstances.

Similar and Related Phenomena. See the Series-B subject indexes under: Lamarckism and Inheritance of acquired characters.

Entries

X1. Guinea pigs. In 1894, L. Hill wrote to the editor of Nature about an experiment to demonstrate the inheritance of acquired characters---a subject of much scientific interest in the late 1890s.

> It may be of interest to your readers to know that two guinea pigs were born at Oxford a day or two before the death of Dr. Romanes, both of which exhibited a well-marked droop of the left upper eyelid. These guinea pigs were the offspring of a male and a female guinea pig, in both of which I had produced for Dr. Romanes, some months earlier, a droop of the left upper eyelid by division of the left cervical sympathetic nerve.
>
> The result is a corroboration of one series of Brown-Sequard's experiments on the inheritance of acquired characteristics. A very large series of such experiments are [sic] of course needed to eliminate all sources of error. (R1)

Reference

R1. Hill, Leonard; "The Inheritance of Acquired Characters," Nature, 50: 617, 1894. (X1)

BMA26 Ear, Mouth, and Nose Valves in Mammals

Description. The presence in some mammals of valves of various sorts that seal off the ears, mouth, and nose from water and dust. The incidence of this phenomenon is mixed, with some highly aquatic animals not so equipped, and some terrestrial mammals possessing the valves for no discernible purpose.

Data Evaluation. Several standard reference works on mammalogy remark on these valves. They are matters of common knowledge to mammalogists and are duly mentioned in most authoritative works. Rating: 1.

Anomaly Evaluation. The valves under discussion are of several types and appear in many species far apart on the mammalian family tree. Valve-creating genes from a common ancestor seem unlikely. Independent invention also appears improbable because of the large number of species sporting such valves. If convergent evolution is the answer, then it occurred separately several times with different kinds of valves resulting. Anomalists must always bear in mind that the terms "independent invention" and, especially, "convergent evolution" sound impressive but say nothing specifically about how random mutations in rather diffrent genomes ended up with similar biological devices. The details are mostly missing. We present this complaint often in this Catalog. And why were some highly aquatic mammals slighted? However, once again, we cannot maintain that random mutations plus natural selection cannot, in principle, accomplish the results cataloged below---given enough time. Therefore, we do not claim an anomaly here, but we do register suspicion.

Possible Explanations. See above discussion. Add morphic resonance as an alternate possibility, along with Cairns-type "directed" or "adaptive" evolution.

Similar and Related Phenomena. Webbed toes in many mammals, some aquatic, some not (BHA40).

Entries

X0. Introduction. A well-designed aquatic mammal should have valves and appropriate musculature that can seal off its ears, nose, and mouth when it dives. As we see below, many mammals, especially the cetacea (whales and dolphins) and pinnipeds (seals, sea lions, and walrus), have "evolved" such devices.

But, there are other mammals with similar valves, and not all are aquatic. Most, like the beaver, are semiaquatic. The camels, however, inhabit an environment that is frequently dusty, and nostril closure is a useful property for them. The giraffe's need for nose valves is less obvious.

No pretense is made here that our list of mammals possessing these valves is complete.

X1. Ear valves.

The platypus. Consistent with its supposed primitiveness, the platypus's valves are simple in design.

> ...when it submerges, the eyes and ears, which lie in a common furrow on each side of the head, are covered by skin folds that form the edges of the furrow. (R3)

When underwater, the platypus is both blind and deaf, but its electrosensitive bill (BMO in Mammals II) is well-developed for hunting aquatic creatures that generate electric fields.

Cetacea and pinnipeds. These totally aquatic mammals have well-developed ear valves.

Aquatic rats. These South American rodents are also called fish-eating rats. In some of them:

> ...the external ear is diminutive and the slitlike ear opening can be closed by muscular contractions to keep out water. (R3; R2)

Beavers. Ear valves close automatically when beavers submerge. (R1)

X2. Mouth valves. Of course, an animal's mouth can be kept shut to keep out water, but one mammal has a special valve better suited to its life style.

Muskrats.

> Flaps of skin that fold in behind the front incisors and seal the mouth allow the muskrat to use its teeth for digging and carrying roots and food without swallowing water. (R1)

Naked mole rats. These animals burrow using their teeth and have a flap of skin that keeps dirt out of the rest of the mouth.

X3. Nose valves.

Cetacea and pinnipeds. In the former, the blowholes can be tightly closed, while the pinnipeds have slit-like nostrils that can be closed firmly when diving. (R3) However, the blowholes of the whales and dolphins are unusual enough to be singled out for further discussion. (BMA27)

Beavers. Nose valves close automatically when the animal submerges. (R1)

Hippopotamuses. Nostrils are located on top of the snout and can be shut tight. (R3)

Central American water mice. These rodents can close their noses with flap-like valves. (R3)

Giant African water shrews. Nostrils have flaps that close when this insectivore is submerged. Note that these shrews are classified as Insectivora, not Rodentia like the water mice. They are not closely related. (R3)

Otter civets. These animals of Southeast Asia are classed among the Carnivora. They, too, have flap-like valves to close off their nostrils. (R3)

Camels. Slit-like nostrils can be closed to keep out dust and sand. (R3)

Giraffes. Nostrils can be closed at will. (R3) Why this feature is so important for the giraffe is not obvious.

Sloth bears. When sucking up termites, sloth bears can close their nostrils. (R3) See BMA30-X8 for details on this animal's vacuum-cleaner technique.

Humans. Human nostrils are equipped with musculature and "wings" that resemble the nostril-sealing apparatus of some of the other mammals. Of course, they are no longer functional in humans. See BHA41 in Humans 1.

References

R1. Rue, Leonard Lee, 111; Pictorial Guide to the Mammals of North America, New York, 1967. (X1-X3)

R2. Eisenberg, John F.; Mammals of the Neotropics, vol. 1, Chicago, 1989. (X1)

R3. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1, X3)

BMA27 Displaced Nostrils

Description. Nostrils that are located at positions displaced significantly from the usual location at the end of the nose or snout and/or placed asymmetrically off the body's longitudinal axis.

Data Evaluation. The accepted reference works on mammalogy duly record the mammalian anomalies noted below. Rating: 1.

Anomaly Evaluation. Questions beginning with "why" and "how" come to the fore here. Why are the blowholes of some cetaceans located off center? Why did the position of the elephant's nostrils migrate? How was nostril migration orchestrated, particularly the gross displacement of the cetacean breathing apparatus? This migration required wholesale changes in external and internal anatomy. Transitional fossils are essentially nonexistent to show us how this was accomplished in (supposedly) small discrete steps via the accumulation of random mutations. Rating: 1.

Possible Explanations. "Migration" may be the wrong word. There may have been only one or two large saltations in morphology, although these radical, systemic changes would require evolutionary mechanisms not yet recognized.

Similar and Related Phenomena. The evolution of bat wings (BMA41); the migration of flatfish eyes (BFA); the metamorphosis of caterpillars into butterflies (BAA).

Entries

X0. Background. The nostrils of mammals are almost always at the end of the nose or snout. Some point downward, like our own; others point outwards, like those of all New World monkeys (in contrast to Old World monkeys where the downward orientation prevails). Furthermore, nostrils are normally located on the plane that defines bilateral symmetry; that is, nostrils are not displaced to the right or left of the body axis. It is of interest to anomalists when gross exceptions to normal body plans are found because they may signal that anomalies exist.

X1. Greatly displaced nostrils and blowholes.

Cetacea. Virtually everyone knows that whales and dolphins breathe through blowholes located on the tops of their heads. This relocation of normal mammalian nostrils represents a major restructuring of physiognomy.

> Cetaceans are streamlined. The breathing mechanism (one or two blowholes) has migrated to the top of the head, accompanied by a pronounced telescoping of the skull in which both the upper and lower jaws have extended far forward of the bony entrance to the nares. With the blowholes in this position, the cetaceans can exchange air without interrupting the smooth forward motion of the body. (R2)

The word "migrated," like the word "evolved" obscures the fact that many, many changes in the skeleton, musculature, and organs had to occur in synchronism---without compromising the survivability of the animal. Actually, we can see a similar but lesser sort of migration in real time by observing the movement of the eyes of a maturing flounder.

Elephants. This obviously terrestrial mammal displays several characteristics of marine mammals, such as webbed toes and lack of hair. It is therefore interesting to quote E. Morgan on the matter of elephant nostrils:

> The opening in the skull for the nostrils has migrated dorsally, as with whales and other marine mammals; it emerges above the eyes. This is not readily observable because in the soft tissue the air canal thereafter continues downward and emerges at the end of the trunk. (R1)

Did elephants evolve from aquatic ancestors? A reasonable question considering all the elephant's marine affinities. (See BMT6-X2 for elephant swimming capabilities.)

Hippopotamuses. Valved nostrils are located on top of the snout. A minor change, to be sure, but another interesting and pertinent adaptation to aquatic life. (R3)

X2. Asymmetric blowholes. The blowholes of several whales and dolphins are positioned to the left of the body axis:

- Sperm whales. The skull of this mammals is the most asymmetrical of all mammals.
- Pygmy sperm whales
- Narwhals
- Irrawaddy dolphins
- Beiji dolphins

Surely this list is incomplete.

The offset blowholes may have been dictated by the development of organs for generating and receiving sonar signals. For example, the sperm whale's spermaceti organ required rerouting the animal's air passages. (R2, R3)

References

R1. Morgan, Elaine; The Aquatic Ape, New York, 1982. (X1)
R2. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X1, X2)
R3. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1, X2)

BMA28 Unexpected Functions of Noses and Nostrils

Description. Those functions of noses and nostrils beyond the mere inhalation and exhalation of air. We exclude the recognized manipulatory capabilities of the elephant's trunk and the excavating properties of pig snouts.

Data Evaluation. Though familiar to mammalogists, the nasal functions subsumed here rarely appear in the popular literature. They are mentioned in many authoritative works, such as those referenced at the end of this entry. Rating: 1.

Anomaly Evaluation. We present these unexpected nasal functions as curiosities only---not as significant anomalies. Of course, the question of how they evolved is always with us, but this issue fades into the background here in the bizarreness of the functions described. Rating: 3.

Possible Explanations. Using the language of the evolutionists, the described functions have survival value and therefore exist! A bit tautological we submit.

Similar and Related Phenomena. The multitalented beaks of birds (BBA).

Entries

X1. Nasal sound emission and focussing. Contrary to the general impression, not all bats echolocate by emitting sound pulses from their mouths. Most do, but some interesting exceptions exist. (R3)

> Other species, notably Slit-faced Bats, False Vampire Bats, Old World Leaf-nosed Bats, Horseshoe Bats and New World Leaf-nosed Bats, emit their echolocation vocalizations through their nostrils. These bats fly with their mouths closed. The species emitting their calls through their nostrils often have elaborate facial ornamentation. Typically the ornaments are leaf-like, but the details vary from family to family and species to species. (R1)

Experimentally changing the position of a bat's nose leaf will alter its perception of its surroundings.

X2. Nasal displays. Bypassing the elephant's trunk and the impressive nose of the proboscis monkey (BMA29), we find that seals have cornered the market on bizarre nasal displays.

Elephant seals.

> Both species are characterized by large overall size and the trunk-like, inflatable proboscis of adult males. The proboscis reaches full size in animals about eight years old. Its tip then overhangs the mouth in front, so that the nostrils open downwards. An enlargement of the nasal cavity, internally it is divided into two parts by the nasal septum. Externally the proboscis is flattened and less obvious in the nonbreeding season. When breeding, Mirounga can erect this organ, partly by blood pressure, assisted by inflation, to form a high, bolster-shaped cushion on top of the snout. (R3)

Hooded seals. The males of this species display a prominent nasal appendage called a "hood." Part of the nasal cavity, this can be inflated into a bilobed football-like object. In this, the hooded seal resembles the elephant seal, but there is something more bizarre:

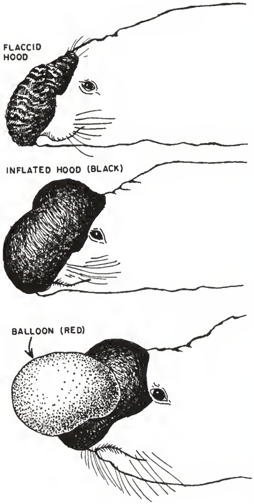
> In addition to the hood, adult males have the ability to extrude a red, membranous "balloon," mainly from the left nostril. This is accomplished

by closing one nostril and blowing air into the hood. The membrane dividing the nostrils eventually bulges from the pressure and presses through the open nostril, forming the balloon. The two bizarre structures---hood and balloon---are inflated in response to disturbances and as part of the courtship display. (R2)

Crabeater, Weddell, and southern elephant seals. These species, when agitated, typically foam at the nose. (R2)

References

R1. Fenton, M. Brock; Bats, New York, 1992. (X1)
R2. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 192. (X2)
R3. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1993. (X1, X2)



In addition to its inflatable hood, the male hooded seal blows a red balloon out of its left nostril.

BMA29 Nasal Features with Unknown Functions

Description. Mammalian noses---some quite weird---that depart radically in design from the noses of closely related species. The purposes of these deviant nasal features are unknown.

Data Evaluation. The bizarre noses cataloged here are matters of common knowledge among mammalogists and are described in the standard reference works. Rating: 1.

Anomaly Evaluation. It is frustrating to zoologists to find a prominent animal feature with no apparent purpose. Usually, flamboyant features can safely be ascribed to attracting mates or showing social status, but these expanations do not seem to apply here. Curious, but not highly anomalous. Rating: 3.

Possible Explanations. None offered. Actually, none may be needed! Nature may just be frivolous once in a while.

Similar and Related Phenomena. In one looks diligently, one can find unexplained features in every animal; viz., the occasional human sacral spot (BHA19, in Humans I).

Entries

X1. Proboscis monkeys. This strange monkey swims and dives well. Its feet are partially webbed, too; but:

> The outstanding feature of the genus is the protruding nose, which becomes long and pendulous in old males; it is less developed in females. In young animals the nose is turned upward as in Simias. The large nostrils open downward. Bennet suggested that the nose may be involved with attracting females or radiating excess body heat. (R2)

Other mammalogists suspect that the male's huge nose is involved in producing its long, drawn-out, resonant honking call. (R1)

X2. Saigas. Another strange nose belongs to the saigas---antelope-like mammals ranging from western Ukraine to Mongolia.

> A remarkable character of the Saiga is the inflated and proboscislike nose. The nostril openings point downward, and there are unusual internal structures. The bones of the nose are greatly developed and convoluted, and the nasal openings are lined with hairs, glands, and mucous tracts. In each nostril is a sac lined with mucous membranes, a feature found in no other mammals except whales. (R2)

One student of the saiga ventured that the inflated nose is used for moistening and cooling inhaled air. Another suspects that it is instead a heat exchanger for cooling the blood. The saigas also possess an exceptionally keen sense of smell, and its weird nose may be associated with that faculty. (R2)

X3. Tube-nosed bats. About a score of species of bats possess noses characterized by tubes that project from their noses. Looking like tiny hoses, they are sometimes a half centimeter long. Tube-nosed bats occur among the Old World fruit bats and among the so-called

The purpose, if any, of the nasal tubes of the tube-nosed bats is unknown.

"plain-nosed" bats. These species are widespread throughout Asia and Australia. But no one seems to know what the tubes are for or why they evolved in distantly related groups of bats. M.B. Fenton mused:

> Since tubular nostrils occur in bats that eat fruit as well as species that eat animals, diet offers no obvious explanation for them. Similarly, tubular nostrils occur in echolocating and non-echolocating bats. Future observations of tube-nosed bats may suggest a function for these striking features, but for now, their functional significance remains unknown. (R3)

Some birds, notably the albatrosses, also sport tubular nostrils. (BBA)

References

R1. Dunbar, Robin; Remarkable Animals, New York, 1987. (X1)
R2. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1-X3)
R3. Fenton, M. Brock; Bats, New York, 1992. (X3)

TEETH AND TUSKS

BMA30 Curious Teeth and Dentitions

Description. Teeth and dentitions with features sharply different from those of mammals in general, as listed below:

X1. Hinged teeth
X2. Egg teeth
X3. Forward-pointing teeth
X4. Backward-pointing teeth
X5. Scalpel-like teeth
X6. Sieve-like teeth
X7. Tubule teeth
X8. Missing teeth
X9. Asymmetrical dentitions

The above list cannot be considered complete, for we have cataloged only the phenomena most interesting to us. Additional "dental" phenomena that seem to have more profound implications follow this entry.

Data Evaluation. All data have been extracted from authoritative sources. Needless to say, many other worthwhile sources have not yet been studied, so this Catalog entry is incomplete. Rating: 2.

Anomaly Evaluation. Most of the curious teeth cataloged here enable their possesssors to survive better. Such adaptations, even though they seem remarkable to the compiler, are explicable in principle by evolutionary theory. Therefore, no anomaly can be claimed here. We do have, though, "hints" of anomalousness from the perfection of these adaptations and the apparent lack of intermediate forms in the fossil record. Our policy is to record such phenomena for the effect they may have on future modifications to the theory of evolution.

Possible Explanations. None required.

Similar and Related Phenomena. "Remarkable" adaptations and examples of "perfection" are to be found in all Series-B catalog volumes. See the Subject Indexes under: Perfection problem. Marching teeth (BMA31).

Entries

X1. Hinged teeth. Although hinged teeth are known among the snakes, fishes, and lissamphibians, it is not generally recognized that a few mammals also sport them. R.A. Kiltie mentioned this mammalian dental oddity in a letter to Science in 1981.

Muntjacs and Chinese water deer.

> I wish to point out that hinged upper canine teeth have been described in two mammalian genera: muntjacs (Muntiacus) and Chinese water deer (Hydropotes). This arrangement allows these ruminants to move their jaws from side to side while masticating plant foods; without hinging, these canines would interlock with the lower jaw and prevent its sideways movement. (R1)

The upper canines of these two species elongate into formidable tusks several inches long. Supposedly for defensive purposes, one wonders how effective they can be if hinged. Also, which came first; the hinging or the formation of tusks? Or did they evolve simultaneously? Without hinges, tusked deer would starve; without tusks, these deer would suffer more from predation. It would be interesting to see how these two selection forces, along with random mutations, conspired to develop these unique hinged tusks.

X2. Egg teeth. The monotremes usually end up in the mammal guides, even though they lay eggs instead of giving birth to live progeny. Following this custom, we mention them here. The eggs of the monotremes are somehow conveyed to the female's pouch where incubation occurs.

Echidnas. Also called spiny anteaters, the unhatched young of these strange animals temporarily possess an enamel-covered egg tooth. This sharp instrument is required to slit open the tough, leathery egg. (R6, R7) This egg tooth is soon lost, and adult echidnas have no teeth at all---a feature shared with most mammals that feed heavily on termites, such as the "ordinary" anteaters, pangolins, etc.

The egg tooth of the young echidna reminds one of the egg teeth of most birds and reptiles, which must also escape egg shells. The echidna's egg tooth, however, is a real enamel-covered, mammal-like tooth and not a temporary projection on a bird's bill. It is questionable, therefore, that it is a feature inherited from an ancestor common to reptiles, birds, and mammals.

X3. Forward-pointing teeth. Teeth that point forward are of little use in killing and masticating prey. A compelling function must exist for teeth of this type for them to have evolved.

Weddell seals. The upper incisors of these Antarctic seals are used for cutting sea ice to make breathing holes. To this end, the outer upper incisors are about four times longer than the inner incisors and project forward to make them more effective ice-cutting tools. (R5, R7)

Cross reference. It has been debated without resolution as to whether the narwhal's greatly enlarged tooth (tusk) is employed in breaking ice. See BMA34-X3.

X4. Backward-pointing teeth. As with forward-pointing teeth (X3), those that point backward must perform some vital function for them to have evolved.

Bats. The baby or milk teeth of most infant bats are turned inward. This feature, so useful to baby bats, is used by F. Hitching as an example of biological "perfection," where intermediate stages of development would seem to be useless.

> The milk teeth of baby bats are turned inwards so that they can cling on to the mother's hair as she hangs high from the ground. If this faculty had not appeared fully operational, would it not have been fatal both for individual baby bats and thus for the entire species? (R2)

Such examples of "perfection" are very common. To some, they seem to contradict the Darwinian notion that evolution proceeds in small increments rather than quantum jumps from nothing to fully operational, "perfect" characteristics.

X5. Scalpel-like teeth. Mammalian teeth are mainly designed for puncturing, shearing, tearing, and crushing. Teeth shaped and sharpened for incision-making are decidedly unusual.

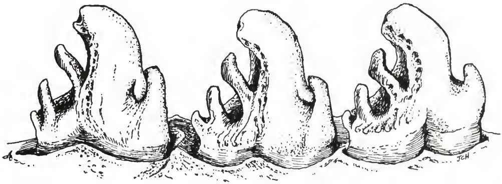
Vampire bats. The three known species of vampire bats, all in the New World, have incisors and canines specialized for incision-making. Their cutting edges are V-shaped or sickle-like. So sharp are these teeth that prey are rarely aware that they have been slashed. (R4, R7)

Vampire bats subsist entirely on a liquid diet. With no need to masticate, their other teeth are reduced in size and crushing surfaces are absent. This loss of unneeded capabilities is common in nature, and taken for granted by biologists; but the details as to how the genome is modified by such disuse are not clear.

X6. Sieve-like or comb-like teeth.

Crabeater seals. Actually, these Antarctic seals eschew crabs. Instead, they dote on krill, which they strain from the water with special teeth. R.R. Reeves et al have this to say on these curious teeth:

> The dentition of these seals is unusual. There are two upper pairs



Crabeater seals strain krill from seawater with their sieve-like teeth, much like baleen whales do with their baleen.

and one lower pair of small incisors in addition to the small and even smaller lower canines. The postcanines are multicuspid, the cusps forming separate, well-defined lobes. Upper and lower postcanines interlock to form a kind of sieve, allowing the seal to filter krill from seawater. A bony flange behind the last lower cheek teeth keeps food from escaping from the corners of the mouth. (R8)

The baleen whales also filter feed on krill, but they have no functional normal teeth. The strips of baleen that constitute their filtering apparatus are, like the rhino's horn, derived from highly modified hair. With the flamingoes, filtering is accomplished by a cleverly designed bill. (BBA) Many other filter-feeding devices can be seen among the fish, barnacles, anemones, etc.

Colugos or flying lemurs. So different are the colugos that they are placed in an order of their own (Dermoptera). They are not true lemurs and are not even found on Madagascar. They do not filter feed, so their comb-like teeth are something of a mystery.

The lower incisors are developed into peculiar "comb teeth" that vaguely resemble the teeth of true lemurs (Primates). The difference is that each lower incisor of Cynocephalus may have as many as 20 prongs radiating from one root, while in true lemurs, each prong of the comb is a single tooth. (R7)

X7. Tubule teeth.

Aardvarks. Mammals that feed predominately on termites usually have anomalous dentition or, often, no functional teeth at all, as with anteaters. The aardvark is also fond of termites and enjoys them with its own sort of curious teeth.

The aardvark's teeth do not all grow simultaneously. Teeth in the front of the jaw develop first, but when the animal reaches maturity they fall out, to be succeeded by others farther back in the jaw.

The cheek teeth, which are covered externally by a layer of cement, each resemble a flat-crowned column and are composed of numerous hexagonal prisms of dentine surrounding tubular pulp cavities, hence the ordinal name Tubulidentata ("tubule-toothed"). The teeth of aardvarks grow continuously and lack enamel. (R7)

X8, Missing teeth. Missing teeth are not unusual among the mammals, but sometimes the adaptation of the resultant gap is bizarre enough to deserve special notice.

Sloth bears. This Asian bear feeds heavily on termites. Instead of the anteaters' long snout and sticky tongue, it has developed a vacuum-cleaner approach. Its inner upper incisors are missing, creating a prominent gap in the front teeth. The palate is hollow. After a termite nest has been exposed and excess dirt blown off, the sloth bear sucks up the termites. Its vacuum cleaner is so robust that it can be heard 500 feet away, and often leads hunters to the animal. (R7)

X9. Asymmetrical dentitions. Perfect bilateral symmetry of course does not exist; viz., the internal organs of mammals. Nevertheless, the dental formulas of mammals are generally highly symmetrical; that is, teeth on the right side of the jaw are always matched by similar teeth on the left side. Deviations from this condition are curious enough to catalog here.

Pygmy killer whales. The heads of whales are more asymmetrical than those of other mammals; i.e., eccentric blow holes (BMA27). In view of this general tendency in this species, it is not especially surprising to find that some of these whales have asymmetrical dentitions.

Pygmy killer whales have eight to eleven teeth in each side of the upper jaw and eleven to thirteen in each side of the lower jaw. Many specimens reportedly have one fewer on the right than on the left side. (R3)

References

R1. Kiltie, Richard A.; "Hinged Teeth," Science, 214:390, 1981. (X1)

R2. Hitching, Francis; The Neck of the Giraffe, New Haven, 1982. (X4)

R3. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X9)

R4. Eisenberg, John F.; Mammals of the Neotropics, vol. 1, Chicago, 1989. (X5)

R5. Editors of Time-Life Books; Amazing Animals, Alexandria, 1990. (X3)

R6. Rismiller, Peggy D., and Seymour, Roger S.; "The Echidna," Scientific American, 264:96, February 1991. (X2)

R7. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1, X2, X5-X8)

R8. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X6)

BMA31 Marching Teeth

Description. Teeth that move in unison, single file, from the rear of the jaw toward the front. Teeth at the front of the line fall out when they are worn. New teeth erupt at the back of the jaw to replace them. Marching teeth seem to have evolved mainly in animals that consume large quantities of coarse plant food.

Data Evaluation. Marching teeth are a recognized character of elephants and manatees. That they also occur in some pigs, wallabies, and kangaroos is not as well known, although the fact is duly recorded in mammal guides. Rating: 1.

Anomaly Evaluation. Marching teeth depart profoundly from the usual mammal dentitions, in which milk teeth are replaced from below by permanent teeth. The presence of marching teeth in very distantly related mammals is remarkable enough to raise questions about the evolution of the phenomenon. Elephants and manatees seem to be rather closely related, so that a common ancestor with marching teeth is a reasonable explanation. Pigs, though, are distantly related to elephants and manatees, and marsupials are even farther away on the evolutionary tree. Since common ancestors with marching teeth are unlikely in these instances, independent invention of the character, or possibly parallel evolution, is usually supposed. These evolutionary processes are possible in principle but viewed with suspicion in this Catalog, because they are so glib and lacking in detail.

Possible Explanation. Alternatives to independent invention and parallel evolution are morphic resonance and "directed" or "purposeful" evolution; both of which are anathema to mainstream biology.

Similar and Related Phenomena. Refer to the Subject Indexes of the Series-B catalogs under: Parallelisms; Evolution, adaptive. Replacement of shark teeth (BFA); the marching teeth or "darts" of some snails (B1A).

Entries

X0. Introduction. When some species of sharks lose teeth, they are replaced by others directly behind. It is not as well known that a few mammals and marsupials also replace worn out teeth with new ones. In the case of mammals, however, the teeth in each jaw march forward in file, with new teeth erupting in the back of the jaw to replace those lost at the front of the line. Not only is the "marching teeth" phenomenon intriguing but it may, since it is such a unique and rare character, reveal and challenge evolutionary relationships.

X1. Elephants. The best-known marching teeth are those of the elephants.

> These teeth do not succeed one another vertically in the usual mammalian pattern, but come in successively from behind, the series moving obliquely forward. When the foremost tooth is so worn down as to be of no further use, it is pushed out, mostly in pieces. (R3)

X2. Manatees.

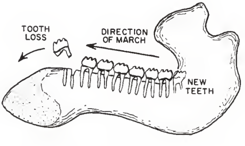
> The teeth of manatees are continuously replaced horizontally throughout the animal's life. As each tooth moves forward with the migration of the entire row, its roots are resorbed. By the time it reaches the front of the row and is lost, it has been replaced by a newly erupted tooth at the rear of the row. (R4)

The tooth-replacement process is basically the same as that of the elephants and points to a common ancestor perhaps 60 million years ago. (R2) The rate of tooth movement in the manatee jaw is estimated at 1-2 millimeters per month. (R5)

X3. Dugongs. Although dugongs and manatees are both sirenians and are similar in appearance, their dentitions differ. The dugong's teeth march like those of the manatee, but they are evidently not replaced. Therefore, older animals often have only a couple teeth left.

While the dugong's teeth do not march quite like those of the elephant and manatee, the male dugongs often do sport small tusks. More rarely, a female will have them, too. This feature is certainly elephant-like and could betray a close evolutionary relationship. (R3)

X4. Pigs. In Walker's Mammals of the World, one finds mention that some pigs also have marching teeth like the manatees and elephants. Nothing more specific has been found. (R3) Pigs are even-toed ungulates well-separated from the elephants and manatees on the evolutionary tree.



The marching teeth of the manatees.

X5. Marsupials. Some wallabies and kangaroos have marching teeth like those of the elephants and manatees. (R3) In this instance, a common ancestor with marching teeth is not claimed, due to the huge taxonomic gap separating the species. Instead, independent inventions of marching teeth are usually postulated.

References

R1. Domning, Daryl P.; "Marching Teeth of the Manatee," Natural History, 92:8, May 1983. (X2)
R2. Bright, Michael; The Living World, New York, 1987. (X2)
R3. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1-X5)
R4. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X2, X3)
R5. O'Shea, Thomas J.; "Manatees," Scientific American, 271:66, July 1994. (X2)

BMA32 Microbats and Megabats Have Strikingly Different Dentitions

Description. The observation that the dentition of the megachiropterans (flying foxes) is so different from that of the microchiropterans (small, echo-locating bats) that the two groups of bats may have had separate origins.

Data Evaluation. Except for the general comment quoted below (X1), no other sources have mentioned radically different dentitions separating the two groups of bats. No specifics on the differences are available either. Rating: 3.

Anomaly Evaluation. Even though there have been claims that the neurology of the megabat eye-brain system resembles that of primates more than that of the microbats (BMO in Mammals II), taxonomists remain adamant that all bats had a single origin. The existence of radically different dentitions would be in direct opposition to this firmly held classification. Rating: 1.

Possible Explanations. In the absence of specifics, we can say only that R. Wesson's claim (R1) may be an extreme interpretation of the facts.

Similar and Related Phenomena. The bat eye-brain connection (BMO in Mammals II); bat DNA comparisons (BMC in Mammals II).

Entries

X1. General observation. In his book Beyond Natural Selection, R. Wesson asserted:

> It is strong evidence of separate origins that the dentition of megachiropterans is quite different from that of microchiropterans and could not have been derived from their insectivore-like teeth. (R1)

Reference

R1. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X1)

BMA33 "Unperfection" In Strap-Toothed Whales

Description. The inability of male strap-toothed whales to open their jaws more than 2 inches because of tusk-like teeth from the lower jaw curving up and over the upper jaw.

Data Evaluation. Strap-toothed whales are uncommon but enough specimens have been collected to provide adequate descriptions in the cetacean literature. Rating: 1.

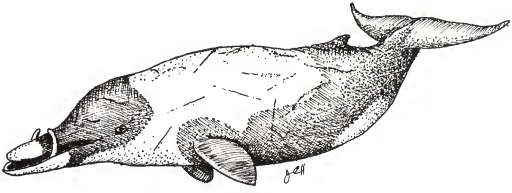
Anomaly Evaluation. The severe limitation on jaw movement for such large animals (average length: 6 meters) would seem to compromise the males' ability to capture and consume food. Surely, this must be an example of bad design or "unperfection" in nature! It raises suspicion that natural selection is not the efficient winnower of bad adaptions that we are led to believe; and this is mildly anomalous in the compiler's view. Rating: 3.

Possible Explanations. Natural selection may not yet have had enough time to prune the misfit strap-toothed whales from the evolutionary tree. Or, the strap teeth may actually perform a useful but unrecognized service, such as channelling food into the throat. (However, females thrive without these teeth!)

Similar and Related Phenomena. Many mammalian tusks seem useless and even detrimental (BHA34). Some male pigs have grotesquely shaped tusks (BHA34); could there be an evolutionary connection?

Entries

X1. General observations. Strap-toothed whales ply the frigid waters surrounding Antarctica. Adults average about 6 meters in length.



Adult male strap-toothed whales can barely open their jaws, yet they seem to capture all the food they need.

The most interesting and diagnostic feature of this species is the strap-shaped pair of teeth that emerges from the mandibles, well behind the tip of the beak, in males. The teeth extend upward and backward beside the upper jaw, eventually curling over it and preventing the mouth from opening fully. (R1)

The male's strap-like teeth, which remind one of the tusks of some pigs, may be 30 centimeters long. (R4) When fully developed, the males cannot open their jaws wider than about 5 centimeters (2 inches), which would seem to limit the food intake of such a large animal. (R3)

Zoologists have tried to rationalize this apparent severe impediment to the male's survival. S. Leatherwood and R.R. Reeves suggest that these strange teeth actually help channel food into the throat. (R1) L. Tangley ventures that, if this whale stuns its prey with sound, as some of the cetacea do, a large mouth opening is not actually necessary. (R2) However, if the strap teeth do perform a useful function, why don't the females have them, too?

References

R1. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X1)

R2. Tangley, Laura; "A Whale of a Bang," Science 84, 5:74, May 1984. (X1)

R3. Ralls, Katherine, and Brownell, Robert L., Jr.; "A Whale of a New Species," Nature, 350:560, 1991. (X1)

R4. Redford, Kent H., and Eisenberg, John F.; Mammals of the Neotropics, vol. 2, Chicago, 1992. (X1)

BMA34 Questionable Utility of Mammalian Tusks

Description. The apparent uselessness of the tusks borne by some mammals.

Data Evaluation. All data have been extracted from authoritative works on mammals. Rating: 1.

Anomaly Evaluation. A survey of tusk-bearing mammals reveals that most tusks do indeed add to their bearers' survival capability or are neutral in this regard. The exceptions are few and minor: the upper tusks of the babirusa; the small tusks of male dugongs; and the backward tusks of an extinct elephant. Therefore, although some mammalian tusks may seem burdensome and of marginal utility (as with male narwhals), most have some survival value and do not challenge evolution via natural selection. Rating: 4.

Possible Explanations. Those tusks that do not seem useful to human observers may actually have some unseen value to their bearers. Some other tusks, such as those of the male dugongs, may be vestigial or still in the process of being discarded, since many mammalian species are of rather recent origin.

Similar and Related Phenomena. The teeth of the strap-toothed whale (BMA33); possibly useless horns and antlers (BMA36).

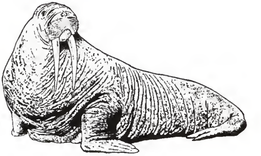
Entries

X0. Introduction. We inquire here into those mammals bearing tusks, asking whether these overdeveloped teeth actually do have useful features that would encourage their development through natural selection.

X1. Walruses. The tusks of male walruses may reach a meter in length, those of the females are a bit shorter. Naturalists proclaimed for many years that walruses used their tusks for digging clams and other marine food from the sea floor. More careful observations have shown that this is not the case. Rather, the tusks have several uses:

- Intraspecies fighting and intimidation
- Defense from predators such as polar bears. (Walruses sometimes win!)
- Cutting through ice
- Hanging onto ice floes
- Pulling out of the water.

Walrus tusks definitely have great utility.



Contrary to popular belief, the walrus does not use its tusks to dredge up clams from the sea floor.

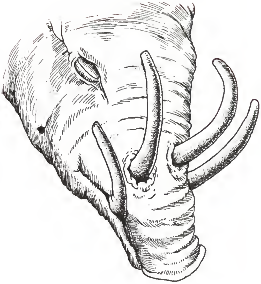
X2. Babirusas. The tusks of most pigs are eminently suited to defense and rooting. In Southeast Asia, though, we find perhaps the strangest pig of all, the babirusa. We focus here on this animal's bizarre tusks, as described by E.K. Rice:

> The creature's oddest characteristic is the two impressive pairs of curving tusks grown by the males. One pair

are simply extended lower canines, but the second are actually the upper canines, the sockets of which have rotated, resulting in tusks that grow through the top of the muzzle and emerge from the middle of the animal's face. The effect is bizarre and startling. The males fight with their daggerlike lower canines and probably deflect opponents' blows with the upper set, thus protecting their eyes. (R4)

The probable defensive value of the upper tusks is echoed in Walker's Mammals of the World (R7), but apparently this is still surmise. R. Wesson is highly skeptical; he states outright that the upper tusks of the babirusa "have no known use." (R6) He goes on to point out an additional bad design feature: these tusks often curve backward so much that they penetrate the upper jaw or skull.

One would suppose that strong natural selection forces would have to be exerted to rotate teeth and evolve them into such unusual tusks, but was parrying sufficient?



The two inner tusks of the babirusa grow up through the animal's upper muzzle.

X3. Narwhals. Narwhals have only two teeth, and neither is functional as a tooth. In males, the right tooth remains embedded in the gums, while the left one erupts and protrudes through the upper lip. Eventually it may reach a length of 3 meters, making it a formidable instrument. The modern consensus is that the male narwhals spar with these tusks during the breeding season. Scars on the males and even embedded bits of tusks support this conclusion. (R3, R6) Other suggested uses are:

- Ice breaking (R5)
- Skewering prey
- Probing the seabed for food.

Since females very rarely develop tusks, they would be at a disadvantage if the main purpose of the tusks were in the above list of three. Male-to-male combat, then, seems to be the most likely use for the tusks.

In sum, ungainly though the male narwhal's tusk may be, it has a legitimate function; and it is no more anomalous than the huge antlers of a male elk.

X4. Dugongs. The upper incisors of adult male dugongs and, sometimes, very old females elongate into short tusks that can be readily seen protruding through the upper lips. The purpose of these tusks is unknown. (R8)

X5. Elephants. Living elephants have many uses for their tusks: fighting, levering, rooting, and working for humans. Tusk utility is therefore not a question with modern representatives of the Order Proboscidea.

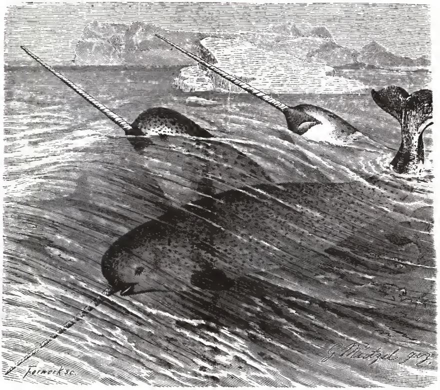
Some extinct elephants, however, apparently had backward-pointing tusks. (R1) We question the usefulness of such tusks.

X6. Deer. The upper canines of the males of several species of Asian deer elongate into formidable tusks. In musk deer, for example, the tusks may attain 7.5 centimeters. Chinese water deer, muntjacks, and tufted deer have tusks, too. These weapons are said to be capable of seriously injuring dogs and other predators. (R7) Nothing anomalous here.

X7. An interesting generalization. E. Morgan, in her book The Aquatic Ape, comments that tusked mammals tend to be nearly hairless and prefer aquatic or marshy habitats. (R2) Except for the tusked deer, this appears accurate; but what does it mean in evolutionary theory?

References

R1. Carrington, Richard; The Mammals, New York, 1963. (X5)
R2. Morgan, Elaine; The Aquatic Ape. New York, 1982. (X7)
R3. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X3)
R4. Rice, Ellen K.; "The Babirusa: A Most Unusual Southeast Asian Pig," Animal Kingdom, 91:46, March/April 1988. (X2)
R5. Thomas, Warren D.; Dolphin Conferences, Elephant Midwives,..., Los Angeles, 1990. (X3)
R6. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X2)
R7. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1-X3, X6)
R8. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X4)



The male narwhal's tusk (actually a grotesquely elongated tooth) is probably mainly used for jousting with other males.

BMA35 Toothlessness in Mammals

Description. The existence of several groups of mammals without teeth or with functionless teeth. The great majority of these toothless mammals are filter-feeders (baleen whales) and termite consumers (anteaters), which have little need for rending and masticating prey. In some cases, normal mammalian teeth have been replaced with other devices to aid feeding.

Data Evaluation. All data used come from standard reference works. Rating: 1.

Anomaly Evaluation. Anomalies occur at two levels in the toothlessness phenomenon. First, biologists do not know the details of how the disuse of teeth is conveyed to the genome and translated into the loss of teeth and the transmission of this change to progeny. To maintain the evolutionary paradigm, it must be assumed that random mutations that lead to toothlessness are always occurring, but that natural selection permits these changes to manifest themselves only when they increase fitness or are neutral in this regard. This is tautological in the sense that it just states that toothlessness can be fitter than toothness or at least as good. This is equivalent to stating that survivors survive! It is merely a restatement of the basic observations of a natural phenomenon with out details of the mechanisms involved.

Second, in rare cases, tooth loss must be synchronized with the synthesis of new feeding mechanisms, such as baleen in whales. The loss of half a mouth full of teeth would probably be detrimental; the creation of a few plates of baleen would be useless in filtering out krill. It's another case of "perfection" or "what good is half a wing?" In fact, it is even more difficult to imagine the maintenance of whale fitness as teeth were gradually lost and baleen plates slowly erected.

Possible Explanations. Random mutations plus natural selection can explain any biological development. "Directed" or "purposeful" evolution can, too, but the process can be faster and occur in large saltations, but detailed mechanisms are unknown here, too!

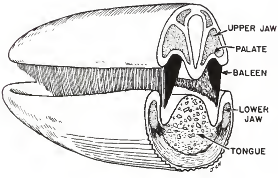
Similar and Related Phenomena. The evolution of the vertebrate eye (BHO1 in Humans II). See the Subject Indexes in the Series-B catalogs under: Perfection, Evolution, etc.

Entries

X0. Introduction. Throughout the phyla, it is common for physical characters to diminish or atrophy with disuse. Blind fish in caves and nearly sightless moles typify the phenomenon. Mammalian teeth also demostrate this tendency, shrinking when not employed in chewing, as with the tiny molars of the vampire bats (BMA30). The reduction in tooth size is carried to the extreme in the filter-feeders and termite-eaters, where food is swallowed without mastication, although some crushing may be involved. Here, teeth are: (1) missing completely; (2) present only in the embryo; or (3) present but not erupted.

X1. Filter-feeders. Flamingoes, spoonbills, and whale sharks are typical of those animals that strain tiny organisms from water. Among the mammals, the baleen whales are the best-known filter-feeders.

Baleen whales. Some of the largest whales are in this group: the huge blue whale, the humpback, the right whales, etc. These whales are toothless as adults, although teeth are found in the embryo, where they are ultimately absorbed. Instead of teeth, their mouths are filled with impressive arrays of baleen plates. Baleen is a substance much like that in human fingernails, but of course the plates in whales are much larger. The sieve-like rows of baleen strain krill and other organisms out of the water. The supression of normal mammalian teeth and the manufacture of baleen (thought to come from hair cells) poses problems for the evolutionists. The presence of teeth in the embryos of baleen whales suggests that they evolved from toothed ancestors. Once again, we must ask if random mutations plus natural selection can provide smooth, viable transitional forms between toothed ancestors and toothless, baleen-dependent whales. Just saying that baleen whales "evolved" is no longer sufficient. At least a few details of viable transitional genotypes and phenotypes are required as well as explanations of how environmental forces might instigate and control the transition.



Section through the jaw of a baleen whale.

Actually. some zoologists believe that the baleen and toothed whales are so radically different from one another that they must have had separate, fundamentally different origins. (R1)

X2. Termite-eaters. Termites (white ants) are favored by many mammals. So nutritious and ubiquitous are termites that three divergent, geographically separated orders of mammals subsist on them almost exclusively---and all of these animals have dispensed with teeth altogether.

Anteaters. Four species of anteaters live in Central and South America. Except in very rare instances, they have no teeth at all. (R2)

Pangolins or scaly anteaters. Occupying Asia and Africa, the seven species of pangolins possess no teeth. (R2)

Echidnas or spiny anteaters. Found in Australia and New Guinea, these monotremes (two species) have no teeth, although some grinding transpires between the back of the tongue and palate. (R2)

X3. Crushers.

Duck-billed platypuses. Young platypuses do display tiny teeth as well as replacement buds below some of them. Yet, in the adult, these are all discarded and replaced by horn-like plates in both jaws. Crustaceans and other prey are crushed between these plates. (R2)

As with the fetal teeth of baleen whales, the teeth of the young platypuses suggest they had toothed ancestors, but how and why were the teeth replaced by horny plates? See discussion in X1.

X4. Swallowers. Taxonomists class the beaked whales with the toothed whales, but the fact is that the 18 species of beaked whales are "functionally" toothless. Most male beaked whales show only two teeth, both in the tip of the lower jaw. In females, these teeth seldom erupt. Evidently, the males use their small armory for fighting, for many of them are heavily scarred. Occasionally, a few nonfunctional teeth will appear, but for all practical purposes the beaked whales are toothless. (R1, R2)

The diet of the beaked whales consists mainly of squid, octopus, fish, and crustaceans, which are apparently swallowed whole.

References

R1. Leatherwood, Stephen, and Reeves, Randall R,; Whales and Dolphins, San Francisco, 1983. (X1, X4)

R2. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X2-X4)

HORNS AND ANTLERS

BMA36 Questionable Utility of Some Horns and Antlers

Description. (1) The near uselessness of some horns for defense; (2) The infrequent application of horns for defense; and (3) The heavy energy investment in growing and carrying horns and antlers. It is recognized that some horns are useful to their owners.

Data Evaluation. Most data come from recognized mainstream works on mammals. Two authors expressing doubts about the utility of horns are outspoken critics of evolution (R1, R4). Rating: 2.

Anomaly Evaluation. Like the male peacock's tail, some but not all horns seem designed only for display and intimidating males of the same species. If females select fitter males when horns are employed in these ways, then the evolution of horns can be understood in a conventional evolutionary framework. But not all horns can claim such utility. The horns of giraffes, pronghorns, and rhinos---present on both males and females---do not seem to be used extensively in intraspecies or interspecies confrontations. These horns do not add much to the fitness of these species. In a few cases, then, evolution's urge to create horns may have been misdirected. But, there is no philosophical reason why evolution may not be a little off the mark occasionally. After all, giraffes, pronghorns, and rhinos have been around a long time without being elimnated by natural selection! Rating: 3.

Possible Explanations. Horns and antlers may contribute to a species' fitness in ways not yet understood.

Similar and Related Phenomena. Possible nonutility of tusks (BMA34).

Entries

X0. Introduction. Among the hoofed mammals, paired horns grow only on the even-toed animals (the artiodactyls). Horns of a sort also appear on the rhinos, which are odd-toed animals (perissodactyls), but the rhinos' horns are radically different from those of the deer, cattle, and other even-toed mammals. (See BMA38.)

Restricting the discussion to the even-toed horn-bearers, R. Wesson has remarked that the development of horns seems to have been something of an evolutionary imperative in this group:

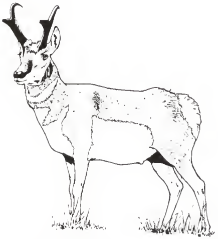
> A potential for paired horns seems to have developed in the ancestry of artiodactyls after separation from the perissodactyls. Only artiodactyls have paired horns, but their horns are made in several different ways and have evolved independently as many as seven times; something in the genome facilitates the formation of paired horns without specifying how they are to be made. (R4)

Indeed, the formulas for growing horns and antlers vary widely between deer, bovids, the pronghorn, giraffes, etc. When a major physical characteristic asserts itself so powerfully in such different ways, one would expect horns to confer considerable additional "fitness" to their bearers. But this may not always be the case.

The horns of the ibex are so unwieldy and curve back so far that they seem useless for defense against predators. Their main functions must be display and in bouts with other males. Quite a burden to carry for these purposes!

X1. Some horns badly designed for defense. An ostensible purpose of horns and antlers is self defense. Yet, among the deer, excepting the caribou, horns grow on the males only, leaving the females unprotected. Furthermore, many horns curve backward so far that their sharp points are directed away from any predator. Other horns are so long, so heavy, and/or so convoluted that they are difficult to use against agile predators. (R4, R5)

X2. Horns sometimes not used for defense. Horn-bearing mammals rarely use them to drive off predators. Mostly, it seems, horns and antlers are employed primarily by males to establish dominance within the species. Of course, muskoxen, with their outward-pointing horns can deter wolves; and bull fighters know that toro's horns can be lethal. On the other side, the giraffes' horns serve no defensive purpose---perhaps no purpose of any kind. Both male and female pronghorns have horns, but they run from danger rather than confronting it with their horns. (R2) And even the formidable horns of the rhinos are rarely used in defense or offense. Rather, rhinos apply their tusk-like



Since both male and female pronghorns sport horns, the horns seem useless in sexual displays. Rather than employ them for defense, pronghorns rely instead upon their speed. The purpose of the horns is not clear.

lower incisors to this task. (R3) See BMA38.

X3. Horns are costly in evolutionary terms. Horns, particularly the antlers of some of the deer family, are costly in terms of the energy required to regrow them each year and then carry them around for months. Quoting from G.R. Taylor's The Great Evolution Mystery (R1):

> Walter Modell, who made the study of antlers his special interest, says: 'The antler is a strange and uneconomic experiment, extremely costly to its possessors in many ways, and it seems destined eventually to disappear.' Which suggests that the real mystery is why antlers appeared at all, leave alone why they sometimes became so huge. (R1)

References

R1. Taylor, Gordon Rattray; The Great Evolution Mystery, New York, 1983. (X3)
R2. Miller, J.A.; "Antelope Horns: Female Perspective?" Science News, 124:183, 1983. (X2)
R3. Dunbar, Robin; Remarkable Animals, Enfield, 1987. (X2)
R4. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X0-X2)
R5. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMA37 Horns Correlated with Toes and Stomachs

Description. The restriction of paired horns to only those even-toed mammals with four-chambered stomachs. (Rhinos are odd-toed, but their horns are not paired and are structurally unrelated to those of the even-toed mammals, as elucidated in BMA38.)

Data Evaluation. The generalizations proffered below were made by a zoologist specializing in horns and antlers. Rating: 1.

Anomaly Evaluation. The claimed correlation, which can be proved by inspection of various mammal guides, implies that biological characteristics do not always develop independently. In other words, the genes controlling the development of horns in mammals also play roles in the evolution of toes and stomachs. Biologists have been aware of such links for decades, but there does seem to be a popular conception that characters are genetically independent. This error can be dispelled by mentioning the linkage between resistance to malaria and sickle-cell anemia. Although it is rather bizarre that horns, stomachs, and toes should be genetically linked, no anomaly exists at the level of generalization used here. Of course, geneticists have no knowledge yet as to the specific genes involved and how they link said characteristics. Rating: 3.

Possible Explanations. None required.

Similar and Related Phenomena. The survival of apparently deleterious characters in the face of natural selection forces is often explained by genetic linkage; that is, a fitness-reducing character may be genetically linked to a highly beneficial character and thus survive.

Entries

X0. Cross reference. In BMA36, the appearance of horns in the even-toed mammals (artiodactyls) was alluded to as an evolutionary "imperative." Here, we expand this notion to include the stomachs of this class of horn-bearers.

X1. General observations. It is curious, remarked W. Modell, that almost all even-toed ungulates with four-chambered stomachs (the true ruminants) possess horns, antlers, or at least knobs on their heads. On the other hand, those even-toed ungulates with three-chambered stomachs (the false ruminants: llamas, camels, etc.) do not have even suggestions of horns. Neither do the even-toed mammals with single-chambered stomachs (pigs, hippos, etc.). Modell then asked two questions:

> What connection can there be between horns or antlers and a perfect ruminant stomach and even-toed hoofs? By what odd quirk of evolution did these seemingly unrelated characteristics come to be associated with one another, if indeed the association is not mere coincidence? (R1)

Reference

R1. Modell, Walter; "Horns and Antlers," Scientific American, 220:114, April 1969. (X1)

BMA38 Horn and Antler Curiosities

Description. Curious, bizarre horns and horn-like structures on mammals.

Data Evaluation. All entries have been gleaned from reputable journals and zoological reference works. Rating: 1.

Anomaly Evaluation. No anomalies are claimed here. Rating: 4.

Possible Explanations. These phenomena can be compared to the terata; that is, biological errors and missteps, such as two-headed calves.

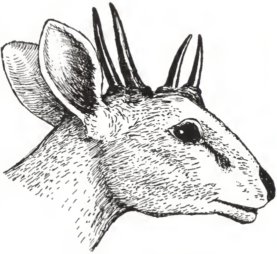
Similar and Related Phenomena. Oddities of mammalian eyes (BMA24); curious mammalian teeth (BMA30 and 31).

Entries

X0. Introduction. At the outset, one must recognize that horns and antlers, like most other mammalian features, are not always perfectly formed. Single-antlered deer are not especially rare. Even an occasional female deer will have antlers. (R2, R3) Horn deformities are also found among the bovids and other even-toed mammals. Now that these minor terata have been acknowledged, let us examine a few of the more curious horns.

X1. Four-horned artiodactyls. All even-toed mammals (artiodactyls) possess only one pair of horns, except for a single antelope species. Such rarity is worth notice here.

The four-horned antelope or chousingha. Unique among the bovids, the chousingha is found in India and Nepal. It is a small antelope, reaching only about 2 feet at the shoulders. The rear pair of horns are 3-4 inches long; the front pair are only an inch or so long. Not very intimidating, but biologically unique nevertheless. (R4)



The four-horned antelope.

X2. Horns on odd-toed mammals.

Rhinos. The rhinos' horns are not attached to the animals' skulls. Rather, they originate in the skin. They are solid enough, but not bony. Instead, they are composed of compressed keratin and possess a fibrous texture. (R4) They seem to be like hair glued solidly together.

As mentioned in BMA36, rhinos are not reported to use their horns in attack or defense.

Impressive though the rhino's horns may seem, they are not bone but rather hairs welded together.

X3. Five-horned artiodactyls.

Giraffes. Giraffes of both sexes display horns of a sort. Two horns are always prominent; frequently, two smaller ones occur in front of these. In some animals, a fifth protuberance appears roughly between the eyes. These giraffes are termed "five-horned." All five horns in these instances are formed in the same way---and giraffe horns are unlike those of any other mammal.

At birth, the horns are mere knobs of cartilage. These quickly ossify and thereafter grow throughout the animal's life. Initially, the bony cores of the horns are separate from the skull, but later fuse with it. The horns are covered with skin and hair, except at the tips, where the hair gets worn off. (R4)

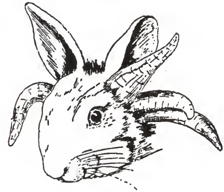
Besides the two prominent horns, this giraffe has a third protuberance between the eyes. Some giraffes may also have two additional horn-like structures.

* * *

X4. Horns on mammals without hooves.

Horn-like structures sometimes sprout in odd places on other mammals. These growths, presumably dermal in origin, are so bizarre that we mention two species so afflicted. Note that these growths are very rare and irregular, and one should not make too much of them.

Rabbits. Horned rabbits have been reported occasionally by hunters. One of these afflicted animals, shown in the sketch, was shot in Missouri in 1946. "The protuberances were soft and rubber-like and, when flexed, they returned slowly to their original position." (R1)



A "horned" rabbit shot in Missouri.

Humans. Human horns, also irregular and growing from almost any part of the body, but usually the face, are covered in some detail in BHA46 in Humans I. The most interesting facets of human horn-like structures are (1) A tendency to be inherited; (2) Women are afflicted more often than men; and (3) They are more frequent among some ethnic groups.

References

R1. Rowe, Kenneth C.; "Note of a 'Horned' Cottontail from Northwest Missouri," Journal of Mammalogy, 28:405, 1947. (X4)

R2. Robinette, W. Leslie, and Jones, Dale A.; "Antler Anomalies of Mule Deer," Journal of Mammalogy, 40:96, 1959. (X0)

R3. Ryel, Lawrence A.; "The Occurrence of Certain Anomalies in Michigan White-Tailed Deer," Journal of Mammalogy, 44:79, 1963. (X0)

R4. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1-X3)

EXTREMITIES

BMA39 Remarkable, Usually Paralleled, Innovations in Mammalian Extremities

Description. Features of mammalian hands, feet, and wings that depart substantially from the normal designs of these extremities in ways that reflect considerable biological innovation. Usually, such innovations are closely tailored to the unusual and highly specialized life styles of their possessors. Almost all of the innovations cataloged below are paralleled in other, often distantly related, mammals.

Data Evaluation. Data come from authoritative natural history guides and catalogs and books by eminent naturalists. Rating: 1.

Anomaly Evaluation. The potentially anomalous elements of the phenomena cataloged here are: (1) substantial biological innovation; and (2) the frequent replication of the innovation in distantly related mammals. The first element is primarily a judgment call, while the second can be determined objectively. It is also a matter of judgment as to whether one or both of these two elements is anomalous. Dedicated evolutionists will assert, with much logic, that random mutations plus natural selection can in principle account for the phenomenon very nicely. But, skepticism reigns in this catalog regarding the efficacy of evolution in explaining substantial biological innovation and parallel evolution. As is our custom, we catalog the phenomena that seem challenging to us but do not assign ratings of intuitively perceived anomalousness.

Possible Explanations. "Adaptive" or "purposeful" evolution may be at work rather than random mutation. This concept, which is just as vague and superficial as "conventional" evolution, would accelerate innovation and adaptation to unusual life styles and environmental niches. As usual, no details as to mechanism are offered.

Parallel evolution could also be explained by the radical theory of morphic resonance.

Similar and Related Phenomena. See the Subject Indexes in the Series-B catalogs under: Evolution, adaptive; Parallelisms.

Entries

X1. Rotatable hind feet.

Tree squirrels. Careful observers of tree squirrels will often see them hang downward from their hind feet and descend tree trunks headfirst. They can do this only because their rear feet can swivel 180° so that the claws face upward. This evolutionary innovation is obviously of great value to these highly arboreal creatures. (R6)

Margays. Rotatable hind feet have evolved twice---in the tree squirrels and in a member of the cat family that spends much time in the trees of Central and South America. The margay is, in fact, the only cat favored with rotatable, squirrel-like hind feet. J.F. Eisenberg described this striking feline adaptation in his Mammals of the Neotropics:

> The margay is adapted to an arboreal life. Unlike all other cats, it can pronate and supinate its hind foot; thus, when it descends from a tree the hind foot rotates around the ankle so that the animal can hang vertically, much like a squirrel. (R5)

In addition to being a remarkable example of adaptation to life in the tree tops, it is also a good case of parallel evolution in far-separated species.

X2. Reversed feet.

X2. Reversed feet. If rotatable hind feet are useful to mammals that make their living scrambling around in trees, it is reasonable to inquire about mammals that hang by their hind feet when at rest. Has evolution also favored them with rotated hind feet?

Bats. Bats are hangers extraordinaire---perfect candidates for reversed feet. We shouldn't be surprised when we discover that bats have evolved just the kind of feet they need:

> The hind feet of all bats, both mega and micro, point backwards, and they are the only mammals that display such a feature. Many microbats can run about on all fours like mice but their back feet still point backwards. (R2)

The above words were penned by I.T. Sanderson, and he doubtless meant that bats are the only mammals with permanently rotated hind feet. The hind feet of squirrels and margays are "rotatable."

X3. Extra digits. Humans, cats, and many other mammals occasionally sport extra digits. This characteristic often runs in families. Here, however, we refer to those extra digits that are found on all members of a species. Sometimes, they are there for some obvious fitness-improving application; often their purpose is obscure.

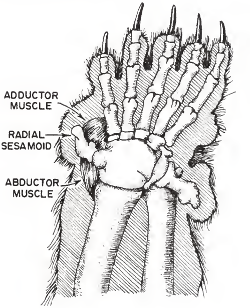
Greater pandas. Those zoo favorites, the greater pandas, are adept at stripping the leaves off the bamboo stalks that constitute almost 100% of their diet. The leaves are stripped when the panda draws the stalks between his fingers and what appears to be a dexterous, opposable thumb. This thumb, though, is not a true digit at all, as S.J. Gould points out:

> The panda's "thumb" is not, anatomically, a finger at all. It is constructed from a bone called the radial sesamoid, normally a small component of the wrist. In pandas, the radial

> sesamoid is greatly enlarged and elongated until it almost equals the metapoidal bones of the true digits in length. (R3)

The greater panda's sixth "digit" possesses a bone for strength and muscles to move it like a real finger. Gould, a staunch evolutionist, is quick to add that the bone and muscles are not new anatomical features but simply well-known parts of the mammalian hand that have been turned to a new purpose.

Finally, the tibial sesamoid bone in the greater panda's hind foot is also enlarged, but not as much as the corresponding radial sesamoid in the hand. The hind feet show no obvious extra digits. (R3) Whatever mutations and natural selection forces encouraged the development of the hand's extra digit also influenced the hind foot. It is reasonable, therefore, to inquire whether the radial and tibial sesamoids are genetically linked?



The extra "thumb" of the greater panda is really an elongated radial sesamoid bone.

Lesser or red pandas. Roving across much of the same territory as the bear-like greater panda is the raccoon-like lesser or red panda. The two pandas look somewhat alike, and they both like bamboo shoots. Nevertheless, most zoologists hold that they are not closely related at all and are, instead, prime examples of parallel evolution. (BMA1) The parallelisms extend to the extra digit on the hand---the lesser panda has one, too, and it is also a development of the radial sesamoid bone. (R11) For a bear and a raccoon to acquire an extra digit in the same way, for the same purpose, certainly puts pressure on that very vague notion of the biologists called "parallel evolution."

Moles. Something like the pandas' extra digit can also be seen on some moles. (R7) Our reference does not name those species so favored. Moles are insectivores that eschew bamboo shoots, so the purpose of their extra digit must be quite different from that of the pandas. Perhaps it improves the digging efficiency of the front paw.

Water opossums or yapoks. These water-loving marsupials of Central and South America favor fish and crustaceans, and one can surmise that wider hands with extra digits might enhance their hunting capabilities. Perhaps to this end, evolution has enlarged a bone in their forepaw to create a sixth digit. (R6)

* * *

X4. Ice claws. Some animals inhabiting the Arctic change their appearances with the seasons. Most common is the switch to white fur and feathers as winter approaches. The five known species of collared lemmings also turn white with the advent of snow---and they are the only rodents to do this. But, in addition, these particular lemmings improve their digging tools for winter use.

Collared lemmings.

> The third and fourth claws of their forefeet are unusually large and well adapted to digging. In summer these claws are about normal in appearance, but with the approach of winter they develop a peculiar double effect in a vertical plane, which makes them very strong and well suited for burrowing in the frozen earth or in the

snow and ice. (R8)

In the northern climes are many other closely related lemmings and voles. Why did they get short-changed in the matters of color changes and ice claws?

X5. Greatly lengthened digits. Primatologists report than chimps often poke twigs into holes in logs for the purpose of extracting resident grubs. At least two very distantly related groups of animals have developed special fingers that simulate the chimps' grub-extracting twigs. The first is the aye-aye, a primate like the chimps; but the second is the marsupial genus *Dactylopsila*, which encompasses four species of striped possums.

Aye-ayes. Madagascar harbors many strange mammals, such as the koala lemur, a primate that looks and behaves a lot like the marsupial koala. An even stranger Madagascar primate is the aye-aye, which, as we shall see below, also has a marsupial mirror image.

The aye-aye is a small primate (only about 5 pounds in weight) with huge naked ears and big eyes. All of the aye-aye's fingers are long and thin, but the third is especially long and spidery, terminating in a hook-like claw. The aye-aye first employs this peculiar finger to acoustically locate grubs in their tunnels by tapping logs and listening with their big ears. When a grub has been located, that long, thin third finger is inserted to hook and drag the grub out.

Madagascar aye-ayes have exceptionally long middle fingers and big ears. They are percussive foragers.

Aye-ayes also dote on the three-chambered ramy nuts. Often, only one of these chambers will be filled with meat. The aye-aye employs the same tapping strategy to locate the right chamber. It then gnaws it open and extracts the meat with that talented third finger. (R1, R8, R10)

It has recently been determined that the aye-aye's third finger can move independently of the other fingers and over a wide range of motion. (R10) Only humans, apes, and some monkeys can do this with their digits.

Striped possums. Like the mammals of Madagascar, the marsupials of Australia and New Guinea evolved in relative isolation. It is at least curious, then, to find that the four species of striped possums embracing the marsupial genus (Dactylopsila) all have an extra-long finger on each hand.

> This genus is characterized by large first incisor teeth and a slender, elongated fourth digit with a hooked nail on the forefoot. Both features are more pronounced in the subgenus Dactylonax and are shared by the aye aye (Daubentonia), a primate found on Madagascar. (R8)

Just as the aye-aye is an oddity among oddities on Madagascar, so are the striped possums a bit weird among the marsupials of Australia and New Guinea.

> Odd one out among the group is the striped possum, with its primary diet of insects and grubs. That elongated fourth finger makes it especially adept at probing cracks and hollows in rotting wood, and it is likely the striped possum, like the aye-aye, detects the hollow spaces tunnelled by wood-boring insects and their larvae by tapping with its feet along trunks and logs. (R4)

In the aye-aye and striped possums we find unusual, highly specialized physical attributes and hunting behavior duplicated closely in primates and marsupials now located an ocean apart.

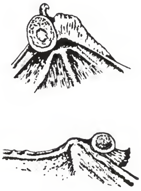
X6. Suckered feet. Above, in X2, we see how the feet of bats have rotated 180° to accommodate their habit of hanging headdown in caves, hollow trees, barns, etc. In the tropics especially, there are many other places for bats to attach themselves if only they could get a grip on smooth, damp surfaces---large leaves, for example. Evolution has risen to this challenge by creating suckers on the feet of some bats.

Sucker-footed bats. As happens so often in nature, sucker-footed bats have arisen twice; once in the New World, and again in the Old World, but only on that biologically creative island of Madagascar.

Sucker-footed bats have moist, fleshy, adhesive disks on their wrists and ankles that allow them to roost on unfurled leaves. To improve suction, the bats lick these disks. They can be seen adhering to smooth, damp leaves, but with their heads up not down like almost all other bats. (R6, R9)

Although they function in the same way, the suckers of the New World and Old World sucker-footed bats are quite different histologically and in anatomical details. They probably evolved independently. (R8)

Walker's Mammals of the World also catalogs a "disk-footed" bat living in Southeast Asia. Rather than suckers, this species has only footpads; but these help it cling to smooth surfaces.



Discs on the bottoms of the thumbs and feet of a New World sucker-footed bat.

X7. Stowable wings. New Zealand is famous for its flightless birds. These remote islands are also the only home of two species of bats that can fly but prefer to clamber around forest floors. Obviously, large, delicate wings are not made for such terrestrial activities. Evolution has provided these bats with a simple solution: stow the wings, get them out of the way. Two other species of bats in Southeast Asia also find that wings hamper their terrestrial operations; and they stow their wings, too.

New Zealand short-tailed bats. The two species are very agile on the ground. They can run nimbly and quickly climb sloped surfaces. Here is how they get their wings out of the way:

> Structurally, these bats are unique: the claws are needle sharp, and the wings are remarkably transformed. The thumb has a large claw with a small talon projecting from it, and the claws of the feet also have talons. The membrane is thick and leathery along the sides of the body, forearm, and lower leg. The wings can be rolled up beneath this leathery membrane when the bat is not flying. (R8)

The taxonomic status of the New Zealand short-tailed bats has been debated for years. Recent protein analyses show surprising affinities to New World bats. "Surprising" because of the huge geographical separation involved. One would expect the New Zealand bats to be related rather closely to those bats in Southeast Asia that also stow their wings; but, not so!

Naked or hairless bats. In fact, these two Asian species do possess a few hairs, but they certainly look hairless. Like the New Zealand short-tailed bats, the naked bats of Southeast Asia can move easily along the ground and inside the hollow trees and holes in the ground in which they roost. When not flying, these bats use their hind feet to push their wings into special pouches along the sides of their bodies. This done, they can move much more freely.

An interesting aside: the mammae of the females are located near the pouch openings, and it was formerly thought that they carried their young in the pouches and nursed them in flight. This application of the pouches is now generally discounted. (R8)

References

R1. Lydekker, R.; "A Remarkable Mammal," Knowledge, 24:269, 1901. (X5)
R2. Sanderson, Ivan T.; Investigating the Unexplained, Englewood Cliffs, 1972. (X2)
R3. Gould, Stephen Jay; The Panda's Thumb, New York, 1980. (X3)
R4. Vandenbeld, John; Nature of Australia, New York, 1988. (X5)
R5. Eisenberg, John F.; Mammals of the Neotropics, vol. 1, Chicago, 1989. (X1)
R6. Emmons, Louise H.; Neotropical Rainforest Mammals, Chicago, 1990. (X1, X3, X6)
R7. Gould, Stephen Jay; "Eight (or Fewer) Little Piggies," Natural History, 100:22, January 1991. (X3)
R8. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X4-X7)
R9. Fenton, M. Brock; Bats, New York, 1992. (X6)
R10. Cohn, Jeffrey P.; "Madagascar's Mysterious Aye-Ayes," BioScience, 43:668, 1993. (X5)
R11. Mebane, Alexander; Darwin's Creation Myth, Venice, 1994. (X4)

BMA40 Parallelisms in Mammalian Extremities

Description. The appearance of nearly identical modifications in mammalian extremities, often in distantly related animals. The modifications cataloged here lack the innovative character of those in BMA39, but they are so widespread that they deserve mention.

Data Evaluation. Most data were extracted from Walker's Mammals of the World, to which were added a few supplementary facts from books by recognized authorities. No claim is made that the lists below are complete. Rating: 1.

Anomaly Evaluation. The extremity modifications below are deemed good examples of widespread parallelism among the mammals, including the marsupials. Since the modifications are not as "remarkable" or "innovative" as those in BMA39,the likelihood of independent invention is more likely, as in the many cases of webbed toes. Also, some of the modifications occur among closely related species, such as the many flying squirrels. This makes inheritance from a common gliding ancestor a promising explanation for some of these particular parallelisms. These explanations may not account for all of the parallelisms between mammals and marsupials. We rate this phenomenon as moderately anomalous. Rating: 2.

Possible Explanations. See above. As always in discussing morphological parallelisms, morphic resonance might be involved, assuming it exists. To be complete, it should also be recorded occasionally that scientific creationists insist that all "kinds" of living creatures were created independently. Parallelisms are obviously "explained" in this way, but supernatural creation is rejected by most scientists.

Similar and Related Phenomena. See the subject indexes in the Series-B catalogs under: Parallel evolution.

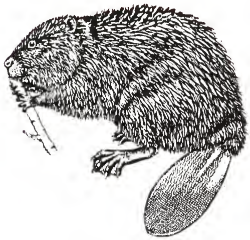
Entries

X1. Webbed feet. Webbed feet confer appreciable advantages on mammals in aquatic habitats. It comes as no surprise that this useful feature is widespread, even among distantly related mammals. But, how did so many mammals acquire this feature? When reviewing the (doubtless incomplete) spectrum of web-footed aquatic mammals presented below, consider whether: (1) They are all examples of independent invention; (2) They all are derived from a very primitive common ancestor; or (3) They are the product of pervasive parallel evolution.

- Marsupials (water possums or yapoks)
- Insectivores (web-footed tenecs, aquatic shrews, the Pyrenan desman)
- Rodents (the beaver, the nutria, many water rats and water mice)
- Carnivores (marine and fresh-water otters, the fishing cat) (R4)

Aquatic mammals without webbed feet. Evolution short-changed at least two highly aquatic mammals: the marsh mongoose and a South American water rat (Scapteromys tumidus). (R4)

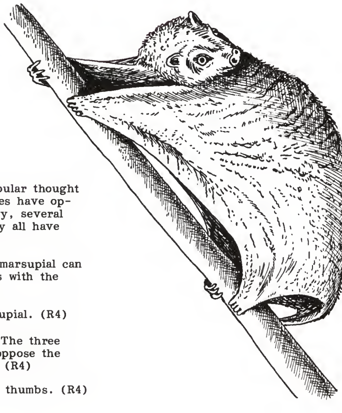
Terrestrial mammals with webbed feet. On the other hand, at least two mammals that do not now lead an aquatic existence do have webbed feet: South American bush dogs (R3) and elephants (R1) One is tempted to classify elephants as at least semiaquatic, given their love of water. They have been known to swim 48 kilometers at speeds up to 2.7 kilometers/hour. (R4)



Like many other aquatic mammals, the beaver has webbed feet. Its tail, though, is used for steering, not propulsion.

X3. Gliding membranes. In discussing the frequent close parallelism between the marsupials and placental mammals (BMA1), the strong similarity of the marsupial flying phalangers and mammalian flying squirrels served as one example. Of course, these animals do not fly, they just glide; but they all do possess large aerodynamically useful membranes stretching between front and back feet---an interesting parallelism to find so widespread among mammals.

- Marsupials (6 species of flying possums or phalangers)
- Dermoptera (2 species of colugos or flying lemurs---not true lemurs)
- Rodents (43 species of flying squirrels) (R4)



The colugo or gliding lemur parallels the flying squirrels and phalangers.

X2. Opposable thumbs. Popular thought has it that only the primates have opposable thumbs. In actuality, several other mammals do, and they all have aboreal habits.

Ring-tailed possums. This marsupial can oppose its first two fingers with the other three. (R2, R4)

Koalas. Ditto for this marsupial. (R4)

Large American opossums. The three species in this group can oppose the thumbs on their hind feet. (R4)

Malay tree rats. Opposable thumbs. (R4)

References

R1. Morgan, Elaine; *The Aquatic Ape*, New York, 1962. (X1)

R2. Vandenbeld, John; *Nature of Australia*, New York, 1988. (X2)

R3. Emmons, Louise H.; *Neotropical Rainforest Mammals*, Chicago, 1990. (X1)

R4. Nowak, Ronald M.; *Walker's Mammals of the World*, Baltimore, 1991. (X1-X3)

BMA41 The Existence of Functional Wings on Mammals

Description. The existence of wings capable of sustained flight in mammals. Wings and the consequent ability to fly are, like the vertebrate eye, so complex and innovative that they deserve separate consideration as regards their origin and evolution.

Data Evaluation. The primary references are an authoritative volume on bats plus a *BioScience* article of the origin of bat flight. The problem here is not in the soundness of the references or in demonstrating the reality of the phenomenon. Rather, the fossil record for bats is so scanty that evolutionary scenarios are at best highly speculative. So far, there is no fossil trail leading from a reasonable flightless ancestor to modern bats. Rating: 3.

Anomaly Evaluation. First of all, we do not know whether we need one evolutionary scenario or two, because the microbats and megabats (flying foxes) may not be closely related at all. Second, no evolutionary scenario of any kind can be constructed until some transitional fossils are uncovered. Even though it is conceivable that random mutation and natural selection can produce flying mammals once, even twice, we must view these superficial evolutionary scenarios with great suspicion. Two reasons: (1) The "half-a-wing" problem, or can viable reasonable transitional forms exist? and (2) The complexity problem, or can random mutation really create in a cordinated way all the skeletal, neurological, and other biological innovations required by an aerial, echo-ranging mammal?

Possible Explanations. See above.

Similar and Related Phenomena. Other important entries of this general type are deep-diving capability (BMT6) and the vertebrate eye (BHO1 in *Humans II*). also see the Series-B Subject Indexes under: Complexity, Half-a-wing problem, Perfection problem.

Entries

X1. General observations. Over 50 mammals have the ability to glide upon stretched body surfaces, but only the bats (some 900 species) are capable of sustained, powered flight.

Bats. All biologists presume that bats evolved from non-flying predecessors. So, somehow, some small, mouse-like quadruped developed greatly extended fingers with membranes between them and learned how to fly. Furthermore, a large suite of muscles, joints, feet, nerve fibers, and other structures had to develop in parallel with the wings so that a viable, flying mammal could make a living at all intermediate stages along the way.

A typical microbat showing how its fingers are connected by membranes. (Chiroptera = winged hand.) Given its outsized ears, this is probably a spotted bat.

Unfortunately, the fossil record is mute as to how and from what mammalian stock bats emerged. The earliest fossil bats appear about 60 million years back in the stratigraphic column, and these are virtually identical to modern bats, including all the refinements for agile aerial activities. Though ostensibly mouse-like, the fossil record does place bats closer to the shrews (insectivores) than the mice (rodents). Consequently, evolutionists picture bats evolving from small, nocturnal, forest-dwelling, insect-eating, shrew-like animals.

The bats' evolutionary scenario leading to wings and flight closely follows that proposed for birds, except that it is easier to imagine membranes appearing between fingers rather than feathers, which are a good deal more complex.

One idea, called the Insect Net Theory, proposes that bat wings began as webs of skin on the forepaws of that postulated shrew-like ancestor. This animal utilized this lucky change (due to random mutation) to catch insects. It prospered and escaped the scythe of natural selection. In fact, more random mutations lengthened the fingers and extended the membranes. Finally, a point was reached where crude flight was possible. The Insect Net Theory is not widely accepted today, for either bats or birds. It is said to lack mathematical support! (R1)

A second theory---more acceptable to mainstream zoologists---is called the Top Down Theory. M.B, Fenton reviewed this in his excellent book, Bats:

> The more popular Top Down Theory proposed that web-like membranes permitted proto-bats to glide. In this scenario, a proto-bat could scamper up the trunks and branches of trees searching for insect prey and from the top glide to the next tree and begin again. This theory makes economic sense because it means that the proto-bat would not have to climb down to the ground to move from one tree to the next.
>
> We presume that at some point the proto-bat began to take insects as it glided from one tree to another. The next stage would have involved flapping the gliding membranes, and evidence from mathematical models reveals that an ancestral bat could have generated lift during both the upstroke and the downstroke. (R1)

Anomalists will immediately recognize both theories as superficial stories lacking details and any accounting for the multitudinous simultaneous changes required to change a non-flying shrew-like mammal into a master of flight. Any acceptable theory has to identify all the synchronous changes in the phenotype and relate them to changes in the genotype and factor in, as well, the winnowing effects of natural selection.

The microbat-megabat question. For 200 years, biologists have been trying to decide whether the microbats are so closely related to the megabats (the flying foxes) that wings and flight need to have evolved only once. However, some biologists maintain that the two types of bats evolved from different ancestors, and this poses a problem for evolutionists.

> If that is true, then flight would have evolved twice in mammals, and this evolution would have led to surprisingly similar solutions to problems of wing formation. For instance, both megabats and microbats have elongate fingers with wing membranes stretched between them. The other groups of flying vertebrates, birds and pterosaurs, have evolved different ways to support their wings. Thus, if megabats and microbats evolved flight independently, then their evolution would be an important lesson of how similar selection pressures produce similar morphologies apparently because of historical constraints inherent to their common mammalian origin. (R2)

Favoring a single origin for the bats are their almost identical wing structures and musculature. On the other balance pan are different brain morphologies and eye-brain neurologies. This issue has not yet been decided and could go either way.

A megabat with clinging infant. Despite the resemblance to the microbats, the megabats may have had a different evolutionary origin.

References

R1. Fenton, M. Brock; Bats, New York, 1992. (X1)
R2. Thewissen, J.G.M., and Babcock, S.K.; "The Origin of Flight in Bats," BioScience, 42:340, 1992. (X1)

BMA42 Atavism in Mammalian Extremities

Description. The appearance in wild and domesticated mammals of features of the feet similar to those supposedly discarded long ago during the animal's evolution to the modern type.

Data Evaluation. Observations of this phenomenon in domesticated animals (horses) are well-established. Data on wild animals (whales) are still only cursory, although the sources employed are considered sound. Rating: 2.

Anomaly Evaluation. Our earlier, more general entry on atavism in mammals (BMA6), concentrated on domesticated animals, where reversions to the "wild type" are common in selectively bred animals. There, the anomaly concerned the implication of such atavism on speciation---something Darwinism demanded but breeding experiments could not accomplish. The present entry, however, involves reversions, not to recent "wild types," but rather to features that existed millions of years ago. Atavisms from this far back are not so challenging to evolutionary theory, for they can always be understood as the fluke expression of a long-suppressed gene. This "understanding" is only superficial like the many confident assertions heard in evolutionary pronouncements. Rating: 3.

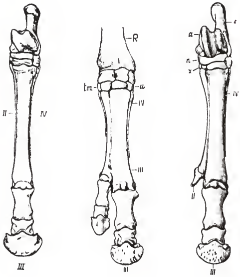
Possible Explanations. See above.

Similar and Related Phenomena. Atavism and reversion in mammals (BMA6).

Entries

X1. Extra toes.

Horses. O.C. Marsh, a renowned American naturalist of the 1800s, was intrigued by the occasional appearance of extra toes on domestic horses. His lengthy paper on the subject was published in an 1892 issue of the American Journal of Science. In fact, extra toes on normally single-toed horses are rather easy to account for with the concept of atavism; that is, throw-backs to earlier stages in the evolution of horses when they were all "polydactylic." The genomes of horses evidently retain the information necessary to reproduce vestiges of now discarded foot designs. (R1-R3) But why should they do this?



O.C. Marsh provided these sketches of polydactyl horses in his 1892 paper.

X2. Entire feet. Normally, whales seem footless from the outside. (R4) Internally, one may find skeletal vestiges of feet, especially the hind feet. (BMI) But, nothing shows externally except:

...every once in a while a modern whale is hauled in with a hind leg, complete with thigh and knee muscles, sticking out of its side. These atavistic hind limbs are nothing less than throw-backs to a totally pre-whale stage of their existence, some fifty million years old. (R5)

Such atavisms are used to demonstrate that whales evolved from terrestrial quadrupeds.

References

R1. Auld, R.C.; "Some Cases of Solid-Hoofed Hogs and Two-Toed Horses," American Naturalist, 23:447, 1889. (X1)

R2. Marsh, O.C.; "Recent Polydactyle Horses," American Journal of Science, 3:43:339, 1892. (X1)

R3. Gould, Stephen Jay; "Hen's Teeth and Horse's Toes," Natural History, 89:24, July 1980. (X1)

R4. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X2)

R5. Bakker, Robert T.; The Dinosaur Heresies, New York, 1986. (X2)

TAILS

BMA43 Parallelisms and Lack Thereof in Prehensile Tails

Description. The possession of prehensile tails by arboreal members of several orders of distantly related mammals. Equally interesting is the absence of prehensile tails on many highly arboreal mammals closely related to species that do have them.

Data Evaluation. All information used here came from Walker's Mammals of the World (R1). It is quite possible that some prehensile-tailed mammals were missed because this feature is not always mentioned. So, generalizations in this entry should be viewed with this in mind. Rating: 2.

Anomaly Evaluation. Prehensile tails demand special musculature. When this characteristic appears in distantly related mammals, parallel evolution is usually touted as a serious explanation. Since all prehensile-tailed mammals identified below are arboreal, one can easily maintain that a convergence of niche or environmental pressures fostered the parallel developments of this feature. Exactly how the same environmental pressures induce just the right sequences of "random" mutations in substantially different genomes is never specified. When one looks at all highly arboreal mammals, one finds many species lacking this useful evolutionary development. This is puzzling because some of these disadvantaged arboreal mammals are closely related to and have genomes similar to those of prehensile-tailed species. Rating: 1.

Possible Explanations. "Adaptive" evolution in which evolution is somehow accelerated in the direction of meeting urgent environmental requirements. Morphic resonance could apply here, too, but on a selective basis. Both of these ideas are just as superficial and fuzzy as some of the assertions of evolutionists!

Similar and Related Phenomena. Prehensile tails in non-mammals, such as sea horses (BFA) and reptiles (BRA).

Entries

X1. General observations. Tails, prehensile tails in particular, intrigue humans, perhaps because of deeply buried ancestral memories! Many of the other primates do possess these most useful appendages, as a visit to the zoo will confirm. But, humans, the great apes, and many monkeys have lost or never had prehensile tails. Since prehensile tails require unique muscle engineering, it seems worthwhile to survey all mammals to see which species have been blessed with prehensile tails by evolution and which species, for some reason, were bypassed.

Primates. Many arboreal monkeys, as exemplified by the spider monkeys, boast prehensile tails. But many other tree-loving primates, such as the orang-utan, lemurs, macaques, etc., do not. (R1)

Rodents. Rummler's mosaic-tailed rats (4 species in New Guinea) have prehensile tails. Some other mosaic-tailed rats have weakly prehensile tails. None of the tree rats---apparently---has a prehensile tail. (R1)

New World anteaters (Xenarthra). Prehensile tails are found on the silky and lesser anteaters, both arboreal. The terrestrial greater anteater does not. (R1)

Old World or scaly anteaters (Pholidota). Those scaly anteaters (pangolins) that are arboreal do have prehensile tails; the nonarboreal species do not. These anteaters are only distantly related to those of the New World, yet the same arboreal/terrestrial split applies an ocean away. The "other" sort of anteater, the spiny anteater or echidna is a terrestrial monotreme and does not have a prehensile tail. (R1)

The arboreal silky anteater possesses a prehensile tail, whereas the terrestrial giant anteater does not.

Carnivores. The only prehensile-tailed carnivores noted so far are the kinkajou (Central and South America) and the bintourong (Southeast Asia). Both are arboreal. (R1)

Other mammalian orders. Squirrels, tree shrews, sloths, and other arboreal mammals all lack those useful prehensile tails.

Reference

R1. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMA44 Break-Off Tails

Description. The possession by a few mammals---all rodents---of tails that break off easily and then partially regenerate. The object, of course, is to delude predators and give the animal a chance to escape.

Data Evaluation. All data are from Walker's Mammals of the World, a highly reliable source. Rating: 1.

Anomaly Evaluation. Since all of the mammals favored by evolution with break-off tails are rodents, the phenomenon can be explained as inheritance from a common ancestor rather than parallel evolution. But why should other rodents, equally at risk and having the same common ancestor, have ordinary undetachable tails? To be sure, this is but a minor puzzle. Of greater consequence is the appearance of the identical phenomenon in lizards. Do we have independent invention of break-off tails or parallel evolution across a very wide taxonomic chasm (reptiles to mammals)? Independent invention seems more likely given the relative simplicity of the characteristic. Still, a lot of random mutations, working on different mammalian and reptilian genomes, had to take place to duplicate fragile vertebrae and and regeneration processes. Just saying "independent invention" passes over all the biological details. Rating: 2.

Possible Explanations. Independent innovation in mammals and reptiles and, within rodents, inheritance from a common ancestor.

Similar and Related Phenomena. Break-off tails in reptiles (BRA).

Entries

X1. General observations. Predators thinking that they have caught a lizard for supper often find they are clutching only a still-thrashing tail. Their main course has disappeared, and the animal will regenerate another tail in due course. This escape strategy---the break-off tail---is usually mentioned only in connection with lizards, but many rodents can perform the same trick, although regeneration of the tail may not be so perfect.

The tails of the members of some families break off readily when the animals are caught by the tail, enabling them to escape. A partial replacement of the lost portion of the tail then grows. The skin of the tail may also break readily and slip off beyond the break, leaving the flesh and bone exposed. The animal later amputates the exposed portion of the tail with its teeth, and the end heals. (R1)

Rodents. A partial listing of rodent families possessing break-off tails follows:

- Deer mice
- Rock rats
- Spiny mice
- Spiny rats
- The Dassie rat

There exist about a thousand species of rodents, and only a tiny minority loses their tails so readily.

Reference

R1. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMA45 Propulsive Tails

Description. The presence on some aquatic mammals of: (1) Normal mammalian tails modified to improve propulsive thrust in water using lateral flexion; or (2) Fish-like tails to improve thrust using vertical flexion. The latter tails represent a major innovation in mammals in terms of structure and operation.

Data Evaluation. The basic descriptive data are taken from two impeccable zoological source books (R2, R3). Rating: 1.

Anomaly Evaluation. Minor modifications of mammalian tails for propulsive purposes seem amenable to conventional Darwinian explanations. An anomalist, however, cannot be so sanguine when confronted by the tails of the cetacea (whales and dolphins) and the sirenia (manatees and dugongs). He or she will see immediately three characteristics of these tails that put pressure upon mainstream evolutionary ideas:

(1) Innovation. No physiological structures in the mammalian line resemble the whale-type tails. Many separate inventions and changes had to occur to the (supposed) terrestrial predecessors of the cetacea and sirenia. Among these were: efficient hydrodynamic design, the development of new tissues and muscles, adaptation of the nervous system to a new mode of propulsion, and the development of new control centers in the brain. Is random mutation capable of producing so much synchronous innovation?

(2) Complexity. Added to the above biological innovations were more mundane infrastructures: skin, blood vessels, etc. These all had to coevolve with the in-

novations in a coordinated way so that the animal's survival was not compromised. Can random mutation and natural selection accomplish such a complex task?

(3) Parallelisms. These may have occured at one of more of three taxonomic levels: Class, fish/mammal; Order, cetacean/sirenian; Suborder, toothed whales/ baleen whales. Obviously, these areas of potential parallelism are listed in order of perceived decreasing evolutionary distance. Scientists do not know at what taxonomic levels independent invention and/or parallel evolution occurred.

We have not included here the familiar "half-a-wing" complaint of the anti-evolutionists because "half a tail" would seem to be useful whereas "half-a-wing" would be of doubtful utility.

Throughout this Catalog, the theoretical ability of random mutation, as modulated by natural selection, to accomplish all evolutionary feats, such as the creation of whales' tails is admitted. We intend to imply that this standard explanation is superficial and intuitively does not seem sufficient.

Possible Explanations. Morphic resonance, or "directed" evolution," or some similar, but still unrecognized, natural principles.

Similar and Related Phenomena. Cetacean dorsal fins (BMA46). See Subject Indexes under: Parallelisms; Complexity; Innovation; Evolution, adaptive.

Entries

X0. Introduction. In general, mammals leading aquatic lives use their feet for propulsion, but a few have added refinements and, in some marine mammals, entirely new propulsive organs. The full spectrum of modifications includes; (1) The presence of dense hair on the toes to generate more propulsive force (as in many aquatic rodents); (2) The addition of webbing between the toes (beavers, etc.); (3) The flattening of the feet and addition of tissue extensions to create flippers (seals and sea lions); (4) The modification of existing tails for propulsion (some rodents and insectivores); and (5) The evolution of fish-like tails on the bodies (whales, dolphins, manatees, etc.). In this entry, we are concerned only with the last two on the list. Of these, the last, the invention of a fish-like propulsive tail in mammals---a whole new organ in a sense---provides special problems for evolutionary theory.

First, though, for completeness, we look at those mammals that use ordinary mammalian tails, with minor modifications, for aquatic propulsion.

* * *

X1. Normal mammalian tails modified for propulsion. The beaver's large, flattened tail immediately comes to mind in association with this title, but beavers use their webbed hind feet for propulsion. The tail is mainly for steering while swimming. Other rodents, however, have vertically flattened tails which, when moved from side to side, fish-like, generate forward thrust in the water.

Neotropical water rats. This South American rodent's tail is made into a propulsive unit by long, shiny guard hairs on its underside. Moved laterally, it supplements the webbed hind feet. (R2)

Giant African water shrews.

> The body is cylindrical, and the thick, powerful tail is strongly compressed laterally. The short, rather weak limbs have five nonwebbed digits. A longitudinal flange of skin is present along the inner border of the hind foot, so that it may be pressed smoothly against the body and tail in swimming. The tail seems to be the only means of propulsion in the water. (R3)

* * *

X2. Whale-type tails. All of the cetacea (dolphins, whales) and sirenia (manatees and dugongs) have propulsive tails that, excluding the manatees', look remarkably fish-like, except that they are flexed up and down rather than from side to side. (Manatee tails are paddle-like and not forked.) Repeating for emphasis: Whale-type tails represent a major innovation in the evolution of mammals.

Cetacea. During their evolution, the cetacea had to reconfigure much of the land-mammal body they (supposedly) began with. Their nostrils were moved to the tops of their heads; their entire respiration system was revamped for deep diving; echo-location equipment was installed; they had to learn to give birth and suckle their young underwater; and; of course, make an efficient tail for swimming. This latter innovation required the cetacea to largely dispense with their hind feet and pelvis and then generate skin, flesh, connective tissue, muscles, nerves, etc. and shape them into something that would propel them through the water fast enough to make a living in the ocean.

Antievolutionists habitually home in on this broad spectrum of major biological changes in the cetacea and deny the possibility that random mutation and natural selection are capable of orchestrating so many coordinated modifications. Consider, for example, the objections of F. Hitching:

> One of the principal problems for Darwinians in whale evolution is constructing a pattern of events for the whale's tail to emerge in small, naturally selected steps. The point is that the tail moves up and down, whereas in a land mammal it moves from side to side. This may sound like a relatively small difference, but anatomically it is not. It means that somehow the whale's ancestor had to get rid of its pelvis.

Hitching goes on to explain the anatomical reasons why the pelvis had to be discarded.

> So for the up-down action in whales to emerge, there simultaneously had to be random genetic changes that diminished the pelvis while allowing the tail to grow larger. (R1)

He concluded that the odds of all these required changes happening together were "stupefyingly long."

Of course, the same sort of objections can be applied to the evolution of the cetacean's echo-ranging, their pressurized nipples for suckling their young, those huge mouths filled with baleen rather than teeth, and so on.

The whale evolutionary scenario is further complicated by the great biological differences between the baleen and toothed whales. Many orders of mammals are separated by lesser differences. Some biologists think that these two groups of whales had different origins. Yet, the tails are pretty much the same! As for which animal or animals were the immediate dry-land ancestors of whales, there seems to be no consensus.

Sirenia. The dugong tail is flat, horizontal, and forked like that the most cetacea, but the manatee tail is paddle-like or spatulate. Both flex up and down. None of the sirenia has any hint of vestigial skeletal hind feet, and their pelvises are reduced to two bones suspended in muscle. Beyond these differences, the comments about the evolution of cetacean tails also apply to sirenian tails. (R3)

Manatee tails are spatulate unlike those of the dugong, which are whale-like.

Taxonomists believe that the sirenia are closely related to modern elephants and hydraxes. Any evolutionary link to the cetacea is a very long one. The clear implication here is that the tails of the cetacea and sirenia, though very much alike, had independent origins as, perhaps, did the tails of the baleen and toothed whales.

References

R1. Hitching, Francis; The Neck of the Giraffe, New York, 1982. (X2)
R2. Eisenberg, John F.; Mammals of the Neotropics, vol. 1, Chicago, 1989. (X1)
R3. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1-X3)

OTHER EXTERNAL FEATURES

BMA46 Mammalian Dorsal Fins

Description. The presence of dorsal fins on some marine mammals, particularly the cetacea.

Data Evaluation. Two respected catalogs of cetaceans (whales and dolphins) were consulted. It is quite possible that some finless cetaceans were missed in our cursory survey. Rating: 1.

Anomaly Evaluation. Although the cetacean dorsal fins are not as complex and impressive as the cetacean tails (BMA45), they are still innovative among the mammals---a physiological feature made out of whole cloth, so to speak, because none of the cetaceans' terrestrial mammalian forebears ever had a pressing need for a dorsal fin and never even developed the rudiments of one. Besides the innovative aspect, whale and dolphin dorsal fins parallel closely those of the very distantly related fishes. If parallel evolution is involved here, the taxonomic gap is very large. Finally, although evolutionists can argue that the requirements of marine life should force the evolution of dorsal fins in the cetacea, some whales and dolphins never responded to such environmental pressures and now compete very well without a trace of them; their flippers can control rolling motion adequately.

So, we can ask the perennial question about whether the cetacean dorsal fins are independent inventions or the results of parallel evolution. More puzzling here is why dorsal fins evolved at all in mammals, since they seem of only secondary importance to survival. Why bother? Rating: 2.

Possible Explanations. See above discussion.

Similar and Related Phenomena. Cetacean and sirenian tails (BMA45).

Entries

X1. General observations. Aquatic animals usually possess fins and/or flippers to control rolling motion. Most but not all fish have prominent dorsal fins in addition to pectoral and various others types of fins. Aquatic mammals can control rolling with the flippers they derived from their forelimbs, but most aquatic mammals (seals, muskrats, water rats, etc.) have no dorsal fins. In fact, there is no structure along the mammalian backbone that could serve as the nucleus of a dorsal fin. Nevertheless, most of the cetacea (whales and dolphins) do have dorsal fins, and some of them are very, very prominent, as in the killer whales. The sirenia (manatees and dugongs), however, do not have dorsal fins, although they did evolve whale-like tails. Let us look now more closely at this rather spotty distribution of dorsal fins among aquatic mammals and whether they are really useful enough to have evolved.

Cetacea. S. Leatherwood and R.R. Reeves generalize as follows:

> In most species some sort of irregularity---usually a fin, but sometimes a hump or ridge---is present along the midline of the back. It could act as a kind of keel, or perhaps it is more important as a medium for heat exchange. However, species that lack a dorsal fin appear equally suited to their roles. Bowhead whales make their way among the heavy ice floes of the Arctic, and right whale dolphins race across vast oceanic expanses in temperate latitudes, both apparently finding no need whatsoever for a dorsal fin. (R1)

In addition to the bowhead whale, the right whales have no dorsal fins either. Note that right whales and right whale dolphins are quite different species; the latter evidently deriving its name from the former---both being dorsal-finless. (The old story is that right whales are "right" because the old whalers considered them prime sources of whale oil.)

One more cetacean sans dorsal fin is the finless dolphin, a resident of Indo-Pacific waters. This is the smallest cetacean, averaging only 1.6 meters in length. It resembles the beluga or white whale, which does have a ridge along the back but no prominent dorsal fin. (R1, R2)

Other marine mammals. As already mentioned, the sirenia have no dorsal fins, nor do the seals, sea lions, and sea otters. The freshwater beaver, muskrat, and other aquatic rodents do not either.

References

R1. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X1)

R2. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMA47 The Remarkably Long Neck of the Giraffe

Description. The remarkably long neck of the giraffe. In fact, this animal's neck is so long that many major biological modifications had to accompany its lengthening.

Data Evaluation. The giraffe's dimensions and general morphology were extracted from Walker's Mammals of the World, where only a single species is recognized. Doubts about the ability of modern evolutionary theory to explain the giraffe's long neck came from scientific journals and two books by critics of evolution. Rating: 2.

Anomaly Evaluation. Several mammalian browsers have developed particularly long necks that help them reach high foliage; viz., the dibatags and gerenuks. But, the giraffe's neck is so long that major body modifications were required during the (supposed) evolution from short-necked, okapi-like mammals. The complexity of these changes is assessed in X1, below. So extensive are these changes that they put pressure on the accepted evolutionary mechanisms of random mutation and natural selection.

Possible Explanations. "Adaptive" or "purposeful" evolution, a controversial theory for which no details on mechanism are available.

Similar and Related Phenomena. See Series-B Subject Indexes under: Complexity; Perfection problem.

Entries

X0. Background. The giraffe is the tallest living terrestrial mammal. Males average 5.3 meters or just over 16 feet in height; females are 2-3 feet shorter. As zoo goers well know, almost half of the giraffe's towering stature is due to its long neck; and therein resides an evolutionary problem.

Giraffes are generally thought to have evolved from a short-necked creature looking something like today's okapi. The evolutionary problem is getting from a short neck to a long neck in a biologically acceptable way. Unfortunately, the fossil record is silent about intermediate forms of proto-giraffes; there are no fossils of medium-necked giraffe-like animals. (R3, R5)

Most of today's evolutionists fervently hold that paleontologists will eventually dig up fossils supporting the idea that the giraffe's neck lengthened in small, discrete steps. The story is appealing and oft-repeated. A giraffe with a little longer neck---the result of random mutations---would be able to reach higher foliage and be "fitter" than herbivores with short necks. Of course, Nature would "select" the long-necked mutants over those not so favored. Step by step, giraffes with ever-longer necks would dominate the giraffe population.

But, in 1963, A. Brownlee questioned the logic of this scenario:

> Doubts on the extent of the survival value conferred by ability to reach high twigs arise when it is considered, as Graham Cannon pointed out, that the male giraffe is some 2 ft. taller than the female and thus by natural selection the females would tend, disastrously, to be eliminated in times of drought; Himmelfarb similarly objects that the young would tend to be eliminated likewise. (R1)

The punctuated-equilibrium evolutionists speculate that long-necked giraffes could have evolved from short-necked proto-giraffes in a single quantum jump. But no one knows how this might have been consumated biologically, with synchronous genome changes modifying the skeleton, muscles, nervous system, circulatory system, etc.

Taking another tack, B. Charlesworth wrote in 1984 that the giraffe, as a species, might possess enough inherent variability in neck length for environmental pressures to stretch the neck to its present size without mutations! Droughts or some other natural force would purge the species of short-necked animals, leaving only the long-necked giraffes we see today. There would be no evolution of new species, as in the Darwinian scenario, just a population shift, as occurs with the famous peppered moths or all those drug-resistant bacteria.

But Darwinian evolution, punctuated evolution, and intra-species variation gloss over the many coordinated changes and outright innovations inherent in the lengthening of the giraffe's neck, as delineated below.

X1. Giraffe-neck complexity. If we are forced to accept a short-neck ancestor for today's giraffe, any mechanism of change collides head-on with the complexity problem, just as in the case of the whale's tail (BMA45). R. Wesson has outlined this problem very succinctly in his book Beyond Natural Selection:

> The protogiraffe had not only to lengthen neck vertebrae (fixed at seven in mammals) but to make many concurrent modifications: the head, difficult to sustain atop the long neck, became relatively smaller; the circulatory system had to develop pressure to send blood higher; valves were needed to prevent overpressure when the animal lowered its head to drink; big lungs were necessary to compensate for breathing through a tube 10 feet long; many muscles, tendons, and bones had to be modified harmoniously; the forelegs were lengthened with corresponding restructuring of the frame; and many reflexes had to be reshaped. All these things had to be accomplished in step, and they must have been done rapidly because no record has been found of most of the transition. That it could all have come about by synchronized random mutations strains the definition of random. (R5

Similar complaints have been voiced by A. Brownlee (R1) and A.T.J. Hayward (R2). And in such critiques one discerns the real anomaly of the neck of the giraffe.

References

R1. Brownlee, A.; "Evolution of the Giraffe," Nature, 200:1022, 1963. (X0, X1)

R2. Hayward, A.T.J.; "Unanswered Questions," Nature, 243:367, 1973. (X1)

R3. Hitching, Francis; The Neck of the Giraffe, New Haven, 1982. (X0)

R4. Charlesworth, Brian; "Evolution and the Giraffe's Neck," New Scientist, p. 59, October 18, 1984. (X0)

R5. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X0, X1)

BMA48 Curious Affinities in the Arrangements of Genitals

Description. Nonstandard arrangements and/or locations of male genitals in mammals: (1) penis attached to cloaca; (2) scrotum in front of penis; and (3) enclosed testes.

Data Evaluation. All data extracted from standard scientific works on mammals. Lists are probably incomplete. Rating: 2.

Anomaly Evaluation. In the motley collection of data presented below, three generalizations stand out: (1) The conventional assertion that the monotremes are the most primitive of the mammals is underscored; (2) Highly aquatic and burrowing animals usually have protected genitals---a situation amenable to conventional evolutionary explanation; and (3) The remarkable parallelism between the marsupial and placental moles is strengthened. Only the last of these can be considered anomalous. Rating: 2.

Possible Explanations. See BMA1 for possible explanations of parallelisms between marsupials and placental mammals.

Similar and Related Phenomena. Affinities between aquatic mammals (BMA14); affinities between marsupials and placental mammals (BMA1)

Entries

X1. Penis attached to the cloaca. In the monotremes (platypus, echidnas), the penis is attached to the wall of the cloaca (the common orifice for excretion and copulation). (R2) This arrangement is essentially identical to that found in modern turtles, crocodilians, and birds. This unexpected affinity supports the contention that the monotremes are the most primitive of the mammals; that is, they are closest to the "lower" animals on evolution's Tree of Life. Be this as it may, some "advanced" mammals, such as the beaver, still retain the primitive cloaca, although the penis is not attached to it.

X2. Scrotum in front of the penis. In most mammals, the reverse arrangement prevails.

Marsupials. All male marsupials have their scrotums located in front or above their penises, except the marsupial mole, which has no scrotum. (R2).

Rabbits, hares, and pikas. These mammals, all in the Order Lagomorpha, have the normal mammalian arrangement of the penis and scrotum reversed, just like most of the marsupials. They are the only placental mammals with this arrangement. (R2) The evolutionary significance of this strange affinity, if any, is unclear.

X3. Internal testes. It is understandable that nature would streamline marine mammals for speed by locating their testes internally beneath the skin. The same is true for burrowing mammals, like the shrews and moles, where a scrotum would interfere with digging. But, we would not bother cataloging this phenomenon unless there were some interesting exceptions and affinities.

Whales and dolphins. In all of the cetacea, the genitals are enclosed. (R1) No problem here or in the next group of mammals.

Manatees and dugongs. The same is true will all the sirenia. (R2)

Seals. The testes are internal in the true seals (the Phocidae), such as the ringed seal; but in the fur seals and sea lions (the Otariidae) they are external, as in most mammals. Note that the fur seals and sea lions are markedly less aquatic that the true seals. (R3) There is definitely a strong correlation between aquatic habits and the lack of scrotums.

Elephants. The male genitals are enclosed. (R2) In this, recall that elephants are not only water-lovers but possess other characteristics of marine mammals, such as near hairlessness. (BMA14)

Water possum or yapok. This South American aquatic marsupial does possess a scrotum, but when it takes to the water the scrotum is pulled into a well-developed pouch. The yapok is the only marsupial where both sexes have pouches. (See BMA49.) (R4)

Moles, shrew moles, and desmans. These burrowing insectivores have no scrotums. (R2)

Marsupial mole. Like the placental moles, this marsupial has no scrotum. Its testes are located between the skin and abdominal wall. (R2) This affinity heightens the astounding parallelism between the marsupial and placental moles. (BMA1)

References

R1. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X3)
R2. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1-X3)
R3. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X3)
R4. Redford, Kent H., and Eisenberg, John F.; Mammals of the Neotropics, vol. 2, Chicago, 1992. (X3)

BMA49 Unusual Pouches on Mammals

Description. Mammalian pouches posessing characteristics for which it is difficult to imagine internediate stages of evolution. Added to these pouches that appear to be anomalous are others that must be labelled as merely "curious" or even "bizarre."

Data Evaluation. A wide spectrum of articles from science journals and reference works. With one exception (R7), these sources are accepted mainstream publications. Rating: 1.

Anomaly Evaluation. Nature is continually surprising us with "bizarre" and "marvelous" adaptations. But these properties depend upon human perception and do not challenge any scientific paradigms in this Catalog entry. Most of the unusual pouches described below, therefore, must be labelled as merely "curious" and not anomalous. Those pouches than can be designated anomalous occur where it is hard to conceive of those small, intermediate steps of development (required by Darwinian theory) that ultimately lead to the functional pouch. Again, this is a "problem of perfection" where deviation from the extant pouch design results in an unworkable design with little or no survival value. The anomalous pouches cataloged here are the female yapok's watertight pouch (X1) and the external, evertable cheek pouches of some rodents (X2). Rating: 2.

Possible Explanations. Evolutionists are adept at inventing reasonable scenarios for the development of "perfect" biological devices, and pouches are so simple in design that they may well have Darwinian explanations. Punctuated equilibrium may have prevailed in pouch evolution, but the mechanisms of large saltations are obscure.

Similar and Related Phenomena. See Series-B Subject Indexes under: Perfection.

Entries

X0. Introduction. Mammalian pouches have three principal applications: (1) carrying young; (2) carrying food; and (3) stowing extremities. Our presentation will follow in the same order.

Most pouches are not considered anomalous, but several do pose some interesting problems in terms of their evolution.

X1. Pouches for carrying young. The marsupials are the only mammals that transport their young in pouches, and not all of them do that. Many of the smaller marsupials are pouchless and do very well without them. Other marsupials, as well as the monotreme echidnas, sport pouches only during the breeding season. (R3, R10) In fact, the pouch situation is complex enough to warrant a quotation from Walker's Mammals of the World:

> The best developed pouches are found in marsupials that climb (phalangers), hop (kangaroos), dig (bandicoots and wombats), or swim (the yapok), but some small, terrestrial marsupials have no pouch. In certain didelphids and dasyurids, among others, the pouch consists merely of folds of skin around the mammae, which help to protect the attached young. Many marsupials develop pouches only during the reproductive season. When well developed, a pouch may open either to the front or the rear, depending on genus. (R10)

It is now obvious that one cannot accurately define marsupials as "pouched mammals." Unfortunately, the popular concept of a marsupial comes from watching kangaroos on TV or in the zoo.

The great variety of marsupial pouches or the lack thereof is not anomalous, but there are two marsupials whose pouches catch the anomalist's eye.

Koalas. We can understand how the forces of natural selection would not favor a forward-opening pouch on burrowers, such as the wombat, but the koala is eminently arboreal. A.A. Snelling, an Australian creationist, has written about the potential gravity problem faced by young koalas.

> Of particular interest is the fact that the female koala's pouch opens backwards, that is, toward the rear. This unusual feature is shared only with wombats, bandicoots and thylacines (Tasmanian tigers). On the other hand, kangaroos and possums all have pouches which open forwards (or upwards). Such features in animals are generally closely related to their habits. But in the case of the koala and the wombat, the habits are totally different. It is obvious that the rearward-facing pouch of the

Koalas are great climbers, but their pouches open downward---a bad move by evolution?

> wombat was designed to overcome the problem of the pouch's becoming filled with earth when the animal is burrowing. It is not so easy to appreciate the value of such an upside-down pouch to a tree-climbing animal like the koala. All the possums that share the koala's arboreal habits have a deep forward-facing pouch, which forms a safe repository for the young while the mother is climbing. The evolutionist who looks for common ancestry relationships finds this baffling. (R7)

The incongruity of the koala's pouch strengthens Snelling's creationist view that koalas (and all other "kinds" of life) were created as is. An evolutionist is not as embarrassed as Snelling suggests, for he or she believes that many other biological characteristics firmly tie koalas to the marsupial branch of evolution. Since koalas are survivors of millions of years, despite the upside-down pouch, the pouch is obviously sufficient for the young koalas. (We have recorded no instances of them falling out of their mother's pouch!)

The extinct thylacine, mentioned in the foregoing quote, was not a burrower, but one can suppose that having the pouch opening in the rear protected the young thylacine from damage from undergrowth as its mother chased after prey. (R5)

Yapoks or water possums. The yapok is an aquatic South American marsupial. Both male and female have well-developed pouches. (See the male's application in X3.) The female utilizes her pouch in the usual marsupial way, but when she swims a powerful sphincter muscle seals the pouch opening so tightly that no water can enter and drown any inhabitant. (R6, R11) A logical question is: Won't the baby yapok suffocate? The answer (rather glibly) given is that the young yapok can tolerate low oxygen levels for several minutes. (R10)

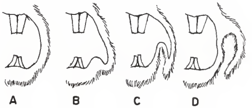
The female yapok's pouch once again highlights the "perfection problem" in biological evolution. What good is half a pouch? Or, in this instance: What good is half a sphincter muscle? The pouch must seal well or the baby yapok perishes. Pouch evolution via small steps seems improbable here. Also, the baby yapok's tolerance for low oxygen levels would have to be coordinated with the evolution of the pouch.

The only aquatic marsupial, the female yapok has a watertight pouch for its young.

* * *

X2. Pouches for storing food. It is a matter of common observation that many rodents, such as chipmunks, temporarily store food in their cheeks. The development of internal cheek pouches by small steps can be understood in Darwinian terms, but not all mammalian food-storage pouches are internal.

Pocket gophers, pocket mice, kangaroo rats, kangaroo mice. Rather than storing food like chipmunks, these rodents have developed fur-lined cheek pouches that can be emptied (everted) by special muscles. (R10) How could such neat, self-cleaning, external food carriers have evolved in small steps? C.A. Long has sketched a Darwinian scenario that begins with internal cheek pouches that first develop external furrows, then gradually invert and turn into external pouches, as illustrated. (R1) However, S.J. Gould, of the punctuated-equilibrium school, doubts this step-by-step "story":



Hypothetical stages in the evolution of external cheek pouches: (A) the primordial condition; (B) internal cheek pouch formed; (C) inversion of the internal pouch; and (D) specialization of the external, fur-lined pouch. (R1)

> What good is an incipient groove or furrow on the outside? Did such hypothetical ancestors run about three-legged while holding a few scraps of food in an imperfect crease with their fourth leg?...These tales, in the "Just-So Stories" tradition of evolutionary natural history, do not prove anything. But the weight of these, and many similar cases, long ago wore down my faith in gradualism. (R2)

We have, therefore, another example of the "perfection problem." What good is half a pouch or, in this case, a slightly creased cheek? (R9)

Sea otters. Sea otters dive for their food and are afterwards seen on the surface, floating on their backs, cracking shellfish and munching on crustaceans. Obviously, it would be very efficient if this animal could collect several food items per dive and then surface to eat them. To this end, Nature has provided the sea otter with a pouch of skin under each foreleg and extending across the chest, which serves as a collecting bag for whatever appeals to its appetite. (R12)

The sea otter's pouch is much simpler in design (no eversion muscles) than the external cheek pouches. We can see how it might logically have developed in small steps.

X3. Pouches for stowing extremities.

The naked or hairless bat. The wings of this bat of Southeast Asia evidently interfere with its ability to clamber about in the hollow trees in which it roosts. Solution: stow the wings.

> A pouch is present in both sexes along the sides of the body, formed by an extension of a fold of skin to the upper arm bone and to the upper leg bone. This pouch opens toward the rear and is 25-50 mm deep. The folded wings are pushed into these pouches by the hind feet. (R10)

Here, the evolution of the pouch had to be coordinated with the foldability of the wings---both evidently responding to the exigencies of close quarters in the roost.

Whales. Streamlining characterizes all marine mammals, for the reduction of drag greatly improves speed. For this reason, organs are often "internalized." Whale flippers, which are used mainly for steering and stabilizing, can generate considerable drag. Often, whales press their flippers close to the body to improve their hydrodynamic performance. Some of the beaked whales go even further. They snugly stow their flippers into special indentations in their sides called "flipper pockets." (R4)

Yapoks. Apparently, the male yapok is the only marsupial male to own a pouch. It is not watertight like the females'

(X1), but it does have a purpose. When this aquatic marsupial swims, the male's scrotum is pulled into the pouch, thus streamlining the animal and protecting the testes. (R8, R9, R11)

The genitals of male whales and dolphins are similarly protected in body recesses with slit-like openings. This is an interesting parallelism between distantly related aquatic mammals, but it is probably not parallel evolution. Rather, it seems to be an opportunistic retention of the marsupial pouch for a new purpose. How did the aquatic habits of the yapok encourage the expression of the marsupial "pouch genes" in the male? Or did the male pouch precede the adoption of aquatic life?

References

R1. Long, Charles A.; "Evolution of Mammalian Cheek Pouches and a Possibly Discontinuous Origin of Higher Taxons (Geomyoidea), American Naturalist, 110:1093, 1976. (X2)

R2. Gould, Stephen Jay; "The Return of Hopeful Monsters," Natural History, 86:22, June-July 1977. (X2)

R3. Kirsch, John A.W.; "The Six-Percent Solution: Second Thoughts about the Adaptedness of the Marsupialia," American Scientist, 65:276, 1977. (X1)

R4. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X3)

R5. Marshall, Jeremy H.; "Directional Pouches," Nature, 309:300, 1984. (X1)

R6. Eisenberg, John F.; Mammals of the Neotropics, vol. 1, Chicago, 1989. (X1)

R7. Snelling, Andrew A.; "The Bear That Isn't," Creation/Ex Nihilo, 11: 16, no. 4, 1989. (X1)

R8. Emmons, Louise H.; Neotropical Rainforest Mammals, Chicago, 1990. (X1, X3)

R9. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X2)

R10. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1-X3)

R11. Redford, Kent H., and Eisenberg, John F.; Mammals of the Neotropics, vol. 2, Chicago, 1992, (X1, X3)

R12. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X2)

BMA50 Spurs on Mammals

Description. The presence of spurs on the ankles of the monotremes. In the male platypus, these spurs can administer a poison.

Data Evaluation. The sources are: Walker's Mammals of the World and a review article in Scientific American; both of which are considered highly reliable. Rating: 1.

Anomaly Evaluation. Even though the monotreme spurs are unique weapons among the mammals, they are only mildly anomalous amidst the generous mix of avian and reptilian characteristics exhibited by the monotremes. Such characteristics include both spurs and associated poisons. Indeed, since the monotremes are conventionally considered to be the most primitive of the mammals, one might reasonably expect to find such features carried over from even more primitive species. Rating: 3½.

Possible Explanations. None required.

Similar and Related Phenomena. Secretion of poisons in mammals (BMC in Mammals II), a characteristic more anomalous than the monotreme spurs.

Entries

X1. General observations. Spurs are usually associated with birds rather than mammals. True, no placental mammals have spurs, nor do any of the marsupials, if our little survey is accurate. This leaves only the (supposedly) primitive monotremes. Indeed, all three species of monotremes do have spurs. Perhaps they are a legacy bequeathed them from the (supposedly) even more primitive birds and reptiles.

Platypuses. Not only does the platypus possess spurs on its hind feet, but it manufactures a poison that can be administered via the spurs.

> The ankles of both hind limbs of the male have inwardly directed, hollow spurs that are connected with venom glands. The spur is found on both sexes when they are young, but it degenerates in the female. The gland secretes venom that is passed on to the spur and can be injected into other animals by erection of the spur. (R1)

How efficacious is the male platypus' weapon?

> Hunters and dogs alike found that even a stunned or dying platypus could trade tit for tat. Males have sharp spurs on their hind legs that dispense a strong venom. A platypus could kill a dog by clamping its legs around the dog's muzzle, driving in its spurs and releasing poison. Occasionally the animals spurred hunters, who experienced severe pain, swelling and weeks of partial paralysis. (R2)

Since the spurs are effective only on the adult male, their primary purpose is probably in combating other males during the breeding season.

Echidnas. Males have horny protuberances on their ankles which can be likened to spurs. No poison is secreted by these animals. (R1)

References

R1. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)
R2. Hoffman, Eric; "Paradoxes of the Platypus," Scientific American, 264: 18, March 1991. (X1)

MISCELLANEOUS TOPICS

BMA51 Odor Convergence

Description. Parallelisms in odor-based defense among mammals.

Data Evaluation. So far, the only source alluding to this type of parallelism has been Walker's Mammals of the World. Rating: 1.

Anomaly Evaluation. The coincidence of visual and odor-based parallelisms between the marsupial striped possums and placental skunks is certainly curious, but otherwise the animals are divergent. These marsupial-placental parallelisms are much weaker than those of the moles. It is a connection worth mentioning, however. Rating: 3.

Possible Explanations. Chance, morphic resonance; the usual speculations about biological convergences. See BMA1 for further discussion.

Similar and Related Phenomena. The striped possums are also convergent with mammalian aye-aye in the matter of long fingers and percussion foraging (BMA40).

Entries

X1. General observations. Rarely do biologists employ odor in making taxonomic comparisons. This is probably because humans are relatively insensitive to odors. But who can ignore the emanations of skunks and other mammals with odoriferous glands?

Striped possums. The four marsupials in this group bear black and white stripes, which make them look much like American striped skunks. Accentuating the parallelism is the extremely unpleasant and penetrating odor produced by a gland. Fortunately, the possums cannot spray this secretion. (R1)

Reference

R1. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

The marsupial striped possum from Australia not only looks like an American striped skunk but it also produces an unpleasant odor.

BMA52 Whole-Body Vibrations of Mammals

Description. Whole-body vibrations of mammals, including humans.

Data Evaluation. This phenomenon was mentioned in only one source: Walker's Mammals of the World. See BHA56 for a reference on human whole-body vibrations. Rating: 2.

Anomaly Evaluation. The source and purpose of whole-body vibrations are unknown. Whole-body vibrations are not even a recognized characteristic of animals. Whenever a phenomenon is unrecognized, unappreciated, and unexplained by science, we accord it a high anomaly rating. Rating: 1.

Possible Explanations. None offered.

Similar and Related Phenomena. Human whole-body vibrations (BHA56). The use of substrate vibrations for communication (BMT9, BRT, BAT).

Entries

X1. General observations. Like odors (BMA51), whole-body vibrations are not usually noted in the mammalian field guides. Likewise, vibrations of the ground or substrate have long been ignored as a potential medium of animal communication. This is now changing as scientists are finding that many arthropods, amphibians, and other species use vibrations as signals. Whole-body vibrations may not be significant in the communication context, but it is important to record their existence, whatever their purpose, if any.

Bats.

> Ernest P. Walker detected a vibration of the entire body, legs, and wings at 52 cps in the common big brown bat of North America (Eptesicus) and similar vibrations in other North American insectivorous bats. Apparently this vibration is under the bat's complete control and seems to occur only when the bat is resting and contented. It ceases when the bat goes to sleep. (R1)

All bats may vibrate in this way. One cannot escape comparing bat vibrations with the purring of cats.

Humans. See BHA56, in Humans I for human whole-body vibrations.

Reference

R1. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMB BEHAVIOR

Key to Phenomena

BMB0 Introduction

Our chapter on mammal behavior differs sharply from the usual textbook treatments because it focusses on behavior that is anomalous or at least curious and puzzling. The ordinary biology books are, understandably, organized around accepted paradigms---evolution, in particular. In contrast, most of the themes running through this chapter challenge such paradigms. The following list of salient "departures" from conventional thinking demonstrates this.

(1) Marsupials, usually looked down upon as inferior to placental mammals, are actually well-adapted to their environments and can compete well with the placentals.

(2) Many impressive behavioral convergences are obvious among the mammals, especially between geographically separated marsupials and placentals.

(3) Mammals are not the automatons and slaves to instinct that many animal behaviorists maintain. Many are remarkably intelligent and innovative in responding to new situations.

(4) Several sorts of mammal behavior seem to be correlated with the moon.

(5) Some mammals gather in strange geometrical "formations" and participate in great "mass movements."

(6) Some mammals have eusocial tendencies, as epitomized by the naked mole rat, which emulates the social insects in its colony organization.

Here, as elsewhere in this series of Catalogs, a Fortean tendency to collect oddities and bizarre facts will be evident. This is intentional, and no apologies are made!

BMB1 The Adaptedness of Marsupials

Description. The long-term survival and adaptedness of marsupials in the face of competition from placental mammals.

Data Evaluation. A single review paper by a specialist in the Marsupialia from American Scientist, an authoritative source. Rating: 1.

Anomaly Evaluation. The general opinion, both present and historical, of scientists and laymen alike is that marsupials are inferior to and more primitive than the placental mammals. The extensive survey referenced below denies this widespread characterization of the marsupials. This well-supported assertion merely corrects a widely held opinion and does not threaten to overturn any major paradigms. Therefore, the anomaly rating is a modest one. Rating: 3.

Possible Explanations. None required.

Similar and Related Phenomena. The morphological parallelisms between marsupials and placental mammals (BMA1).

Entries

X0. Background. Human contacts with wild marsupials in North America are limited to the Virginia opossum. This animal moves slowly and really does not appear to be very bright compared to squirrels and other placental mammals in the region. Zoo marsupials, too, such as kangaroos, seem a notch less competitive than their placental associates. Apparently, Darwin was not particularly impressed with marsupial capabilities either. Indeed, today's biologists generally regard marsupials as more "primitive" than the placental mammals, although more advanced that the monotremes, such as the platypus. Do the marsupials deserve this low opinion of biologists and people in general?

X1. The adaptedness of marsupials. Of the 4,400+ known species of mammals, only about 250 are marsupials. They inhabit mainly Australia and South America, but once had respresentatives in Europe. They successfully occupy the same environmental niches as the placental mammals, except for the oceans and the air. But the key point is that the marsupials have survived millions of years---as long as the placental mammals---and still thrive today. In some places they are even overabundant despite competition from placental mammals.

J.A.W. Kirsch has examined the adaptedness of marsupials around the world and has concluded:

> Features of their physiology and diversity suggest that marsupials represent an alternative but not inferior kind of mammal, valuable in understanding the course of mammalian evolution. (R1)

In asserting that marsupials do not really fit into the widely accepted progression of evolutionary advance from the monotremes to the marsupials to the placental mammals, Kirsch adds:

> Rather, marsupials present one of the most convincing cases in support of branching phylogeny; as should be evident even from this brief survey, the 250 species of marsupials, representing but 6 percent of living mammals, display almost as wide a range of structural and ecological adaptations as do the placentals, strongly suggesting that is these respects there are no limitations to marsupial anatomy and physiology and that, as a paradigm of mammalian evolution at least, marsupials are far from useless. (R1)

In other words, marsupials are equal but different.

Reference

R1. Kirsch, John A.W.; "The Six-Percent Solution: Second Thoughts on the Adaptedness of the Marsupialia," American Scientist, 65:276, 1977. (X0, X1)

BMB2 Mammals Resist Conditioning by Behaviorists

Description. The failure of mammalian behavior to be molded by typical behaviorist conditioning experiments.

Data Evaluation. All data were extracted from a popular book (R2) written by two scientists, who based their presentation on a scientific paper in a well-known refereed journal (R1). However, the data spectrum is very narrow, and further experimental data are desirable. Rating: 2.

Anomaly Evaluation. The phenomena of this entry undermine the contention of the behaviorist school of psychology, which insists that all animal behavior is molded by external forces, that they are only automatons guided by instinct. Since behaviorism is still influential in psychology, the animal-conditioning experiments described below are anomalous. Rating: 2.

Possible Explanations. Animals are actually guided by both instinct and intelligence.

Similar and Related Phenomena. Animal intelligence (BMB5, BMB6).

Entries

X0. Background. Mammals and all other animals, too, can be looked at in at least three ways:

(1) They are conscious, intelligent, self-directed creatures---just like humans, although of course not as intelligent!

(2) They are essentially automatons and, though conscious, are controlled entirely by instinct.

(3) They are not conscious in the human sense, and their behavior can be conditioned entirely by external forces.

The third position is that of the behaviorist school, which sees all animals as plastic and whose behavior can be molded (conditioned) in any way that is physically possible.

Although strict behaviorism is not as dominant as it once was, it is still influential in animal psychology. Furthermore, if animal psychologists are not behaviorists, they usually subscribe to the tenet that animals are mere automata (#2 above). #1 above is presently the view of only a small minority of scientists. But, we shall return to the question of animal intelligence in BMB5 and BMB6.

X1. Experimental disproof of behaviorism. Critical experiments with several species of animals were carried out by K. and M. Breland. Beginning as dedicated behaviorists, they set up typical conditioning experiments.

Raccoons.

> For example, trying to condition a raccoon to pick up two coins and put them into a metal box to receive an immediate food reward, the Brelands ran into difficulty: "Not only could he not let go of the coins, but he spent seconds, even minutes, rubbing them together...and dipping them into the container. He carried on this behavior to such an extent that the practical application we had in mind---a display featuring a raccoon putting money in a piggy bank---simply was not feasible. The rubbing behavior became worse and worse as time went on, in spite of nonreinforcement." (R2)

Pigs.

> Pigs trained to deposit large wooden coins in a piggy bank for immediate food rewards would do well for a few

Raccoons have confounded behaviorists!

weeks but then begin dropping the coins repeatedly, rooting them, tossing them into the air, and rooting them again indefinitely. (R2)

Obviously, the raccoons and pigs didn't realize they were infinitely moldable.

Similar problems arose with such other mammals as whales, porpoises, cows, etc. The Brelands had to conclude that classical conditioning theory was invalid, and that animals were primarily creatures of instinct (#2 above).

References

R1. Breland, Keller, and Breland, Marian; "The Misbehavior of Organisms," American Psychologist, 16: 681, 1961.

R2. Augros, Robert, and Stanciu, George; The New Biology, Boston, 1987. (X0, X1)

BMB3 Mammal Activity Correlated with the Moon

Description. The correlation of the activity of mammals with the position of the moon in the heavens.

Data Evaluation. Researchers, particularly psychologists, have been attracted to this claimed phenomenon for decades. Most of their attention has been focused on the human animal, but work with laboratory animals has not been ignored. Consequently, a substantial literature exists---mainly in books and the psychological journals. Here, we employ only a few of these references. (See the long bibliography in R5 for more.) In the interest of brevity, we present only three typical sorts of experiments. As in the case of studies on humans, the data from this large body of data are often contradictory. The reality of the phenomenon, therefore, is seriously in doubt. Rating: 3.

Anomaly Evaluation. Since there is no widely accepted mechanism by which the position of the moon can affect animal behavior, this phenomenon, if substantiated, would be very anomalous, especially since most scientists ridicule it. Rating: 1.

Possible Explanations. The phenomenon might have an electrical basis involving positive ions, as outlined in BHB4-X8, in Humans I.

Similar and Related Phenomena. Human behavior and the moon (BHB4); human eminence correlated with astronomical phenomena (BHB28).

Entries

X0. Background. Scientists of course recognize that the moon raises the tides, but they resist the claim that animal behavior can be affected by the moon's position in the sky. This philosophical antagonism is apparently a carryover from science's passionate hatred of astrology. Despite this antipathy, a few scientists, mainly psychologists, have braved the mainstream's current and have carried out experiments aimed at detecting the long-supposed effect of the moon on animal activity. Much of this pioneering work has involved human behavior, particularly disturbed human behavior, for the word "lunacy" has a strong basis in popular belief. (See BHB4 in Humans 1.) In comparison to the work with human subjects, similar research with animals is rather skimpy and limited in scope. There is enough suggestive evidence, though, to justify this Catalog entry.

X1. Laboratory experiments. An important pioneer in the study of the lunar effect on animal activity has been F.A. Brown, Jr. He searched for such effects over a wide spectrum of animals. Typical of his work involved that workhorse of psychology, the laboratory rat.

Rats. In a classic experiment, Brown and his colleague, E.D. Terracini, kept a rat in a closed cage with constant illumination, temperature, and atmospheric pressure for a 60-day period, effectively isolating it from natural variables like sunlight. During this time, they observed the rat's cycles of physical activity while it was decoupled from the environment. Even though thus artificially isolated, the rat's activity followed the moon's position. Further:

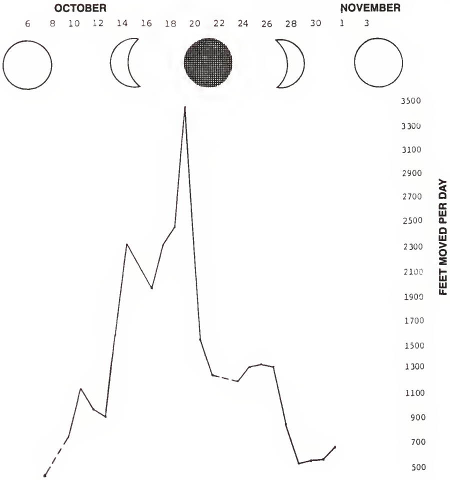
> Activity was high during hours the moon was below the horizon, and low when above. Spontaneous running at the first lunar hour was 6 times that at the 11th hour...Superimposed upon the dominant lunar-day periodism were minor, transient, solar-day patterns of locomotor activity. terminating spontaneously or through apparent submergence in the larger amplitude, lunar-day cycles. (R2)

These results were subsequently duplicated and confirmed, not only with rats but other rodents, such as hamsters. (R3, R5, R6) There have been, in fact, too many such experiments to cover here. Those interested in pursuing the subject further should consult the bibliography of R5.

X2. Experiments in natural settings. A more natural setting for exploring the lunar effect in animals was reported by J.C. Jahoda in 1973.

Grasshopper mice. An outside enclosure 4.215 x 5.845 meters in size was instrumented to register when grasshopper mice left their nest and how far and how fast they moved. Captured wild mice were injected with bits of radioactive wire so that their positions could be monitored at all times. Their enclosure was fenced and meshed to exclude predators. It was, however, open to the weather and otherwise a good simulation of the mice's natural habitat.

> There was a noticeable correlation between the lunar cycle and amount of activity, with maximum activity near new moon and minimum near full moon. The difference between the amount of activity occurring under the various phases of the moon was tested using the Analysis of Variation (AOV) method and the Least Significant Difference (LSD) test. For the statistical analysis, the month was divided into units termed



Activity level of a mouse during the lunar cycle. (After Jahoda, R4)

lunar phase units. These units consisted of the days with no rain occurring within the 5-day interval centered on the four lunar phases. The analysis indicated a significant difference in activity between new moon and full moon for all mice (P = .05). The quarter moons did not differ significantly from either new or full moons, and the activity level under the quarter moon lay between the low level at full and the high level at new moon. (R4)

The lunar periodicity of the grasshopper mouse was the same as the 29.53-day lunar cycle. Their circadian cycles shifted progressively each month as the time of moonset changes. This experiment essentially confirmed those done under the usual laboratory conditions (X1).

X3. Informal, nonscientific observations.

All wild and domesticated mammals. Sometimes, laymen who spend much time outdoors observe and correlate animal activity unavailable to lab-confined scientists. We present the following information in the spirit of inquiry, even though it is of questionable provenance.

For years, J.A. Knight published what he called the Solunar Tables, which told fishermen the best times to go fishing; that is, the times when the fish were the most active. Knight maintained that his popular tables also applied to all animals, wild and domesticated. And sportsmen of all kinds agreed that the Solunar Tables were very useful. All animals follow rest-activity cycles, and Knight believed they were correlated with the moon. The astronomical effect was very small, he said, and could be overwhelmed by changes in atmospheric pressure, temperature, wind, etc. He did not claim his tables were infallible ---just helpful, all else being equal.

Knight divided the animal "day" into four 6¼-hour periods, which means the complete animal "day" is almost the same as the lunar day rather than the 24-hour solar day. In each animal "day" were four periods of activity and an equal number of rest periods. The two major activity periods occurred when the gravitational pulls of the sun and moon reinforced one another. (R1)

Perhaps Knight's Solunar Tables should be filed with the weather predictions of the Farmer's Almanac. Nevertheless, the folk wisdom of the Solunar Tables superficially resembles the conclusions emerging from the more rigorous scientific experiments.

References

R1. Anonymous; "The 6¼-Hour Cycle of Wildlife Activity," Cycles, 7:269, 1956. (X3)

R2. Brown, Frank A., Jr., and Terracini, Emma D.; "Exogenous Timing of Rat Spontaneous Activity Periods," Society for Experimental Biology and Medicine, Proceedings, 101:457, 1959. (X1)

R3. Gauquelin, Michel; Cosmic Clocks, Chicago, 1967. (X1)

R4. Jahoda, John C.; "The Effect of the Lunar Cycle on the Activity Pattern of Onychomys leucogaster breviauritus, Journal of Mammalogy, 54:544, 1973. (X2)

R5. Katzeff, Paul; Moon Madness, Secaucus, 1981. (X1)

R6. Tromp, S.W.; "Studies Suggesting Extra-Terrestrial Influences," Cycles, 33:179, 1982. (X1)

BMB4 Anomalous Altruism: Hard to Find!

Description. Altruism in mammals that cannot be explained by the Darwinistic concepts of kin altruism or reciprocal altruism.

Data Evaluation. The examples of possible anomalous altruism presented below were found in well-established catalogs of mammals. Rating: 1.

Anomaly Evaluation. Kin and reciprocal altruism (defined in X0) explain rather well just about all of the many cases of mammalian altruism. Pure altruism does not seem to exist among the mammals. Of the two examples of potentially anomalous altruism given below, only one is very convincing, and even it scarcely challenges the prevailing evolutionary explanations of altruism. Rating: 3.

Possible Explanations. None required.

Similar and Related Phenomena. Human altruism (BHB17); collective action in mammals (BMB25-31, 33).

Entries

X0. Background. How can altruism in animals be made compatible with "survival of the fittest"; that is, Darwinism? Why should an animal give its food, effort, or even life for another, when doing such means that its genes stand less chance of being propagated? Evolutionists have come up with two explanations of altruism that are consistent the dictates of natural selection. In fact, these explanations are so widely applicable that anomalous altruism is virtually impossible to find.

(1) Kin altruism, in which an animal aids or sacrifices for a close relative. This makes evolutionary sense because this relative carries some of its genes, so helping the relative helps to transmit some of its genes to the relative's progeny. In the animal world, kin altruism is obviously instinctive rather than consciously planned.

(2) Reciprocal altruism, in which one animal aids another because it hopes to be helped in return in the future. This is seen in groups of unrelated vampire bats, where blood is shared with bats that have not been able to find prey. (R4)

In the wild, altruism ranges from one baboon grooming another to ants or bees giving up their lives for the colony. Nature is full of altruistic behavior like this, but evolutionists are able to explain just about all of it in terms of kin or reciprocal altruism. Faced with such universally applicable explanations for altruism, we are left with only two seemingly deviant cases.

Cross references. For possible human altruism, see BHB17 in Humans 1. For colonial and eusocial behavior in other mammals, see BMB31.

X1. Pathological altruism.

Cetacea. It is well known that whales and dolphins show great concern for other members of their species, particularly individuals within their own pod or group. For example, bottle-nose whales will not desert a wounded companion until it dies. (R1) Doubtless, this is kin altruism. However, some dolphins carry this concern to the extreme; that is, to unrelated dolphins and even other species.

Normally, if a dolphin is weak and sinks below the surface, other dolphins, even unrelated ones, will dive and lift it to the surface so that it can breathe.

> Occasionally a dolphin carries this aiding behavior to extremes, such as a mother who carried her stillborn baby for days until it had begun to decompose, or the bottle-nosed dolphin that carried a dead shark for eight days without stopping to eat. Some conscious thoughts seem likely to accompany this aiding behavior, even when the effort is misguided. (R3)

In other words, can evolution explain the existence of instincts that impel such a sacrifice of effort for a dead shark? If anomalous altruism does exist, this may be an example of it.

X2. Negative altruism! Altruism implies action; negative altruism implies a lack of action that benefits another animal. In some circumstances, humans often call this mercy or chivalry.

Barbary sheep. During the rutting season, males typically stand a few meters apart and charge one another, lowering their horns just before impact. However, Barbary sheep and probably other sheep, too, will not charge an opponent who is not ready or who is off balance. (R2) It would certainly be an advantage to attack during an opponent's moment of weakness. Without doubt, this can be explained as a special example of reciprocal altruism.

References

R1. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X1)

R2. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X2)

R3. Griffin, Donald R.; Animal Minds, Chicago, 1991. (X1)

R4. Fenton, M. Brock; Bats, New York, 1992. (X1)

BMB5 Mammal Intelligence: Anecdotal Evidence

Description. Informal accounts of various sorts of mammal behavior that suggest intelligence to the percipient.

Data Evaluation. Most of the anecdotes adduced here come from the scientific literature and popular science publications. The soundness of the sources is not at issue here but rather the value of anecdotes in substantiating claims of anomalies. Anecdotes are subjective, unsystematic, and often subject to perceptual distortion. At the very most, they can be only suggestive in assessing the reality of mammalian intelligence. Rating: 3.

Anomaly Evaluation. Even with humans, who communicate readily with researchers, intelligence is a fuzzy concept. Here, we assume that adaptive and innovative behaviors in mammals are good indicators of intelligence.

Most animal behaviorists still believe animals are merely automatons guided mainly by instinct, and they can usually find ways to interpret all types of animal behavior according to this paradigm---just as evolutionists are wont to explain everything (usually very superficially) in Darwinistic terms. Animals cannot think or reason according to the paradigm being challenged here. Although somewhat weakened today, the animals-as-automatons paradigm still reigns, and evidence undermining it is considered highly anomalous. Rating: 1.

Possible Explanations. Mammals are more than automatons and possess intelligence in various degrees.

Similar and Related Phenomena. Human intelligence phenomena (BHB35 through BHB43, in Humans I); human-mammal communication (BHX1, in Humans III); mammal intelligence overshoot (BMB6); the inheritance of learned behavior (BMB7); mammal communication (BMT8); mammal tool use (BMT11); mammal "engineering" (BMT12); mammal collective behavior (BMB25 through BMB31 and BMB 33).

Entries

X0. Background. This is the section where we pass along a few amusing dog-and-cat tales. Of course, we allow a few stories about other clever species, too. Of dog-and-cat anecdotes there are a great many, notably in the more popular literature. Collectively, these seem to indicate that mammals possess a lot more intelligence than present biological paradigms would acknowledge. We could recite intelligent-animal anecdotes indefinitely, but they alone they would never convince mainstream scientists that mammals are much more than mere automatons. For this reason, only a very small sample of abundantly available dog-and-cat stories are appropriate here.

Mammal IQ tests do not exist. To assess mammalian intelligence, we must watch mammals perform in the wild and under laboratory conditions. One measure of mammal intelligence is the speed, efficiency, and flexibility of their information processing, but such variables are very difficult to measure in animals. Therefore, we resort here mainly to anecdotes demonstrating the ability of many mammals to respond appropriately and even creatively to changing and novel situations. Certainly, these abilities are also measures of intelligence.

Cross references. We also see intelligence in other activities of mammals, such as communication and collective action. References to such Catalog entries are given above under Similar and Related Phenomena.

X1. Subjective impressions. Who can look one's dog in the eye and not see a sentient, thinking animal? Such an impression is not admissible in the court of science, but even scientists who have been lectured long about the dangers of anthropomorphic thinking cannot completely escape this feeling. Take, for example, these impressions of some dolphin researchers.

Dolphins.

> [B.] Smuts, [D.] Reiss, and others who have been intimately associated with dolphins have a rich stock of stories and anecdotal observations on which such impressions rest. They speak of the animals' prolonged and evocative eye contact, intense curiosity, savvy and creativity in problem solving, and richly varied personalities. They cite a wide repertoire of behaviors, ranging from altruism to manipulative, teasing, and even deceiving. (R7)

X2. Selected anecdotes. Cat-and-dog tales never see print in modern scientific publications, so we must hark back to the last century, when anecdotes about animal behavior fueled debates over the reality of animal intelligence. The major criterion for selecting the accounts below is the animals' ability to adapt to new situations and solve problems creatively.

Dogs. The following account is from an 1881 issue of Knowledge, an English scientific magazine of the day.

> During my boyhood my father had the shooting over some property adjoining a deer park, and we owned at this time a very intelligent setter, which used also to retrieve. One day my father shot and wounded a hare, which made its way through a hole in the park paling. The dog leaped over the paling, caught the hare, and brought it back to the fence in its mouth. It then tried several times to return by leaping the paling, but the weight of the hare prevented it from reaching the top. After resting awhile it bethought itself of the hole through which the hare had come, and, taking the hare to this hole, it pushed it through, then leaped the park paling, and brought the hare to my father. (R4)

The following letter from Nature is two years older than the preceding account and, if we can believe the story, seems to show planning and compassion.

> "Priests" is a hotel on the way from the Calaveras Grove of Big Trees to the Yosemite. In former years, on the arrival of the stage, the landlady would send the dog to the poultry

> yard to catch chickens for the Tourists' dinner. Now the dog "takes time by the forelock." The stage is due at six o'clock. About five o'clock the dog saunters leisurely down the road till he meets the stage, he then bounds back to the poultry yard, catches chickens, bites their heads off, and takes them to the cook! The number of chickens he kills bears a relation to the number of passengers he saw on the stage.
>
> A gentleman who was stopping at the hotel for a few days went into the woods one afternoon with a gun. When he returned the dog came to him in much excitement to see what game he had taken. Finding his hands and his bag empty the dog ran into the forest and returned in less than an hour with a bird, which he gave with an air of compassion to the unskillful hunter. (R2)

Cats.

> During the recent severe winter a friend was in the habit of throwing crumbs for birds outside his bedroom window. The family have a fine black cat, which, seeing that the crumbs brought birds, would occasionally hide herself behind some shrubs, and when the birds came for their breakfast, would pounce out upon them with varying success. The crumbs had been laid out as usual, one afternoon, but left untouched, and during the night a slight fall of snow occurred. On looking out next morning my friend observed Puss busily engaged in scratching away the snow. Curious to learn what she sought, he waited, and saw her take the crumbs up from the cleared space and lay them one after another on the snow. After doing this she retired behind the shrub to wait further developments. This was repeated on two other occasions, until finally they were obliged to give up putting out crumbs, as Puss showed herself such a fatal enemy to the birds. (R1)

In more recent times, D. Gould encountered a feral cat which, when he tried to trap it, proved equally clever.

> Although I have made an adequate living as a mechanical design engineer, it took me a couple of minutes to work out how to position the various rods and links to set and bait the trap, which done, I observed from a concealed position. The cat duly arrived, studied the trap suspiciously from different angles, retired, sat and contemplated. Then, after less time than it had taken me to work it out, she entered the trap purposefully, placed her paws underneath the trip plate, took the food and backed out. (R10)

Rats. It seems to be widely acknowledged that rats somehow steal eggs that are much too large for them to carry in their mouths. There is the charming story, "verified" by an accompanying rendition of a Japanese fan painting, that one rat will lie on its back grasping the egg while another rat grabs its tail and pulls both rat and egg away. (R5) This tale is not any more fantastic than the next one, which comes from an impeccable source.

Malayan sun bears.

> A young captive observed the way in which a cupboard containing a sugar pot was locked with a key. It then later opened the cupboard by inserting a claw into the eye of the key and turning it. Another captive scattered rice from its feeding bowl in the vicinity of its cage, thus attracting chickens, which it then captured and ate. (R8)

Southern sea lions. An interesting strategy is employed by some of the bachelor males of this species. They invade terrtories of dominant males and kidnap pups, thus luring females away from the harem. (R8) This tactic seems to indicate a modicum of intelligence.

California sea lion. Rio, a female sea lion, seems to be able to perform feats of logic, even though not specifically trained to do so:

> She learned that pairs of objects go together---say, a ring and a baseball bat, and the same baseball bat and a clothes hanger---and then realized on her own that the ring, bat, and hanger form a group of interchangeable objects. Thus, if she saw the

> hanger, she knew it belonged with the ring because both of those items belonged with the bat. (R9)

Rio recognized what is called by psychologists an "equivalence class." It implies recognition that if A = B and B = C, then A = C.

Chimpanzees. The problem-solving abilities of these primates are very impressive, as related by R. Augros and G. Stanciu in their The New Biology.

> ...many animals seem to reason and draw conclusions from what they perceive. For example, Wolfgang Kohler's classic experiments demonstrated the chimpanzee's power of insight and apparent capacity to make inferences. Apes used sticks to reach food suspended from the ceiling; others piled boxes on top of one another to solve the same problem. One animal even led the experimenter to a place under the banana and then leaped onto his shoulders to grab the fruit. (R6)

Orang-utans.

> Tool use by fully wild orangutans is much more limited than has been reported for the chimpanzee, but released captive individuals use sticks for digging, fighting, prying, eating, scratching, and many other purposes. Some of these ex-captives learned (without human assistance) to untie complex knots securing boats and rafts and then to shove off, board, and ride the vessels across rivers. (R8)

Dolphins. Two female dolphins at the Kewalo Basin Marine Laboratory, in Hawaii, have learned the meaning of several hand signals from their trainers. Here is what happened when L. Herman, the Lab Director, gave them the signals for "tandem" and "creative," meaning "do something creative together."

> The dolphins break away from their trainers and submerge in the 6-ft.-deep water, where they can be seen circling until they begin to swim in tandem. Once they are in synch, the animals leap into the air and simultaneously spit out jets of water before plunging back into the pool. The trainers flash huge smiles at their flippered pupils and applaud wildly. The animals also seem delighted and squeak with pleasure. (R11)

X3. The marsupial question again. In BMB1, we described how the marsupials are often maligned as being "not as quick" as the placental mammals. However:

> Recent laboratory studies have demonstrated that the learning and problem-solving abilities of marsupials often equal or exceed those of some placental groups. (R8)

Implicit in the above quotation is the admission by some scientists that mammals, marsupial and placental, are indeed intelligent.

X4. Stupidity in mammals. Like humans, the other mammals differ wildly in their acumen; they are not all clever, as the foregoing might imply. Take, for example, the chimpanzee, Sultan, and his actions an experiment involving piling boxes on top of one another to reach food:

> ...one chimpanzee, Sultan, piles up boxes beneath the place where the fruit was on the previous trial, not under where it hangs now.

Then, after four weeks of piling boxes to reach food, the food is placed outside the cage with a stick long enough to reach it. This is too much for Sultan:

> Sultan drags a box to that spot at the bars, opposite which the objective is lying (outside), and turns first one side, then the other towards the bars quite stupidly, fetches more boxes, and begins again as if to build. (R6)

References

R1. Greenock; "Intellect in Brutes," Nature, 20:196, 1879. (X2)
R2. Gunning, W.D.; "Intellect in Brutes," Nature, 20:30, 1879. (X2)
R3. Dupre, A.; "Intellect in Brutes," Nature, 20:243, 1879. (X2)
R4. Lucas, R. Clement; "Reason in Animals," Knowledge, 1:94, 1881. (X2)
R5. Michell, John, and Rickard, Robert J.M.; Living Wonders, New York, 1982. (X2)
R6. Augros, Robert, and Stanciu, George; The New Biology, Boston, 1987. (X2, X4)
R7. Wintsch, Susan; "You'd Think You Were Thinking," Mosaic, 21:34, Fall 1990. (X1)
R8. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X2, X3)
R9. Bower, B.; "Sea Lion Makes Waves with Logical Leaps," Science News, 142:293, 1992. (X2)
R10. Martin, C.G.; "Clever Cat," New Scientist, p. 53, August 29, 1992. (X2)
R11. Linden, Eugene; "Can Animals Think?" Time, 141:54, March 22, 1993. (X2)

BMB6 Evolutionary Overshoot in Mammalian Intelligence

Description. The possession by some mammals of considerably more intelligence than their present existence requires. It should be borne in mind that we cannot objectively measure the intelligence of animals. There is no mammal IQ test. We also have no way of knowing how much intelligence is required to survive in the multitude of various environments on earth. This phenomenon depends upon subjective evaluations.

Data Evaluation. We employ here the comments of but one scientist, a political scientist at that, but a very astute one. Furthermore, we are dealing with subjective impressions here, and they are of dubious scientific value. Rating: 3.

Anomaly Evaluation. Since evolution is supposed to proceed in small steps as an organism adapts to a changing environment, the existence of large gaps between mammalian intellectual potential and the actual intellectual abilities needed for survival is highly anomalous. Rating: 1.

Possible Explanations. Mammalian intelligence may have evolved long ago when much more of it was needed for survival. Or, evolution may proceed in large steps (saltations), so that overshoots occasionally occur.

Similar and Related Phenomena. Human cultural overshoots (BHB14); human perfect pitch (BHT14); large brains of humans (BHO22); possible psychic abilities of humans (P).

Entries

X1. General observations. After showing how the great apes seem to possess more intelligence than their survival requires, particularly the gorillas with their vegetarian diets and predatorless lives, R. Wesson comments:

> If human intellectual powers cannot be clearly related to pressures of selection, neither can those of other large primates. If it is true, as Roger Lewin suggests, that there has been a parallel evolution of the most closely related large primates---gorilla, chimpanzee, and human---other factors than survival of the fittest must have played a part in all three cases. (R1)

Wesson next extends this conclusion to the cetaceans, notably the baleen whales, which have huge brains, complex intra-species communication, few predators, and whole oceans to strain food from.

Reference

R1. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X1)

BMB7 Progressive Learning Improvement in Successive Generations of Mammals

Description. The improvement in the ability to perform specific tasks in succeeding generations of mammals. This apparent improvement in learning occurs in the progeny of both trained and untrained (control) animals.

Data Evaluation. The relevant experiments with laboratory animals were performed early in this century by respected scientists. Papers and discussion of the controversial and contradictory results were published in mainstream scientific journals. To our knowledge, similar experiments have not been conducted in recent times. Rating: 2.

Anomaly Evaluation. The intent of the experiments adduced here was to demonstrate or disprove Lamarckism; that is, the inheritance of acquired characters, in this case, learned behavior. Results were contradictory on this score, and Lamarckism was considered disproved. These results are not anomalous, since they are consistent with present paradigms. However, learning did improve with successive generations of both trained and untrained animals. Science has no acceptable mechanism that can explain such improvements. R. Sheldrake asserts that his theory of morphic resonance involving "morphogenetic fields" can account for the observed phenomena. Morphic resonance is anathema to most of science, so the anomaly level here is high. Rating: 1.

Possible Explanations. Morphic resonance.

Similar and Related Phenomena. A great many biological phenomena, such as parallel evolution, *might* be explained by morphic resonance. See Series-B Subject Indexes under: Lamarckism; Morphic resonance; Acquired characters.

Entries

X0. Background. Early in this century, the inheritance of acquired characters or Lamarckism was not viewed with the disdain it is in our age of DNA and modern genetics. In those simpler days, several respected scientists tried to prove or disprove Lamarckism in their laboratories using laboratory animals in learning experiments. The most famous of these were conducted over a period of several years by Harvard's W. McDougall.

If McDougall had conclusively demonstrated the reality of Lamarckism, we would have a first-class anomaly, but this was not to be, as we shall see shortly. But an anomaly of an entirely different sort emerged from the attempts to confirm McDougall's work. It is this anomaly that is the subject of this Catalog entry.

X1. Learning experiments with mammals. Inbred rats were favored for most of the Lamarckian experiments of the 1920s and 1930s, but the first pertinent experiment we have in our files employed white mice.

White mice. I.P. Pavlov, the Russian scientist of conditioned reflex fame, experimented with white mice, conditioning them to go to a feeding station at the sound of a bell. Early on, at a 1923 meeting in Edinburgh, Pavlov claimed that he had indeed shown that the conditioning his mice exhibited or "learned" was transmitted to their progeny,

> The first generation of white mice required 300 lessons. Three hundred times was it necessary to combine the feeding of the mice with the ringing of the bell in order to accustom them to run to the feeding place on hearing the bell ring. The second generation required, for the same result, only 100 lessons. The third generation learned to do it in 30 lessons. The fourth generation required only 10 lessons.

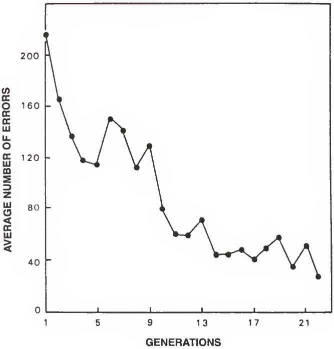
The inheritance of acquired learning seems clearly demonstrated here, but Pavlov subsequently retracted his claim and never repeated the experiment. (R6)

Rats. The experimental setup devised by W. McDougall was rather simple. He utilized the standard white laboratory rats of his day, placing them:

> into a tank of water from which they could escape only by swimming to a gangway and climbing up it. There were two such exits, one on either side of the tank. One exit was illuminated, and if they chose this one they received an electric shock as they left the water. The other [dimly illuminated] exit was quite safe. The next time they were put into the tank, the gangway that was previously illuminated was now in dim light, while the other exit was lit up and electric shocks were given there. The rats had to learn that it was painful to leave by the illuminated exit but safe to take the other one. (R9; R8)

McDougall published a series of reports on his work beginning in 1927. (R1) We present next the results he published in a 1930 paper. They are typical of the whole series.

> Twenty-three generations of rats have been trained in the tank to the performance of a specific task. The rats of the successive generations have displayed increasing facility in mastering this task. Whereas rats of the control stocks make on the average about 165 errors (and receive the same number of shocks) before learning to avoid the shock, rats of the 23rd generation of trained stock



McDougall's experiments showed that the average number of errors by rats decreased with successive generations, suggesting that learned behavior can be inherited.

> make on the average only 25 errors; the latter have acquired a greatly increased facility in mastering the task, the increase being measured by the difference between 165 and 25 shocks required for learning. (R2)

These findings seemed to show that learned behavior was definitely passed on to the rats' progeny; but this conclusion was abhorent to most biologists, since Lamarckism had now been rejected by mainstream science. McDougall's results had to be confirmed by others beform one could even think about embracing Lamarckism.

F.A.E. Crew, at the University of Edinburgh, repeated McDougall's experiments in the early 1930s. He found no decrease in the number of errors made by rats of successive generations. Crew also employed control rats and found no difference between their performance and that of the trained rats. Strangely, Crew's rats seemed to learn more quickly than those of McDougall. (R4, R5, R7)

Another group that tried to replicate McDougall's experiments was located in Melbourne. The chief investigator was W.E. Agar. (R3) We use here R. Sheldrake's summary of the Australian work.

> In Melbourne, W.E Agar and his colleagues also found that the first generation they tested learned far quicker than McDougall's original rats. They continued to test fifty successive generations of rats over a period of twenty years, and like McDougall found a progressive increase in the rate of learning in subsequent generations. But, unlike McDougall, they also repeatedly tested control rats which were not descended from trained parents. These too showed similar improvement. (R9)

Quite reasonably, Agar et al concluded that the improved performance could not be due to Lamarckism, for if it had, the increase would have shown up only in the progeny of the trained rats.

The question remained, and still remains: Why did the improvement occur? In this question resides the anomaly of this entry. R. Sheldrake believes that the improvement in both trained and untrained rats is exactly what should have occurred if his theory of morphic resonance is correct. In fact, the initial performance improvements over McDougall's rats, noted by both Agar and Crew, can also be accounted for by morphic resonance!

It remains to be added that relevant maze experiments were carried out in the 1930s at the University of California by R.C. Tryon. He showed that both "bright" and "dull" rats became progressively better at running the maze with each succeeding generation. Tryon's results can be interpreted as confirmatory of McDougall's water-tank experiments. Tryon, however, while admitting that his work could be interpreted as favorable to Lamarckism, preferred the theory that the improved performance was due to the increased vigor of later generations. (R5)

One can see, therefore, that the results of the Lamarckian experiments were mixed at best---so much so that we have not recorded them in a separate entry, preferring to focus on the possible evidence for morphic resonance.

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R1. McDougall, William; "An Experiment for the Testing of the Hypothesis of Lamarck," British Journal of Psychology, 17:267, 1927. (X1)

R2. McDougall, William; "Second Report on a Lamarckian Experiment," British Journal of Psychology, 20:201, 1930. (X1) We are not referencing the rest of this series.

R3. Ager, W.E., et al; "Fourth (final) Report on a Test of McDougall's Lamarckian Experiment on the Training of Rats," Journal of Experimental Biology, 31:307, 1954. (X1)

R4. Crew, F.A.E.; "A Repetition of McDougall's Lamarckian Experiment," Journal of Genetics, 33:61, 1936. (X1)

R5. Drew, C.G.; "McDougall's Experiments on the Inheritance of Acquired Habits," Nature, 143:188, 1939. (X1)

R6. Razran, Gregory; "Pavlov and Lamarck," Science, 128:758, 1959. (X1)

R7. Medewar, P.B.; The Uniqueness of the Individual, New York, 1981. (X1)

R8. Sheldrake, Rupert; "A New Science of Life," New Scientist, 90:766, 1981. (X1)

R9. Sheldrake, Rupert; The Presence of the Past, New York, 1980. (X1)

BMB8 The Transfer of Learning via Brain Extracts

Description. Experimental evidence that information, which includes learned behavior, can be transferred from one mammal to another through the injection of brain extracts. The donor and recipient may be of different species.

Data Evaluation. The sources used here are predominantly prominent scientific journals. Pertinent research has been carried out in several respected research laboratories. The experimental findings are strongly positive as to the reality of the claimed anomaly, but there have been null results, too. This mixture of pluses and minuses dictates a low anomaly rating. Rating: 3.

Anomaly Evaluation. Neuron connections (synapses) are widely believed to form the basis of vertebrate memory. Interconnected networks of neurons, for example, may constitute a "memory trace." If these surmises are correct, it is not clear how such interconnections can be transferred from one animal to another by what are termed "memory molecules." The well-known barrier excluding blood from the brain further weakens the memory-molecule idea. Not only is the memory-transfer mechanism unknown, but theory seems to preclude its existence. Rating: 2.

Possible Explanations. See X2 below for one theory.

Similar and Related Phenomena. Learning transfer outside the Mammalia (BFB, BLB); the apparent lack of memory traces in animals brains (BHO23 in Humans II.)

Entries

X0. Introduction. Exactly how information is stored in an animal's brain remains a mystery. Manifestly, the vertebrate brain is very unlike a computer's hard disc. Is a datum stored as synapses of the brain's neurons? How are body chemicals involved? One way to find and explore the wellspring of memory is to take a brain containing a known memory, grind the grey matter up, and then inject it into another animal known to be without the known memory. If the naive animal's behavior then indicates that the memory had been transferred, it would seem that some molecule(s) in the brain extract can indeed carry information from one individual to another.

X1. Learning-transfer experiments. Learning-transfer experiments began in the early 1960s, when brain extracts from trained flatworms were injected into untrained flatworms. The injected flatworms actually acquired some of the knowledge of their trained kin. Fish have also been employed in this sort of research. The laboratory experiments summarized below enlisted rats and mice, sometimes both in the same experiment. We have arranged the research that we have come across in our sweep of the literature in approximate chronological order.

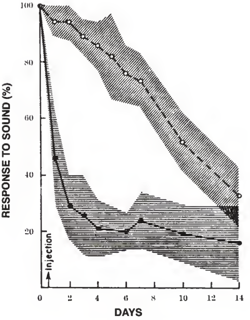
1965. Apparently the first researcher to use mammals in learning-transfer experiments was E. Fjerdingstad at the University of Copenhagen.

> He trained rats to go to light in order to receive water, then injected the brain material from trained rodents into naive ones. The recipients did not imitate the donors' learned habit right off, but they did acquire it faster than control rats that had not been injected, implying that the injected brain material indeed boosted learning. (R8)

Also in 1965 came the first report from G. Ungar at Baylor University. He and C. Oceguera-Navarro exposed rats to the sharp sounds of a steel hammer hitting a metal plate every 5 seconds. It goes without saying that the rats at first were startled, but eventually they became habituated. Such habituation is considered an elementary form of learning. Brain extracts from the habituated rats were they injected into naive mice. Ungar and Oceguera-Navarro concluded as follows:

> The preliminary experiments reported here show that an elementary form of learning, habituation to sound, can be transferred to untrained animals by injecting them with a peptide-type material extracted from the brain of habituated animals. This

> factor is absent from the brains of non-habituated animals. Further experiments are in progress in other learning situations, other routes of introduction of the transfer factor and with extracts of circumscribed areas of the brain. (R1)



Habituation curves for mice injected with extracts of normal rat brain matter (o) and sound-habituated rat brain matter (●) (After Ungar, R1)

Additional results from Ungar and his colleagues will appear later in this annotated chronology.

Also in 1965, the results from a different type of conditioning experiment were published by F.H. Babich et al, who were affiliated with the University of California, Los Angeles.

> Rats were trained in a Skinner box to approach the food cup when a distinct click was sounded. Ribonucleic acid [RNA] was extracted from the brains of these rats and injected into untrained rats. The untrained rats then manifested a significant tendency (as compared with controls) to approach the food cup when the click, unaccompanied by food, was presented. (R2)

1966. Studies similar to those of Babich et al were reported by F. Rosenblatt et al at Cornell. Using rats conditioned to perform different tasks, they found a significant tendency for learning to be transferred. (R4)

So far, the experiments described support the transfer of learning by injecting brain extracts from trained into naive animals, even across species barriers.

But some negative reports also began to appear in the journals.

In Science of April 6, 1966, W.L. Byrne et al summarized the results obtained at six different institutions by a total of 23 researchers---all of whom were engaged in learning-transfer work.

> In 18 experiments no clear evidence of a transfer of any of these kinds of training from trained donors to recipients was found. (R5)

Continuing in this negative vein were the findings of M. Luttges and four colleagues located at the University of California at Irvine.

> The technique used in all cases was to grind the brains of animals trained by some stimulus, such as food, extract from them a chemical called ribonucleic acid (RNA) and inject this into untrained animals. The theory is that RNA molecules carry memories in coded form and that these molecules can be transplanted from one animal to another, thereby transferring memory and learning.
>
> .....
>
> No evidence of memory transfer was found in any of the experiments. (R3)

Note that the foregoing conclusions apply only to RNA as the memory-transfer molecule.

1967. The negative findings did not deter Ungar. His 1967 paper in Nature asserted:

> An earlier finding that learned be-

> haviour can be transferred to naive subjects by injection of extracts of brains from trained animals is re-examined by a less ambiguous method. The possibility of transfer is confirmed, but the mechanisms involved are still obscure. (R6)

1968. Then, at the 1968 meeting of the American Association for the Advancement of Science in Dallas, Ungar was even more certain about the reality of the learning-transfer phenomenon, insisting that his data:

> show an overwhelming probability that learned information can be transferred chemically under appropriate experimental conditions. (R7)

1982. The most recent report in our collection is also positive on the reality of the phenomenon. This work closely paralleled previous experiments. It was carried out at Knox College by B.G. Oden and colleagues.

> The results support the conclusion that acquired behaviors can be transferred between animals by transferring brain DNA, and further suggest that the transfer effect is dependent upon and specific to the learning of the donors. (R10)

In sum, then, the great majority of the reports that we have found on the claimed phenomenon support its reality. But it is a majority, not a unanimous vote, for some investigators found no effect.

X2. Is there a memory molecule? G. Ungar, who tenaciously attacked this question experimentally, believes so, and he presented his theory in the September 1973 issue of Science Digest.

> To explain how memory molecules are formed, Dr. Ungar proposes that each neuron in the brain has its own unique chemical label. When two neurons form a synapse joining nearby pathways, the label from one neuron enters other. As a result, the other neuron synthesizes a memory molecule. This consists of the labels from both neurons. The molecule makes the connection between the two neurons permanent, though exactly how it does this is not yet known. Similarly, every other synapse has its own memory molecule.
>
> Memory molecules, then, store memories by permanently setting up the route along which electrical impulses travel. Thus, when scotophobin is injected into a rat, it makes certain permanent new connections between neurons. These are the same connections the molecule originally made in the brain of the donor rat. Since the connections are now the same, electrical impulses can follow the same routes. Therefore, both animals now possess the same memory. (R9)

It should be reemphasized that the mechanism described by Ungar is still only a theory.

References

R1. Ungar, G., and Oceguera-Navarro, C.; "Transfer of Habituation by Material Extracted from the Brain," Nature, 207:301, 1965. (X1)

R2. Babich, Frank R., et al; "Transfer of a Response to Naive Rats by Injection of Ribonucleic Acid Extracted from Trained Rats," Science, 149: 1965. (X1)

R3. McBroom, Patricia; "Memory Transfer Unlikely," Science News Letter, 89:151, 1966. (X1)

R4. Rosenblatt, Frank, et al; "The Transfer of Learned Behavior from Trained to Untrained Rats by Means of Brain Extracts," National Academy of Sciences, Proceedings, 55:548 and 55:787, 1966. (X1)

R5. Byrne, William L., et al; "Memory Transfer," Science, 153:658, 1966. (X1)

R6. Ungar, G., and Irwin, L.N.; "Transfer of Acquired Information by Brain Extracts," Nature, 214:453, 1967. (X1)

R7. Anonymous; "Transfer of Fear from Rats to Mice," New Scientist, 41:30, 1969. (X1)

R8. Anonymous; "Learning and Memory Transfer: More Experimental Evidence," Science News, 100:308, 1971. (X1)

R9. Graff, Gordon; "Chemical Memory for Instant Learning," Science Digest, 74:85, September 1973. (X2)
R10. Oden, Bratt G., et al; "Interanimal Transfer of Learned Behavior through Injection of Brain RNA," Psychological Record, 32:281, 1982. (X1)

BMB9 Behavior Correlated with Lunar Distance at Birth

Description. The correlation of ambulatory behavior with lunar distance at birth.

Data Evaluation. We have only a single report on the phenomenon. The needed replication has not yet been found in the literature. Phenomena as controversial as this require corroboration. Rating: 3.

Anomaly Evaluation. Any correlation between the behavior of animals and the distance or position of the moon is highly anomalous. The phenomenon at hand smacks of astrology, the tenets of which are emphatically rejected by science. Rating: 1.

Possible Explanation. None offered.

Similar and Related Phenomena. Correlation of human behavior (including intelligence) with various astronomical phenomena. (BHB3, 4, 10-12, 28-30, 35, 41 in Humans 1).

Entries

X1. Experimental data.

Rats. The lunar correlation reported below was discovered accidentally during research at the University of Tennessee.

> A significant correlation of .877 between lunar distance at the time of birth and the number of squares traversed in an open-field situation 21 to 25 days later was found for 19 litters that had been exposed continuously during their prenatal development to a 0.5 Hz, 3 to 30 gauss Rotating Magnetic Field (RMF), over a year. RMF-exposed litters that were born on or near lunar perigees traversed fewer squares in an open field than those born on or near apogees. RMF-exposed litters tested "blind" also showed the relationship between lunar distance at time of birth and later open-field activity. 12 control litters did not show a significant correlation. (R1)

Reference

R1. Persinger, Michael A.; "Prenatal Exposure to an ELF Rotating Magnetic Field Ambulatory Behavior, and Lunar Distance at Birth: A Correlation," Psychological Reports, 28:435, 1971. (X1)

BMB10 Mammalian Art and Music

Description. The apparent appreciation of art and music by mammals and their creation of the same. An aesthetic sense in mammals.

Data Evaluation. Animal art has received considerable attention from scientists and others, perhaps because humans do not expect "dumb" animals to possess any aesthetic sense. Most of the writings on animal aesthetics, however, are in popular magazines and books. Much of the writing is in anecdotal form with strong anthropomorphic bias. Finally, it is questionable whether animal art is really art. It doesn't look like art to many. Rating: 3.

Anomaly Evaluation. Art is concerned with such factors as beauty, form, balance, symmetry, message, and other highly subjective values. The general belief is that only humans can appreciate and create works embodying such characteristics. The phenomenon at hand, animal art, is therefore unexpected; but is it anomalous? Given that apes are thought to be closely related to humans on the mammal-family tree, it is really rather likely that they, too, have some genes that confer the aesthetic sense on them. Elephants are more distantly related, but they do have large brains and considerable intelligence; and intelligence does involve such aesthetic factors as the recognition of form, symmetry, and symbols. In this context, animal art does not appear very anomalous, assuming it does exist. When the "animals-as-automatons" paradigm is considered, however, any hint of artistic proclivities among non-human animals is definitely anomalous. Rating: 1.

Possible Explanations. The aesthetic sense coevolves with intelligence.

Similar and Related Phenomena. Mammalian singing (BMT8); mammalian dancing (BMB13); human culture as a evolutionary overshoot (BHB14 in Humans I); bowerbird "art" (BBB).

Entries

X1. Mammal art. By mammal "art" we mean the creation by mammals of groupings or "compositions" of lines or daubings. The instruments may be sticks, pencils, brushes, paint-smeared fingers, in short any marking device. Mammal art ranges from marks in the sand to paint on canvas. We also include here assemblages of decorative objects. In some cases, animal art is not easily distinguishable from human "modern art!"

Primates. The art of primates (other than ourselves) never seems to come naturally. Apparently, no one has ever seen wild apes or monkeys engaged in artistic endeavors. But once shown how to draw in human laboratories and given the proper instruments, paper, etc., several primate species continue on their own, and with enthusiasm. Chimps are particularly happy with drawing and painting. Gorillas, orang-utans, and some monkeys will also draw given encouragement. All the primates draw without the standard rewards (bananas, etc.) and seem to enjoy art for art's sake. They even will object if one of their pictures is removed before it is "finished!"

D.D. Davis evaluated primate art in his book The Unique Animal, basing some of his observations on the work of D. Morris, who made a long study of animal art. (R2) Davis wrote:

> The scribbles of these animals develop and change over time as they acquire experience. An individual ape usually starts with relatively simple lines, but with experience changes more and more to multiple scribbles. There appears to be a distinct patterning and sense of design employed in these scribbles. Each animal appears to have an individual drawing style which seems to be fairly constant over time. Any attempts by the experimenter to influence the kind of picture being produced were always unsuccessful.
>
> From these results we can fairly confidently assume that the apes are capable of at least some primitive degree of aesthetic enjoyment of their artistic work. However, the most important fact in this area is that none of these apes or monkeys was ever able to reach the imitative or representational stage of art. That is, none of these animals, no matter how old or experienced, was ever able to draw a crude picture or outline of some object. A human child's scribbles quickly become imitative, but a chimp's never do. In other words, they were never able to formulate the conventions or symbols that were necessary before art can become a form of communication. (R4)

A fan-pattern drawing by a female chimpanzee. (R4)

An interesting feature of ape art is sometimes observed when an animal is presented with an asymmetrically marked piece of paper. It will study it and then make the drawing symmetrical with appropriately placed lines. (R3)

Amusing anecdotes relating to ape art were related by J. Diamond in The Third Chimpanzee: The paintings of two chimps, Congo and Betsy, were shown at the Royal Festival Hall in London. Most pieces found ready buyers, even though the artists were identified properly. When ape art has been surreptitiously entered in regular art shows, unsuspecting critics have remarked on the dynamicism, rhythm, and sense of balance evident in the sketches. (R8)

Diamond commented further on animal art:

> These paintings by our closest relatives do start to blur the distinction

> between human art and animal activities. Like human paintings, the ape paintings served no narrow utilitarian function of transmitting genes, and were instead just produced for satisfaction. One could object that the ape artists, like the elephant Siri [Siri is on stage below], made their pictures just for their own satisfaction, while most human artists aim to communicate to other humans. The apes didn't even keep their paintings to enjoy but just discarded them. (R8)

As coincidence would have it, the very day this section was being written, the daily paper arrived displaying a photograph of an orang-utan, named Nonja, busily engaged in completing a drawing. Housed at Vienna's Schoenbrunn Zoo, Nonja is preparing for her third exhibition, in Vienna, in February 1995. (R9)

Elephants. J. Diamond above mentioned the Asian elephant, Siri. There is, in fact, an entire book devoted to Siri and elephant art. (R5) Many of the observations concerning ape art are also applicable to elephant art. We have, for example, another amusing comment from an art critic, this time regarding Siri's art. An expert on abstract expressionism, J. Witkin, not knowing that Siri was an elephant, gushed:

> These drawings are very lyrical, very, very beautiful. The energy is so compact and controlled, it's just incredible. (R6)

But animal art is more important than as a generator of anecdotes. First, let us see what elephant art looks like and then see if it tells us anything significant about elephants.

Siri and other elephants obviously grasp the drawing instruments with their trunks. Dexterous as an elephant's trunk is, it is not as suitable for drawing as a chimp's hands. Nevertheless, Siri does well in imitating some modern art. (See illustration.) What is most significant biologically is that wild elephants have been seen using their trunks to make drawing motions in the dust. Captive elephants sometimes take sticks or stones in their trunks and spontaneously scratch marks on the ground. (R6) In contrast to the apes and monkeys, elephants seem to have an innate urge to make markings, which one can interpret as drawings. One would expect the apes, rather than the much more distantly related elephants, to spontaneously generate something close to human art.

The elephant Siri "drew" this. (R5)

Rodents. We have so far found only one other mammal that indulges in art---and this stretches the definition of art rather far.

A South American rodent, the plains viscacha, constructs extensive burrows. These animals collect many inedible items ---sticks, stones, bones, objects dropped by humans---and display them above ground around their burrows. Can this activity be considered art, like that of the Australian bowerbirds, or are the viscachas just collecting miscellanea like pack rats? (R7)

X2. Music appreciation. Many animals, mammmals foremost among them, are noticeably affected by music. Since most of the music animals are exposed to is human-produced, we have cataloged most mammal reactions to music in BHX2, in Humans III, where we attend to the complex interfaces between humans and other animals. It is there, for example, that we discuss the use of music in snake charming. So also are the reactions to music of elephants (who tend to sway with the music), cows (who do the same), and dogs (who may keep time). However, we can legitimately enter here an anecdote describing the reactions of a mammal to naturally produced music-like sound.

Mice. The instrument involved here is the aeolian harp, which when its strings are stroked by the wind generates a pleasant, music-like sound.

> The wind drawing through and over the strings makes a very pretty, soft, musical sound. One day, as she sat reading in her room, near the window. she observed a mouse moving in front of her. Presently another made its appearance, till she had an audience of six mice, all intent on the musical sounds. Not being afraid of mice, she arose from her seat and carefully stopped the music without frightening them. They remained silent for a few moments and then ran away. After a few minutes the music was resumed, they all appeared again, and came still nearer her person, making a faint squealing noise. For days the coming of the mice was a regular thing. (R1)

This anecdote should be compared with those involving "singing mice." (BMT8)

X3. Cross references: music-making and dancing. Of the animals, the birds are best known for their musical talents. Humpback whales have also received considerable notice in the literature. It develops that many other mammals sing (mice, moose, monkeys) and sometimes in choruses (whales, lemurs). In this Catalog, these vocalizations are treated as forms of communication rather than as indicators of an aesthetic sense. This is in keeping with the practice of ornithologists to treat every bird song, no matter how complex and beautiful, as a signal or a communication. Therefore, the songs of the humpback and other mammals are to be found in BMT8.

In the context of aesthetics, several species of rodents "waltz" or dance, but biologists do not consider these "performances" to be aesthetic productions either. So, for mammalian dancing, see BMB13.

References

R1. Pike, Nocholas; "Musical Susceptibility of Animals," Scientific American Supplement, 46:19069, 1898. (X2)
R2. Morris, Desmond; The Biology of Art, New York, 1962. (X1)
R3. Bleakney, J. Sherman; "A Possible Evolutionary Basis for Aesthetic Appreciation in Men and Apes," Evolution, 24:478, 1970. (X1)
R4. Davis, Don D.; The Unique Animal, New York, 1981. (X1)
R5. Gucwa, David; To Whom It May Concern, New York, 1985. (X1)
R6. Diamond, Jared; "Art of the Wild," Discover, 12:79, February 1991. (X1)
R7. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)
R8. Diamond, Jared; The Third Chimpanzee, New York, 1992. (X1)
R9. Anonymous; Baltimore Sun, January 25, 1995. (X1)

BMB11 Handedness in Mammals

Description. The preference in some mammals for the use of one hand, foot, or fin over the other. This handedness or lateralization is noticed mainly in those mammals that use their hands or paws in manipulation, but it also extends to locomotion and head movements.

Data Evaluation. Animal behaviorists have devoted considerable research effort to lateralization phenomena, mostly in the study of captive primates. Our short bibliography below represents only a fraction of the available literature. The major concern with handedness data is that they are often inconsistent and even contradictory. There is obviously some handedness evident in the other mammals, but it is not as strong and consistent as it is in humans. Rating: 3.

Anomaly Evaluation. Until fairly recently, as explained in X0 below, humans were thought to be the only lateralized animals. In fact, strong lateralization or handedness was intimately associated with language development and, in turn, humaness. Therefore, the discovery of strong lateralization in other mammals would challenge a minor paradigm of the animal behaviorists. Rating: 2.

Possible Explanations. Handedness in the other mammals is so weak that it may well be a consequence of the environment, including experimental setups, habits, and even learning by watching strongly lateralized human experimenters.

Similar and Related Phenomena. Human handedness phenomena (BHB20-23 in Humans 1).

Entries

X0. Background. The supposed uniqueness of humans is thought by some scientists to be closely tied to the strong tendency (roughly 90%) of humans to use the right hand rather than the left in manipulative tasks. This linking of humaness and handedness seems to be a debatable association, as the discussion below will demonstrate.

The basic idea behind this assertion is that strong lateralization allows the two sides of the human brain to specialize. The left side, which controls the right hand in righties, is associated with the use of language as well as manipulation, whereas the right side of the brain is assigned to intuitive, synthetic, and holistic tasks. Of course, this is usually reversed in lefties. The basis for the humaness-handedness connection is that lateralization and language go hand in hand---and the use of language is a hallmark of humaness. Animals without language (and therefore "inferior" to us) should not show strong lateralization. A lack of lateralization in other mammals, therefore, has long been the expectation of biologists. However, in 1987:

> [P.] MacNeilage, together with his colleagues.., first raised the question of nonhuman primate handedness in an article in Behavioral and Brain Sciences. Pulling together results from 45 studies on such widely divergent species as bush babies, macaques, and chimpanzees, the three argued that these primates did display hand preferences. Not only would such preferences for specific tasks indicate neurological asymmetry, but they may also have paved the way for the development of languages. (R4)

This report by MacNeilage stimulated more studies on nonhuman handedness. As we shall see below, not only do our closest relatives, the apes, seem to be somewhat lateralized, but other mammals, too, seem to show a tendency toward handedness. Such findings of course challenge the notion that lateralization is an indicator of language proficiency and, therefore, evolutionary superiority.

But the results we present are not clear-cut. It's all a murky business. The issue is complicated further by the discovery that language is not a left-brain function in all right-handers; neither is the reverse true in lefties. (BHO24-X3, in Humans I)

X1. General observations. Among the primates, handedness is rather easy to determine, because most use their hands to throw missiles at zoo-goers, to reach for food, to fish for termites with twigs, to crack nuts, etc. But even mammals without dexterous hands exhibit handedness in various ways. The little collection that follows certainly tends to show that handedness is not a human monopoly.

Primates. The studies of primate handedness is not always clear-cut and consistent, as the following quotations will demonstrate.

> Spontaneous manual lateralization using uni- and bimanual trials was studied in an orang-utan and a chimpanzee. The orang-utan was consistently right-handed particularly in a bimanual co-ordination test, where digital-pinch grasping was performed by the right hand. For the chimpanzee, a shift occurred from left to right manual dominance in a unimanual test; however in knuckle-walking, phalanx support was always performed with the left hand first. (R1)

A rather weak tendency toward left-handedness in chimps was evident is another study:

> Table 3 [not reproduced] shows that a weak but consistent trend toward left-sidedness found for termite fishing also holds across all known large-scale studies of chimpanzee tool use. Termite fishing, ant fishing, nut cracking, and missile throwing by chimpanzees all fell within the range of 53-59% left-sided when data in each study were pooled. (R6)

These percentages must be compared with human 90% right-handedness.

Other observations seem to bolster the case for primate lateralization. Squirrel monkeys, when trying to catch goldfish, like to do it left-handed. (R4) Ruffed lemurs also showed a strong left-hand bias in reaching for food that had been tossed into a moat. (R4)

More recent work has confused the question of handedness in chimpanzees and in primates in general:

> Recent findings have revealed population-level right-handedness for bipedal but not quadrupedal reaching in chimpanzees, orangutans, bonobos, and gorillas. In contrast, studies of bipedal reaching in monkeys have failed to reveal a significant population-level bias, whereas prosimian species have exhibited a population-level left-hand bias. (R7)

Scientific observations aside, it has long been noticed by the general public that humans predominantly cradle infants on the left side. But, since humans are strongly lateralized, some bias in baby-cradling is to be expected. Some primate studies suggest that apes, too, preferentially cradle their infants on the left side, too. Here is one analysis of this interesting phenomenon:

> When they cradle a baby, 80 per cent of women hold it against the left side of their body, regardless of whether they are left- or right-handed. Now researchers have discovered that female chimpanzees and gorillas show the same bias (Animal Behaviour, vol. 39, p. 1224). The behaviour may be telling us that the brains of the great apes are organized in a very similar way to humans, with the left and right side carrying out specialised jobs. (R3)

The above observations were made by J. Manning and A. Chamberlain of the University of Liverpool. However, the work by W.D. Hopkins et al did not confirm the conclusions of Manning and Chamberlain. It seems that older infants (up to 1½ years) in the Manning-Chamberlain study have minds of their own and override their mother's preferences! (R7)

Cats. Non-primates may be mildly lateralized. The handedness of cats has been measured by watching them reach for food in a tube: 20% preferred the right paw and 38% the left. The rest were ambidexterous. (R2)

Impalas. Male impalas display many more scars on the right side, suggesting that in combat with other males they preferentially turn to the left. (R5)

Dolphins. When these cetaceans are placed in tanks, they prefer to swim counterclockwise. Interestingly, it is a matter of common observation that humans tend to circulate counterclockwise in small parks, markets, and on cruise-ship decks! (R5)

References

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R2. Bradshaw, John L.; "The Evolution of Human Lateral Asymmetries: New Evidence and Second Thoughts," Journal of Human Evolution, 17:615, 1988. (X1)
R3. Mason, Georgia; "Why Do Humans and Apes Cradle Babies on Their Left Side?" New Scientist, p. 28, July 21, 1990. (X1)
R4. Morell, Virginia; "A Hand on the Bird---and One on the Bush," Science, 254:33, 1991. (X1)
R5. Bradshaw, John L.; "Animal Asymmetry and Human Heredity: Dextrality, Tool Use and Language in Evolution---10 Years after Walker (1980)," British Journal of Psychology, 82:39, 1991. (X1)
R6. McGrew, W.C., and Marchant, L.; "Chimpanzees, Tools, and Termites: Hand Preference or Handedness," Current Anthropology, 33:114, 1992. (X1)
R7. Hopkins, W.D., et al; "Chimpanzee Hand Preference in Throwing and Infant Cradling: Implications for the Origin of Human Handedness," Current Anthropology, 34:786, 1993. (X1)

BMB12 Curious Forms of Locomotion

Description. Unusual forms of walking, running, and swimming on land, on water, and under water.

Data Evaluation. Various mammal guides and a few scientific journals contributed to this melange---all apparently very reliable. Rating: 1.

Anomaly Evaluation. No anomalies here, just curiosities. Rating: 4.

Possible Explanations. None required.

Similar and Related Phenomena. Dancing in nonhuman animals (BMB13); unusual aerial displays of dolphins (BMB32).

Entries

X1. Whale-tail sail tales. We doubted this story until we saw it corroborated in Walker's. (R8)

Right whales.

> One of their favourite toys is a great storm---to lesser mortals something to be feared and avoided, but to the great whales a boisterous playmate. Raising their immense flukes they sail downwind, then swim back and repeat the game, again and again. (R6)

X2. Running on water. Insects, such as water-striders, do this, and other lightweight animals can also skitter across the water buoyed up by surface tension. Of the mammals, only shrews seem to be able to run on water effectively.

American water shrews. This species is very much at home in the water and able to dive and swim under water for for almost a minute.

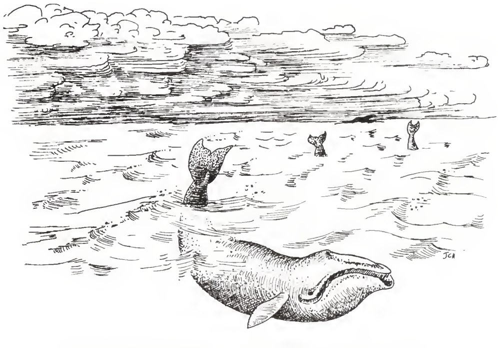
> This species has been observed "running" on water, evidently deriving support from surface tension and buoyancy from air trapped by the hairs of the feet. (R8; R2)

Pacific water shrews. Also water-runners, these animals are able to stay on top of the water for 3-5 seconds. (R8)

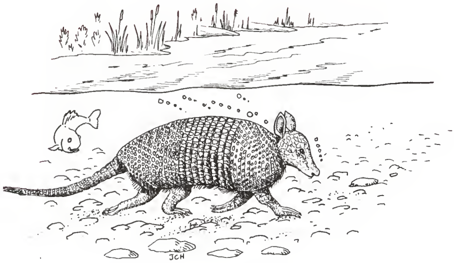
X3. Underwater walkers.

Nine-banded armadillos. With their coats of heavy armor, one would expect these animals would sink like rocks. But they are not afraid of water; they swim well and can hold their breath for as long as 6 minutes. Here is how they deal with water obstacles:

> To cross a narrow stream or river,



Right whales have been seen using their tails as sails in very windy weather. This seems to be a form of play.



When confronted with a river obstacle, the nine-banded armadillo may walk across on the bottom of the stream.

> the armadillo holds its breath and walks along the bottom. If the river is too wide to be crossed in this fashion, the armadillo surfaces, gulps in air to inflate its intestines, and completes its journey buoyed up by its built-in waterwings, holding its slender, pink-tipped nose above water like the periscope of a submarine. (R3)

There are 20 species of armadillos in the New World, and the only species reputed to cross streams under water is the nine-banded armadillo, Dasypus novemcintus, a variety of long-nosed armadillo. (R8)

X4. Side-swimming cetaceans.

Susus. There are two species of this long-beaked river dolphin, one in the Ganges and the other in the Indus.

> The susu is exceptional in the way it swims. As the only side-swimming cetacean, it cruises along the bottom, usually tilted to the left, nodding continuously. Since it never stops emitting echolocation-type pulses, the susu is believed to navigate and find food with the help of an extremely sophisticated bisonar system. (R5)

The susu is almost blind; its eyes do not even have crystalline lenses. Actually, sight would be of little use in the muddy rivers it frequents. (BMA24-X1)

Finwhales. A lesser degree of tilt may be exhibited by the finwhales.

> ...finwhales are strongly and asymmetrically countershaded (grey above, lighter beneath) indicative of a rightward list in their normal posture. (R7)

X5. Curious gaits.

Horses. H. Tributsch found horses that run like camels in Peru.

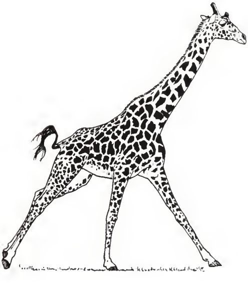
> When a friend in Lima mentioned once that there were horses in Peru than

> ran like camels, my face must have reflected my incredulity. He stubbornly stuck to his statement, and soon thereafter I found myself on a stud farm south of the capital. The horses bred there did indeed amble like camels, moving both legs on the same side simultaneously. The normal gait of the horse---the trot, whereby one front leg and the opposite hind leg move simultaneously---was completely unfamiliar to these animals. (R4)

These Peruvian horses are descended from those used in the Peruvian coastal desert. Their strange, camel-emulating gait is better adapted to loose sand, and they have been bred selectively to acquire this useful gait.

Giraffes and okapis. Both the giraffe and the okapi have the camel's gait, too, but they do not usually travel over loose sand, so the origin of their gait is more mysterious. A.I. Dagg expounds on this question:

> The walking gait of the giraffe is usually considered as unique among mammals. The giraffe walks or "paces" by lifting the two limbs on the same side of the body approximately at the same time, rather than by moving alternate legs on either side in the manner of the horse and other mammals. A.B. Howell concludes that the unusual gait of the giraffe is necessary to keep the long legs of the animal from interfering with each other. Because of the giraffe's height, its lateral or transverse inertia is great enough to counteract the disruptive "pacing" walk which would prove too disturbing to the stability of a smaller animal. (R2)



Giraffes move both legs on one side simultaneously---the so-called "camel's gait."

Dagg noted on a visit to the Bronx Zoo that the smaller okapi, closely related to the giraffe, also had the same peculiar gait. But the okapi does not have the giraffe's long legs, and the "interference" explanation given above would not apply. (Apparently, Dagg did not know about camels and the Peruvian horses,)

Short-nosed bandicoot. About the size of a large rat, these marsupials move their forelegs and hind legs separately; that is, there is no gait in the usual sense of coordinated movement of the front and rear legs. (R8)

References

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R2. Dagg, Anne Innis; "Gaits of the Giraffe and Okapi," Journal of Mammalogy, 41:282, 1960. (X5)

R3. Rue, Leonard Lee, III; Pictorial Guide to the Mammals of North America, New York, 1967. (X3)

R4. Tributsch, Helmut; How Life Learned to Live, Cambridge, 1982. (X5)

R5. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X4)

R6. Vandenbeld, John; Nature of Australia, New York, 1988. (X1)

R7. Bradshaw, John L.; "Animal Asymmetry and Human Heredity: Dextrality, Tool Use and Language in Evolution---10 Years after Walker (1980), British Journal of Psychology, 82:39, 1991. (X4)

R8. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1, X2, X5)

BMB13 Mammals that Waltz and Weave

Description. Rather bizarre motions of mammals that have neither obvious purpose nor external stimuli. These motions include waltzing or dancing, circling, shaking, and weaving.

Data Evaluation. Waltzing mice have been observed for two centuries or more and have been duly recorded in the scientific literature. The phenomenon extends to other rodents, but they have not received as much attention. The weaving phenomenon has been recorded only for elephants, and we have collected only a single reference here. Rating: 2.

Anomaly Evaluation. The waltzing behavior is thought to be pathological and cannot be called anomalous, although it is most intriguing. (Of course, our anthropomorphic bias may prevent scientists, particularly behaviorists, from admitting that other species may dance for pleasure!) Elephant weaving is even more curious, but it is evidently something all elephants do. Since the origins and purposes (if any) of dancing and weaving are controversial and somewhat mysterious, we must accord the phenomenon at least a low anomaly rating. Rating: 3.

Possible Explanations. See above.

Similar and Related Phenomena. Whirling dervishes (?); spinner dolphins (BMB32); tumbler pigeons (BBT); mammalian vibrations (BMA52); human vibrations (BHA56 in Humans I).

Entries

X1. Dancing mammals. "Waltzing" mice have intrigued biologists for many years. It is less well known that at least three other species of rodents are also afflicted by the same rare, inheritable, nervous defect. Besides dancing and waltzing, mice may "shake" or "circle." Our discussion, though, is confined to the more common waltzing animals. All of these erratic behaviors are probably pathological in origin.

Mice. Perhaps the most famous waltzing mice were those bred in Japan in the Nineteenth Century.

> Early in life they exhibit the tendency which has earned for them the name above applied. When a mouseling leaves the nest its gait consists of an evident attempt to proceed in a straight line; this is frustrated by a tremulous movement of the head, which is nervously shaken from side to side. Shortly, a tendency is exhibited to turn; this develops into a rotary motion, performed with extraordinary rapidity, which constitutes the peculiarity of the waltzing mouse.
>
> The ordinary routine of daily life is constantly interrupted by this mad disposition to whirl, frequently indulged in for several minutes, and, with an occasional stoppage of a few seconds, continued for hours. The floor of one of Mr. Haley's cages being somewhat rough, the mice actually reduced their feet to stumps before it was noticed. Like ordinary mice they sleep during the day, but apparently waltz the whole night long. If, however, they are disturbed during daylight, they leave their bed and work off some surplus energy.
>
> The rotation is so rapid that all individuality of head and tail is lost to the eye, only a confused ball of black and white being recognized. Very often they spin in couples, revolving head to tail at such a speed that an unbroken ring only is perceived. (R1)

Rats. During some breeding experiments

in the 1930s, H.D. King isolated a strain of waltzing rats starting with wild rats. Several of these waltzers appeared only after the first 5,000 rats were bred. When the waltzers were bred to each other, their 84 offspring included only two male waltzers and one female waltzer.

King described her experiment is the Journal of Mammalogy. (R2) Here, we quote from a short summary of her waltzers' peculiar behavior that was published in Science Digest.

> The waltzing rats may whirl rapidly in a small circle for several seconds, then run in loops, large circles, or the figure eight. When the cycle of these movements is disturbed, the rats tend to run wildly about the cage, making new circles. If they escape the cage, they are easily caught for they pause every few moments to whirl vigorously, and they seem incapable of running any distance in a straight line. (R3)

Voles. In 1960, a waltzing female vole was born in a laboratory colony that had been bred from wild stock. Her behavior closely resembled that of the waltzing mice and rats. (R5)

Guinea pigs. Waltzing guinea pigs were mentioned in H.D. King's paper in the Journal of Mammalogy. No details were presented. (R2)

X2. Weaving. The rhythmic weaving or swaying motion cataloged here is exhibited by all members of the one species in which it has been observed. (If there are other weavers, we have not recorded them, yet.) Weaving is probably not a pathological behavior, like waltzing, but its purpose and origin are unknown.

Asian Elephants. The trunk, tail, and ears of elephants are in almost constant motion, but they are minor and random compared to the rhythmic weaving now described by F.G. Benedict and R.C. Lee.

> In the major muscular movement of weaving, the elephant usually sways from side to side, shifting the weight from one foot to the other, and less often moves forward and back, shifting the weight from the front legs to the rear legs and the reverse. At night, when the animals are not excited by the presence of onlookers or by the other stimuli incidental to circus life, it was frequently observed that these weaving motions had an extraordinarily uniform tempo. At the New York Garden between 1 and 4 A.M., many of the Ringling herd were noted to move from side to side at a tempo of about ten movements in 28 or 29 seconds. The forward and back motion, although less common, likewise has a uniform rhythm. One elephant was exceptional in the fact that the time for 10 movements was nearer 16 rather than 28 seconds. ...No external stimulus could be associated with the observed tempo, and we were convinced that the rhythmic nature of the elephant's motion is a clearly established fact. (R4)

It would not be surprising if African elephants also display this phenomenon.

References

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R2. King, Helen Dean; "A Waltzing Mutation in the White Rat," Journal of Mammalogy, 17:157, 1936. (X1)

R3. Anonymous; "Waltzing White Rats," Science Digest, 1:94, April 1937. (X1)

R4. Benedict, Francis G., and Lee, Robert C.; "Further Observations on the Physiology of the Elephant," Journal of Mammalogy, 19:175, 1938. (X2)

R5. Warnock, John E.; "Waltzing in the Genus Microtus," Journal of Mammalogy, 45:650, 1964. (X1)

BMB14 Predator-Prey Mismatches: Dolphins and Toothed Whales

Description. The existence of a suite of mismatches or incompatibilities between the speeds, maneuverabilities, and feeding structures of the dolphins and toothed whales (the Odontocetes) and the quantities and nature of the prey they are able to capture.

Data Evaluation. The observations collected here derive from extensive field and tank observations of dolphins and toothed whales. Despite their soundness, they are circumstantial in terms of proving a widely questioned hypothesis. More field data directly applicable to the hypothesis proposed in X5 are required. Rating: 3.

Anomaly Evaluation. The implication of the observations collected here is that dolphins and toothed whales employ high intensity sound in hunting. Although this hypothesis is still considered unproven and radical by many zoologists, its proof would not put any cherished biological paradigms at risk. Rating: 3.

Possible Explanations. The implied hypothesis (above and X5) is correct.

Similar and Related Phenomena. Cetacean sound-generating organs (BMO in Mammals II); cetacean echo location (BMT3-X2); the use of sound by pistol shrimp (BAB); the human use of dynamite in fishing.

Entries

X0. Introduction. Dolphins and toothed whales feed mostly on fish and squid. It is true that all of these aquatic mammals are armed with teeth; some species with many, but others have just a couple ineffective ones. Strangely, the latter species feed well despite their handicap. Dolphins are speedy and maneuverable enough to run down their prey, but the ponderous sperm whales dote on squid that should be able to elude them easily. These are a few of the mismatches or incongruities in the cetacean predator-prey relationship. We will expand on them a bit and see where they lead.

X1. Size, speed, and maneuverability. Sperm whales are not famous for speed and maneuverability. Yet, they consume huge quantities of swift surface fish (mackerels, barracudas, tuna, salmon) and deepsea squid, which are among the fastest animals in the oceans when they turn on their jet-propulsion system. Furthermore, sperm-whale stomachs yield many tiny fish that the whales would have difficulty catching if it was even worth their while. In fact, the caloric value of a 10-pound squid is less than the energy a whale would have to expend in pursuing it. (R1-R4)

Other apparent predator-prey mismatches are:

- Narwhals/pandalid shrimp
- Killer whales/herring
- Beaked whales/squid

X2. Feeding structures. The beaked whales are functionally toothless (BMA35). The dental array of the males usually consists of just two lower incisors. Nevertheless, beaked whales, though rare in numbers, manage to catch all the prey they need. The male strap-toothed whales are even worse off.

They can open their mouths only about 3 inches. (BMA33) But their stomachs are usually full of fish and squid. (R1-4)

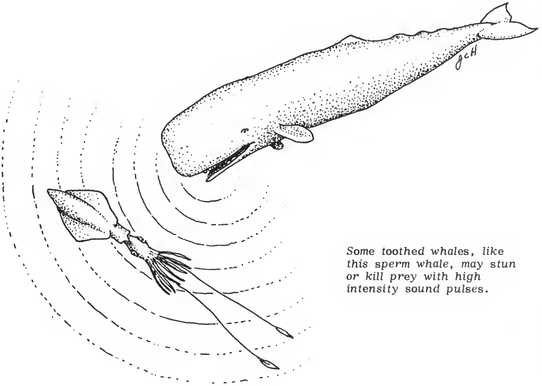
Even more curious are reports from whale factory ships describing sperm whales with congenitally deformed jaws that are essentially useless in hunting. The stomachs of these whales yield squid aplenty. (R5) How could these deformed whales have survived?

On a paleontological note, K.S. Norris and B. Mohl have remarked that the fossils of the ancient toothed whales typically have many prominent teeth. What development in evolutionary history led to the loss of teeth in so many of the toothed whales and yet permitted them to prosper? (R1-R3)

X3. Condition of captured prey. Almost all the food items found in the stomachs of sperm whales are without tooth marks. Even large squid and sharks over 9 feet long have not been bitten. (R1-3)

X4. Behavior of prey. When prey fish are introduced into tanks containing dolphins, they seem to become seriously disoriented by the sonar clicks of the dolphins. (R1, R3)

X5. Implications and a hypothesis. Taken together, the above data suggest that somewhere in the march of evolution the dolphins and toothed whales acquired a device and/or hunting technique that did not require formidable teeth and high speed plus maneuverability. A reasonable replacement for teeth and speed would be a device that disoriented or stunned prey so that they could be easily caught and swallowed. Since fish do seem to be disoriented by the low-power, navigation sonar of captive dolphins, perhaps more intense sound would debilitate them or even stun them.



Some toothed whales, like this sperm whale, may stun or kill prey with high intensity sound pulses.

Fish can be stunned easily by sound, as those fishermen who employ dynamite well know. Actually, tests have shown that dolphins are capable of greatly increasing the intensity of their sound pulses---enough to stun some fish. (R1-3) Extrapolating these ideas to the huge sperm whale, with its massive sound producing and focussing apparatus, we can believe that even very large prey might be debilitated and swallowed.

So, the cetacean "stun-gun" hypothesis is not at all unreasonable.

References

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R2. Anderson, Ian; "Stunned Prey Are Easier to Catch," New Scientist, 100: 807, 1983. (X1-X3, X5)
R3. Tangley, Laura; "A Whale of a Bang," Science 84, 5:74, May 1984. (X1-5)
R4. Norris, Kenneth S,; Dolphin Days, New York, 1987. (X1. X2, X5)
R5. Bright, Michael; The Living World, New York, 1991. (X2, X5)

BMB15 Curious Lures Used by Mammals

Description. The use of lures---usually body parts---by mammals in attempts to attract and capture prey.

Data Evaluation. We have only anecdotes to offer here. Although they originate in respected scientific journals, their character makes them of very questionable value. Rating: 3½.

Anomaly Evaluation. At the least, the anecdotes offered here are delightful; at the most, they tell us that some mammals are observant and clever. We will never know if these hunting techniques, when found to be true, arose accidentally or were designed through observation and reasoning. We assume the latter is correct and assign the phenomenon a high level of anomalousness, mainly because animal behaviorists accord the other animals no reasoning power whatsoever. Rating: 1.

Possible Explanations. Mammals are more clever than most animal behaviorists allow, or the anecdotes that follow are untrue.

Similar and Related Phenomena. Fishing technique of the cassowary (BBB); other evidence of mammalian intelligence (BMB5, BMB6); collective activities of mammals (BMB25-31 and 33).

Entries

X0. Introduction. The use of lures to capture prey is found in many phyla from human-made duck decoys to the pseudofish dangled by the angler fish. Mammals other than humans seem to use lures only rarely, preferring to ambush or run down their dinners. We do find, though, a few wonderful old tales of mammalian ingenuity in the literature. E.W. Gudger, a naturalist at the American Museum of Natural History in years past, greatly enlivened stodgy journals with his collections of oddities and miscellany involving fish. He is our primary source of the anecdotes that follow. Not surprisingly, all but one tale involve fish or crustaceans. (R1, R3)

X1. Mammal tails as fish and crustacean lures. Fish and crustaceans (crabs and crayfish, especially) may be lured to mammal tails if: (1) They look edible; (2) They provide shade and shelter; and (3) They make sounds like something edible. We begin with the last possibility.

Jaguars. E.W. Gudger's delightful collection of anecdotes about the fishing skills of the jaguar (R1) includes observations by a most famous naturalist, A.R. Wallace, cofounder with Darwin of the theory of evolution.

> This is no less an authority on the natural history of the Amazon Valley than Alfred Russell Wallace, who spent the years 1848-1852 in exploring the Valley and in gathering data for his "Narrative of Travels on the Amazon and Rio Negro" (London, 1853). On page 455 he wrote: "The jaguar, say the Indians, is the most cunning animal in the forest; he fishes in the rivers, lashing the water with his tail to imitate falling

The jaguar is said to use its tail to imitate the splashing of fruit falling in the water in order to attract fish.

> fruit, and when the fish approach hooks them up with his claws." Here is given not merely the action of the tail but an explanation of how and why it has come to be so used. (R1)

Continuing his long parade of jaguar fishing anecdotes, Gudger quotes another naturalist of the Nineteenth Century who spent years in Brazil and the Amazon Basin, H.H. Smith. This quotation is from Smith's 1879 book Brazil, the Amazons and the Coast.

> The spotted Jaguar belongs here [on the rivers of Brazil] by right; he is a fisherman as well as a hunter, and ...you never find him far from water. The Indians have a curious story about his fishing. The Jaguar, they say, comes at night and crouches on a log or branch over the water; he raps the surface of the water with his tail gently, and the tambakis, or other fruit-eating fish come to the sound, when he knocks them out with his paw. I do not take it upon myself to say that this story is true, but I have heard it from all sides, and from persons who aver that they have seen the fishing. (R1)

Gudger, being a scientist, recognized that his impressive collection of jaguar tales (There are many more.) did not prove the phenomenon to be true. But, reflecting upon the jaguar's admitted intelligence and the abundant testimonial evidence, he thought there might be something to the story.

Cats. In 1942, E.W. Gudger read an account, printed in several North Carolina newspapers, about the fishing technique of a domestic cat. Gudger wrote to the observer, a W.G. Heavner, and received more details about the fishing cat:

> I have in my backyard a circular cement pool about seven feet in diameter and 20 inches deep...To this pool, with its constant supply of water, all the neighbors' cats and dogs would come to drink. Sometimes one of these cats would sit on the projection while drinking.
>
> This pool was heavily stocked with goldfish, but presently these began to disappear. My five-year-old grandchild told me that she had seen a large gray tomcat, who belonged to a neighbor, catching the fish in my pool. It was hard for me to believe this but I caught him in the act. This cat apparently learned that the fish would come when the water was disturbed. So he got to sitting on the rock projection with his tail in the water and would wiggle it to attract the fishes, and, when they would come up to see what was happening, he would snatch one out. (R1)

Foxes and other bushy-tailed mammals. Just as South America generated anecdates about fishing jaguars, Europe and North America have a folklore on fishing foxes. These stories are so old and doubtful that Gudger put little stock in them. We will illustrate with a quotation from Olaus Magnus from 1555.

> Among the shelving rocks of Norway I have seen a fox put his tail down into the water between the rocks and draw out several crabs and devour them. This is not an unusual sight, since fishes do not cling to a thing which is let down, especially if it is hairy, as crabs do. (R3)

The foxes' technique---also said to be used with success by coyotes, raccoons, and otters---differs from that of the jaguar, as do the prey. The goal of the fox is to get crustaceans to grab on to its bushy tail and perhaps entangle their legs and spiny body in the hair.

Although Gudger found many fox-type stories, he did not consider them as convincing as the jaguar's tale.

Old woodcut of a fox catching crayfish with its tail.

Rats. About rats, Gudger found only one anecdote, but it is colorful and a tiny bit more believable than the fox story. The locale is an island off New Guinea and is so remote and exotic that almost anything could happen!

> While on a trip to the Trobriand Islands, [C.A.W.] Monckton had a most interesting experience. He spent a night on a small coral island with a few stunted trees but no other vegetation. During the night he was disturbed by rats crawling over him. Next morning, while his breakfast was being prepared, he walked to the other side of the little island wondering what rats could possibly find for food, since absolutely no land-grown food was available. While sitting there, he saw how the rats got their breakfasts. He writes thus:
>
> "I noticed some rats going down to the edge of the reef---lank, hungry-looking brutes they were, with pink naked tails. I stopped on the point of throwing lumps of coral at them, out of curiosity to see what the vermin meant to do at the sea. Rat after rat picked a flattish lump of coral, squatted on the edge and dangled his tail in the water, suddenly one rat gave a violent leap of about a yard, and, as he landed, I saw a crab clinging to his tail. Turning around, the rat grabbed the crab and devoured it, and then returned to his stone; the while the other rats were repeating the same performance." (R3)

X2. Erratic behavior as a lure. The sort of lure now described may be more common than our single reference suggests, for most animals are very curious. The tale was told to F.W. Preston by Major H.K. McKee, Commissioner for Northern Rhodesia.

> Some years ago, in Northern Rhodesia, I came upon a Mongoose acting in a very strange manner. He was standing up on his hind legs, and falling over sideways, first on one side, then on the other. A flock of guinea fowl were evidently as surprised and inquisitive as I was, for they gradually drew closer and closer to the performer. Then suddenly the Mongoose sprang on them and in a few leaps killed four of them. (R2)

References

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R2. Preston, F.W.; "Mongoose Luring Guinea Fowl," Journal of Mammalogy, 31:194, 1950. (X2)

R3. Gudger, E.W.; "On Certain Small Terrestrial Mammals That Are Alleged to Fish with the Tail," American Midland Naturalist, 50:189, 1953. (X1)

BMB16 Novel Escape Tactics

Description Escape tactics employed by mammals that involve novel actions beyond their usual, instinctive escape techniques. These innovations usually represent clever adaptations to changes in the environment and/or threats from new predators.

Data Evaluation. Unfortunately, each of the three escape tactics detailed below is supported by only a single reference, and only one of these comes from a scientific source. Furthermore, the data are mostly anecdotal. We cannot safely draw important conclusions from such limited information. However, it is likely that we have not discovered many other innovative escape tactics; many pertinent anecdotes never get recorded in the scientific literature. Rating: 3.

Anomaly Evaluation. Novel escape tactics, assuming their reality imply that mammals can reason and devise new tactics to fit new circumstances. This would mean that mammals are not the automatons claimed by many animal behaviorists. However, if mammals are automatons controlled by their genes, it is difficult to see how their new escape tactics could have evolved in small steps through a series of small random mutations, especially in the case of X3, where the escape tactic would must have evolved in century or less. Rating: 1.

Possible Explanations. Mammals are observant, innovative, and clever.

Similar and Related Phenomena. Marsupial adaptedness (BMB1); mammalian intelligence (BMB5, BMB6); novel hunting techniques (BMB15).

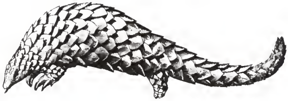
Entries

X1. Selected observations. All mammals are prey at some time, even humans (BHX8 in Humans 111). Each mammal has its bag of escape techniques. Most of these are mundane, such as ducking into a burrow, climbing a tree, or simply running away as fast as possible. These actions seem to be primarily instinctive, like the widespread human fear of snakes. Our aim here is the cataloging of some escape tactics that are so novel and highly specialized that their existence is difficult to ascribe to instinct alone.

Pangolins. Normally, a pangolin or scaly anteater will roll up into a tight ball when threatened, but in at least one place this tactic is not enough for it to escape its major predators. An innovation was required for its survival.

Siberut is a rugged island west of Sumatra. The natives there relish pangolins as do the resident pythons. Just rolling up into a stationary ball spells doom for Siberut pangolins. R.R. Tenaza has described how they manage to escape---at least some of the time.

> On 27 August 1972 at 0530 hours (28 minutes before local sunrise), while walking along a hill ridge trail in dense primary rain forest in south central Siberut, I heard foliage rustling several meters from the trail and moved quietly towards it to investigate. When close to the noise I switched on my flashlight and saw an adult pangolin 3 meters away scratch- the earth around some low shrubs, apparently seeking insects or other food. The pangolin immediately went to a nearby sapling that was 2 meters tall and stood upright on its hind legs as if intending to climb it but then, as I approached, returned to all fours and crossed in front of me towards an edge 5 meters from the sapling where the ground slope increased from a gradual 10° to a steep 38° (measured with a Brunton Compass) down into a stream bed 60



The pangolin or scaly anteater has been observed to curl up into a ball and escape by rolling downhill!

> meters lower in elevation. Upon reaching the edge, the pangolin rolled itself into a ball and rolled rapidly down the slope, colliding noisily with vegetation along its path. Despite the dense shrub layer on the slope, which was difficult for a man to move through, I estimated from the noises that the distance between myself and the pangolin increased by more than 30 meters in 10 seconds. (R3)

Pangolins have not been seen using this stratagem elsewhere. Did the Siberut pangolins put together the concepts of "steep hill," "rolling ball," and "dense vegetation" together and reason out this escape tactic, and then teach it to their progeny? Or is the tactic coded into their genes via evolution? The evolutionist would postulate a series of small random mutations that led some pangolins to run to a steep hill before rolling up into a ball. Natural selection would favor these pangolins, and they have survived on Siberut!

Arctic hares. Hares inherit oustanding speed and jumping capabilties, but in the Arctic they combine these escape mechanisms with sidewise-jumping and backtracking. Like the rolling pangolins, the hare's novel technique may require extra explanation.

> The Arctic hare has a truly amazing strategy of escape. Lindell Page was following the hare (Lupus arcticus) up a hill on snowshoes when he came to what looked like the end of the animal's tracks. He turned around and found the tracks of the hare doubling back on his trail.
>
> When the hunter got back about one fourth mile the extra back tracks stopped. Then looking around, Page, the hunter, found that the hare had jumped 12 feet to one side and continued up the hill. This procedure Mr. Page said is common to the Arctic hare. (R2)

L. Page's observation was originally published in the May 1970 issue of Alaska. It was one several collected in an article by O.L. Brauer in the Creation Research Society Quarterly, bearing the title: "Biological Oddities That Are Unaccountable by Evolution." Creationists are always interested in such phenomena because they feel that they cannot have evolved by a series of small, random mutations---they are too well-designed and cannot be developed through intermediate, ineffective steps. In other words, they are examples of "perfection" in biology.

Jack rabbits. Jack rabbits are actually hares in the same genus as the Arctic hare. Great jumpers, too, they can leap 20 feet if pressed, say, by a coyote. They have added to their speed and jumping talents a rather gruesome trick. According to L.L. Rue, III:

> Trickery is another ruse employed by the jack rabbit. It has a very limited territory (about two acres) for an animal that is capable of covering so much ground and so knows thoroughly every topographical feature of its domain. When chased by a predator, the jack twists and turns through the brush and dodges along its trails. If closely pursued, the jack rabbit may duck under a barbed

wire fence in the hope that its pursuer will decapitate itself. This trick has been recorded so many times that it must be a favorite of the jacks. (R1)

Note that barbed wire fences have been a feature of jack-rabbit territory for only a century or so. This is hardly time enough for novel behavior to evolve and get encoded in the genes. Rather, the jack rabbits have observed and learned; they may not be the automatons proclaimed by many animal behaviorists.

References

R1. Rue, Leonard Lee, Ill; Pictorial Guide to the Mammals of North America, New York, 1967. (X1)

R2. Brauer, Oscar L.; "Biological Oddities That Are Unaccountable by Evolution," Creation Research Society Quarterly, 9:41, 1972. (X1)

R3. Tanaza, Richard R.; "Pangolins Rolling Away from Predatory Risks," Journal of Mammalogy, 56:257, 1975. (X1)

BMB17 Feigning Death

Description. The sudden change when threatened from an active state to a death-like state called catatonia. An offensive odor from scent glands may accompany this state. When the threat is removed, normal activity returns, but perhaps not for hours.

Data Evaluation. The popular and scientific literature assure us that the Virginia opossum indeed plays possum when threatened, but we do not know if this is a voluntary act or just a case of shock. In other words, it may not be a distinct phenomenon under control of the animal. The rarity of possum-playing is also an issue. Finally, we have no statistics on the utility of feigning death in the wild. We do know, however, that the Virginia opossum is a highly successful marsupial in an environment of many capable placental predators, but its rare habit of playing possum may not contribute significantly to this success! All in all, though, our knowledge of the phenomenon seems superficial as well as conficting. Rating: 3.

Anomaly Evaluation. If feigning death is a voluntary act and not shock, its survival value seems about zero, for the animal can easily be killed when immobile. If, though, a predator loses interest in an apparently dead animal---and this seems unlikely if the predator is really hungry---there indeed is some survival value in a death feint. If, however, predators are not fooled, then the ploy has negative survival value, and an anomaly exists, because natural selection should have eliminated the habit long ago. Rating: 2.

Possible Explanations. Possum-playing is not a ploy at all, just an involuntary state of shock caused by trauma.

Similar and Related Phenomena. Hognose snakes also play dead (BRB).

Entries

X0. Introduction. The feigning of death is often difficult to distinguish from two other phenomena observed in mammals: (1) Fascination, which is akin to mesmerism and can be induced in some mammals by snakes (BMX in Mammals II), humans (BHX2 in Humans III), and other predators; and (2) Shock, which may be seen, for example, in deer that have been grazed by a hunter's bullet but not seriously injured, and, in some animals, by the mere handling by humans (BHX2). In death-feigning, fascination, and shock, the affected animal is immobile and seems superficially to be dead. It is possible that death-feigning may be a form of shock. In fact, the word "catatonia" can be used to describe all three states.

The purpose of feigning death is to deter predators. But does this ploy actually work in the wild? And, if it does work, does it help the fittest survive?

X1. General observations.

Opossums. Everyone "knows" that opossums play dead when threatened! This popular generalization is applied in North America to the Virginia opossum Didelphis virginiana), which, be it noted, is an opossum and not a possum. (Possums live in Australia; opossums in the New World.) In the New World, there are about 70 species of opossums, and only the Virginia opossum plays possum very often. Of the other 69, only the white-eared opossum of Central and South America tries this trick, and then only very rarely. (R3, R4)

Now that the rarity of possum-playing among the opossums as a group has been established, we use the description of the phenomenon found in Walker's Mammals of the World:

> Death-feigning, referred to popularly as "playing possum" and technically as catatonia, is a passive defensive tactic of D. virginiana, employed occasionally, but not always, in the face of danger. In this state the opossum becomes immobile, lies with the body and tail curled ventrally, usually opens the mouth, and apparently becomes largely insensitive to tactile stimuli. The condition may last less than a minute or as long as six hours. Although catatonia seems partly onder the conscious control of the animal, there are physiological changes suggesting a state analogous to fainting in humans. Death feigning may cause a pursuing predator to lose the visual cue of motion or to become less cautious in its approach, thereby giving the opossum a better chance to escape. (R4)

No one doubts that the Virginia opos-

The Virginia opossum rarely plays "possum" despite popular belief to the contrary.

sum does feign death---but how frequently? The popular and much scientific literature strongly suggests that all Virginia opossums play possum all the time when threatened. This is very far from the truth, as attested by the following comments from naturalist L.L. Rue, 111:

> Some experts claim that playing possum is an involuntary act, similar to a fainting spell in a human being. Others believe that it is a conscious act performed by the animal when danger threatens. In this state, the opossum falls on its side and lies limply, its mouth hanging open. This appearance of death has value, for the dog, cat, coyote, or other predator loses interest after giving the carcass a few half-hearted shakes. It has been my personal experience that opossums rarely play possum. Of the thousands of opossums that I have handled, only ten or twelve collapsed as expected. The others tried to escape by running away or by turning around and biting. (R2)

A misled public is not anomalous, but a misled scientist is. To illustrate, R. Wesson sees possum-playing as a challenge to evolution (the [?]s are added to contrast Wesson's belief with the above statements):

> It is more serious that an opossum (Didelphis) usually [?] reacts to being seized by becoming immobile, tail curled and mouth open. This hardly discourages a predator [?] from dinner, and if released the animal does not take the opportunity to scamper away but remains as though paralyzed for some minutes. There is no apparent utility on this behavior [?]; called catatonia, it seems to arise from some failure of nerve, like human fainting. On the other hand, there would be no strong selection against catatonic immobility; by the time the opossum gives up, there is probably little it could do to save itself [?]. (R5)

Obviously, Rue and Wesson differ on the efficacy of possum-playing. In truth, we have no statistics on how predators react to dead-looking opossums.

In sum, death-feigning among New World opossums appears to be very rare,* with only one species known to use the ploy with any frequency, and then hardly all, despite popular belief. Further, we do not really know whether playing possum is a truly voluntary act or just an uncontrolled descent into a state of shock.

*But in Florida, outside of Orlando, about 1989, my cocker spaniel cornered a opossum in my fenced back yard, and after about 5' of mutual teeth baring, Grady bit the 'possum on the butt, whereupon he fell over paralyzed, even when Grady nuzzled & sniffed along his belly. (He did grin though)

Cape hares. Another mammal that seems to feign death is the Cape hare, also known as the Cape jerboa. (It is not a jerboa at all!)

> In German Southwest Africa the Hottentots employ a similar method of hunting the "springhaas," Cape jerboa or Cape hare. They beat the bush by moonlight, and, when they see a "hare" creeping from its hole, throw themselves on the ground and raise a horrible din. The poor beast, paralyzed by fright, remains motionless until the hunters creep to it on all fours and kill it with their clubs. (R1)

This seems more like a case of shock rather then a death feint.

Hyenas. We also have a fleeting reference to hyenas feigning death. (R1)

Hedgehogs, pangolins, armadillos, etc. When threatened, several mammals may roll up, lay still, and present only quills or armor to their predators, we cannot tell if they are in a state of catatonia or not. We assume that they are not, and that they are fully awake and confident of their other defenses.

References

R1. Anonymous; "Cataplexy, or Feigning Death," Scientific American Supplement, 61:25123, 1906. (X1)
R2. Rue, Leonard Lee, III; Pictorial Guide to the Mammals of North America, New York, 1967. (X1)
R3. Emmons, Louise H.; Neotropical Rainforest Mammals, Chicago, 1990. (X1)
R4. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)
R5. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X1)

BMB18 Anomalous Selection of Prey

Description. The selection by predators of prey that are not "less fit," meaning that the "fittest" do not necessarily escape predation more often.

Data Evaluation. Our information is several times removed from the actual field work; namely, a comment by a zoologist in a popular book based on a scientific book reviewing collected field studies. The reality of the claimed phenomenon is also complicated by the difficulty of measuring fitness in wild animals. Nevertheless, the comment quoted below is important enough to catalog despite the tenuous nature of the data. Rating: 3.

Anomaly Evaluation. "Survival of the fittest" is a phrase with great popular appeal. To most, it means the strongest, healthiest, and most intelligent members of a species are the most likely to survive. In this Catalog entry, the threat is restricted to predation alone. Ignored are environmental catastrophes, sportsmen's guns, ivory seekers, battles for breeding rights, etc. In this narrow sense, the phenomenon is anomalous because it clashes with a historically famous assertion of evolutionists. Rating: 2.

Possible Explanations. "Survival of the fittest" is at best indeterminate and at worst incorrect.

Similar and Related Phenomena. Effect of human warfare on the "fit"; biological extinctions in the fossil record (ESB1 in Anomalies in Geology).

Entries

X1. General observations. Prominent in the popular conception of "evolution" is the phrase "survival of the fittest." The question at hand is: Are the fitter animals really more likely to avoid predation than the less fit? This question might be answered by observations in the field. Although "fitness" is admittedly hard to measure, a naturalist can at least make a rough stab as to whether strong, healthy animals are less prone to predation. Of course, this answers the question only in part because it ignores the role of "fitness" in surviving disease and environmental traumas.

E. Curio reviewed observations of differential predation in his 1976 book: The Ethology of Predation. Based on Curio's findings, D.R. Griffin wrote the following:

> Predators are thought to select for attack members of a herd that are weak, sick, very young or very old, although an extensive review of the evidence bearing on this question showed that the results of many investigations failed to support this widely held belief. (R1)

Reference

R1. Griffin, Donald R.; Animal Minds, Chicago, 1992. (X1)

BMB19 The Puzzle of Flavor Aversion

Description. The acquisition of aversion to flavor in a food if consumption of the food is followed by illness, even though the illness occurs long after the consumption of the food. Often, the flavored food needs to be sampled only once for the phenomenon to occur.

Data Evaluation. We have only a single overview article from Science, but this article implies that flavor aversion is a well-researched phenomenon. No references are given in the article. Our literature research is deficient here. Rating: 3.

Anomaly Evaluation. In direct contradiction of traditional learning theory, flavor aversion can be acquired without the required immediate consequences and subsequent reinforcement. These facets of learning theory are not especially vital to science, so the anomalousness is minimal here. Be it noted, however, that the evolution of the biochemical mechanism of flavor aversion remains unexplained and constitutes another sort of anomalousness. The following anomaly rating is based only upon flavor aversion's challenge to learning theory. Rating: 3.

Possible Explanations. Flavor aversion, as it now exists in mammals, developed because the avoidance of toxic foods, such as poisonous plants, has been crucial in evolution.

Similar and Related Phenomena. Resistance of mammals in conditioning experiments (BMB2).

Entries

X1. General observations. Exterminators have long been aware that rats possess an uncanny ability to avoid poisoned food. This very useful talent seems to derive from the phenomenon of flavor aversion.

Flavor aversion links the taste of food and some induced condition or event following consumption of the food to the behavior of the animal afterwards. Rats, for example, may sample poisoned food, get very ill, and will thereafter avoid food with the poison flavor. This all seems quite reasonable and what one would expect. But we shall see below that the details of the flavor-aversion phenomenon clash with well-established learning theory.

Our treatment of flavor aversion concentrates on laboratory rats, because most experiments have employed these animals. However, flavor aversion has been observed in fish, reptiles, snails, and representatives of other phyla.

Rats. It is in the laboratory rat that the following anomalies and curiosities of flavor aversion have been observed.

- Rats can acquire flavor aversion even when illness (often induced by radiation) does not immediately follow food consumption. In fact, hours may intervene. Traditional learning theory insists that stimulus and response should be presented together for learning to occur.

- Rats can acquire flavor aversion after only a single poisoning. Again, learning theory states that several reinforcements are required.

- Rats retain flavor-aversion behavior for long periods, even though they may sample the flavored food many times without getting ill (experimentally, through a dose of radiation).

- Flavor aversion is difficult to induce by electric shock and other "persuasions"---illness is fundamental to the phenomenon.

- Visual or auditory stimuli followed by illnesses (again often radiation induced) are not very effective in initiating flavor aversion.

- Flavor aversion develops more readily if the flavor is novel. However, the phenomenon can be initiated by almost any flavor, even that of water or something as vital to the success of the species as sexual secretions, though not as easily.

- Various drugs, such as psychoactive substances, which produce no observable illness, also induce flavor aversion. (R1)

Coyotes. Some success has been had in controlling coyote predation on sheep by scattering sheep carcasses laced with lithium chloride on the range. The coyotes get sick, develop flavor aversion, and thereafter leave the sheep alone. (R1)

Humans. Flavor aversion has been seen in humans when they become ill after radiation treatments for cancer. (R1)

Reference

R1. Wallace, Patricia; "Animal Behavior: The Puzzle of Flavor Aversion," Science, 193:989, 1976. (X1)

BMB20 The Scarcity of Vampirism in Mammals

Deescription. The dearth of mammal species that consume blood as their primary sustenance, despite the large number of suitable prey on all continents except Antarctica.

Data Evaluation. Our discussion is based mainly on the work and thoughts of a single specialist in bat research. More data and other thinking are required here. Rating: 3.

Anomaly Evaluation. Nature generally abhores large vacant niches, so the lack of vampirism in mammals is at least unusual and puzzling, although not especially anomalous seeing that no fundamental paradigms are affected. Rating: 3.

Possible Explanations. See discussion below under X1.

Similar and Related Phenomena. Vampirism among the other phyla, insects and fish in particular. The human use of living horses and cattle as renewable sources of blood food.

Entries

X1. General observations. Vampirism has arisen in several phyla. It is most obvious among the insects, but some fish subsist largely on blood, and a few birds drink the blood of wounded animals. Among the mammals, vampirism is extremely rare, with only three living species of bats belonging to the vampire clan. Yet, suitable prey are common, especially in countries with abundant livestock, which essentially are docile containers of vampire food. The reason for this Catalog entry lies in two questions: (1) Why are mammalian vampires so rare, given that open niches are widespread? and (2) Why are the only mammalian vampires (the three bats) confined to South and Central America?

One response might be that vampires require specialized equipment. Vampires should be small in size compared to their prey; they should be able to operate at night when prey are sleeping or tethered; they require special teeth or skin-penetrating equipment for making incisions plus a supply of anticoagulant; and they need infrared sensors to find where blood is close to the surface of the prey. Once these requirements are fulfilled, the vampire has access to a plentiful supply of renewable sources of a nearly perfect food. These are not insurmountable problems for evolution. Many insects and some fish have evolved the proper equipment, but mammals have lagged far behind. This is strange because mammals have invaded niches that are even more challenging, such as the abysses of the oceans.

Bats. Of the 900 or so species of bats only three are vampires today. (There were many more species in the past.) And these three are all living in the New World tropics. Africa with its great herds of large mammals would seem an ideal area for bats to evolve vampirism. Europe, North America, and Asia, too, are wide-open niches. Many species of bats take to the night air on these continents, but none has adopted vampirism.

Is there an evolutionary barrier that makes the acquisition of vampirism difficult? Scientists have puzzled for years over how bats initially became vampires without coming to any consensus. The fruit-eating bats have the right dental equipment but they have never been attracted to blood sources, despite the superior quality of blood over fruit as a food. Other theories have the insect-eating bats being attracted to the insects and parasites that frequent the wounds of large mammals. In consuming these insects they might have acquired a taste for blood and graduated into vampirism from these starting points. (R1, R2)

In sum, science has not yet answered the two questions posed above.

Humans. We should mention in passing that humans have not completely avoided vampirism. Mongol tribes based on the horse have utilized the animal not only for transportation and milk but also blood food when on the march.

References

R1. Fenton, M. Brock; Bats, New York, 1992. (X1)
R2. Timson, John; "How Vampire Bats Acquired a Taste for Blood," New Scientist, p. 18, January 9, 1993. (X1)

BMB21 The Use of Medicinal Plants by Mammals

Description. The consumption of specific plants for specific medicinal purposes by mammals. The plants involved are not regularly used for food and, indeed, may be toxic if ingested in quantity. In some instances, humans also use the same plants for similar purposes.

Data Evaluation. Several primatologists and ecologists have recorded this unusual behavior in the field, but observations are few in number and limited to just a handful of species. Rating: 2.

Anomaly Evaluation. At issue is how mammals learn that certain non-food plants are useful in illnesses, for controlling parastites, for controlling fertility, and even the sex of their offspring. No one has ever observed adult mammals instructing their progeny in these matters, assuming that they can convey such concepts in the first place. With humans, medical knowledge is accumulated down the generations, but this does not seem to occur in the instances cited below. If knowledge of the medicinal value of plants is instinctive, it is unclear how such information was originally gathered and encoded in the genes. Rating: 1.

Possible Explanations. The medicinal value of plants is actually conveyed from one animal to another; that is, it is learned behavior; but human observers have not yet seen this happen.

Similar and Related Phenomena. See the Subject Indexes in the Series-B catalog volumes under: Instinct.

Entries

X0. Introduction. It is accepted that animals of all kinds instinctively consume minerals and other substances when their bodies signal the need. Many mammals, for example, visit salt licks. Humans, too, are known to eat dirt and clay, ostensibly to acquire needed minerals. Birds swallow small animal bones to get the calcium they need for eggshells. The examples are many; and we accept that these behaviors are somehow programmed into the genome and passed from parents to progeny without requiring relearning. The details of how these instincts were coded are always glossed over, but the subject at hand concerns substances much more specialized than salt and calcium: medicines or, actually, plants with medicinal value. We organize this material according to the medicine's probable purpose.

X1. Control of disease and/or parasites.

Chimpanzees. In Tanzania's Gombe National Park, the resident chimpanzees regularly seek out aspilia bushes and consume the plant's leaves in a rather stilted fashion:

> Instead of promptly tearing off the leaves and eating them, the animal gingerly closes its lips over the unplucked leaf and holds it for a few seconds. Several leaves are tried in this way before the chimp selects one and places it in the mouth.
>
> Then, instead of chewing the leaf, the ape rolls it around in the mouth for perhaps 15 seconds and then swallows it whole. Over as much as 10 minutes the chimp may select and swallow up to 30 small leaves. (R1)

After reading reports of this strange behavior, biochemist E. Rodriguez found that the aspilia leaves contain an oil that kills disease-causing bacteria, fungi, and parasites such as nematodes. (R1, R3, R4)

It must be added that human researchers sampling the aspilia leaves found them extremely unpleasant to eat. Obviously, the chimps were not consuming the aspilia leaves for their taste or nutitional value!

Interestingly, humans living in the area testify that the aspilia leaves are good for stomachaches and in treating wounds. Even more interestingly, The chimps and humans use the same three species of aspilia while avoiding the fourth species endemic to the region.

Another African plant that chimpanzees seem to consume solely for its medicinal value is the bush Vernonia amygdalina. The pith of this plant contains a bitter juice that native Tanzanians use to treat parasites and disease. Primatologist M. Huffmann has seen an obviously ailing chimpanzee consuming the juice from this plant. Within a day, the animal was on the road to recovery. (R3, R4)

X2. Control of the gender of offspring.

Mantled howler monkeys. (Alouatta palliata). K. Glander, Duke University, has suggested that some howler monkeys control the sex of their offspring through their diets.

Glander divides howler monkey females into three groups. In the first are the high-ranking females that predominantly produce male offspring. This "male-offspring" strategy favors these females because the males they produce tend to become dominant adults that will pass on more of the females' genes than would female offspring, who are limited in the number of infants they can engender in comparison to the males. Similar optimization strategies, according to Glander, induce middle-ranking females to produce mainly female progeny, and low-ranking females to birth almost all males.

These howler monkeys seem to control the sex of their offspring pharmacologically by selecting certain plants to eat. These plants, in turn, control the electrical conditions in the females' reproductive tracts to either attract or repel sperm carrying the male Y-chromosomes, which are thought to carry different electrical charges than the X-carrying sperm. (R3, R5)

It will take much more research to validate these startling assertions. We also have to ask how these instincts (or conscious, calculated strategies?) evolved. Since so many of the medicinal plants are distasteful, why would the monkeys eat them in the first place and thus learn, instinctively or consciously, their value in advancing the prospects for their genes?

X3. Control of fertility.

Wooly spider monkeys or muriquis. K. Strier, a primatologist at the University of Wisconsin, has discovered that these monkeys seem to intentionally eat plants that affect fertility.

> She reports that muriqui monkeys in Brazil may be reducing their fertility after giving birth by ingesting leaves that contain an isoflavonoid, a compound structurally similar to estrogen. On the other hand. when they are ready to have offspring, she has noticed that they appear to eat more of a legume called the "monkey ear" that produces a steroid that could enhance fertility. (R4)

X4. Induction of labor.

African elephants. Ecologist H.T. Dublin spent almost a year following the daily activities of a pregnant elephant in Tsavo Park in Kenya. This elephant had an almost unvarying daily routine as she searched for food. She rarely walked more than 5 kilometers.

> But one day the elephant marched toward a riverbank some 28 kilometers away and stopped in front of a small tree of the family Boraginaceae. This particular species, previously unlisted among the elephant's meal choices, was one that Dublin had never seen before. The ecologist watched as her subject devoured the entire tree, leaving nothing but a stump. Four days later, back at the old stomping grounds, the elephant

gave birth to a healthy baby. (R3)

Dublin found out afterward that pregnant women in Kenya commonly make tea from the leaves and bark of the same tree to induce labor or abortions. (R3)

This is an intriguing anecdote, but it is important to determine whether this is a common practice among pregnant elephants.

References

R1. Anonymous; "Chimps Practice Medicine," San Francisco Chronicle, December 27, 1985. Cr. J. Covey. (X1)

R2. Anonymous; "Herbal Medicine: R_x for Chimps?" Science News, 129:38, 1986. (X1)

R3. Cowen, Ron; "Medicine on the Wild Side," Science News, 138:280, 1990. (X1, X2, X4)

R4. Gibbons, Ann; "Plants of the Apes," Science, 255:921, 1992. (X1, X3)

R5. Lewin, Roger; "What Monkeys Chew to Choose Their Children's Sex," New Scientist, p. 15, February 22, 1992. (X2)

BMB22 Unrationalized Murder in Mammals

Description. The killing of one mammal by another of the same species in situations that do not seem to be associated with the transfer of the genes of the murderer, or those of close relatives, to subsequent generations.

Data Evaluation. Virtually all of the observations of unrationalized murders among mammals have been recorded by zoologists working in the field. However, the references we have amassed mentioning these reports are from the popular scientific literature. Additionally, our suspicion is that there exist many more examples of this phenomenon. So, our files are probably incomplete. Rating: 3.

Anomaly Evaluation. An important tenet of today's animal behaviorists is that animals act almost exclusively in ways that promote the promulgation of their genes or those of close relatives. The types of murders classified below (X1-X5) seem to contradict this paradigm. However, the "selfish gene" or "selfish animal" concept is so malleable that an imaginative animal behaviorist may be able to rationalize some of our examples and thus de-anomalize this Catalog entry. We acknowledge the weakness of this claimed anomaly by giving it a low rating. Rating: 3.

Possible Explanations. See above discussion concerning the weakness of this claimed anomaly. Human speculation about the motives of other species is fraught with danger, and we may be misinterpreting the observations.

Similar and Related Phenomena. Altruism in mammals (BMB4); altruism in humans (BHB17 in Humans I).

Entries

X0. Rationalizing murder in mammals. When one mammal murders another of the same species, biologists usually rationalize it in terms of each animal's (assumed) overriding goal of passing his or her genes on to the next generation. Next in priority in this view of life is the promulgation of the genes of close relatives, since they include many of his or her genes. (R3) Only then does priority shift to promoting the welfare of the animal's wider social group or species.

This sociobiological outlook, which makes individual selfishness the driving force behind almost everything an animal does, successfully explains murders of the types now reviewed.

Siblicide. A young mammal may kill siblings to assure preferred access to resources. This is observed in spotted hyenas (R6), fur seals (R5), and undoubtedly other mammals.

Infanticide. A new alpha male in a group may kill the offspring of the previous alpha male to cause the mothers to come into estrus quickly and/or to channel resources to his own offspring. This type of murder is found in many primates. (R3, R4)

Murder during breeding battles. Probably not as rare as claimed, many harem-maintaining alpha males---most deer, sheep, pinnipeds---will sometimes fight to the death. Even hippos kill one another in mating battles. (R3)

Murders of animals in other social groups. Male chimpanzees actively patrol the boundaries of their territories and kill strangers. Sometimes, this erupts into open warfare, with one group exterminating the other. (R3)

Beyond these well-rationalized sorts of murders are several other types of murder that are not comfortably explained by the "selfish animal" theory.

X1. Murder of close relatives.

Prairie dogs. Pregnant and lactating prairie dogs isolate themselves from the community and become extremely hostile. They even seek out and kill the young of other mothers. This aggression very likely reduces the chances of the murderer's genes being passed on, because neighboring animals are usually closely related in a prairie dog town and therefore carry some of the murderer's genes. (R5)

X2. Accidental murders.

Elephant seals. Subordinate males occasionally gang rape females attempting to get out to sea. These mauled females sometimes die. (R3)

Orang-utans. Rape by individual males is known in this species. Sometimes the females resist to the point of death. (R3)

X3. Cannibalism. We have found only one example of cannibalism in mammals so far. There must be more.

Killer whales. Cannibalism has been observed here. Depending on the relatedness of the victim, this may be rationalized. (R2)

X4. Murder of nonreproducing females.

Mountain gorillas. In Rwanda, an adult male was seen to intentionally kill an aging female as she lay curled up under a tree. The menopausal female had been lagging behind the group and was no longer able to produce progeny. (R3)

X5. Murders of high-ranking males by subordinate males. This type of murder can conceivably be explained in terms of one or more of the murderers subsequently becoming alpha males.

Elephant seals.

> Among elephant seals, most males never get to mate at all; that privilege is reserved for a handful of "alpha" males, who guard enormous harems of females. Every so often, the have-nots rebel in a frenzy of violence. Richard Condit, who studies the elephant seals near Santa Cruz, California, witnessed such a mob attack. A fight between two alpha males had ended with one left stunned but alive. Suddenly a group of subordinate males, barking wildly, leaped onto the downed seal, bit him, beat him, crushed him, and attempted to copulate with him, until he was dead. (R3)

White-tailed deer. Note that the following anecdote did not occur during the rutting season.

> The Boston papers tell a curious story of the retribution which recently came upon a buck, which, by virtue of his superior strength and sagacity, had exercised a tyrannous lordship over the herd of deer on the Common, and had thereby excited the hatred of the younger bucks. The time came when he had to shed his horns. The other bucks gained knowledge of the fact with a marvelous quickness, gathered around him, made a concerted attack upon him and speedily disabled him, despite the gallant resistance he tried to make. He was knocked down, butted and kicked till his head and sides streamed with blood, shoved this way and that, with all the fury accompanying each action that the pent-up spite of years could render itself capable of, and, finally, was reluctantly compelled to give up the ghost. (R1)

People on the Common tried to save the buck but were driven away by the attackers.

X6. Murder of other females by the "queens" of eusocial colonies.

Naked mole rats. The "queen" of a colony of naked mole rats suppresses the breeding of other females by bullying and, sometimes, murder. (R7) (See BMB31-X1 for background.)

Murders of this sort help the queen maintain the dominance of her genes, but they also deprive the colony of workers which, in turn, lessens the queen's reproductive potential.

References

R1. Anonymous; "Animal Retribution," Popular Science Monthly, 20:861, 1882. (X5)

R2. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X3)

R3. Angier, Natalie; "Mother Nature's Murderers," Discover, 4:79, October 1983. (X0, X2, X4, X5)

R4. Fisher, Arthur; "A New Synthesis Comes of Age," Mosaic, 22:3, Spring 1991. (X0)

R5. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X0, X1)

R6. Frank, Laurence; "When Hyenas Kill Their Own," New Scientist, p. 38, March 5, 1994. (X0)

R7. Pennisi, Elizabeth; "Not Just Another Pretty Face," Discover, 7:68, March 1986. (X6)

BMB23 Aquatic Mammals and Face-to-Face Copulation

Description. The correlation of aquatic habits with face-to-face copulation---a rare habit in terrestrial quadrupeds. This phenomenon is sometimes accompanied by evolutionary changes in the locations of the genitals.

Data Evaluation. The habits of the mammals involved with this phenomenon are well-known to biologists. Many of our sources come from popular science-publications, although they are based upon interviews with scientists. Rating: 2.

Anomaly Evaluation. Since aquatic life favors the ventral location of mammalian genitals, as in dolphins, face-to-face copulation is often obligatory and, in some species, more convenient and, therefore, not anomalous. What may be anomalous is the same tendency toward face-to-face copulation and genital relocation in humans and some of the other primates. Such behavior and appropriate physiological changes suggest that humans and some other primates, or perhaps their common ancestor, were once more aquatic. This suggestion accords with the Aquatic Ape hypothesis. Since this hypothesis is roundly rejected by mainstream science, the phenomena cataloged here are highly anomalous. Rating: 1.

Possible Explanations. Besides the Aquatic Ape hypothesis, neoteny has been proposed as an explanation for genital location---and consequent face-to-face copulation. See BHB19-X2 in Humans 1 for further discussion.

Similar and Related Phenomena. Neoteny in humans (BHB10 in Humans 1). See the Subject Indexes in the Series-B catalogs under: Aquatic Ape hypothesis, Neoteny.

Entries

X1. Obligate face-to-face copulation,

Whales, dolphins, manatees, dugongs. The reproductive organs of the cetacea and sirenia are so located that face-to-face copulation is obligatory. (R3)

X2. Optional, frequent face-to-face copulation.

Humans. Face-to-face copulation is common among humans, and the female organs are positioned to favor this mode. See a fuller discussion in BHB19-X2 in Humans 1.

Bonobos or pygmy chimpanzees. Bonobos are highly sexual primates. Frequent copulation (up to a dozen times a day or more!) seems to cement social bonds and avert conflicts.

> Although [common] chimpanzees virtually never adopt face-to-face positions, bonobos do so in one out of three copulations in the wild. Furthermore, the frontal orientation of the bonobo vulva and clitoris strongly suggest that the female genitalia are adapted for this position. (R7)

Orang-utans. In the wild, orang-utan copulation is often a violent affair that resembles rape---physical stability is a necessity. Since orang-utans are highly arboreal, most copulations take place aloft. With the males twice the size of the females, mounting from the rear on a narrow limb is dynamically dangerous ---the female cannot keep her balance. Therefore, these matings are face-to-face. On the ground, though, the male usually approaches from the rear, like terrestrial quadrupeds. Interestingly, the female's sex organs have moved a bit forward to make face-to-face copulation easier, but not as much as in the bonobos. (R4)

Seals and sea lions (pinipeds). These highly aquatic mammals usually mate on shore after the fashion of other terrestrial quadrupeds. However, some matings do take place in the water, and, there, face-to-face copulation seems to occur. (R3)

X3. Optional, but invariable face-to-face copulation. At least two highly aquatic quadrupeds apparently always mate in the water in the face-to-face mode.

Beavers. Beavers do spend consider time on land felling trees and gathering branches. It was assumed by many that they mated like other terrestrial quadrupeds, but more careful observations have shown that they mate in the water and adopt the face-to-face position. (R3)

A.R. Roth has contributed the following observation of a mating of captive beavers:

> On October 6, it was observed that one of the females was in heat. A male followed her constantly and at 4 A.M. on October 7, copulation occurred in the tank of water to which the animals had access. With a great deal of splashing the male turned the female on her back, clasped her firmly around the neck and body with both front and hind feet, and completed the act in about three minutes. (R1)

Sea otters. Sea otters are closely related to the terrestrial weasels. Presumably, they once shared the weasels' mating techniques; that is, mounting from the rear. But now, the sea otter is essentially an aquatic mammal and, like most aquatic mammals, mates face-to-face. Unhappily for the female sea otter, the male has retained the weasel habit of grabbing the female with his teeth. The weasel grabs the female's thick fur on the back of her neck, but this spot is unavailable to the sea otter. Instead, he grabs the female by the nose. During the mating season, female sea otters are often seen with bloody noses. (R3)

References

R1. Roth, Adolph R.; "Mating of Beavers," Journal of Mammalogy, 19:108, 1938. (X3)

R2. Latimer, B.M., et al; "The Pygmy Chimpanzee Is Not a Living Missing Link in Human Evolution," Journal of Human Evolution, 10:475, 1981. (X2)

R3. Morgan, Elaine; The Aquatic Ape, New York, 1982. (X1-X3)

R4. Morgan, Elaine; The Scars of Evolution, London, 1990. (X3)

R5. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X2)

R6. Small, Meredith F.; "What's Love Got to Do with It?" Discover, 13:46, June 1992. (X2)

R7. de Waal, Frans B.M.; "Bonobo Sex and Society," Scientific American, 272:82, March 1995. (X2)

BMB24 Mammal Sexual Cycles Correlated with Lunar Cycle

Description. Lunar periodicity in the breeding cycles of some mammals.

Data Evaluation. We have found only one scientific report on this phenomenon, and it acknowledges several imponderables and limitations. The observers employed captive animals, and lunar cyclicity is only "suggested." Even though the data are "soft" it is important to record all biological lunar periodicities. Rating: 3.

Anomaly Evaluation. The lunar enhancement of sexual activity could be due to biochemical changes induced (in some mysterious way) by the lunar cycle or, perhaps, by the moonlight's effect on the amount nocturnal activity or even the visual appearance of sexual displays. Since we do not know enough to even guess the mechanism involved, an anomaly rating is impossible here.

Possible Explanations. See above discussion.

Similar and Related Phenomena. Correlation of the lunar cycle with human disturbed behavior (BHB4 in *Humans I*) and menstruation (BHF14 in *Humans II*). See also the Subject Indexes in all Series-B catalogs under Moon.

Entries

X1. General observations.

Prosimians (lemurs, galagos, etc.). A lunar periodicity in the sexual cycle of a large group of captive lemurs and lorisoids has been reported by U.M. Cowgill et al, at Yale's Osborn Zoological Laboratory.

> While the obvious contagious nature of the incidence of mating and the possible unknown effects of social facilitation due to olfactory and other behavioral interactions render any rigid statistical treatment impossible, the data appear to suggest a *prima facie* case for a correlation between peaks of sexual activity and the lunar cycle in *Lemur* spp. and possibly *Galago* spp., when the animals are exposed to appreciable illumination, due to the changes in the amount of moonlight. It is clear that the full significance of this can only be assessed on the basis of field observations. Possibly lemurs are active at night chiefly when a good deal of light is available; certainly both in eye structure and observed behavior they are strongly diurnal, unlike the *Lorisoidea*. However it may be noted parenthetically that much of the display movements of lemurs and lorisoids appear to the human observer to be enhanced by moonlight. The long sparse shiny hairs of the lemur tail, the white tail of at least some forms of *G. crassicaudatus*, and even the silver-tipped hairs of many pottos reflect dim light very effectively. (R1)

Rats. The breeding cycle of some tropical rats also follow a lunar rhythm. It was not specified whether these were wild or captive rats. (R1)

Reference

R1. Cowgill, Ursula M., et al; "An Apparent Lunar Periodicity in the Sexual Cycle of Certain Prosimians," *National Academy of Sciences, Proceedings*, 48:238, 1962. (X1)

BMB25 Linear Formations of Mammals

Description. Stationary and mobile lines of mammals. These lines are not necessarily perfectly straight, but the animals are definitely lined up one behind the other.

Data Evaluation. The sources of our observations are primarily guides to mammals prepared by scientists. We have also found two useful articles on echidnas in the more popular scientific literature. Rating: 1.

Anomaly Evaluation. Some linear formations are required to carry out the mammal's task at hand, such as tunnel excavation (X2) and the construction of living bridges (X3). These two categories (X2, X3) are included here because of their bizarre nature. The other cataloged linear formations (X1, X4) seem unnecessary and purposeless. All this means is that humans do not know what is going on inside the minds of the animals involved or what purpose---well known to them---is being served. These linear formations have enough curiosity value to warrant cataloging, but no biological theories seem to be at risk. Rating: 3.

Possible Explanations. Since humans appreciate linear order, some mammals may, too, although it is not customary to give them credit for an appreciation of geometry! More likely, pecking order or social protocols are involved.

Similar and Related Phenomena. Circular formations (BMB26); radial formations (BMB27); spiny lobster caravans (BAB).

Entries

X0. Introduction. It is reasonable to inquire why mammals would organize themselves in linear formations. Ants do this because they are following a linear chemical trail; human soldiers and prisoners file one behind the other because of the human passion for order. But why do spiny lobsters migrate in long caravans? Just as curious are the trains, rows, and chains formed by some mammals.

X1. Trains or caravans. Many mammals will occasionally queue up behind a leader in mobile files, elephants come to mind here. There are two species, though, that deserve special mention.

Echidnas or spiny anteaters. Strangest of all are echidnas during the mating season. From May through September, Australians are startled to see caravans of several echidnas, a female at the fore, snaking along roadsides and through woodlands. This bizarre activity is connected with courtship. (R4) M. Griffith, an Australian biologist, has found that:

> ...when male echidnas are sexually active, they forsake their solitary ways and form "trains" behind a female. A single female may be followed by as many as ten males lined up "Indian file nose to tail." (R6)

The smallest male echidna, usually the youngest, is always the caboose.

The reason for the caravans is not clear. The echidnas conclude the show with another bizarre activity: they make a circular ditch around a tree. (BMB26)

Shrews. Caravaning is also popular with some shrews. Walker's Mammals of the World mentions three caravaning species of shrews (there are probably more): musk shrews, piebald shrews, and some of the white-toothed shrews. This book contains two photos of caravaning shrews, each led by a mother and followed by

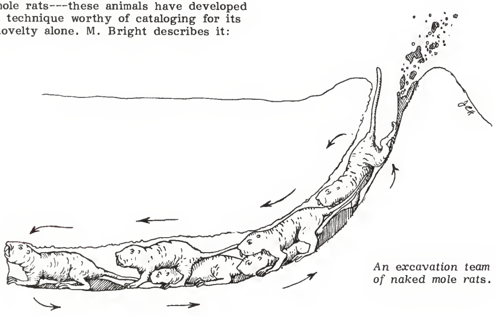
A caravan of shrews. The mother shrew is followed by her half-grown youngsters, each holding on to the animal in front with its teeth.

several half-grown youngsters. It is not uncommon for young mammals to file behind their mother while out foraging, but the shrews do it in a bizarre way: each shrew holds onto the shrew in front with its teeth. (R5)

X2. Linear excavating formations.

Naked mole rats. Many popular articles have told us how naked mole rats are the most social of the mammals---each group a sort of superorganism. Cooperation among the members of each group is thus to be expected. For excavation projects---obviously a major activity of mole rats---these animals have developed a technique worthy of cataloging for its novelty alone. M. Bright describes it:

Burrow digging is a cooperative activity, with several workers forming a miniature production line. At the head of the column a worker digs out the soil with his huge incisors. Lip folds behind the teeth prevent the earth from getting in the mouth. The next in line gathers the loose particles behind its body and shuffles backwards. Those behind straddle their legs and more forward, each one changing to a soil-pusher when it reaches the front. Eventually a continuous chain is formed, those with their bellies against the floor pushing soil backwards and those with their backs against the roof



An excavation team of naked mole rats.

> straddling forwards. At the back of the line one individual kicks the soil outside the burrow, and with such force that a small mound, like an erupting volcano, is formed. (R1, R7-R9)

X3. Living bridges. That some ants build bridges with their bodies is well-known and accepted. But those stories about monkeys making living bridges between trees too far apart for leaping have been relegated to pulp fiction by most scientists. But here the truth is just as strange as fiction. One scientist, C. Lovelace, actually saw such a bridge in operation, in 1905, in South America.

New World monkeys (species not known).

> "These monkeys made a living bridge ...formed by one monkey swinging tail down from a limb and wrapping his tail around the head of another monkey, and so on until five successive monkeys made a pendant chain which then swung back and forth until the ultimate monkey attached himself to a tree across the interval. The remaining monkeys, including two females with little baby monkeys around their necks, then crossed this bridge. The last monkey to cross was ...evidently the leader of the band... The initial end of the bridge then turned loose and the whole band proceeded in the original direction in less time than it has taken me to describe it. (R5)

X4. Linear sleeping formations. Sleeping in rows is definitely an unusual habit among mammals. At least two species of South American bats do this, and the reason remains unknown,

Long-nosed bats. This and the next quotation are from L.H. Emmons' Neotropical Rainforest Mammals.

> They roost in the open over or beside water, on the lower side of a large branch, fallen tree, leaning tree trunk, steep face of a bank, or below a bridge. They roost in groups of 3-45, usually about 12, and they hang in a characteristic straight line, with each bat spaced 2-4 cm from its neighbors. The frosted fur blends perfectly with the tree bark, but the profile of little bumps is a giveaway. They sometimes start to rock back and forth, with all group members swaying like leaves in the wind. (R3)

Doglike sac-winged bats.

> P. kappleri roosts in small groups of one to six near the ground in hollow logs, moist hollow buttressed trees, or caves where the bats hang in contact in a line, each touching with its belly the back of the one in front (they separate if disturbed). (R3)

References

R1. Bright, Michael; The Living World, New York, 1987. (X2)
R2. Eisenberg, John F., Mammals of the Neotropics, vol. 1, Chicago, 1989. (X4)
R3. Emmons, Louise H.; Neotropical Rainforest Mammals, Chicago, 1990. (X4)
R4. Rismiller. Peggy D., and Seymour, Roger S.; "The Echidna," Scientific American, 264:96, February 1991. (X1)
R5. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1, X3)
R6. Dayton, Leigh; "Sex Secrets of the Spiny Anteater," New Scientist, p. 16, April 30, 1994. (X1)
R7. Webster, Bayard; "Scientists Amazed by the Mole Rat's Bizarre Behavior," New York Times, January 24, 1984. (X2)
R8. Honeycutt, Rodney L.; "Naked Mole-Rats," American Scientist, 80:43, 1992. (X2)
R9. Miller, J.A.; "Insect Lifestyle in Rodent Underground!" Science News, 125:39, 1984. (X2)

BMB26 Circular and Ring Formations of Mammals

Description. Circular and ring (annular) formations of mammals.

Data Evaluation. A glance at the references at the end of this entry reveals the strong anecdotal nature of the data. No systematic, scientific study of the phenomenon exists and, considering its Fortean character, few scientists would deign to examine the evidence! Rating: 3.

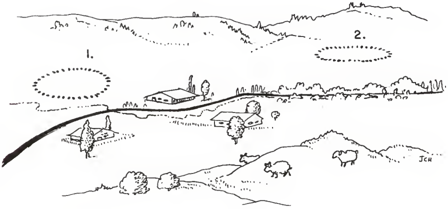
Anomaly Evaluation. Why do groups of mammals adopt circular or ring configurations? Environmental influences, such as terrain and food sources, may play roles in some of the cited observations. Whatever impels roe deer to run in circles will probably never be discovered. These rings and circles are certainly curious and a bit mysterious, but they do not challenge any important biological theories. Rating: 3.

Possible Explanations. See above comments.

Similar and Related Phenomena. Linear formations or trains/caravans (BMB25); radial formations or "kings" (BMB27); the human tendency to wander in circles when lost.

Entries

X0. Introduction. Animals are hardly ever seen arrayed in circular formations. With plants and fungi, rings are more common, as in creosote-bush rings and fairy rings, respectively; where the organism or superorganism expands radially from a central point of origin. In the Class Aves, radar returns tell us that starlings often fan out from their night roosts in circular waves at daybreak. Circles make good defensive formations, too. We see them when musk-oxen group to confront predators. There are also the aggressive Chillingham cattle, which, when approached, also form into a circle with horns directed out-



Two grazing circles of sheep.

ward. (R2) Other circular formations of mammals are not so easily accounted for, as we shall see below.

X1. Grazing circles. Farm animals normally graze in loose flocks that exhibit no particular order. Therefore, when flocks or herds are seen configured in circles, our curiosity is aroused.

Sheep. The observations of J.C. Belcher on Baildon Moor, England, are pertinent here:

> By their very nature sheep tend to be stubborn self-willed animals exhibiting individual characteristics not suggestive of good group coordination. For example, when disturbed by a potential predator, a flock of sheep tends to mass protectively in a group of irregular outline, the group being formed of individual groups of small numbers of sheep. When grazing undisturbed, sheep tend to fan out from a given point, sometimes following a dominant group leader. Progress is usually uncoordinated and ragged. In general, patterns presented by sheep en masse are seen to be haphazard, indeed, generally random in nature. It follows that any suggestion of flocks of sheep forming geometric patterns would appear to be highly improbable, since this would call for group coordination only to be found in such as wolves and wild-dogs. In view of this it would appear that certain exceptional observations made on Sunday 21 August 1988 would be worthy of recording.
>
> Out on an afternoon drive M. Belcher parked his car near the trigonometric survey point on Baildon Moor, near Leeds, in Yorkshire, at approximately 1430 GMT facing north-east. His wife suddenly exclaimed: "Look at that circle of sheep in that field!" That was Sheep Circle 1 on the plan where "a hundred or so sheep were in a circular formation, each sheep being more or less equidistant from the next. At the north end of the field some 20 or 30 cows were standing, grazing and chewing cud in the usual haphazard manner. The circular formation of these sheep was so unusual that I thought I was looking at bales of hay set out in the field by the farmer. Indeed, a stone-age stone circle might have been appropriate on this occasion. I looked around from north-west to north-east, and then espied a similar sheep circle (2) on a plateau opposite...In the sector between north and north-east, flocks of sheep were in other fields but in no case exhibited the circular formation, being in typically haphazard groups." In a second letter Mr Belcher emphasized that the sheep of the two circles were variously standing, laying down, or grazing. All quietly occupied, but nevertheless forming this very regular circular formation. (R3)

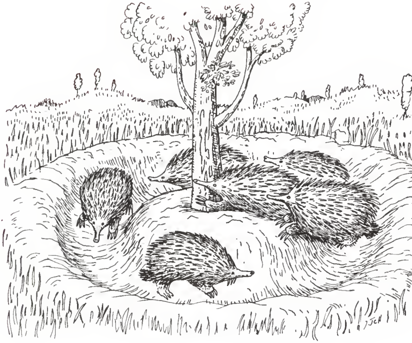
Additional correspondence about sheep circles appeared in the Journal of Meteorology, U.K.. One letter from R.M. Skinner suggested that the circular flocks might have been shaped by fairy rings. The thought being that the underground fungi created unpalatable or perhaps especially succulent grass. No conclusions were reached. (R4)

X2. Circular trains or caravans. Sometimes linear caravans of mammals convert into circles.

Echidnas. Echidna caravans were introduced in BMB25. When the time finally comes for the female heading the train to mate, she anchors herself to a tree with her forelegs. The train of males following her surround her in a ring and excavate a circular trench around her and the tree. (Australians have puzzled over these circular trenches for years.) Eventually, the strongest male evicts all other males from the trench and mating takes place---gingerly, for echidnas are also called spiny anteaters. (R6)

Roe deer. During the mating season, the male roe deer of Eurasia chase the females in circles, wearing tracks into the ground that are popularly called "witches circles." (R5)

Eurasian hedgehogs. In England, this species has been seen running in circles for long periods in a most peculiar



Male echidnas (spiny anteaters) making a mating trench around a female. See text for details.

fashion. Apparently, only individuals are involved. (R7, R8) Here follows an observation recorded in New Scientist:

> It [the hedgehog] was first noticed on 6 May, shortly after midnight. Thereafter, as soon as darkness fell it left the secluded southern part of his garden where it spent the day and ran round the northern portion which is more public, exposed to the noise of traffic and illuminated by street lamps. The animal invariably ran in an anti-clockwise direction. Widdershins? The circle varied to some extent. Normally it was about 15 yards in diameter which it accomplished in about 20 seconds, that is at a speed of about 4.5 mile/h. Typically, there was a steady rapid trot round and round, snout held forward well above the ground. Starting at dusk it kept this up for stretches of two hours or even longer and was seen until half past three in the morning. (R7)

Hedgehogs have been seen running around the same circular path for hours on end. Curiously, they somewhat resemble the circle-running echidnas sketched above!

X3. Carcass circles.

Caribou.

In 1972. 53 dead caribou were found in a circular area located 120 miles southeast of Fairbanks, Alaska. These dead animals were in a circular cluster, not a ring.

> An Army helicopter discovered the animals on June 21, 1972. The carcasses of the 400- to 600-pound animals, clustered in a 50-100-yard circle, had been scavenged by bears and eagles when the pilot flew in two Fish and Game Dept. officials on the following day.
>
> The animals had died suddenly; not of starvation, avalanche, or any detectable poisoning. There was later found a "nine-spoke trench etched by a 'probably larger than average' lightning strike that extended beyond the 50-yard-wide area where the carcasses were found." (R1)

A lightning strike makes sense here. The powerful, lightning-induced currents in the ground are particularly deadly to quadrupeds. And these currents might well have followed a radial pattern emanating from the strike point.

References

R1. Anonymous; "Anomalous Electrical Phenomena," INFO Journal, 3:28, Spring 1973. INFO = International Fortean Organization. Cited source: New York Times, July 31, 1972. (X3)
R2. Bright, Michael; The Living World, New York, 1987. (X0)
R3. Meaden, G.T.; "Sheep in Circular Flocks: Is There a Meteorological, or Some Other Connection?" Journal of Meteorology, U.K., 14:54, 1989. (X1)
R4. Skinner, R.M.; "Sheep Circles and Fairy Rings," Journal of Meteorology, U.K., 15:329, 1990. (X1)
R5. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X2)
R6. Rismiller, Peggy D., and Seymour, Roger S.; "The Echidna," Scientific American, 264:96, February 1991. (X2)
R7. Anonymous; "The Curious Case of the Concentric Runner," New Scientist, 36:743, 1967. (X2)
R8. Wainwright, B.H.; "Hedgehogs Widdershins," New Scientist, 37:322, 1968. (X2)

BMB27 Radial Formations or "Kings"

Description. Radial formations of mammals, heads outwards, with tails touching and usually intertwined. In "kings," the intertwined tails are knotted and/or stuck together with sap, mud, and body products so that members of the cluster cannot escape.

Data Evaluation. As unlikely as mammalian "kings" may appear, there are almost two centuries of observations, including modern cases examined by naturalists and zoologists. In the main, though, the "king" literature is popular and often Fortean in origin. Some of the anecdotes, particularly those from the 1800s, must be viewed with suspicion. Rating: 2.

Anomaly Evaluation. Radial formations with heads outward and untangled tails cannot be labelled anomalous, because such configurations give the cluster a 360° view of the predator-filled environment. It is when the cluster's members' tails are hopelessly knotted or stuck together, as in "rat kings" and "squirrel kings," that the phenomenon becomes really puzzling. The mammals rendered immobile in kings are normally strong and active. It is hard to imagine how they got themselves into such a difficult situation. The mystery deepens when the king's members are mature and well-fed. Did other animals feed them? Kings are unquestionably bizarre, but they are only mildly anomalous because their existence threatens no biological principle. Rating: 3.

Possible Explanations. Mammals that nest together may naturally adopt radial configurations. If they remain so long enough, their tails may get stuck together by tree sap, nest debris, and their own excrement.

Similar and Related Phenomena. Circular formations of mammals (BMB26).

Entries

X1. Radial formations with tangled tails.

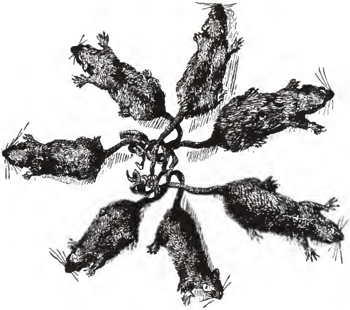
Rats. Few biological phenomena are as unexpected as discoveries of clusters of rats or squirrels, arrayed like spokes in a wheel, with their tails tangled inextricably together in the center. Recognized by naturalists for almost two centuries, these clusters of unfortunate animals are customarily called "kings." This name apparently stems from the old belief that rat colonies are headed by an extremely large rat to whom all other rats brought food and paid homage. Naturally, these specially favored rats were called "rat kings." The kind of rat kings we are investigating here are quite different, being composed of several rats linked together by their tails. In olden times, these clusters were also called "rat-king thrones." Somehow, the terminology became confused. But, there is a connection: our clusters of entangled rats are often mature and well-fed, suggesting that other rats may feed them well. (R4)

Most rat-king tales come from France and Germany. It is not surprising, then, that W. Ley, the German-born collector of odd zoological facts, knew of them. He defined the rat king as follows:

> A Rat King is not a separate species. One is tempted to say "on the contrary," for it consists of a number of rats which cannot be separated.
>
> The average number of rats forming a "king" is twelve, but larger and smaller numbers have been found. The tails of the animals are intertwined in such a manner that the individuals cannot pull free. The whole thing is about two feet in diameter. All the heads point outward, naturally, since the tails are stuck together. Being handicapped in this manner, the animals are not very mobile and in a few cases a dead and dried-out "king" has been found. Evidently the rats had starved to death. But in the majority of the cases the "king" when found was still alive. It often was found because the members composing it were squealing with hunger. (R3)

The oldest rat-king anecdote we have found so far comes from an 1880 issue of the Scientific American Supplement, where it was accompanied by the wonderful illustration here reproduced. A bit of the associated text follows:

> The rat king was taken to a taxidermist, who removed the conglomerate of hair, tallow, clay, etc., that surrounded the knot of tails, so as to enable several scientific gentlemen to make a careful examination. The tails were only entangled, but to such an



A rat king as illustrated in an 1880 issue of Scientific American Supplement.

> extent that it was absolutely impossible to move certain parts, but careful examination showed that none of the tails had grown together...The other rats never desert the rat king, but always supply them with sufficient food, of which the above rat king was a very good proof, as all the members were fullgrown and fat. (R1)

J. Michell and R.J.M. Rickard have come across an even earlier account.

> Perhaps the most astonishing case of all occurred in Dollstedt, a village near Gotha..., in December 1822, when farmhands threshing grain investigated a squealing in the attic of their barn. Climbing up they found a hollow on the topside of the main beam full of rats which made no attempt to escape. The hollow was clean and, according to one account, lined with straw, and the rats were apathetic and weak from hunger. When the rats were pushed out they fell in two squeaking clusters to the floor below; one was composed of twenty-eight individuals and the other of fourteen. Villagers gathered to see the marvel, and later joined in its execution with flails. The rats were separated with great difficulty, and a forester called to witness the strange discovery later testified that the skin on each tail was intact and 'showed the impressions of the other tails, just like leather straps that had been plaited together for a long time'. (R4)

No source was given for this old account.

Adding to our natural skepticism about such improbable stories, despite their large number, is the fact that there seem to be no modern observations of rat kings.

Gray squirrels. If it were not for the discovery in recent times of several squirrel kings, one would be tempted to discard the "king" phenomenon altogether. The most convincing squirrel-king reports have come from the staff of the New York Zoological Park.

> ...we had never heard of such strong and active creatures as squirrels being trapped by having their tails knit together by natural causes. Not one, but three, instances of this peculiar accident have recently come to the attention of the Zoological Park staff.
>
> The latest occurred on the morning of December 31 [1951] when one of our keepers noticed seven Gray Squirrels huddled closely together on the ground at the north end of the Zoological Park. Their bodies extended in different directions and they seemed to be bound by their tails so tightly that any coordinated movement was impossible. They were netted and taken to the Animal Hospital...
>
> Close examination at the Hospital revealed that the seven tails were tightly tangled and knotted together like twisted strands of twine. Individual hairs were matted and interwoven to such an extent that a great deal of fur had to be cut away in order to separate the animals.
>
> All seven squirrels were adults. Two of them, both females, were dead when they were picked up and another was so weak that it died the same day. The other four, once released, were able to scamper away under their own power...From their general condition, it would seem that they had been tied together for several days. (R2)

Admirers of Charles Fort, the American iconoclast who collected "damned" data, have always been partial to "king" stories. In 1985, a squirrel-king observation was printed in the INFO Journal, the organ of the International Fortean Organization. (R5) Even more recently, the English publication Fortean Times recounted two more. (R7) All involved squirrels and all occurred in the States.

X2. Radial formations without tangled tails. A fact that may or may not be pertinent to the king phenomenon comes from South America.

Yellow-handed titi monkeys. At night, small groups of these small monkeys sleep together on a large horizontal branch with their tails intertwined. (R6)

References

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R4. Michell, John, and Rickard, Robert J.M.; Living Wonders, New York, 1983. (X1)

R5. Anonymous; "A Squirrel King?" INFO Journal, no. 47, p. 15, 1985. (X1)

R6. Emmons, Louise H.; Neotropical Rainforest Mammals, Chicago, 1990. (X2)

R7. Anonymous; "Tangled Tales," Fortean Times, no. 63, p. 13, 1992. (X1)

BMB28 Nonmigratory Mass Movements of Mammals

Description. The determined, purposeful, non-migratory movements of swarms consisting of many thousands of mammals. The individual swarms are usually all of the same species, with each swarm headed in approximately the same direction. The swarming mammals are usually fearless, panicky, and psychologically changed. Most of the mass movements considered here may last for days and cover many miles, sometimes resulting in mass mortality.

Data Evaluation. A rather large literature on lemming movements has accumulated over two centuries; a lesser amount exists describing Eastern gray squirrel movements. Virtually nothing has been found on the mass movements of other mammals, except, of course, for normal seasonal migrations. Some popular accounts of mass movements, especially of lemmings, are sensationalized; but a solid core of scientific observations exists for both lemmings and gray squirrels. Rating: 1.

Anomaly Evaluation. The major players in the subject phenomenon---lemmings and gray squirrels---often begin their frenetic mass movements in the presence of adequate food supplies. This fact contradicts the standard explanation given for the initiation of the phenomenon. In fact, the true trigger(s) for the commencements of the movements are unknown. The stimulus is thought by some investigators to be a psychological imperative inherited down the millennia; in other words: a powerful instinct to move en masse in response to overpopulation. The obvious psychological changes seen in the mammals engaged in mass movements seems to support this contention. In any case, the accepted trigger for the mass movements seems incorrect, and the real explanation is still a bit mysterious, as are the ultimate biological, psychological, and geographical objectives. Rating: 2.

Possible Explanations. See above discussion. Psychological imbalances created by by overpopulation; or, in different words, overpopulation causes an instinctive mass exodus of the overpopulated region, although in lemmings especially the exodus is extreme---far greater than necessary to reduce population pressures.

Similar and Related Phenomena. Nonanomalous seasonal mass migrations of many birds, mammals, fish, etc. Mass migrations in search of food, as in locust swarms. Mass strandings of marine mammals (BMB33).

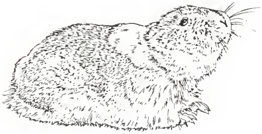
Entries

X0. Introduction. Every few years, the lemming population in northen Europe explodes. Vast numbers of these small rodents can been seen purposefully, frantically heading somewhere---just where, or why, scientists are unsure. The pressures of overpopulation and a diminishing food supply are assumed to trigger these mass movements. But, there are some curious aspects of the mass movements of lemmings and other mammals that deserve closer scrutiny. For example, we will also inquire into the mass movements of North America's Eastern gray squirrels and the mass panics of domestic sheep that occur simultaneously over wide tracts of countryside.

The mass movements that interest us are not like the seasonal migrations of the North American caribou or the restless treks of Africa's wildebeest. Scientists prefer to use the term "irruptions" rather than "migrations" to describe the more-irregular population explosions and subsequent urgent mass movements of lemmings and squirrels. Here, we will often employ here the term "mass movement" rather than irruption or migration, because some of the phenomena described below have little to do with overpopulation and the search for new food sources.

X1. General observations. From the many anecdotes describing the panicky mass movements of lemmings and squirrels, we have selected a few that mention characteristics of the phenomenon that may be anomalous.

Lemmings. Across northern Eurasia and North America, over a dozen small vole-like rodents are classified as lemmings. The lemming we are most interested in is Lemmus lemmus, which inhabits Norway, Sweden, Finland, and extreme northwest Russia. This is the species that, every three or four years, appears in great numbers, often surging across the countryside as if driven. L. lemmus is only about 5 inches long with a very short tail. It is rusty brown with a black stripe down the back and yellow sides---a rather attractive rodent. (R5, R8) Another type of lemming, the "steppe lemming" of northern Asia also "irrupts" but not as spectacularly as L. lemmus, the subject of our inquiry.



One of several species of lemmings.

Many sensational articles have been printed about lemming mass movements and how they throw themselves into the sea and start swimming toward sunken Atlantis. It is true that lemming mass movements are quite remarkable. particularly in the so-called "lemming years," but is there really anything anomalous beyond the impressive spectacle of moving carpets of small rodents? To attempt an answer, we examine five features of lemming mass movements:

1. (1) The sheer scale of the really great lemming irruptions that occur during the "lemming years,"
2. (2) The apparent suicidal nature of the mass movements,
3. (3) The psychological behavior of the lemmings during the start and progress of the movements,
4. (4) The idea that the lemmings are bent on reaching Atlantis,
5. (5) The possibility that irruptions are cyclic and caused by "cosmic influences."

Feature 1. Our treatment of this fascinating list of topics begins with three commentaries on the scale and character of the mass movements.

The truly great lemming years that received scientific attention apparently occurred in the Nineteenth Century. We quote first the description of M. Martins, who was fortunate enough to observe the great irruption of 1839.

> The following year [1839], at the same period [September], we saw them in myriads on the plateau of Lapland. At Bossecop (Lat. 70°) they were rather scarce, and again became so when we descended below the limit of the zone of the white birch. They again became very common in the neighbourhood of Karasuando on the banks of the Muonio, but on the right side of this river, a little below Muonionska (Lat. 67°55'), they were truly innumerable, and it was impossible to look around one without seeing a great number at once, and all running in the same direction parallel with the river. This, then, was the commencement of the migration; the army was on the march. On the plateau, on the contrary, they ran about hither and thither, without inclining to any particular direction. When they descended lower into the plain, their ranks became closer. Linnaeus says, "They trace rectilinear parallel furrows, from two to three inches deep, and many ells distant from each other. They devour everything in their passage, plants and roots, and nothing turns them aside from their course. If a man stand in their way, they slip between his legs. If they meet with a rick of hay, they graw their way through it, and pass along. If a rock opposes their progress, they run around it, and resume their rectilinear course. When a lake occurs on their route they cross it in a right

> line, whatever may be its breadth, amd that very often at its greatest diameter. Should a boat be lying in the line of their passage, they creep over it, and again throw themselves into the water on the other side. Even a rapid river cannot arrest them; they throw themselves into the current, although they should all perish in it." (R1)

Most tabloid-class tales of the lemming movements have the animals flinging themselves en masse into the ocean, as if determined to reach some unseen objective even though they die doing it. That lemmings do plunge into the ocean in great numbers is confirmed by the following quotation from J.E. Hill:

> In 1868 a ship was coming into Trondhjem Fjord, Norway. The captain noticed that the water was covered with small brown objects, like fallen leaves, but these on closer inspection proved to be lemmings, swimming out to sea. For fifteen minutes the ship ploughed through the mass of rodents. (R5)

Confronted with such graphic accounts, it is always wise to temper the subject matter with a less passionate description. Speaking of the lemming population, Walker's Mammals of the World says:

> There are regular fluctuations, with peak numbers reached every two to five years. Eventually an excess population may overutilize the food supply and force the lemmings to begin a large scale movement. At such times the animals may swim across rivers and lakes and appear in human settlements. Many of them die because they are unable to find enough suitable habitat. There have been reliable accounts, especially in northern Europe, of great swarms of lemmings moving over wide areas and eventually plunging into the sea to drown. Such phenomena appear to be unusual and to represent a modification of the typical microtine population cycle rather than any special behavioral aspect of Lemmus. (R13)

Later, we shall question whether a lack of food is the real trigger for the mass movements.

Feature 2. Are the lemmings really bent on mass suicide? A.C. Jenkins believes this interpretation is wrong.

> The most notorious feature of a lemming irruption is the behaviour of the animals on arriving at lake or river or ocean. It is of course not true that they deliberately commit mass suicide. Where they can, they will find a way round a water obstacle, but if there is no alternative they will swim, plunging in fearlessly, for they are good swimmers, and the death that overtakes them in the water is through simple exhaustion, or aquatic predators. (R12)

When considering the mass-suicide angle, it should be remembered that lemmings are tiny animals and so close to the ground that they cannot see across bodies of water of any size, especially if the surface is rough.

Feature 3. While suicide may not be on their minds, lemmings on the move do not act normally. Of great interest here is the observation that lack of food does not seem to be the trigger that unleashes mass movements. The abstract of an article by K. Curry-Lindahl suggests a psychological imperative instead.

> The period of 1959-60 was the first "total" lemming year in Sweden in 18 years. This period of high population of the Norwegian lemming (Lemmus lemmus) was characterized by high reproductive rates and possibly breeding through the winter. As population densities increased there was more movement and a spreading out to new habitats. The cause for the moving appeared to be psychological rather than from lack of food. The population crash did not appear to be associated with either lack of food or predation. It is postulated that the crash was due to a psychological imbalance. (R7)

As a lemming population builds up, the animals become more agitated. Fights are frequent. Then, a "collective nerve" seems to snap; panic sets in and off they go in great swarms. And the lemmings in these mass movements adopt an entirely different character. No longer are they timid and cautious; they become extremely aggressive toward each other and any animal standing in their way. Upon meeting a human, they often give a doglike bark, gnash their teeth, and will not hestitate to attack. (R12)

Feature 4. Do all these swarms of lemmings set their sights on the Atlantic Ocean and the direction of the sunken continent of Atlantis? It has so been suggested. (R2) In fact, though, the individual swarms may be unidirectional, but the different swarms travel toward all points of the compass. Sometimes, two swarms will meet one another while traveling in opposite directions. (R12) When and if they reach salt water, they even swim in different directions. Lapland lemmings swim north; Swedish lemmings head out into the Baltic. (R5)

Feature 5. Lemming populations peak at fairly regular intervals, usually every 4-5 years. It has been claimed that "lemming years" are correlated with the population cycles of certain birds, butterflies, shrews, and voles. (R12) It is natural to wonder if some "cosmic force" controls these simultaneous population peaks. Nowhere in our searches of the literature have we found any indication of such a force or of such a cross-species correlation of population peaks. Each species seems to have a population cycle based on its own food supplies and predators.

In summary, the only feature of lemming mass movements that might be anomalous is the unknown trigger that starts the hordes dashing across the landscape. If it is not the food supply, what is it? It could be psychological---the consequence of high population density. This interpretation might account for the change in lemming character during migration. However, the lemmings' single-minded determination, blind to hazards, is also seen in other mass movements, such as those of the wildebeest.

Eastern gray squirrels. The mass movements or irruptions of the Eastern gray squirrel are not as frequent nor spectacular as those of the European lemmings, but they do exhibit some of the typical characteristics of lemming population explosions.

We set the stage with a general sketch of the phenomenon by L.L. Rue, III, written in the early 1960s:

> Although we still have plenty of Eastern gray squirrels, their numbers cannot compare with the former gray squirrel populations. These grew to such fantastic proportions that squirrels migrated en masse to forested areas in other states. Some of these huge moving blankets of squirrels contained hundreds of thousands of animals. Rivers presented no obstacle to the squirrel hordes, even though vast numbers drowned in the crossing. Within a year or two the greatly reduced squirrel population in the abandoned areas again increased to astronomical proportions. (R9)

One could substitute "lemming" for "squirrel" and still be accurate.

The implication of Rue's paragraph is that overpopulation and food shortages forced the mass movements of squirrels. However, the 1968 irruption of gray squirrels, which saw great hordes of these animals on the move in North Carolina, Tennessee, northern Georgia, and southeastern Missouri did not seem to be associated with the available food supply.

> At first, observers were puzzled by the fact that immediate hunger seemed to play no part in mass movement. Walter Edmunson, district game protector for North Carolina's Western District, reports that there is ample food and that squirrels that died on the highway were "well fed, nice and fat, in good shape." Yet the animals were even entering buildings, evidence they were desperate for something. (R10)

As with the lemmings, we see here squirrels losing their loss of fear of humans in their curious state of panic. Naturalists finally blamed the 1968 squirrel mass movements on a failure of the mast (acorns and beechnuts) crops in the affected areas. In other words, when the squirrels started looking for nuts to store for winter use---not immediate consumption---and found none, they collectively, simultaneously, and in huge numbers decided to look elsewhere.

Something akin to panic set in. The

squirrels began moving out of their home territories, not driven by hunger but by an urge to find storable food. The urge is strong enough apparently to produce lemming-like determination to cross any obstacle, even the three-mile width of Fontana Lake, N.C., a journey for which they are completely unequipped. (R10)

We see again a sort of panic and a fervor that conquers natural obstacles, though with much loss of life. As with the lemmings, squirrel irruptions have their apparently suicidal aspects.

Going off on a different tack, some naturalists have remarked on a cyclic character of squirrel mass movements. For example, in southern Wisconsin, hordes of squirrels were on the move in the years 1842, 1847, 1852, and 1857---irruptions just 5 years apart. (R3) This figure is close to the tendency of lemming populations to explode about every 4 years. No "cosmic influence" has been proposed for squirrel irruptions.

Old World water shrews. Endemic to northen Eurasia, these aquatic insectivores (They are not rodents!) are sometimes seen swimming upstream in close-order formation by the thousands. (R13) No further data have been found here.

Domestic sheep. Cowboy movies may portray the panic of cattle stampede, but domestic sheep are even more subject to mass panic attacks. Over areas hundreds of square miles in extent, all sheep will suddenly and simultaneously run amok, breaking down enclosures, and scattering in all directions. There are no questions of food shortages or overpopulation here. Granted that sheep panics do not display the directional discipline of lemming marches, they do retain the areal scope and the synchronicity of lemming irruptions.

C. Fort recorded sheep panics in his New Lands. (Scientists have registered little interest in them!) Following in Fort's footsteps J. Michell and R.J.M. Rickard collected even more records of the phenomenon. We quote three cases from the latter's book Living Wonders:

> 1888. On the evening of 3 November thousands of sheep were simultaneously terrified over an area of twenty-five by eight miles in the Thames Valley near Reading. Next morning they were found widely scattered, some of them hiding in hedges and still panting with fear.
>
> 1889. In the Chiltern Hills, not far from the Thames Valley, on 25 October, many flocks of sheep broke violently out of their folds at about the same time over an area of thirty square miles.
>
> 1938. One night in December 'almost all the sheep in Britain started behaving crazily. They broke down their pens and tried to escape' (Daily Mirror, 7 May 1967). (R11)

These types of short-lived mass panics, occurring over wide areas, differ from the lemming phenomenon in duration, lack of common direction of movement, and very likely in the triggering force. For example, sheep flocks could well be panicked by a meteoric fireball.

See also BMB36 for a similar phenomenon involving "berserk" cows.

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R1. Martins, M.; "The Migrations and Manners of Lemmings,: Edinburgh New Philosophical Journal, 30:448, 1841. (X1)

R2. Crotch, M. Duppa; "The Norwegian Lemming and Its Migrations," Scientific American Supplement, 3:1196, 1877. (X1)

R3. Anonymous; "Hordes of Squirrels," Science News-Letter, 14:134, 1928. (X1)

R4. Jackson, Ralph C.; "Migration of Gray Squirrels," Science, 82:549, 1935. (X1)

R5. Hill, John Eric; "Lemming Hordes," Natural History, 54:180, 1945. (X1)

R6. Anonymous; "The Lemmings Are on the March Again," New Scientist, 8:1635, 1960. (X1)

R7. Curry-Lindahl, Kai; "The Irruption of the Norway Lemming in Sweden in 1960," Journal of Mammalogy, 43:171, 1962. (X1)

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R10. Anonymous; "Squirrels Erupt in Appalachia," Science News, 94:359, 1968. (X1)
R11. Michell, John, and Rickard, Robert J.M.; Living Wonders, New York, 1983. (X1)
R12. Jenkins, Alan C.; Mysteries of Nature, New York, 1984. (X1)
R13. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMB29 Collective Hunting Techniques

Description. Sophisticated hunting methods employing several or more predators that require considerable foresight, intelligence, and team action in comparison to the simple running down of prey or the overwhelming of large animals by weight of numbers.

Data Evaluation. Most of the techniques described below have been observed repeatedly by naturalists. The pertinent reports come from reliable science journals, magazines, and books authored by professionals. Rating: 1.

Anomaly Evaluation. An anomaly is claimed here only because of the still-surviving paradigm that insists that animals are only automatons---creatures of instinct alone. The hunting methods cataloged here belie this tenet. Rating: 2.

Possible Explanations. Many, probably all, mammals are not automatons but thinking creatures capable of rather complex strategies.

Similar and Related Phenomena. Mammalian resistance to conditioning (BMB2); intelligence in mammals (BMB5); predator-prey mismatches (BMB14); unusual lures employed by mammals (BMB15); remarkable escape tactics (BMB16).

Entries

X0. Introduction. A line is drawn here between collective hunting techniques that can be explained as largely instinctive and more sophisticated methods that seem to betoken planning, intelligence, subtlety, and intercommunication. Since many mainstream zoologists hold that animals are automatons that cannot plan ahead and collectively execute complex maneuvers, the sophisticated techniques we catalog here must be considered anomalous.

First, though, two representative collective hunting methods that are not considered anomalous: (1) The collective running down of prey by shifts of wild dogs, wolves, etc.; and (2) The collective attacks of small mammals on much larger mammals, as when pods of killer whales prey on large baleen whales.

X1. Simple collective herding techniques. This hunting method consists merely of cooperatively concentrating and surrounding the prey.

Bottle-nosed dolphins. Dolphins not only cooperate with each other when preying on fish but with humans on shore. (See BHX5 in Humans III for more on this.)

> The members of a group may cooperate in hunting fish, with some individuals crowding the fish toward shore and others patrolling offshore to prevent the fish from escaping, or with different units carrying out a synchronized attacks at opposite ends of a school of fish. (R3)

Dusky dolphins.

> Dusky dolphins (Lagenorhynchus obscurus) of coastal water in Argentina herd anchovy (Engraulis sp.) into tight balls against the surface. When the fish become lethargic, possibly due to oxygen deprivation in the tight cluster, dolphins take turns feeding on the fish. (R2)

Killer whales. These cetaceans herd not only fish but also pinnipeds. (R2)

South American sea lions.

> On Bird Island in the Falklands, gangs of sea lions sometimes surround and trap rockhopper penguins on land. They have been seen to flay the penguins before eating them, leaving the skin with head, flippers, and feet still attached. (R5)

X2. Collective hunting employing deception.

Lions. The rather sophisticated hunting strategy described below by animal behaviorist D.R. Griffin was observed in Kenya's Amboseli National Park. The prey consisted of two groups of wildebeest. Fifty to sixty were grazing on the woodland side of the Park road, while a hundred or so more had moved to an open plain 150-200 meters from the road.

> As we paused to watch the wildebeest, four or five lionesses approached with a business-like gait along the edge of the plain, roughly parallel to the road and within a few meters of it. Both groups of wildebeest obviously saw them, for they stopped feeding and watched the lionesses intently. Because the ground was irregular we could not see the lionesses all the time, but when about 200 meters from the two groups of wildebeest two climbed to the tops of adjacent mounds where they sat upright, and remained stationary but conspicuous. After a few minutes had passed we could make out a third lioness slinking, her belly pressed close to the ground, along a ditch that paralelled the road. Although she was visible to us only occasionally, it was clear that she was moving toward a position roughly midway between the two groups of wildebeest. She soon crawled out of our view and for several minutes nothing seemed to be happening at all. (R4)

Then, suddenly, a fourth lioness charged out of the forest toward the wildebeest between the road and forest. This group bolted toward the group of wildebeest on the plain. As they leaped over the ditch, the hidden lioness jumped up and caught one. (R4) Certainly, preplanning was required to execute this rather complex strategy.

X3. Sophisticated entrapment schemes.

Humpback whales.

> Unlike other baleen whales, humpbacks feed heavily on small fish such as herring and sardines. They capture them with their own version of a fisherman's net. Several humpbacks will join forces to compress a school

of fish by blowing streams of bubbles around the school's periphery. When the fish are packed tight, the whales dive into the middle of them with their jaws agape. The cooperative action necessary for such foraging behavior presumably requires more intelligence than the vagrant straining of the seas for krill as practiced by the gray, blue, and other baleen whales. (R6; R1)

The curtain of bubbles generated by the humpbacks circling the school of fish apparently intimidates the fish, and individuals are afraid to penetrate the curtain, even though they could easily do so.

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R3. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)
R4. Griffin, Donald R.; Animal Minds, Chicago, 1992. (X2)
R5. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X1)
R6. Martin, Glen; "Killer Culture," Discover, 14:110, December 1993. (X3)

BMB30 Unusual Assemblies of Mammals

Description. The gathering of several or more mammals for what observers interpret as deliberations or rituals of some sort. Vocalizations may accompany such "meetings."

Data Evaluation. On the whole, the information we have uncovered on this phenomenon is scientifically unacceptable. It comprises anecdotes from newspapers and other popular sources. Only the assemblies of spotted hyenas (X3) seem to have been observed by scientists. Rating: 4.

Anomaly Evaluation. If animals are the automatons that many animal behaviorists still insist, the assemblies of mammals described here would be highly anomalous. Animals should not deliberate or conduct rituals! Rating: 1.

Possible Explanations. None required. The data are too weak to support the claims.

Similar and Related Phenomena. Bird "courts" and "wakes" (BBB); ant "funerals" (BAB).

Entries

X0. *Introduction*. Mammals gather in numbers for such purposes as mating, mutual protection, and simply because food is abundant in limited areas. But even those who accord mammals considerable intelligence would not claim that they gather for deliberation or ritual purposes. Given these doubts, it is especially anomalous that some mammals *may* actually congregate for purposes thought to be exclusively human.

X1. *Apparent deliberations*.

Dolphins (species not given). Although we have consulted a mass of dolphin literature, we have seen no other mention of the following phenomenon:

> It has often been observed throughout the seas that before dolphins intiuate any group action they have a conference. A group of dolphins, called a pod, will float together just below the surface of the water, facing each other. They politely take turns vocalizing until a consensus is finally reached. (R4)

X2. *Apparent funerals and wakes*.

The popular literature contains many anecdotes relating how individual mammals seemingly exhibit grief over the death of a mate or group member. Beyond such individual expressions of emotion, claims that some mammals hold funerals with many attendees crop up here and there in newspapers and, especially, Fortean publications.

Red foxes. Red foxes, for example, are said to hold funerals or wakes for dead comrades. The only evidence we have found for this supposed bizarre custom is weak, indeed. In the July 1973 issue of *Pursuit*, a now-defunct Fortean magazine, J.S. Martin relays a tale told by a C. Shelmandine, of Schoharie County, New York. Shelmandine avers that one night he heard red foxes "singing"---much as coyotes howl together in the West. The sound came from the direction of the den of a well-known male fox called Old Joe, who had lost a leg in a trap in the past. Getting dressed and donning his snowshoes, Shelmandine made his way through the woods and approached Old Joe's den. As he got close, the "singing" stopped. Around the den's entrance Shelmandine found many fox tracks---four-legged fox tracks---and marks in the snow where the foxes had been sitting. Digging into the den, Shelmandine found Old Joe's body. He deduced that foxes in the neighborhood had been holding a funeral for venerable Old Joe! (R2, R3)

On this "soft" evidence, few scientists would accept Shelmandine's conclusion; but it does make a good story.

Domestic cats. Legend and newspaper stories say that cats, too, hold funerals. A letter to an English newspaper (the *Sun*, January 18, 1973) relates how eight neighborhood cats were seen sitting in a circle around the recent grave of the letter-writer's pet Persian. (R3) The cats apparently were *not* singing on this occasion.

Other mammals. J. Michell and R.J.M. Rickard state in their book *Living Wonders* that badgers, langurs (a species of monkey), and stoats (weasels) have been observed in processions carrying along the body of a dead member of their species! (R3)

Indeed, the evidence for any kind of mammal funeral is very questionable.

X3. *Mating assemblies*.

During their breeding seasons, some mammals, such as deer and seals, collect in groups of several females plus a dominant male. Such assemblies are recognized forms of mammalian behavior. However, one species seems to go a bit farther.

Spotted hyenas. All we have found is one sentence in a field guide by J. Dorst and P. Dandelot:

> At mating season, the spotted Hyaena assemble in large meetings, particularly at bright moonlight; the noise is undescribably hideous and a real pandemonium precedes mating. (R1)

References

R1. Dorst, Jean, and Dandelot, Pierre; Larger Mammals of Africa, London, 1970. (X3)

R2. Martin, John Stuart; "Why Did the Foxes Sing?" Pursuit, 6:57, 1973. (X2)

R3. Michell, John, and Rickard, Robert J.M.; Living Wonders, London, 1982. (X2)

R4. Thomas, Warren D., and Kaufman, Daniel; Dolphin Conferences, Elephant Midwives, and Other Astonishing Facts about Animals. Los Angeles, 1990. (X1)

BMB31 The Existence of Eusocial Mammals

Description. The existence of several species of mammals with social structures resembling, in various degrees, those of eusocial insects (ants, bees, termites, etc.).

Data Evaluation. A considerable literature---both scientific and popular---has grown up around the naked mole rat. References on other eusocial mammals, such as the dwarf mongoose, are more difficult to find. Field research on eusocial mammals has been complicated by the fact that they all spend much of their lives underground. In the case of the naked mole rat especially, most data come from laboratory colonies rather than naturally occurring colonies. Rating: 2.

Anomaly Evaluation. Gene-propagation theory or "the selfish gene" concept has been partially successful in accounting for eusociality and reproduction altruism in insects where the males are haploid (one set of chromosomes). The theory is not as convincing in mammals, where the males are diploid (both sets of chromosomes). The consequence of this fact is that female mammals gain no genetic advantages by giving up their reproduction function to a queen. (See X2 below for details.) In addition, eusocial mammals, naked mole rats in particular, exhibit a spectrum of highly specialized, often bizarre, adaptations to underground, eusocial life that would seem to require strong evolutionary pressures to develop. These pressures do not appear to have existed with the mammals. In short, extant evolutionary theory does not seem very successful in explaining mammal eusociality. Rating: 2.

Possible Explanations. None offered.

Similar and Related Phenomena. Anomalous altruism in mammals (BMB4); eusocial insects (BAB); cold-blooded mammals (BMC in Mammals II); humans (BHB17 in Humans I).

Entries

X0. Introduction. Various sorts of social structures have evolved among the mammals. Some mammals, like the badger, are solitary, consorting with others only for mating. Elephants travel in matriarch-led herds containing breeding females and young males---mostly all closely related to each other. In gray-wolf packs, the social bonds become stronger. Only the alpha male and alpha female gray wolf breed. They suppress breeding among others in the pack. All wolves in the pack---usually close relatives---cooperate in advancing the pack's fortunes.

Altruism among the non-breeding individuals in the gray-wolf pack is customarily explained in terms of maximizing gene propagation. (See BMB4.) Briefly, because of their close genetic relationship to the alpha male and female, the genes of a non-breeding wolves are still propagated along to future generations if the pack is cohesive and cooperative hunting successful.

In the context of such "gene-propagation" explanations, most mammalian social structures can be rated as non-anomalous. But what about more extreme forms of sociality---so-called "eusociality"? The now-famous naked mole rat and a few other mammals display social structures akin to those of ants, bees, termites, and other insects. In these "eusocial" insects, one finds the ultimate in altruism. In eusocial insects, the colony revolves around a queen who is the sole breeder and who is attended by several castes of workers and soldiers. Only the queen and a few drones breed. All others forfeit breeding in order to serve their colony. Workers are dispensible and will readily die for the good of the colony. Are there really mammals that live like this? Actually, mammalogists were quite surprised when the discovery of the naked-mole-rat social structure answered this question affirmatively. Be this as it may, is the existence of these eusocial mammals anomalous? Answering this question is the major goal of this entry. (See X2 below for an analysis.)

In addition to examining the evolution of eusociality in the naked mole rat, this wrinkled sausage of a mammal possesses several bizarre characteristics well worth recording, for they make this animal's evolution and geographical dispersal harder to explain. And, as we shall see in X1 below, the naked mole rat is not the only mammal with strong eusocial traits in need of explanation.

X1. General observations of eusocial mammals.

Naked mole rats. Gerbil-sized (3 to 6 inches long) naked mole rats really do resemble wrinkled sausages. Despite their name, they are not completely naked, having a few stiff hairs along their backs. These hairs are doubtless useful in feeling their ways along their long, dark tunnels. Their prominent large incisors are employed in digging the hard clay soils of their East African home (Kenya, Somalia, Ethiopia). Some of their tunnel complexes extend for a kilometer or more. These undergound colonies of naked mole rats usually number about 75, but up to 300 have been observed. (R3, R4) Observing them is extremely difficult because, like most termites, they studiously avoid the surface.

Taxonomically, naked mole rats are rodents and not moles, which are insectivores. Nor are they rats, being more closely related to porcupines and guinea pigs. (R6, R7, R13)

Before delving into the question of how mammalian eusociality might have evolved, it is worthwhile listing some of the unique, often bizarre, characteristics of the naked mole rats.

- The only breeding female in a naked mole rat colony is, as with ants and bees, designated a "queen." She has two or three male consorts. She may be twice the size of the average colony member. (R8)
- The fertility of other colony females is somehow suppressed. At first, biologists believed that pheromones released by the queen were responsible. (R3, R4) Later research disproved this and suggested that it is the queen's presence and bullying ways---sometimes even murder---that suppresses fertility in other females. (R10, R13) Actually, no one yet knows for certain.
- The naked-mole-rat colonies appear to have three overlapping castes of

workers. Unlike insects, these castes include both sexes and seem based on animal size. (Caste 1) The smallest animals do most of the hard work, such as tunnelling, foraging, and nest-building. (Caste 2) The next largest mole rats are termed "infrequent workers" in the sense that they work less than members of Caste 1. They do, though, help defend the colony against attacks. (Caste 3) The largest animals work little and sleep a lot. They mainly help raise the young and defend the colony. (R4) The three castes are not well-defined and actually form a continuum. Caste-1 workers keep the queen and higher castes fed.

- Of more than passing interest is the fact that naked mole rats are the only cold-blooded mammals. (R4) They control their body temperatures by moving between sun-warmed, near-surface tunnels and the cooler ones below.
- Remarkable genetic uniformity exists in these colonies. The animals are almost clones of one another. (R5, R11, R14). However, colonies that are far-separated geographically are also far-separated genetically---so much so that they might as well be different species.
- Naked mole rats are extremely long-lived as rodents go---10-15 years. (R3, R4)
- The primary food of these animals consists of large underground tubers, some of which weigh 100 pounds and more. When their exploratory tunnels come across a tuber, it is only partly consumed and left to recover before again being tapped for food. (R3, R4)
- The naked mole rats' conveyor-belt technique of excavation was described in BMB25. (R1, R2, R4, R6, R12)
- Naked mole rats feed their young feces. In fact, even adults will beg feces from other colony members. (R8, R9)
- In the presence of a pregnant queen, non-breeding adults, including males, exhibit nipple development. (R9) (See below for lactating, non-breeding females in the dwarf-mongoose eusocial colonies.)
- When a pair of non-breeding adults is removed from a colony, they quickly become fertile. (R10)
- Even with a social structure well-adapted to underground life, naked mole rats are not nearly as numerous or successful as gophers living solitary lives. (R6)
- Since naked mole rats are virtually never seen on the ground surface, it puzzling that they have been able to effect such wide geographical distribution.

With such an array of bizarre attributes, we would be remiss not to catalog naked mole rats---even if their evolution and dispersion were well-explained.

Common African mole rats. One other species of mole rat, *Cryptomys damarensis*, is also highly social. Perhaps this furred species in on the track toward the extreme eusociality of its cousin, the naked mole rat. In this species, there is also a single breeding queen, but usually she has only a single male consort. A rough caste system based on animal size prevails, again with the smaller animals doing most of the work. L. Gamlin elaborates:

> In many ways, *Cryptomys damarensis* is intermediate between the solitary mole rats, which account for the other three genera of the Bathyergidae, and the naked mole rat. It inhabits arid regions, as *Heterocephalus* does, but is found mainly in the Kalahari and parts of Namibia, where the ground is much softer. Like *Heterocephalus* it specialises on roots and tubers and rarely comes above ground. Some of these tubers are large and widely dispersed, making cooperative digging worthwhile. *Cryptomys* is a true homoiotherm [warm-blooded animal] unlike *Heterocepahlus*, and yet it maintains a lower body temperature than most mammals. Its coat is a sparse covering of fur, somewhere between the thick pelt of the other mole rats and the nakedness of *Heterocephalus*. The colonies are also closer together, and it seems likely that individuals migrate from one to another. (R4)

Black-tailed prairie dogs. North America also has a mammal with eusocial proclivities.

> North American black-tailed prairie dogs exhibit a system somewhat similar to naked mole rats. Within a prairie-dog town, only half the females in any given area bear young. The other females care for the young, even nursing them. (R13)

The above assertion seems in conflict with the existence of intraspecies murder in prairie-dog colonies. See BMB22-X1.

Dwarf mongooses. None of the many articles we have found on naked mole rats mentions the dwarf mongooses and their unique social structure. These African carnivores live in groups of 10 to 12. Only one female and one male breed. All other sexual activity is suppressed. Strangely, below the alpha male and female, the highest ranks go to the youngest and presumably the smallest---just the opposite of the naked-mole-rat hierarchy. (R7)

The degree of eusociality of the dwarf mongoose is captured in the following quote from Walker's Mammals of the World:

> Despite the rigid class structure, or perhaps because of it, intragroup relations are generally harmonious, and severe fights are rare. Subordinate adults clean, carry, warm, and bring food to helpless young and take turns "baby-sitting" while the rest of the group forages. Females in addition to the mother sometimes nurse the young. The youngest mobile animals seem to have the role of watching for danger and alerting the others by means of visual signals or a shrill alarm call. Often, a single animal occupies an exposed position, where it serves as a group guard. One series of observations showed that when a low-ranking male became sick, it was allowed a higher than normal feeding priority and was also warmed by other group members. In another case, a group restricted its normal movements in order to provide care and food for an injured member. (R7)

R. Wesson has remarked on another peculiarity of this species: Subordinate males and females do copulate, but they fail to conceive! (R6)

X2. The theoretical justification of eusociality. The power of biological theory in the context of eusociality was demonstrated by entomologist R. Alexander, as related by C. Tudge:

> Richard Alexander, an outstanding theorist, actually predicted on theoretical grounds in a lecture in the 1970s that if there was such a thing as a eusocial mammal, then it would probably be a rodent (small and fast-breeding) and live underground in an extremely safe environment (dense colonies are innately vulnerable), preferably without even leaving its quarters for food. A biologist in the audience told Alexander that naked mole rats seemed to fit the bill, and put him in touch with Jennifer Jarvis, who was working on them. (R10)

Obviously, then, thinking applicable to insect colonies is also useful in mammalogy---at least in part. In insect colonies, the willingness of female workers to abstain from reproduction in favor of their queen is explained---at least in part---in terms of gene propagation. But, can gene-propagation considerations also account for reproduction altruism in eusocial mammals?

There is a difference. With bees, the males are haploid; that is, they have only one set of chromosomes, since they developed from unfertilized eggs. The ramification of this is that each female worker is more closely related to her sisters than to her mother (the queen). Worker bees, the females, then, do not really labor for their queen, but for each other. The queen, in essence, is merely a machine through which the workers produce genotypes more like their own than if they mated themselves! This reasoning, though statistically correct, is sometimes undermined when the queen mates with more than one male. If these multiple-male matings are frequent, the gene-propagation explanation for reproductive altruism breaks down even among the insects.

The foregoing biological diversion was necessary to explain why the gene-propagation theory is less applicable to the naked mole rat. You see, the male naked mole rats are diploid, not haploid like bee males, each male naked mole rat possesses two complete sets of chromosomes. The upshot of this difference is that female naked mole rats are equally closely related to each other and the queen. The asymmetry is gone. The female mole rats would propagate their genes just as readily by mating themselves. But, in reality, they allow the queen to do all the breeding. How could this situation, so contrary to gene-propagation theory, have evolved? It turns out that the queen suppresses such extra-curricular copulation, but just how is not yet certain. (R8, R12)

Summarizing, gene-propagation theory may be applicable to eusocial insects in some cases, but it is less convincing as an evolutionary driving force among eusocial mammals.

One further unanswered question: How did naked mole rats get so widely dispersed geographically, when they hardly ever venture on the surface?

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R3. Pennisi, Elizabeth; "Not Just Another Pretty Face," Discover, 7:68, March 1986. (X1)

R4. Gamlin, Linda; "Rodents Join the Commune," New Scientist, p. 40, July 30, 1987. (X1)

R5. Young, Steven; "Naked Mole Rats Keep It in the Family," New Scientist, p. 38, May 12, 1990. (X1)

R6. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X1)

R7. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

R8. Bertram, Brian; "Underground Mysteries," Nature, 354:29, 1991. (X1)

R9. Michener, Gail R.; "Societies from Underground," Science, 253:803, 1991. (X1)

R10. Tudge, Colin; "Consider Their Ways," New Scientist, p. 43, August 3, 1991. (X1, X2)

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R14. Sherman, Paul W., et al; "Naked Mole Rats," Scientific American, 267:72, August 1992. (X1)

BMB32 Unusual Aerial Displays

Description. The sudden leaping into the air by several species of mammals in stereotyped displays that include spinning and somersaulting. Both terrestrial and marine mammals indulge in these enigmatic acrobatic performances.

Data Evaluation. The mammals that perform aerial acrobatics are rather common. As a consequence, a good deal of anecdotal evidence has accumulated in books and articles by naturalists. Detailed scientific investigations, however, are not yet to be found in our files. This may explain why the purpose(s) of these displays are still debatable. Rating: 2.

Anomaly Evaluation. No consensus exists as to the exact purpose(s) of mammalian aerial displays. Many possible explanations are on the table, and some of these, such as intragroup communication, are very reasonable. With so many attractive interpretations available and no major biological paradigms in danger, aerial displays must be relegated to the "slightly enigmatic" category. Rating: 3.

Possible Explanations. Intraspecies communication. Signals to predators concerning the health and speed of the displaying animals. Play.

Similar and Related Phenomena. Tumbler pigeons and other "acrobatic" birds. (BBB)

Entries

X1. Land mammals: stereotyped leaps. Some animals, even humans, will leap into the air just for the fun of it. With some common African prey mammals, however, a form of stereotyped jumping called "stotting" or "pronking" is thought to convey a message to would-be predators. The precise meaning of this supposed message is still being debated.

Thomson's gazelles. The most famous African stotter is the common Thomson's gazelle or "tommy." When most African bovids encounter a predator that is too close for comfort, they turn and run. But often in the process:

> ...they also go in for a very curious display, before and during the run. They bounce up in the air, keeping all four legs straight. Stotting, as the display is known, must make the animal visible, and presumably also vulnerable to the predator. It certainly attracts the human observer's attention, and there has been no shortage of 'explanations' for this strange behavior. (R4)

Actually, at least 11 hypotheses have been proposed. T. Caro has observed Thomson's gazelles stott on more than 200 occasions, usually in response to a cheetah or himself. Caro thinks that adult gazelles stott to proclaim to the cheetah that it has been detected and no longer has surprise in its favor. Cheetahs often do give up after stotting. Further, stotting gazelles have never been seen to be caught---so far. (R4)

Another popular explanation of stotting is that it advertizes the health and speed of the stotting animal. thus discouraging the predator. But, J. Diamond speculates that predators would soon catch on that virtually all Thomson's gazelles can stott whether they are in fine or poor running condition. Stotting, therefore, would be an imperfect ruse. (R7)

A Thomson's gazelle in mid-stott.

A. Zahavi, in contrast, insists that stotting is an honest signal that stotters cannot be caught.

> Zahavi's idea was that when signals are used to persuade, as in threats or sexual attraction, signalling systems will evolve around costly, wasteful signals. Thus, the 'stott' of a Thomson's gazelle while being chased by a predator---as it runs it jumps up into the air holding its legs out straight---is an utterly wasteful, frivolous and even reckless thing to do. But this very wastefulness, iron-

> ically, assures the predator of the gazelle's ability to flee: stotting is an honest signal because only the best quality gazelles can afford to 'handicap' themselves by stotting. (R10)

Stotting may also be merely a signal to the rest of the gazelles in the area to flee. As indicated at the outset, there are several other potential explanations.

Springbucks. Superficially, springbucks look a lot like Thomson's gazelles as far as coloration and pattern are concerned. But they are substantially larger, have a different dental formula, and possess an erectile crest along the spine. They are also impressive stotters, leaping as high as 3.5 meters into the air. (R6)

Pronghorn antelopes. This North American mammal of the West's open spaces makes sudden, enigmatic leaps into the air from a standing position. Some jumps are to the right, others to the left. Naturalists think these might be signals associated with the mating season. (R2) In any case, the pronghorn's jumps are not associated with the presence of predators and are, therefore, not stotts.

House mice.

> For no obvious reason, young house mice like to leap from all fours, twist in the air, land, dash a foot or so across the floor, and then leap again. Sometimes they just bounce up and down in one place. They're not looking for food or water, and they're not running away from anything. (R9)

Such erratic behavior may just be the simple, joyful play of young animals. (See also: "Waltzing" mice in BMB13.)

X2. Marine mammals: spinning and somersaulting. All manner of marine mammals will "breach" and otherwise break the water surface for a split second, perhaps propelling themselves completely clear of their normal environment. Some of the dolphins are even more acrobatic, not only leaping completely clear of the water but spinning or somersaulting in their brief flight. The precise reason for these energetic aerial displays is open to debate.

Spinner dolphins. The most famous of the acrobatic cetaceans are the spinner dolphins, of which there are several forms. Spinner dolphins prefer the warmer portions of the Atlantic, Pacific, and Indian Oceans. The descriptions we now present are based upon observations of the Pacific spinner dolphins.

K.S. Norris has studied these spinner dolphins most of his life, and his account of their spinning betrays his great affection for them.

> A dolphin flashes up nearly vertically from the blue depths. Propelled by powerful strokes of its flukes, it bursts from the sea into the air, wet and gleaming. The animal, called a spinner by fishermen, has thrown itself into rotation by twisting its upper head and body, like a spinning skater. All during the arcing leap, which may reach a height of almost ten feet above the sea surface, the animal spins: a flickering blur of flukes, fins, and body, moving too fast for our eyes to resolve. It reenters in a crash of spray, sinks, rotating ever more slowly as it descends, attended by a twisting plume of silvery bubbles. The dolphin recovers and swims off into the shadowy blue, only to spin again and again, sometimes a dozen times in succession. (R5)

A more technical description of the spinner's brief flight has been provided by F.J. Hester et al. Their observations were made in connection with studies of the curious association of schools of spinner dolphins swimming near with surface with deeper schools of yellowfin tuna. (BMX in Mammals II)

> Two types of jumping behavior were distinguished. The first was a combination of forward motion and the upward movement necessary to bring the blowhole clear of the water. Quiet animals traveling slowly often simply moved close enough to the surface to expose the blowhole and submerged again. As swimming speed increased, the amount of the body exposed increased until, at moderate speeds, the entire animal was out of the water.

> The second type of jumping behavior differed from the former in the following ways: the angle of departure from the water was usually much greater; the duration of the jump was increased manyfold; and the animal rotated rapidly on its longitudinal axis. The longest airborne time recorded was 1.25 seconds. Using the laws of accelerated motion and assuming the leap to be vertical, we calculated a height for the jump of a little over 6 feet and an escape velocity of 20 feet per second or nearly 14 miles per hour. Quite frequently the animals did not clear the water completely and spinning occurred with the tail submerged. The animals often made several spinning jumps in sequence. Clockwise and counterclockwise rotation appeared equally prevalent. The same animal sometimes rotated in a reversed direction on subsequent leaps. Reentry into the water was invariably rostrum first. (R1)

Noting that remoras were frequently attached to spinner dolphins, Hester et al suspected that the spinning activity might be an attempt to dislodge them. Careful study of films failed to confirm this hypothesis. None of the dolphins seen to spin had remoras attached. (R1)

K.S. Norris also doubts that the dolphins spin to remove remoras. He leans instead toward interpreting the spinning and the actions preceding and following it to be a form of intraschool communication.

> After puzzling what spins might be good for, I've already described how we finally concluded that they could be short-range omnidirectional markers that defined the dimensions of a school for all its members. Any dolphin could locate those splashes coming from any direction and in effect hear the local positions of the school members. These splashes, together with the other sounds the dolphins made, could explain the mysterious synchrony of widely spread spinner schools. (R5)

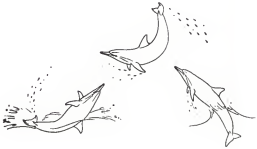
Hourglass dolphins. This beautifully marked black-and-white dolphin of Antarctic waters also spins about its longitudinal axis on occasion. (R3)

Dusky dolphins. From Whales and Dolphins by S. Leatherwood and R.R. Reeves, we have this account:

> This is an acrobatic species. If one in a herd begins to breach, others will often follow suit, causing a lively turmoil at the sea surface. Somesaulting is common, particularly after feeding episodes. (R3)

White-beaked dolphins. This is another spinning and somersaulting species. (R3)

Pacific white-sided dolphins. Another somersaulting species. (R3, R6)



Several species of dolphin somersault seemingly just for the fun of it. (R5)

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R9. Anonymous; "The Players and the Slugs," Discover, 13:15, September 1992. (X1)

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BMB33 Mass Strandings of Live Cetaceans

Description. The stranding on beaches of groups of live toothed whales numbering from several to nearly one thousand. The animals involved are generally healthy and often attempt to restrand after being refloated by humans.

Data Evaluation. Many popular and scientific accounts of mass strandings are available. We have used only a handful of them. However, very few of these events have been investigated first-hand by scientists. The main parameters of this phenomenon remain ill-defined. Rating: 2.

Anomaly Evaluation. The salient question in mass strandings is: Why? At least a dozen explanations have been advanced. (See X4 below.) None seems completely adequate. However, mass strandings constitute only a minor anomaly because no major paradigms are at stake. The expunging of this anomaly seems to only require further research and the selection of the correct explanation(s) from among several reasonable possibilities. Rating: 3.

Possible Explanations. See X4 below for a discussion of them.

Similar and Related Phenomena. Solitary strandings of cetaceans, seals, and other marine mammals due to disease, injury, and weather factors. The mass movements of lemmings and other mammals (BMB28). The erratic southward incursions of northern birds due to failure of conifer seed crops.

Entries

X0. Introduction. Since ancient times, whales and dolphins have invaded shallow waters and stranded themselves---usually singly, but sometimes by the hundreds. Single strandings usually involve sick or injured animals. Mass strandings, on the other hand, are almost always made up of healthy individuals. What is behind these mysterious incursions into shallow waters that so often lead to death? Even good old Aristotle was puzzled:

> It is not known why they sometimes run aground on the seashore; for it is asserted that this happens rather frequently when the fancy takes them and without any apparent reason.

The big mystery lies in the massive, almost compulsive strandings of living, intelligent mammals; and this is the focus of our inquiry.

X1. A more recent overview. S. Leatherwood and R.R. Reeves, two modern authorities on the cetaceans, are no less mystified than Aristotle was.

> The truth is that we don't know why an entire herd of whales, usually small or medium-size odontocetes (e.g., pilot whales, false killer whales, melon-headed whales), but occasionally sperm whales as well, will sometimes approach the surf zone as if possessed by an urge to return to the land. It has been argued from records of strandings in the northwestern Atlantic that strandings of a given species become more frequent as that species' local abundance increases. Even when towed back to sea, some stranded individuals refuse to swim to freedom. However, sometimes the stranded animals seem simply to have miscalculated and ventured into a cove or inlet while following prey or avoiding predators. (R6)

X2. Two typical mass strandings. From among many anecdotal accounts, we select two strandings investigated by marine biologists.

January 11, 1970. Southeastern Florida. First, a report by D.K. Caldwell et al indicates how large a stranding herd may be, the extent of coastline involved, and the apparent persistence of the animals.

> During the daylight hours on 11 January 1970, a large number of false killer whales, Pseudorca crassidens, stranded along the southeastern coast of Florida. Although some were reported about 15 miles north near Vero Beach, the greatest number of whales was seen north of the Ft. Pierce Inlet near Ft. Pierce. A single carcass seen near the St. Lucie Inlet, about 20 miles south of Ft. Pierce, was undoubtedly associated with the main stranding but was not seen until nearly 3 days later (probably carried off the beach by the tide and then drifted northward during the interim.)
>
> Because the whales were so widely scattered, and because mass burial operations began early on 12 January, we could not make an accurate count. Reliable, yet conservative, estimates placed the number from 150 to 175. Photographs taken from the level of the beach and including considerably less than a mile of beach clearly show as many as 20 whales.
>
> The whales were alive when stranded, and some were still alive after 24 hours. Efforts by a number of people to drag some of the more active animals back into the water met with typical discouraging results, that is, the whales returned to the beach to strand again, with the possible exception of one or two incompletely documented cases.
>
> Most of the animals reportedly measured 12 to 15 feet in length, with males averaging 2 to 3 feet longer than females. Where we have data, sexes were divided about equally. (R1)

August 19-25, 1971. West coast of Florida. Another series of mass strandings occurred on the Gulf side of the Florida peninsula, as described by W.K. Fehring and R.S. Wells.

> Between 19 August and 25 August, 1971, there occurred on the lower west coast of Florida a series of attempted strandings by a single herd of short-finned pilot whales, (Globicephala macrorhyncha). In each case the whales were prevented from beaching by human observers. Although numerous strandings of pilot whales on the Florida coast have been reported, there have been few first-hand accounts of the behavior of the animals during the stranding. We had an excellent opportunity to record

> one stranding in detail. Hopefully, these observations may shed some new light on this behavior, the causes of which remain a mystery.
>
> At about 1800 hours (hr) (EDT) on 19 August 1971, Mr. Miles Carpenter reported that three pilot whales came ashore on Manasota Key, Sarasota Co., Florida. This occurred on a gently sloping sand beach on the Gulf of Mexico, in less than 1 meter (m) of water. Two animals were pushed into deeper water. They quickly rejoined the main herd, which had remained about 150 m offshore. One of the stranded whales was ridden along the shore for several hundred meters by a youth holding onto the dorsal fin. This animal swam slowly, then turned and quickly disappeared into the herd offshore. The two largest animals of the herd were reported to have remained to seaward and behind the remaining whales.
>
> At about the same time, Dr. Arnold Simon spotted six pilot whales beaching about 1 kilometer (km) south of the above sighting. These animals were pushed off the beach by observers until about 2030 hr (EDT), when they rejoined the herd offshore. The herd was last seen swimming slowly south, parallel to the beach. At this time the tide was outgoing, the wind and sea were calm, and there was no appreciable current.
>
> Shortly after dawn on 20 August, unidentified observers sighted a herd of pilot whales stranded on a gently sloping sand beach on the Gulf side of Gasparilla Island, Lee Co., Florida. This site is located about 1.5 km north of the Boca Grande lighthouse and 18.5 km south of the attempted beaching on Manasota Key the previous evening. When discovered, two of the whales had already died, and the remainder were grounded in about 1 m of water. The tide was outgoing, and the winds and sea were calm.
>
> Aerial photographs supplied by W.H. Woodcock showed the herd spread out over an area 75 m in diameter. Forty-four whales were involved, and the two largest were noted in the photographs to have remained initially about 50 m offshore from the rest of the herd. The stranded animals were grouped into several pods of three to seven whales clustered together.
>
> A large crowd of people made several attempts to push the whales off the beach, but the animals returned to the shore each time. (R2)

The two largest whales were towed 400 meters offshore, and eventually the whales near the beach moved out to sea with them. On 25 August, 12 to 13 pilot whales were discovered stranding themselves near the Marquesas Islands, 35 kilometers west of Key West. A large whale in the group had an abnormal dorsal fin identical to that belonging to a whale photographed earlier at Gasparilla Island. (R2)

Fehring and Wells concluded their long report with:

> The most important observation we made at Boca Grande was that stranding did not involve disoriented panic, but rather a deliberate shoreward movement. Although the cause of these beachings remains unclear, the motivation for them was apparently not momentary, for it seems to have lasted for at least one week and over a distance of 275 km in this case. (R2)

X3. Some general characteristics of mass strandings.

Species involved. Essentially all species of whales, both toothed (Odontocetes) and baleen (Mysticetes), have stranded on beaches singly---usually found dead and probably washed ashore in that condition. In fact, some of the rare beaked whales are known mainly through strandings, since they are almost never seen at sea. Mass strandings, however, are a different matter.

First, virtually all mass strandings involve toothed whales. Pilot whales and false killer whales seem to be the most common mass stranders (R9), although we have seen no comprehensive statistics.

Second, those toothed whales that do mass-strand tend strongly to be deep-water species. Those dolphins that make their living in the shallow waters close to shore, such as the familiar bottlenose dolphin, never seem to beach themselves en masse. They will come close to shore to fish and even to cooperate with humans in fishing. (BHX5 in Humans III) In Western Australia, dolphins voluntarily come close to shore to mingle with human waders---and get free food---but they never strand themselves.

Numbers of whales in mass strandings. Only a few dozen whales make up most mass strandings. In the two Florida mass strandings mentioned in X2, scores of animals tried to beach themselves. The record seems to be held by 835 false killer whales that stranded in 1946, at Mar del Plata, Argentina. All of these perished. (R9)

Stranding sites. From X2, we realize that Florida records mass strandings on both coasts. Another favorite North American site is around Eastham, Massachusetts, on Cape Cod, where many groups of pilot whales have come ashore. There is some speculation that some strandings are connected with conditions of the geomagnetic field (R7, R10, X4 below) Nevertheless, it is a fact that some mass strandings, such at that on Florida's Gulf coast (X2), are stretched out over many miles of coast and persist for days and could hardly be connected with local magnetic field variations.

Psychological distress of stranding whales. It has been proposed that stranding whales do so because they are panicked. While there are instances where the stranded animals are highly distressed and are heard calling out (presumably) to their unstranded companions, who refuse to leave them (R5); many stranding animals seem composed and very deliberate about their actions, as the Florida Gulf coast case above. (X2) The same case emphasizes the persistence of the stranders. Even when "saved" by humans, they may continue to try to beach themselves.

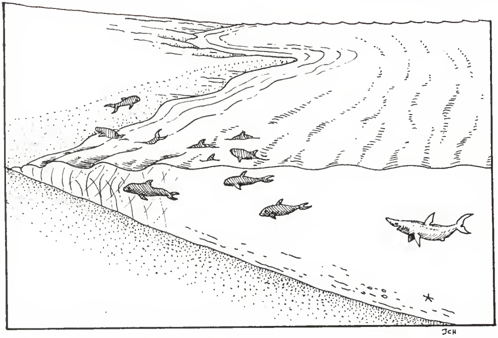
X4. Possible reasons for mass strandings. As in the case of land-mammal stotting behavior (BMB32), over a dozen explanations of mass stranding have been offered. None of these is especially convincing in itself. Of course, several may be operative together in some mass strandings.

Predator pressure. Sharks and killer whales do prey upon the species of toothed whales that strand frequently. In none of the mass-stranding reports examined have such predators been mentioned; nor have any of the stranded animals appeared wounded by attacks. Added to this is the fact that even humans have historically had great difficulty in herding whales ashore for slaughter, as was commonly done during the days when shore-based pilot-whale fisheries were active. (R3) Conceivably, a large group of killer whales might accomplish such a task, but, if so, why do they not follow the prey in close to the shore? Killer whales along the Argentina coast often follow sea lions right up to the beach.

Stranding while pursuing prey fish. The whales that frequently strand tend to be deep-water species and would not be expected to fish so close to the shore. A more telling mark against the accidental grounding of many whales in the excitement of the chase is the common observation that they often strand themselves again and again when pulled off the beach by humans---all in the absence of prey fish.

Distortion of sonar navigation echoes by gently sloping beaches. The Dutch scientist, W. Dudok, noticed that many mass strandings take place on gently sloping beaches. The sonar echo-ranging signals that the whales employ for hunting and navigation might, he supposed, be distorted by the highly inclined reflector as the whales approach shore. Such reflections, unfamiliar to deep-sea species, might confuse the animals. (R3, R9) However, M. Klinowska points out that echo-ranging baleen whales to not strand en masse nor do the coastal dolphins. Furthermore, in mass strandings around Britain, about one-third occur along steep shores that should return strong sonar echoes. (R10)

Disease and parasites. A popular explanation for mass strandings has been that the whales are diseased or the organs used in navigation are infected with parasites. Unfortunately for these two ideas, many stranded whales are perfectly healthy (R10), with parasite infections so small as to be unlikely to



Toothed whales beaching en masse may have been confused by distorted sonar echos returning from a gently sloping beach.

affect normal sonar navigation. (R5, R9)

Autopsies of toothed whales caught in the open ocean often show frequent infections of parasites in their echo-ranging apparatus, but these whales do not appear inconvenienced. It is possible, though, that older individuals might be infected with enough parasites to lead their group astray. This is all speculation, however.

Magnetic miscues. Measurements of the geomagnetic field along the U.S. east coast reveal magnetic anomalies that could, in principle, affect whale navigation (R9)---assuming, of course, that whales can sense the geomagnetic field with sufficient precision. J.L. Kirschvink has discovered that mass strandings along the Atlantic coast of Florida and Georgia seem to be focussed on magnetic lows. Perhaps, he theorizes, whales follow "magnetic roads"; i.e., linear geomagnetic lows; during their migrations. Some migrating birds appear to employ geomagnetic cues. Whales might be similarly programmed, but their data bank of navigational cues might have been established when the continents were in different positions! In any case, we do not know if whales actually do use geomagnetic navigation. If they do, the difference between magnetic lows and highs along the U.S. east coast is only about 4%, requiring a very sensitive biological magnetometer. (R7)

M. Klinowska has also looked into the possibility of "magnetic miscues. She theorizes as follows:

> Cetaceans use the total geomagnetic field of the Earth as a map. A timer, also based on this field, allows them to monitor their position and progress on the map. They are not using the directional information of the Earth's field, as we do with our compasses, but small relative differences in the total local field. I arrived at this explanation after a detailed analysis of the records of strandings in Britain, but it has so far been confirmed by two groups working in the U.S.

Similar work is in progress in other parts of the world.

The total magnetic field of the Earth is not uniform. It is distorted by the underlying geology, forming a topography of magnetic 'hills and valleys.' My analysis shows that the animals move along the contours of these magnetic slopes, and that in certain circumstances this can lead them to strand themselves. In the oceans, sea-floor spreading has produced a set of almost parallel hills and valleys. Whales could use these as undersea motorways, but might swim into problems when they came near the shore, because the magnetic contours do not stop at the beach. They continue onto the land, and sometimes so do the whales. (R10)

In addition to stranding because of land-intersecting contours, unpredictable changes in the earth's magnetic field can upset the whales' timing mechanism, causing them to lose their true position on their magnetic dead-reckoning maps. Magnetically speaking, they become lost.

Klinowska's theory is attractive in the sense that one can test it by checking strandings against magnetic contours and magnetic variations. However, the theory requires whales to sense changes in the earth's field of only 1 nanotesla (that is, one part in 50,000). No one has any idea how this can be accomplished biologically. Furthermore, how are the world-wide magnetic reference maps constructed, stored, and accessed in the whales' brains?

Two "far-out" proposals. (1) Cetaceans are believed to be descended from land mammals. Therefore, they probably still retain an instinctive "urge" to flee to familiar terra firma when danger threatens. (R3) (2) The community of cetaceans, known to be composed of very intelligent mammals, has decided to protest humanity's destruction and pollution of the environment by committing mass suicides! (R9)

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R1. Caldwell, David K., et al; "Mass and Individual Strandings of False Killer Whales, Pseudorca crassidens, in Florida," Journal of Mammalogy, 51:634, 1970. (X2)

R2. Fehring, William K., and Wells, Randall S.; "A Series of Strandings by a Single Herd of Pilot Whales on the West Coast of Florida," Journal of Mammalogy, 57:191, 1976. (X2)

R3. Geraci, Joseph R.; "The Enigma of Marine Mammal Strandings," Oceanus, 21:38, Spring 1978. (X3, X4)

R4. Anonymous; "Mysterious Marine Mammal Strandings," Pursuit, 12:133, 1979. (X2)

R5. Parry, Katharine, et al; "Why Do Whales Come Ashore?" New Scientist, 97:716, 1983. (X3, X4)

R6. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X1)

R7. Weisburd, S.; "Whales and Dolphins Use Magnetic 'Roads'," Science News, 126:389, 1984. (X4)

R8. Bright, Michael; The Living World, New York, 1987. (X4)

R9. Ellis, Richard; "Why Do Whales Strand?" Oceans, 20:24, June 1987. (X3, X4)

R10. Klinowska, Magaret; "No Through Road for the Misguided Whale," New Scientist, p. 46, February 12, 1987. (X3, X4)

BMB34 Live and Mummified Seals Found Far Inland in Antarctica

Description. The discovery in Antarctica of live and mummified seals many kilometers inland, often at high altitudes. Most of these wandering seals are crabeater seals, but a few Weddell seals also seem impelled to make fruitless and ultimately fatal journeys inland.

Data Evaluation. Over the last century, scientists exploring Antarctica have dutifully reported their discoveries of errant live and mummified seals in the professional literature. Since hundreds of such seals have now been found, the reality of the phenomenon cannot be doubted. Rating: 1.

Anomaly Evaluation. Scientists are undecided as to why seals should leave the ocean and trek far inland. It could be part of the normal dispersal of a common, expanding species, but one would think that natural selection would have corrected the biological compasses of the inland wanderers long ago. Of course, these biological compasses could be compromised by disease or parasites. Since the aberrant animals are mostly very young, their presence far inland may be due just to inexperience or navigational confusion. Other possible explanations are mentioned in X2 below. When scientists have not yet selected an explanation from among several reasonable choices and no major biological theories are endangered, our anomaly rating must be low. Rating: 3.

Possible Explanations. See above and X2. Relatively recent changes in sea levels and ice cover in Antarctica might have changed seal dispersal patterns. (See ESD5 in Neglected Geological Anomalies.)

Similar and Related Phenomena. Mass strandings of cetaceans (BMB33); crabeater seal dentition (BMA30); the mass movements of lemmings and gray squirrels (BMB28); the occasional incursions of northern birds into southern latitudes when food crops fail. Mummified penguins are also found far inland (BBB).

Entries

X0. Introduction. Normally, no land mammals except humans are to be found living in Antarctica's frigid interior. This is not surprising, for there is nothing there to sustain a population of wild mammals. Nevertheless, a few live and hundreds of desiccated or "mummified" seals have been discovered far inland (some over 100 kilometers from open water) and at high altitudes (some over 1,000 meters). These errant seals were noted almost a century ago by Scott's 1901-1904 expedition. (R3) Many more have been found since, as the pace of Antarctic research has accelerated. Most of the out-of-place seals are the common crabeater seal, but a few Weddell seals also seem to wander in unprofitable directions.

X1. General observations.

Crabeater seals. Probably 99% of all living and mummified seals found far inland in Antarctica are crabeaters. (They are really krill-eaters!) This species is abundant and much more mobile on land than the other seals frequenting Antarctic waters. In addition to their futile, seemingly suicidal forays inland, crabeater seals are noted for their northward wanderings. They often appear off the southern coasts of New Zealand, Australia, South America, and Africa---well north of their normal range. (R6)

At least when the crabeaters travel to the north they remain in their element, but when they head south they encounter immense ice shelves, glaciers, mountains, and a few unusual dry valleys. Nevertheless, some of these animals, mostly pups and subadults, do persist in traveling in the wrong direction and shuffle inland; and, as we shall now see, they are accomplished shufflers!

•One of the most impressive crabeater treks has been described by I. Stirling and E.D. Rudolph:

> On 12 December 1966, 1 km N Mt. Saunders, about 113 km from open water in Byrd Land (76° 50'S, 145° 30'W), a live seal was located from a helicopter on the Crevasse Valley Glacier at an elevation of approximately 920 m. It was moving southeasterly. Taken to McMurdo on 14 December, the animal was identified as a male crabeater pup, 1245 mm long and weighing 25.8 kg. It was so thin its ribs individually showed through its taut skin, so weak that its bite did no damage to a bare hand, and it shivered continuously. (R2)

•December 8, 1966. A live crabeater seal was seen on the Balchen Glacier, 88 kilometers from the coast at an altitude of 920 meters. (R2)

•B. Lytskjold found a carcass 88 kilometers from the coast, altitude 1300 meters. (R7)

•During the 1957-1958 summer exploration season, an American team counted 90 mummified seals in the Taylor Valley. (R1, R2, R5)

Weddell seals. These seals, so typical of Antarctica, also go astray once in a while, but not as often or as far as the crabeaters.

•In 1971, I. Stirling and G.L. Kooyman wrote:

> ...the following records from Weddell seals indicate that seals may on occasion travel several kilometers in a direction of no benefit to them. Heine reported a Weddell seal track on the McMurdo Ice Shelf about 17 km NE Scott Base on 19 February 1965. The seal was heading toward the Aurora Glacier on Mt. Erebus, almost certainly to its ultimate death. From inspection of a photograph of the track, the animal was an adult. Single, live Weddell seals were also seen on the McMurdo Ice Shelf by Heine 28 km E Scott Base on 22 February 1966, and 23 km S Scott Base on 17 February 1966. On 30 November 1966, a track of a young Weddell seal was followed for 8 kilometers south through the hills at Cape Evans and onto the sea ice until the animal was overtaken, still moving steadily south. The seal (a 140 centimeter, weaned male pup) was captured, tagged, and released facing east. It immediately reoriented itself in a southerly direction. (R4)

This seal's insistence on traveling in a suicidal direction reminds one of the strange persistence of cetaceans intent on stranding themselves. Could there be a common navigational error? See BMB33.

•Mummified Weddell seals have been found inland in the Windmill Island region. (R2)

Elephant seals. Mummified remains seen inland in the Windmill Island region. (R2)

Leopard seals. A mummified leopard seal was discovered 27 kilometers inland in the Dry Valleys area. (R2, R4)

X2. Possible explanations of seal suicidal wanderings. In the context of natural selection, it is hard to understand how a suicidal trait might originate and be retained, particularly in such an unforgiving environment.

One explanation is that the seals are simply disoriented, as is thought to be the case with stranding whales (BMB33). That this might be correct is suggested by instances when live seals heading in "unwise" directions were captured and reoriented. These seals promptly turned and resumed their treks inland to certain death---even when open water and other non-wandering seals were in plain view. Parasites or disease might have damaged their navigation organs, whatever they might be.

Another theory proposes that the seals are following, through instinct, some imperative that was once useful but is now deadly. I. Stirling and E.D. Rudolph have elaborated on this and other ideas:

> It has been suggested that inland occurrences of mummified seals indicate recent changes in levels of the Antarctic seas. These observations of live seals provide irrevocable proof that seals can travel inland on their own.
>
> In vertebrates, immature individuals are more frequently recorded outside the normal geographic limit of the species than adults. Most of the mummified crabeater seals recorded have been pups and subadults. Caughley suggested that the occurrence of dead seals inland is merely the result of normal dispersal. Dispersal to the edge of the continent is certainly normal but it seems unlikely that extended migration inland normally occurs. Crabeater seals may have a form of orientation similar to that demonstrated in Adelie penguins. [Also found mummified inland.] Both Lindsey and Bertram recorded a southerly movement of crabeater seals to the continent from the pack ice during the period December through February. According to Lindsey, two-thirds of these are young of the year. It is possible that some seals may become confused when they reach a land of ice-shelf barrier, and continue on a southerly bearing. (R2)

Quite obviously, there is no consensus as to the correct explanation.

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R1. Pewe, Troy L. et al; "Mummified Seal Carcasses in the McMurdo Sound Region, Antarctica," Science, 130: 716, 1959. (X1)

R2. Stirling, Ian, and Rudolph, Emanuel; "Inland Record of a Live Crabeater Seal in Antarctica," Journal of Mammalogy, 49:161, 1968. (X1, X2)

R3. Dort, Wakefield, Jr.; "Mummified Seals of Southern Victoria Land," Antarctic Journal, 6:210, 1971. (X0)

R4. Stirling, Ian, and Kooyman, G.L.; 'The Crabeater Seal (Lobodon Carcinophagus) in McMurdo Sound, Antarctica, and the Origin of Mummified Seals," Journal of Mammalogy, 52: 175, 1971. (X1, X2)

R5. Bright, Michael; The Living World, New York, 1987. (X1)

R6. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X1)

R7. Anonymous; "Seal That Went Walkabout," New Scientist, p. 11, January 15, 1994. (X1)

R8. Watkins, Ron; "Smiling Seal," New Scientist, p. 51, February 5, 1994. (X1)

BMB35 Self-Anointing in Mammals

Description. The application by mammals of stimulating substances, such as leather, and even live animals like ants to their bodies, often resulting in an induced state of apparent euphoria or intoxication. "Anting" is here considered a special case of self-anointing. We have tried to restrict the coverage to instances where anointing seems to lead to unusual changes in behavior.

Data Evaluation. A few cases of self-anointing and anting in mammals have been found in the scientific literature examined so far, but the bibliography here is limited. Except, perhaps, for observations of hedgehog self-anointing, the reports we have found are anecdotal and not systematic. Rating: 2.

Anomaly Evaluation. The primary goal of self-anointing seems to be an altered state of behavior, which humans describe with words like "extreme pleasure," "ecstasy," and "intoxication." The often-suggested explanation that self-anointing is indulged in merely to eliminate or repel parasites is not supported by observations. If pleasure is truly the only objective of self-anointing, as appears likely, we can only rate the phenomenon as curious, because pleasure-seeking behavior is an understandable product of conventional evolution. Rating: 3.

Possible Explanations. See above discussion.

Similar and Related Phenomena. Anting in birds (BBB); mammals, especially dogs, rolling in filth; drug use by humans; cows eating fermented apples, etc.

Entries

X0. Introduction. A dog rolling in manure is indulging in a form of anointing. The acquisition of odors---some very offensive to humans---is a habit of many mammals. Of course, humans with their perfumes and after-shave lotions---some very offensive to other mammals---must be included, too. It is all anointing! All this is hardly anomalous. In order to justify this Catalog entry, we must look for forms of anointing that are bizarre and/or without easy explanation. The domestic cat is a good starting point. When a cat encounters catnip, smells it, and rolls in it, its behavior changes in ways that seem bizarre to humans. Some wild mammals anoint themselves with various substances and undergo similar behavioral changes. Sometimes, anointing is accompanied by obvious pleasure; at other times, the purpose of the anointing is quite mysterious. Such situations are of interest to anomalists.

We recognize two forms of anointing: (1) Anting, in which ants are actively applied to the body or are induced to "attack" the body; and (2) Self-anointing, in which the animal applies various substances to itself. Actually, anting is a special type of self-anointing, but it is so common that we give it separate treatment.

X1. Anting. Birds are frequent anters, both passive and active; but so far we have found only two mammals that indulge in this curious practice.

Gray squirrels. A.M. Bagg called attention to anting by gray squirrels in a note published in a 1952 issue of the Journal of Mammalogy.

> On June 27, 1951, in my yard in Holyoke, Massachusetts, I observed anting being performed by a Gray Squirrel, *Sciurus carolinensis*. My attention was drawn to the animal by the unusual actions it was repeatedly performing on the same patch of bare ground beneath a Colorado Blue Spruce, *Picea menziesii*. These actions were varied. Occasionally the squirrel crawled on its belly across the spot. Again, it rolled its shoulder and back onto the spot, deliberately, in the manner of a dog rolling in filth. A third gesture involved a forward somersault, after which the squirrel rolled on its side like a kitten playing with a ball. This varied performance, which brought virtually all surfaces of the squirrel in contact with the ground, continued for about five minutes; the one particular patch of ground was used in all cases. The actions of the animal appeared deliberate and intentional. Eventually the squirrel walked slowly away.

> When I examined the spot immediately afterward, I found that the squirrel had been rolling and rubbing itself on part of a "trail" along which small brownish ants were passing in some numbers. Further, the patch of ground on which the squirrel performed the above-described actions was occupied by at least three ant holes, from which the insects were issuing. I saw the squirrel scratching itself two or three times during the above performance. (R1)

The above squirrel was engaged in passive anting. In the active form of anting practiced by birds, the ants are grasped by the bill and rubbed into and through the plumage. This act, for reasons unknown, often results in the bird appearing ecstatic or drunk. Obviously, squirrels do have have the proper equipment for active anting.

A series of similar observations of gray squirrels by D.C. Hauser supports Bagg's contention that these mammals do indeed ant like birds. In fact, they seem to find good anting spots by watching birds anting and then usurping their ant supplies. (R3)

Pangolins or scaly anteaters. This mammal, odd in several other ways, is also said to indulge in anting, but in a most peculiar manner.

> According to local legends, a pangolin sometimes takes an ant bath: it settles itself in an ant nest and then raises its scales, allowing the ants to crawl underneath; it crushes the ants by depressing its scales and then goes to water and raises its scales again so that the ants float to the surface. This legend has been interpreted as an extraordinary account of a type of feeding, but it could be a behaviorism comparable to "anting" in birds, that is, a method by which the pangolin allows itself to be cleaned by the ants. (R5)

Anting is not necessarily concerned with cleaning the anter. For example, when birds rub ants into their plumage with their beaks, the ants are immobilized and incapable of cleaning, although they may secrete fluids useful or attractive to the birds.

X2. Self-anointing. As indicated in X0, self-anointing is very common in mammals, including humans. But in some mammals, the phenomenon takes on new dimensions that involve changes in behavior and possibly useful in self-defense.

Hedgehogs (apparently all species). In these prickly mammals, self-anointing has effects approaching those of drug addiction. M. Burton has studied this puzzling phenomenon in hedgehogs. He wrote:

> The idea that an animal may do something merely because it likes doing so is foreign to present-day biological thought. Nevertheless, there are certain lines of conduct that come perilously near this. One of the most outstanding of these is the self-anointing of hedgehogs. This was first recorded as recently as 1912, by Ludwig Heck, who named it selbstbespuchen. Since the German equivalent is clumsy when rendered into English, I have proposed "self-anointing." Since 1912 there have been only three or four further records of this remarkable behavior, and with one exception these have been in the German literature. Judging solely from this, it was natural to assume that the behaviour was abnormal or at least unusual. Subsequent experience has shown me that it is widespread among hedgehogs and frequently indulged.
>
> A typical display of self-anointing is as follows. The animal starts to lick a substance and continues to do so for perhaps half-a-minute. During this time a copious foam, presumably of saliva, appears on the lips. Then, the hedgehog raises itself to the full on its front legs, and turns its head to one side in what appears to be a severe muscular effort, the apparent convulsion being communicated to the rest of the body. Then it turns the head to the rear and transfers the foam to some of the spines by a vigorous flicking action of the tongue. Following this, the animal returns to the normal posture, once more licks up to half-a-minute, and repeats the process, either on the same side of the body or on the opposite side. While the foam is being transferred to the spines, the skin of the back

Some contortions of the Eurasian hedgehog during self-anointing.

tends to be thrown into corrugations, and, such is the vigor of the action, the hedgehog may topple over on one side and lie apparently paralyzed, its limbs rigid and the body contorted. In due course the body is bedecked with patches of foam, mainly on the spines, but sometimes on the hairy flanks also. (R2)

Countering the usual claim that the hedgehog anoints itself to repel parasites, Burton states that hedgehogs entirely free of parasites freely indulge in self-anointing. Furthermore, the hedgehogs give every indication that self-anointing is a pleasurable experience that brings on feelings of ecstasy or intoxication.

Hedgehogs find a long list of substances attractive in the self-anointing routine: leather, cigar-ends, animal droppings, soot, cheese, and even live animals, such as slugs and earthworms. (R2)

Besides the apparent psychological satisfactions gained from self-anointing, hedgehogs may also improve the effectiveness of their already formidable armory of spines. E.D. Brodie, Jr., has pointed out that the animals also anoint with toad skin, which contains venomous, highly irritating substances. Predators encountering spines anointed with toad secretions will have the venom injected into their wounds. (R4)

Small Madagascar "hedgehogs" or hedgehog tenrecs. These small (8-14 centimeters) mammals look outwardly like hedgehogs with their armory of spines. They are, however, classed with the tenrecs. Confined to Madagascar, they seem to have "invented" hedgehog-type self-anointing independently. Instead of licking their spines to apply the anointing substances, the tenrec hedgehogs use their forepaws. In addition, their behavior patterns differ somewhat. Nevertheless, the double convergence of body morphology and self-anointing behavior is remarkable. (R4)

Fox squirrels. It seems likely that many mammals find specific plants and natural substances irresistible, much as cats are drawn to catnip. However, we have found only one report of the "catnip" phenomenon in wild animals other than felines. H.J. Stains provided the following observation:

> AT 7 AM on 23 April 1962, an unusual behavior by a fox squirrel (Scirus niger) was noted. The animal was sitting on its haunches and holding, in its front paws, some material that looked like a ball of dried grass. The squirrel rubbed his head in this ball of material, dropped the ball to the ground and rolled in it, then picked it up again continuing to rub the side of his head in the material. This activity lasted perhaps one minute, whereupon the squirrel dropped the material and scampered a few yards away. The ball of material was retrieved and found to be a clump of wild onions (Allium vineale) which had been pulled up and left on the lawn some 2 or 3 weeks before. The entire behavior pattern reminded me of the reaction of cats to catnip. (R6)

Obviously, the fox squirrel's reaction to the onions was not an bizarre as that of the hedgehogs or even as odd as that of cats with catnip, but the phenomenon is the same.

D.C. Hauser remarked that squirrels (species not specified) may also anoint with maple juice! (R3)

References

R1. Bagg, Aaron M.; "Anting Not Exclusively an Avian Trait," Journal of Mammalogy, 53:243, 1952. (X1)

R2. Burton, Maurice; "A Puzzling Habit of the Hedgehog," New Scientist, 4:1071, 1958. (X2)

R3. Hauser, Doris C.; "Anting by Gray Squirrels," Journal of Mammalogy, 45:136, 1964. (X1, X2)

R4. Brodie, Edmund D., Jr.,; "Hedgehogs Use Toad Venom in Their Own Defence," Nature, 268:627, 1977. (X2)

R5. Nowak, Ronald M.; Walker's Mammamls of the World, Baltimore, 1991. (X1, X2)

R6. Stains, Howard J.; "Unusual Behavior of a Fox Squirrel," Journal of Mammalogy, 44:274, 1963. (X2)

BMB36 Miscellaneous Curiosities of Mammal Behavior

Description. A small collection of curious, amusing, and sometimes slightly anomalous behaviorisms of mammals.

Data Evaluation. The data were collected from publications ranging from respected field guides to newspapers. No overall evaluation is possible.

Anomaly Evaluation. These are mostly just curiosities. No anomalies claimed, although some of the phenomena have long puzzled naturalists.

Entries

X1. Stone swallowing by seals. Sailors of old maintained that the eared seals; that is, the fur seals and sea lions; had an internal pouch known as a "ballast bag," which contained a number of rounded stones. They claimed further that the older seals, which had become quite fat and buoyant, needed these stone-filled ballast bags into order to dive properly. The "ballast bag" turned out to be only the seal's stomach, and this organ frequently does contain stones, whose real purpose remains mysterious. (R1)

F.A. Lucas dismissed the "ballast" explanation by pointing out that seals without stones in their stomachs stayed down just as well as those with rocky ballast! Neither are the stones swallowed to help grind up food, as in bird gizzards, for the stones are found in the stomachs of nursing pups. In fact, nursing pups have been seen carefully selecting stones and then swallowing them. (R3)

Seals young and old are very particular about the stones they swallow.

> It is evident that these things are not swallowed haphazard, but are selected with considerable care from among the articles strewn along the shore, and that a preference is exhibited for rounded objects. This is shown by the fact that, as a rule, only articles of one kind are found in one stomach, although seals do not discriminate between fragments of barnacles and fragments of gastropods. (R3)

Mammalogists are still perplexed today as to the purpose of the stones. In 1992, R.R. Reeves et al could say only:

> Many seals swallow stones and pebbles, but there is no conclusive evidence as to why they do. (R9)

Sometimes small piles of rounded stones foreign to an area will be found on beaches. These were probably disgorged by seals. (R9)

X2. Precopulatory rites of porcupines. Since the following scenario has been revealed vividly in a television documentary, we have no qualms about describing it here!

> One of the most unusual parts of the porcupine courting reactions occurs when the male approaches the female and has olfactorily tested her body and especially her genitals. If he is sufficiently stimulated sexually, he sniffs at her, rubs noses with her, then rears up on his hind legs and tail and walks erect toward the female, usually with his penis fully erected. If she is not in advanced stages of heat, she will probably run away. On the other hand, if she is in advanced stages of heat, she too, will rear on her hind legs and tail and turn to face the male after which they may rub noses. As they stand facing each other, a few inches apart, the erected penis of the male begins to discharge urine in frequent, short spurts which in less than a minute may thoroughly wet the female from nose to tail, especially her ventral and lateral areas. During the process, the female may: (1) object vocally in short, sharp grunts, or cries, (2) reach and strike with her arms in a sort of sparring manner, (3) threaten or try to bite or, (4) at the first opportunity vigorously shake off the urine and run or walk away. If near the point of mating, she may offer only perfunctory objections to the urinary shower...No definite function has as yet been discovered for this unusual urinary shower to which the female is subjected. (R4)

X3. Musth in elephants. Our two information sources on the appearance and purpose of musth contradict one another on important points. First, a description of the musth phenomenon and what it might mean from Walker's Mammals of the World:

> Males over about 25 years old annually enter a condition known as musth, characterized by copious secretions from the temporal gland behind the eye, continuous discharge of urine,

> a great increase in aggressive behavior, and the seeking of and association with female groups. This condition, perhaps resulting from high testosterone levels initially lasts only a few days or weeks, but in males over 35 years old it continues for 2-5 months. Musth does not occur synchronously, but it does come at about the same time each year in any given male, and it is especially frequent during and just after the rainy season. A male in musth is dominant to other males and usually can defeat them in combat, even if the latter are larger and normally higher-ranking. Estrous females emit loud, very low-frequency calls that may attract potential mates up to several kilometers away but are mostly inaudible to humans. A female actively avoids most courting males, tending to choose a large male that is in musth, perhaps one with which she long has been familiar. (R7)

The following statement from a well-known field guide directly contradicts some of the information given above.

> There is no connection between the activity of special glands in the side of the head, discharging an oily product ('musk glands') and breeding condition; this discharge occurs periodically in both male and female, and even in the young. (R5)

The purpose of the discharge from the musth or "musk" glands is unclear, even if the above contradictions are cleared up.

X4. Mammals attracted to electrical apparatus. A surprising number of animals seem to be strangely attracted to electrical wiring. D. Ager, a distinguished geologist, collected a few entertaining examples.

> Swiss cars are being attacked by pine martens, which chew through their electrical cables. The Swiss Automobile Association has advised motorists to keep their cars in garages or spray them with mammal repellents. Similarly, the BBC reported that the more fastidious dormouse in Britain only attacks the electric fittings of Rolls Royces.
>
> .....
>
> New Zealanders had to put metal collars on their telegraph poles to stop bushy-tailed possums (introduced from Australia) climbing the poles and chewing through the cables. (R11)

Squirrels and rabbits have also been fingered in damages to TV antenna cables and other home wiring. (R11) Mammals are not alone in this predilection for electric wiring, ants and land crabs have also been implicated.

Is it the usually pungent insulation that attracts these animals or the flow of electricity?

X5. Hares racing trains. Bear in mind that the following was written in 1862! The scene is England.

> In the early working of railways, particularly with mineral lines like the Stockton and Darlington, the "lamps" employed by night trains were iron baskets filled with burning coal, one of them usually swung on the side of the wagon as a signal to the following train. This light thus speeding along presented a great attraction to hares, which made it so general a practice to approach close to it, that some special allurement must have been exercised over these timid animals. It no sooner, however, came within the swinging traveling blaze that shone along its path than it would accompany the train for many miles mauger [sic] the continued attempts of the stoker to kill it by throwing lumps of coal at it. The position they invariably took in the race was just in advance of the lamp; from which I infer that, as the light would shed its lustre upon only a very limited space of the course, the hare confined itself to this lighted space, clearly because beyond there was darkness. This is evident from the circumstance that, after some distance had been run, if the light for a moment got ahead of the hare, the spell was ended, and puss parted

> company with the blaze...The question yet remains---what motive, curiosity, or impulse enticed this nimble and timid animal to chase and join the running illumination, in spite of the puffing of the locomotive and the rumbling of a running coal train, till it entered within the influence of the delirious dazzle? (R1)

X6. Beserk cows.

> Dairy farmers in New Zealand's Taranaki district are puzzled about why their cows frequently go berserk, leaping fences and bolting and charging through shed for no apparent reason. Disturbances broke out simultaneously on eight adjoining farms six times during December, and farmers say milk production was seriously disrupted. One of the farmers, Gregory How, said he narrowly escaped death when 200 cows suddenly made an about-face on a narrow track and hurtled toward him. (R10)

See also BMB28 for sheep panics affecting large areas.

X7. Impala tongue-flashing. Obviously a signal in the same category as pawing-the-dirt, tongue-flashing is just amusing enough to warrant inclusion here.

> During the mating season, males frequently utter loud, hoarse grunts. Kingdon described tongue-flashing, an extraordinary display of the male impala: upon approaching females or potential rivals, a dominant male opens his mouth widely and extrudes the tongue several times in rapid succession. The females tend to bunch at this signal, while the other males flee, unless they respond in kind, thereby indicating a challenge to combat. (R7)

X8. Elephant attention to their dead and bones.

> Elephants are fascinated by their dead, sometimes laying branches over them, and examining elephant bones. (R8)

Indeed, a recent TV documentary on elephants has shown them fondling elephant bones with their trunks and gently moving and arranging them.

X9. Sloth defecation. Although sloths are sometimes seen swimming rivers, they are virtually helpless on the ground. They voluntarily descend from the trees for only one purpose, and why they bother to do that is a puzzle, seeing that monkeys and other dedicated tree dwellers do not.

> They have the astonishing behavior for an arboreal animal of descending to the ground to defecate: while clinging to a tree trunk they dig a hole with the tail, defecate in it, and cover it over. The necessity arises only about once a week. (R6)

Why do sloths descend to the ground about once a week?

As R. Wesson has commented, it would seem difficult for a consumer of considerable coarse vegetable material to defecate so seldom. (R8) It would also seem difficult for the tail to be used as a digging implement.

References

R1. Anonymous; "Hares Racing with Railway Trains," Eclectic Magazine, 56:143, 1862. (X5)

R2. Anonymous; "The Ballast Bag of the Seal," English Mechanic, 46:339, 1887. (X1)

R3. Lucas, F.A.; "The Swallowing of Stones by Seals," Science, 20:537, 1904. (X1)

R4. Shadle, Albert R., et al; "The Sex Reactions of Porcupines (Erethizon D. Dorsatum) before and after Copulation," Journal of Mammalogy, 27: 116, 1946. (X2)

R5. Dorst, Jean, and Dandelot, Pierre; Larger Mammals of South Africa, London, 1972. (X3)

R6. Emmons, Louise H.; Neotropical Rainforest Mammals, Chicago, 1990. (X9)

R7. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X3, X7)

R8. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X8, X9)

R9. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X1)

R10. Anonymous; "Bovine Bedlam," Greensburg Tribune-Review, January 5, 1992. Cr. E. Fegert. (X6)

R11. Ager, Derek; "Unwary Animals and Vicious Volts," New Scientist, p. 47, January 9, 1993. (X4)

BMT UNUSUAL FACULTIES AND TALENTS

Key to Phenomena

BMT0	**Introduction**
BMT1	**Magnetic Orientation and Navigation in Mammals**
BMT2	**Long-Range Navigation in the Absence of Recognized Cues**
BMT3	**Short-Range Operational Prowess Despite Suppressed Visual and Olfactory Cues**
BMT4	**Mammal Behavior Implying the Existence of Other Unrecognized Senses**
BMT5	**Curious Examples of Soaring and Parachuting Mammals**
BMT6	**Unusual Swimming Capabilities of Terrestrial Mammals**
BMT7	**Remarkable Diving Capabilities of Distantly Related Mammals**
BMT8	**Unusual Vocalizations in Mammals**
BMT9	**Seismic Communication**
BMT10	**Mammals That Imitate Human Words**
BMT11	**Tool Use and Manufacture**
BMT12	**Mammalian Engineering Works**

BMT0 Introduction

Except for humans, few mammals range widely. Some marine mammals, African herbivores, and caribou are exceptions in this regard. The most numerous species---the bats, rodents, and insectivores---usually do not stray far from their home territories, although some bats do migrate. All mammals, though, have to be able to navigate whether the journey is just a few meters away from "home" or 5,000 kilometers to their breeding grounds. To orient themselves and find their ways, mammals utilize various senses. One of these navigation senses is probably based on the earth's magnetic field. Birds apparently have a "magnetic sense," but this sense is only suspected in mammals. Whales may rely in part on a "magnetic sense," but many small mammals, when displaced by humans, find their ways home with great dispatch and without any built-in magnetic compass. How do they find "home" so quickly without obvious instruments? We do not know as yet.

As mammals have filled niches where sight and smell lose their usefulness, as in the night skies, turbid rivers, and ocean abysses, they have developed echolocation and electrosensitive organs. Here, where ordinary senses are blinded, we see many evolutionary innovations as well as parallel biological developments among distantly related mammals. These are also well worth cataloging, since they may challenge the evolutionary paradigm.

In invading aquatic environments, some mammals have also developed remarkable diving capabilities. Some whales and seals can penetrate to great depths and stay under for more than an hour. They are not crushed by the pressure and, in fact, successfully capture prey in the Stygian darkness. They surface rapidly without suffering the bends that humans would. Can evolution account for the massive biological restructuring required?

Humans seem to be laggards among the mammals in terms of developing (or retaining) the specialized biological equipment needed to prosper in the air, in the ocean depths, and in niches where sight is useless. We have had to construct machines to help us. Humans do, however, communicate well. We invent tools and instruments. We go to the moon and survive where no other mammals can. We shall see, though, that the other mammals are not totally without engineering skills and even use tools occasionally---contrary to the popular myth than only humans do such things!

BMT1 Magnetic Orientation and Navigation in Mammals

Description. The ability of some mammals to sense the geomagnetic field and use it as a cue for orienting themselves and navigating in homing experiments and migration.

Data Evaluation. Only a handful of reports have been found purporting to demonstrate experimentally that mammals (other than humans) can sense and use the geomagnetic field for navigation. All of these experiments have employed rodents, so our limited data also have a very narrow focus. Rating: 3.

Anomaly Evaluation. Despite the paucity of experimental evidence, it is generally accepted that many animals, especially birds, possess a "magnetic sense." Therefore, the discovery that this is indeed the case with some mammals is not particularly startling. The anomaly here is really concerned with our ignorance of how the geomagnetic field is actually detected biologically; that is, where is the "magnetic sensor" and how does it provide cues for navigation? This navigation sense in animals has mystified scientists for many years. Rating: 1.

Possible Explanations. Magnetite particles have been found in the tissues of several mammals and could form the basis for a biological magnetometer.

Similar and Related Phenomena. Navigation phenomena in mammals (BMT2); mass strandings of marine mammals (BMB33); navigation in birds (BBT); the human magnetic sense (BHT17 in Humans I); magnetite in mammals (BMI in Mammals II) and humans (BHI15 in Humans II).

Entries

X0. Background. It is widely assumed that some animals, migrating birds in particular, can sense the geomagnetic field and use it for navigational purposes. Even some humans may possess a "magnetic sense," although it must be quite weak and perhaps a relict capability. (See BHT17 in Humans I.) In support of the idea that animals may have this magnetic sense, several species in several phyla have been found to incorporate magnetite in their tissues, although no one knows just how this material is used in producing orientation signals. (See BHI in Mammals II.)

X1. Direct evidence for a magnetic sense in mammals. Numerous experiments have indicated that birds, such as homing pigeons, do employ magnetic cues along with other navigational aids. (BBT) Similar tests with mammals are scarce, due doubtless to the difficulties in finding suitable homing mammals, simulating the geomagnetic field over a large areas, and devising proper instrumention.

White-footed mice. One can appreciate the experimental difficulties involved in the following abstract by P.V. August et al:

> We displaced white-footed mice (Peromyscus leucopus) 40 m away from their home areas and released them in a circular arena. Mice concentrated their exploratory and escape activity in the portion of the arena corresponding to home direction. In another group of mice, we reversed the horizontal component of the geomagnetic field surrounding them during displacement. These individuals concentrated their activity in areas of the circular arena opposite home direction. Mice were not likely using visual, chemical, or kinesthetic cues to establish home direction. Tissues of P. leucopus exhibit strong isothermal remanent magnetization and may contain biogenic ferrimagnetic material. Our results suggest that white-footed mice have a magnetic sense and use the geomagnetic field as a compass cue. (R4)

European woodmouse. A similar experiment by R.R. Baker and J.G. Mather several years earlier produced the same results. Baker and Mather captured wild woodmice and placed them in a cage which restricted their vision and sense of smell. The cage was fitted with copper coils which allowed the experimenters to artificially reverse the direction of the geomagnetic field for half the mice, while permitting the other half to experience the normal field. Both groups of mice were transported 65 kilometers north and released. The control group exposed to the normal field preferred to head in the direction of "home"; that is, the area where they were captured. The other group tended to set off 180° away from the direction of "home." (R1, R2)

X2. Circumstantial evidence for a magnetic sense in mammals.

Cetaceans. A study by J.L. Kirschvink et al, at CalTech, discovered that mass strandings of whales and dolphins along the U.S. southeast coast tended to occur at geomagnetic lows. The implication is that some cetaceans may possess a magnetic sense and use it to follow "magnetic roads." (R3) For more on this subject, refer to BMB33.

References

R1. Mather, J.G., and Baker, R.R.; "Magnetic Sense of Direction in Woodmice for Route-Based Navigation," Nature, 291:152, 1981. (X1)

R2. Anonymous; "Of Mice, Magnetism and Men, " New Scientist, 90:1981. (X1)

R3. Weisburd, S.; "Whales and Dolphins Use Magnetic 'Roads'," Science News, 126:389, 1984. (X2)

R4. August, Peter V., et al; "Magnetic Orientation in a Small Mammal, Peromyscus Leucopus," Journal of Mammalogy, 70:1, 1989. (X1)

BMT2 Long-Range Navigation in the Absence of Recognized Cues

Description. The ability of some mammals to orient themselves toward and travel to specific locations when recognized navigational cues seem to be nonexistent. The specific locations are usually designated as "home", that is a den, nest, pen, or simply familiar territory; but breathing holes in ice and breeding locations are also included. Recognized navigational cues not requiring anomalous sensory capabilities are: landmarks visible by sight and sonar, odors, chemical taste signals in water, sounds, environmental temperature, water currents, wind, and the positions of the sun and moon. These recognized cues are suppressed as far as possible during experiments.

Data Evaluation. In addition to many field observations of wild animal behavior, mammalogists have carried out a large number of release experiments and duly reported them in the scientific literature. We have doubtless collected only a fraction of these, since many journals, especially in languages other than English, have not been surveyed. These experiments are supplemented by many anecdotes about the homing abilities of pets found in popular publications. Here, we attach little significance to the latter observations. There is no need to do more than acknowledge the popularized anecdotes, because the number of scientifically conducted, controlled-rclease experiments is large and quite impressive Rating: 1.

Anomaly Evaluation. In most of the data collected below the usual navigational cues have been eliminated or greatly suppressed. Therefore, a convincing case can be made for the existence of unrecognized navigational capabilities, such as the use of the geomagnetic field. There may also be other navigational senses unrecognized or even unimagined by present-day science. Rating: 1.

Possible Explanations. The existence of a "magnetic sense" by some mammals is a likely explanation, since magnetite particles have been found in several mammals. (BMI in Mammals 11) It is also possible that the ordinary senses of some mammals are so acute that human efforts to suppress recognized navigational cues are inadequate.

Similar and Related Phenomena. Magnetic orientation in mammals (BMT1); anomalous human navigational capabilities (BHT17 and BHT18 in Humans I); navigational talents of birds, where many navigational experiments have been conducted (BBT), and other animals (BRT, BFT, etc.)

Entries

X1. Homing: release experiments. A favorite technique employed in studying the navigational capabilities of mammals is to remove them from their homes, transport them to such a distance that landmarks, odors, and other common sensory cues are mostly eliminated. Obviously, this distance is much greater for a fox than for a field mouse. Most of the pertinent data come from scientific sources and involve the controlled releases of wild animals. It would, however, be a grievous omission if domestic mammals, particularly dogs and cats, were slighted, for some fantastic homing exploits exist here. It is unfortunate that such data are anecdotal. Apparently, it is bad form to carry out homing experiments with domestic animals.

Deer mice. We have located accounts of scientific experiments with two species of deer mice. It is evident from the references appended to these reports that the unsurveyed literature contains many additional, uncollected results of experiments with various other rodents.

The first account is that of a classical release experiment by J.B. Gentry. The second report, by J. Bovet, is especially interesting because the routes followed by the released mice could be followed on the snow. First, Gentry's abstract:

> Homing was successful in 31 of 39 old-field mice (Peromyscus polionotus) released from the center of a 9-acre plowed field 340 to 840 feet from trap sites in occupied habitat surrounding the field. Ninety-one per cent of the homing animals returned the first night; 60% returned by midnight. The majority of returning mice were recaptured in traps adjacent to the set of traps in which they were captured before release. The animals, following release during the daytime, exhibited a sequence of behavior directed toward finding shelter. After dark, the mice moved toward their home range. (R7)

Bovet's abstract is next:

> Some individual Peromyscus maniculatus, displaced far from their homesites and released on snow, produced long trails showing their actual route while moving away from the release point. An analysis of these trails showed that, although the mice involved traveled zig-zagging routes and actually covered more than twice the displacement distance before reaching home, they did not travel at random but followed a homeward-oriented route. (R10)

Bovet remarked in his lengthy discussion that the changing environment produced by regular snow falls made navigation by memory of the landscape unlikely, and that some sort of navigational mechanism was operative.

Old World wood mice. A variation on the normal release experiment involves transporting the animals in an "orientation" cage that is screened so that the animals cannot see their surrounding during transit. Before release and the removal of the screens, the initial orientations of the animals is observed; i.e., do they "instinctively" turn themselves toward "home?" The word "instinctively" implies that the animals are employing some unrecognized navigational cues.

> Orientation-cage experiments on rodent navigation have demonstrated an ability to orient towards home at distances up to 2-3.7 km before the animals can see their surroundings at the release site. Mather and Baker displaced Wood Mice, Apodemus sylvaticus, and tested them before the mice were allowed to see their surroundings and, at the same time, while they had much reduced olfactory information, though 'local' air at the release site was probably not totally

> excluded. A similar indication of homeward orientation was found. Again, the results suggest, but do not prove, that rodents may be capable of route-based navigation even when deprived of vision during displacement. (R13, R19, R20)

Eastern chipmunks. Release experiments with 18 chipmunks in a wooded area on the campus of Cornell University demonstrated only modest homing capabilities. Only a single individual returned after releases 775 feet away. However, other chipmunks did return from lesser distances. The low rate of returns (only 38.8%), the relatively short distances involved, and the long times taken for return (1-7 days) suggest that chipmunk homing---what there is of it---is accomplished through random movements until familiar territory is reached. (R3)

Flying squirrels. After trapping too many flying squirrels in his attic, J.T. Curtis released them in the University of Wisconsin Arboretum ½-mile away. The squirrels-in-the-attic problem did not go away, and it was supposed that the animals were finding their ways back from the Arboretum. So, two were toe-clipped for identification purposes and released a mile away, but still within the Arboretum. One of these animals was retrapped 6 days later. This return is more remarkable for the fact that the flying squirrel had to cross a wide expanse of treeless terrain, something that flying squirrels normally assiduously avoid. (R1)

Cottontail rabbits. Prior to the following report, cottontails were not known to home.

> This note reports the return of a cottontail, Sylvilagus floridanus, to the site of original trapping after its escape from the enclosure in which it had been placed. The cottontail, a female, was box-trapped on the perimeter of a 32-acre field, 5 miles WSW of Prattville, Alabama, on 8 February 1964. After being marked with a No. 3 monel metal tag in each ear, the rabbit was released in a 12-acre enclosure 2 1/3 miles north of the capture site. other than a lapse of 331 days between the date it was released in the enclosure and the date of recapture, details of its escape. route followed, and the time of return are unknown. (R9)

Golden moles.

> The golden moles of this genus have an extraordinary sense of orientation, for they can return directly to the burrow entrance with rapid speed. (R17)

Obviously, the distances involved here are very short. The moles, however, probably cannot see "home" because of the surrounding vegetation, and their return paths are direct, rapid, and different from the meanderings while searching for food.

Bats in general. Bats, the only flying mammals, range far and wide in their unending search for food. Some also migrate long distances. Like many birds, a few bats seem to have exceptional homing abilities. We mention here three such species. Very likely there are many more.

Little brown bats.

> A short-term homing study of Myotis lucifugus lucifugus was conducted in Des Moines County, Iowa, during the months of July and August, 1956. Two bats, released 270 air miles from their home roost, were found back on the roost 17 and 22 days later, respectively. They were liberated in the northwestern corner of the state and returned to the southeastern corner, crossing over flat agricultural land and a number of small river valleys. The total number of bats released at this distance was 34, giving 5.9 per cent recovered. (R2)

Evening bats (Nycticeius humeralis).

> A large colony of evening bats in an attic near Darlington, Montgomery Co., Indiana, was visited on 15 August 1964. We estimated 275 bats in the colony and noted that the young were strong fliers. We captured 146: 83 adult females, one adult male, and 62 immatures. These were taken from the colony about 4:00 PM and transported 96 airline miles ESE in uncovered cages, to Centerville, Wayne Co., Indiana. The one adult male was not used in the experiment. The adult

> females were banded and released at 10:30 PM and the immatures were banded and released a half hour later.
>
> .....
>
> Twelve adult females (14%) and two immatures (3%) were recaptured in the colony 10 days after release (25 August). Twenty-seven days after release (11 September), 12 additional adults were recaptured. Thus a total of at least 24 adult females (29%) and two immatures (3%) had homed. (R8)

Big brown bats. In his book The Mystery of Migration, R. Baker devotes considerable space to bats. He also mentions a release experiment using big brown bats, Eptesicus fuscus. When three dozen of these animals were released 400 kilometers (250 miles) from home, 85% returned successfully. (R14)

California sea lions. Several captive members of this species have been flown to islands off the California coast and released at various points ranging from 115 to 270 miles from their pens in San Diego. They returned between 2 and 7 days later. (R17)

Red foxes. We have come across only one release experiment with this mammal. No previous reports of homing in the red fox are known.

> On 15 November 1968, a female red fox (Vulpes vulpes) was captured in a steel trap 15 mi. N Randall, Hamilton Co., Iowa. The fox was placed in a gunny sack, ear-tagged, collared, and released on the same day in a 13-acre enclosure at Boone, Iowa. On 27 November, the fox was recaptured less than one-quarter mile from the first capture point and 35 miles northeast of the enclosure. (R11)

Although foxes are known to travel long distances, the scientists who carried out the release experiment deemed it very unlikely that the fox could have found its way back to its familiar range in just 12 days by chance alone.

Domesticated animals. Several entire books have been devoted to pets that somehow find their ways home over long distances whilst encountering formidable difficulties. Some of these tales are truly fantastic; but, as mentioned at the outset, we have found no controlled experiments satisfactory to scientists that have employed pets. However, given the large number of well-attested anecdotes of this genre, it is likely that there is some truth in them. With this in mind, we select one dog and one cat anecdote from the collection of J. Michell and R.J.M. Rickard. (R15)

Dogs. Michell and Rickard extracted the following tale from the July 22, 1979, issue of the Sunday Express. It involves an Alsatian named Nick, belonging to D. Simpson of Selah, Washington.

> Nick, aged five, had got lost while on a camping trip with Mr. Simpson in the southern Arizona desert. For two weeks her master searched frantically for her before starting on the 2000-mile journey home. Four months later Nick turned up, bloody, battered and emaciated, at the family home in Selah. Somehow she had travelled along through country described as some of the 'roughest on earth', hundreds of miles across the scorching, waterless desert, across the Grand Canyon and through blizzards, icy rivers and snow-covered, 12,000-foot-high mountain ranges in Nevada and Oregon. (R15)

Actually, we only know that the dog was lost in Arizona and eventually returned to Selah. We really know nothing of what happened in between.

Cats.

> In the autumn of 1977 fourteen-year-old Kirsten Hicks of Adelaide, Ausstralia, left her pretty white Persian cat, Puss, with her grandparents, who lived over a thousand miles away on Queensland's Gold Coast, while she went abroad for a holiday. She returned to the sad news that Puss had gone missing. But the following autumn Puss arrived home, 'footsore and with matted fur'. Th Sydney Daily Mirror (11 October 1978) reported that 'He crossed rivers, sidestepped semi-trailers and stalked the bush in an amazing 12-month trek.' (R15)

Again, there is much surmise in this

anecdote.

X2. Navigation during migration. Some terrestrial mammals, such as wildebeest and caribou, migrate long distances from season to season. Their journeys, though, cover territories where visual, olfactory, and other sorts of cues are abundant. It is therefore difficult to claim that these animals employ unrecognized senses in their long treks. On the open ocean, however, navigational cues are more limited. It is here that we look for anomalous navigational capabilities in migrating mammals, and this means that we are dealing with the marine mammals.

Many of the marine mammals migrate annually from one feeding ground to another. The gray whale, for example, is noted for its annual movements along the coast of western North America. But here again, it is easy to identify potential, nonanomalous navigational cues: visual landmarks on the coast, sonar-located underwater landmarks, temperature changes, chemical markers from different rivers, etc. For this reason, the best evidence for anomalous navigation is found in those marine mammals whose migrations terminate on isolated dots of land far from coastal cues.

Humpback whales. B. Wursig, a marine biologist at California State University, wrote in Science in 1989:

> Our knowledge of how marine mammals obtain locational cues from their environment is incomplete. How, for example, do humpback whales that feed in southeast Alaska find the relatively small Revillagigedo or Hawaiian Islands in a huge expanse of sea? Sun orientation, cueing onto underwater topography by passive listening, echolocation of the bottom, detection of thermal structure, chemoreception by tasting of water masses and current systems, and magnetoreception have all been proposed. Animals in general make use of a multiplicity of cues available to them, and it is possible that all cues above can come into play for various species and areas. Recent hypotheses on magnetic sensing, however, suggest that this sensory modality may be used by long-distance migrating cetaceans. (R16)

Magnetic sensing, as indicated in BMT1, may be real, but science has no idea how biomagnetic sensory organs work, if they indeed exist.

Fur seals. The fur seals that breed on the Pribilov Islands in the Bering Sea winter some 3,000 miles away. In the spring they return unerringly to these same tiny, fog-shrouded islands, often even the same beaches, year after year. (R4)

X3. Under-ice navigation. A long-standing question for mammalogists has been: How do seals in the polar regions find their ways back to their breathing holes after deep, far ranging forays into the dark, ice-covered ocean?

Weddell seals.

> Weddell seals dive routinely to depths of 300 to 400 m and at least occasionally to 600 m. Most dives, even to these considerable depths, do not last longer than approximately 15 minutes, but a 73-minute dive has been documented. Their navigational capabilities seem extraordinary. They manage to return to a specific breathing hole after traveling at least 2 km under ice 2 m thick. (R18; R6)

Ringed seals. Seals, including the Weddell seal above, are not known to echolocate. In this connection, R.R. Reeves et al remark:

> The intriguing question of how they locate prey and breathing holes under ice during winter darkness remains unanswered. (R18)

The same unanswered question also applies to other species of marine mammals inhabiting the polar regions.

X4. Rapid, directed, high-altitude flight. Radar offers accurate real-time observation of the movements of airborne mammals, meaning, of course, the bats. In radar studies, homing cannot be demonstrated for individuals as in the release experiments of X1. Radar can, however, reveal directed movements at altitudes so high that the use of landmarks, odors, etc. is limited, as in a study by T.C. Williams et al.

Free-tailed bats.

> Both search and height-finding radars were used to observe the airborne behavior of free-tailed bats, Tadarida brasiliensis, near several caves in the southwestern United States. Radar echoes from dense groups of bats covered areas as large as 400 square kilometers and rose to altitudes of more than 3000 meters. The presence of large numbers of bats within these areas was confirmed by visual observation from a helicopter. Bat flights appeared on radar at dusk and at dawn as a slowly expanding or contracting target, usually located near a known roost. The direction in which the echo expanded most rapidly was not not due to the drift of the bats by winds. The leading edge often moved at more than 40 kilometers per hour, indicating the capacity for rapid, well-directed, high-altitude flight in these animals. Bats flying at such high altitudes must employ sensory systems other than echolocation for orientation and navigation. (R12)

The identities of these navigation senses are still largely unknown, although one suspects that the bats mentioned above may be able to discern some landmarks far below. The setting sun might also supply a navigational cue.

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BMT3 Short-Range Operational Prowess Despite Suppressed Visual and Olfactory Cues

Description. The ability of some mammals to hunt prey and navigate in environments where visual and olfactory cues are greatly reduced, as in the dark night sky and turbid water. The implication is that senses other than sight and smell are employed in these situations.

Data Evaluation. The data supporting these phenomena are of two types: (1) field observations by experienced naturalists; and (2) controlled, scientific experiments with captured animals. The data have been collected from a variety of books and periodicals, both professional and semipopular. Generally speaking, the quality of the evidence is good, but in field observations it is often circumstantial, because unaided human observers cannot directly detect the ultrasound signals or the electric fields thought to be employed by the animals. Rating: 2.

Anomaly Evaluation. Electrolocation capability and electrosensitivity have appeared in a wide spectrum of mammalian families, especially among the bats and cetaceans. Although the capabilities vary from species to species, it is obvious that there have been either many remarkable instances of parallel evolution or frequent independent inventions of complex, innovativc biological systems. Echolocation in particular requires the synchronous development or modification of organs for sound production, sound focussing, sound reception, and the analysis of complex signals that are immersed in environmental noise and prey-created jamming. See BMA1 for more discussion of our evaluation of the anomalousness of widespread parallel evolution. Rating: 1.

Possible Explanations. Environments lacking strong visual and olfactory cues somehow induce organisms to develop alternative sensory systems. The details of just how these developments are initiated and orchestrated are a mystery.

Similar and Related Phenomena. Human facial vision (BHT10 in Humans I); long-range navigation (BMT2); mammalian ears, sound generating organs, and electrosensitive organs (BMO in Mammals II); echolocation in birds (BBT).

Entries

X0. Introduction. In addition to those senses that facilitate long-range navigation and homing (BMT2), some mammals possess sensory apparatus that confers the ability to pursue prey and find their ways in dark caves and tunnels, in muddy waters, and obstacle-filled environments where the senses of sight and smell are of little use. The capability of a bat to snatch a moth out of the air on the darkest of nights exemplifies the type of senses investigated in this entry.

Bats are not alone in possessing such faculties. Other mammals negotiate turbid waters and underground tunnels with an ease that also points to senses beyond sight and smell. There are, in fact, at least two remarkable short-range location systems in the sensory repertoire of mammals. They both seem to have developed in response to the invasion of environmental niches where eyes and noses have little application. The anomaly lies in the fact that many taxonomically-distant species evolved the same rather sophisticated engineering concepts, although they may have implemented them in different ways. These examples of convergent evolution are remarkable, as is the biological engineering that made them possible.

We begin by examining those observations made under natural conditions that first made naturalists suspect that senses beyond sight and smell are operational. This is, of course, only circumstantial evidence for the existence of unsuspected senses. In X2, we will review briefly the verification and operational characteristics of those "extra" senses as discovered in controlled experiments.

X1. Field observations of short-range operational prowess.

Bats in general. The great majority of the 900-odd species of bats possess sensory apparatus that allows them to maneuver in dark caves and to capture prey at night. It has been amply demonstrated that most bats employ a form of sonar or echo-ranging that uses acoustic signals. With so many species possessing this remarkable capability, we must resort to a few generalizations and then follow with a specific instances that illustrate some important points about bat echolocation that provoke questions about its evolution.

First, three generalizations:

(1) Most microbats prey on flying insects and have highly developed echolocation apparatus. They can generate loud ultrasonic pulses and then detect and process the faint echoes.

(2) Those microbats that feed on nectar, fruit and blood can usually echolocate, but they generally produce only weak sound pulses---just strong enough to avoid obstacles and orient themselves.

(3) The main diet of all of the megabats is fruit and, like the fruit-eating microbats, those few that can echolocate at all have very weak sonar capabilities.

Today, virtually everyone knows that bats avoid obstacles and catch insects using echolocation. But 200 years ago, these capabilities were a source of wonder. Even though the Italian scientist L. Spallanzani had shown circa 1790 that bats lost their mysterious navigational powers when their ears were stopped, no one put two and two together---perhaps because almost all microbats employ frequencies humans cannot hear. (R17) It wasn't until 1940 that D.R. Griffin proved to incredulous scientists that bats harnessed ultrasound to dominate the night skies. (R19) Even though we cannot hear most of the bats' sonar signals, it is possible to make some significant observations---with evolutionary implications---about bats by just observing them in the field without any special apparatus.

Fishing bats. If the scientists of 200 years ago had known about the fishing bats, they would have been even more perplexed by the amazing ability of these bats to catch underwater prey at night. Fishing bats not only demonstrate the acuity of bat echo-location equipment but also pose a question for evolutionists, as now stated.

Since a water surface reflects sound waves, it is not at all obvious how fishing bats catch fish. At first, naturalists believed that fishing bats just dipped their particularly long claws into the water at random and were occasionally lucky enough to snag a fish. More careful observation, however, shows that the New World's Greater Bulldog Bat accurately adjusts its course to intercept fish swimming near the surface. When ultrasound detectors became available, they demonstrated that, as a fishing bat closes in on the still invisible fish, it emits sound pulses at a higher rate (the so-called "feeding buzz"). Evidently. this bat's sonar is precise enough to discern the slight ripples made by the dorsal fin of the target fish as it comes close to the surface. (R11, R16, R17) Fishing bats not only frequent quiet ponds and rivers, but they also fly out beyond the ocean breakers in search of salt water prey. They are often seen following pelicans and schools of predatory fish, for these predators often force small fish to the surface. (R8)

Fishing bats display long, hook-like claws beautifully designed to capture slippery prey. They even have waterproof fur. These highly specialized characters, along with precision sonar, evolved in three genera of bats: Noctilio (2 New World species, including the Greater Bulldog Bat); Myotis (Asia); and Megaderma (Asia) (R14) Here is one more instance of apparent parallel evolution or independent invention of an integrated suite of characteristics among different genera located in geographically separated regions. Still another question for evolution is: Why would bats ever attempt to catch fish in the first place since they cannot been seen visually at night? If fishing bats evolved from insect-eaters, how did they associate tiny water ripples with food?

Megabat echolocation. In contrast to the sonar acuity of the fishing bats, the Egyptian Fruit Bat, one of only two species of echolocating megabats, has crude sonar apparatus. It simply clicks its tongue and listens for echoes. This is enough to orient itself in dark caves and avoid obstacles. Eating mainly fruit, it does not need anything more sophisticated. (R17) Nevertheless, it is echolocation, and it seems to have evolved independently. See BMT4 for more on the evolutionary implications.

Spotted bats. This North American bat differs from all the other microbats. It is an exception to the general rule that the microbats echolcate using ultrasound with frequencies well beyond the 20,000-Hz limit of most human ears. The Spotted Bat generates 5-millisecond bursts of sound sweeping down from 15,000 to 9,000 Hz, all well within human hearing capabilities. In the field at night, one can hear their "feeding buzzes" (increases in sound pulse rates) as they close in on their prey. (R17) If this rather rare bat had been known to earlier naturalists, bat echolocation might have been accepted much earlier.

The much longer wavelengths of the Spotted Bat's signals have required the evolution of huge, almost grotesque, ears to detect the sound pulses bouncing off its insect targets. The anomalist must ask why the Spotted Bat is so different. Why the radical change in sonar frequencies, especially in view of the fact that the longer wavelengths reduce the amount of detail in the bat's sonar "picture"? Did the huge ears coevolve with the frequency change or did they come later? If it was coevolution, how were all the many biological changes orchestrated synchronously through random mutations?

Cetaceans in general. Although the cetaceans as a group make all manner of sounds from the human audio range up to 300 kilohertz (belugas), it is not immediately obvious to the field observer that whales and dolphins employ these sounds for hunting and short-range navigation. Indecd, some do not. One problem in the field is that it is much more difficult to prove that a dolphin closing in on fish is using sonar than it is for a bat chasing a moth. Uninstrumented field evidence for cetacean echolocation, or any other sense, has to be circumstantial. We can deduce, for example, that sperm whales dining on large squid in the Stygian darkness a half mile down must be finding their dinners with some sense besides sight and smell. The use of echolocation by belugas is more apparent to surface observers. These noisy whales, dubbed "sea canaries," can be heard as they chase salmon in turbid coastal waters and thread their ways through narrow leads in the ice pack. (R1) The study of several species of cetaceans under controlled conditions has demonstrated the reality and remarkable acuity of their sonar systems. (See X2.)

Because they employ relatively long wavelength sound for echolocation, the ears of the spotted bats are huge.

Curiously, the cetaceans, like the bats, are split into two major groups: the toothed whales, including the dolphins, and the baleen whales, such as the humpback. The toothed whales, like the microbats, all seem to echolocate; but the baleen whales, like the megabats, are vocal but echolocate very little if at all. Actually, they do not need sonar to scoop up mouthfuls of krill or small fish, just as the megabats can find fruit without sending out sound pulses. These parallels between bats and cetaceans, the major users of echolocation, are fascinating from the standpoint of evolution. Did both bats and cetaceans have dual origins, or did each split off from a common ancestor? (R9)

Seals and sea lions. These animals often hunt in turbid waters just like the dolphins and belugas. Could they also use echolocation? R.R. Reeves et al point out that a few healthy, well-fed seals have been found to be blind in one or both eyes---certainly circumstantial evidence for a sense like echolocation. Another hint comes from the noisiness of seals plying ice-filled polar waters. Some seals generate audible clicks that could well be used for echolocation. (R3, R6, R18) There are also some experimental data that give substance to these suspicions. (See X2.)

Insectivores in general. Several groups of insectivores---shrews, tenrecs, moles, desmans---are suspected of using echolocation as they speed through their tunnels and runways. Supporting this conjecture is the observation that these mammals often emit clicks and ultrasonic squeaks like those noted in mammals known to echolocate. (R10, R14) On top of this, these animals usually have tiny eyes and nocturnal habits---they *need* echolocation to prosper as they *do!* (R2)

Star-nosed moles. One insectivore requires special attention. The star-nosed mole is semiaquatic and is somehow able to locate its prey in muddy water despite its poor eyesight. Naturalists have long puzzled over the star-nosed mole's hunting capabilities. Could it be using echolocation like those dolphins living in muddy rivers? The answer is "no." Rather, the star-nosed mole's underwater sensor is its bizarre, tentacle-equipped nose. Originally, this unique organ was thought to be used in feeling for prey, somewhat as the raccoon uses its sensitive paws. This mole's nose *is* sensitive to touch but it also detects electric fields generated by its prey and homes in on them. In this, it is remarkably like the duck-billed platypus which sports an electrosensitive bill, which it also uses for probing for underwater prey. (R23) (Also see "Platypuses" below and BMO in *Mammals II*.)

Obviously, echolocation is not the only solution to the problem of operating in murky waters.

Rodents in general. Some scientists suspect that some rats and packrats have developed a crude form of echolocation, but the jury is still out here. (R17)

Humans. The tapping of a blind person's cane emulates the sharp clicks emitted by some echolocating mammals. Some experiments show that reflected sound is indeed important to that human sense called "facial vision," but it also seems that *other* environmental cues are used in facial vision. For a more lengthy discussion, see BHT10 in *Humans I*.

Aye-ayes. In her essay on the peculiarities of the Madagascar aye-aye, G. Mason wrote:

> The aye-aye, one of the strangest and rarest species of primates in the world, has an equally unusual method of finding food. Zoologists have discovered that it taps wood to locate cavities under the surface. Its skills are so well developed that it can tell holes containing grubs from those that are empty. It is the only mammal known to use such a technique.

To improve the efficiency of its "percussive foraging," the aye-aye has evolved huge bat-like ears and a highly elongated middle finger on each hand. This specialized finger does the tapping and the big ears relay the nuances of sound to the brain. So sensitive is this specialized form of sonar that the aye-aye can detect grubs 2 centimeters below the surface of the wood. Once a grub has been located, the aye-aye tears into the wood with its forward-curving, chisel-like teeth. The incisors are remarkable for a primate, for they keep on growing, just like those of rodents. When the grub-containing chamber has been reached, the long, narrow middle finger is inserted and the grub is retrieved. A neat combination of attributes. (R13)

What is even more interesting is a comparison of the aye-aye with many of the woodpeckers. Many woodpeckers also employ percussive foraging, have special bills for chiselling, and possess *very long*, spiny tongues for extracting grubs. In other words, the aye-aye is a primate that occupies the niche of a woodpecker. As luck (?) would have it, the aye-aye lives on Madagascar where there are no woodpeckers! A remarkable example of convergent evolution in filling a highly specialized environmental niche.

Platypuses. Like seals, dolphins, and the star-nosed moles, the platypus forages underwater for its sustenance. Even in clear water it needs some extra sensory help, because when it dives its eyes and nostrils seal shut automatically. The strange platypus bill then goes into operation. It is sensitive to touch, but this does not help much in catching its favorite freshwater shrimp and other crustaceans. Could the platypus, too, be an echolocator? As with the star-nosed mole, the answer is "no." Like the mole and some fish, the platypus detects the electric fields generated by its prey. The platypus bill is the electrosensitive organ that corresponds to the mole's tentacle-like nose. (R22) See BMO in Mammals II for more on this unusual electrosensitive organ.

Echidnas or spiny anteaters. A monotreme like the platypus, the Australian short-nosed echidna also possesses an electrosensitive nose. However, no one knows just how this organ helps the echidna in its unending search for more ants. The only pertinent observations are those of the echidna breaking into ant nests and quickly and unerringly finding the nesting chambers. (R21)

Presumably, the long-nosed echidna found in New Guinea also possesses an electrosensitive nose.

X2. Controlled experiments involving hunting and short-range navigation. The purpose of this entry is to present some general performance figures for those mammals that apparently employ echolocation and electrosensitive organs. These data will underscore the sophistication of some of these biological systems. In the context of parallel evolution, some of these systems required the coordinated development of: (1) a sound source, often frequency-modulated; (2) sound-focussing devices, such as nose leaves and (in some cetaceans) sound lenses; (3) sensitive ears and (in some bats) immense pinnae or external ears; and (4) brains capable of analyzing the complex echoes from elusive prey, who may also be emitting jamming signals louder than the echoes. (See BMO in Mammals II for more on the organs involved.)

Little Brown Bats. Experimentally, these bats can echolocate and avoid wires less then 0.25 millimeter (0.01 inch) in diameter. (R4, R17)

Big Brown Bats.

> ...in the laboratory, an echolocating Big Brown Bat first detects a 19-mm-diameter sphere at a range of 5 m. Putting this in perspective, the average Big Brown Bat is 115 mm long, so the 19-mm-diameter sphere is 16% of its body length. Using echolocation, therefore, the Big Brown Bat first detects the sphere at 5000 mm (5 m), 43 times the length of its body. If our vision offered a similar range performance, a 2-m tall person would first see a stop sign at 86 m. It is obvious that in humans, vision gives better resolution over distance than does the echolocation of bats. (R17)

However, bats do this in the dark!

Big Brown Bats can also distinguish between holes than differ in depth by less than 1 millimeter. (R17)

Bats in the family Vespertilionidae. D.R. Griffin's ground-breaking tests of bats demonstrated that bats somehow can pick out the echoes of their sound pulses from much louder background noise.

> It is known from the carefully conducted experiments by [D.R.] Griffin that these insectivorous bats can avoid fine wires (down to 0.3 mm diameter) with reasonable ease, even against a background of noise covering a band of 15 kc/s to 55 kc/s, which in intensity is 35 db greater than the echo being detected. A clear definition of noise level is really required here, but it is sufficient to realize that in fact this acoustic system is no ordinary echo-ranging device such as conventional Asdic or

> Radar. (R1)

"Asdic" is the British term for the American "sonar."

Bats in general. Bat echolocation is not without its drawbacks. Some of their prey species can detect the bats' sound pulses and jam the echolocation system with loud sounds.

Another deficiency illuminates the complexity of bat echolocation equipment and its intimate involvement of the brain. Echolocating bats seem to construct "cognitive maps" of their surroundings, just as humans form mental visual images of places. Unfortunately, bats are sometimes misled by these cognitive maps.

> When flying through thoroughly familiar surroundings, many bats rely heavily on spatial memory. Although orientation sounds continue to be emitted in an apparently normal manner, the bats collide with newly placed obstacles, turn back from the former location of objects that have suddenly been removed, and even try to land on a familiar toehold that has been taken away. (R5)

Luckily for the bats, nature does not often add and remove obstacles just to see how they react! But the bats' ability to create mental "sound pictures" is interesting.

Porpoises (species not specified).

> The porpoise apparatus is more difficult to study than that of bats and consequently is less well known, but it is quite as remarkable. Porpoises can find objects as small as a centimeter in diameter on the floor of a tank, even distinguishing a copper square from an aluminum one of the same size. At a distance of 10 feet, they can detect an object 0.1 inch in diameter. This accuracy is the more amazing because the porpoise has problems the bat does not have. Because the speed of sound in water is five times greater than its speed in the air, the wavelength is five times longer, and hence the sharpness of resolution is five times less. (R15)

Dolphins (species not specified).

> Experiments in the Kailua laboratory have revealed that dolphins wearing soft latex eyecups can distinguish between two cylinders based on a wall-thickness difference of just two-tenths of a millimeter, and can locate a stainless steel sphere only 7.5 centimeters across from up to 120 meters away. Using echolocation, dolphins can differentiate among objects based on size, shape, density, and composition of the objects. It has even been suggested that dolphins' echolocation clicks can penetrate solids like x-rays, stunning fish and allowing the animals to peer inside one another. (R12)

This x-ray feature is not technically surprising. Doctors often use ultrasound to image the internal organs of humans. However, it is hard for humans to conceive of a world where one can see inside another!

U.S. Navy tests show that dolphins can accurately locate a 3-inch sphere 400 yards away. (R20)

Harbor seals. Tests of a 7-year-old male harbor seal raised in captivity have shown that this animal is capable of finding and retrieving a ring 17 centimeters in diameter in total darkness. As this seal searched, he emitted single and double clicks. He could also distinguish between rings of the same size but differing in acoustical impedance. (R6)

Again, we see the penetrating properties of sound waves.

Tenrecs. Tenrecs are shrew-like mammals with tiny eyes and nocturnal ways. E. Gould has experimented with some tenrec species indigenous to Madagascar (called Madagascar "hedgehogs" because of their spines). He plugged the ears of some of these tenrecs and tested them in a dark room.

> Three genera of tenrecs in two subfamilies learned to search the rim of an elevated disc and to find and jump down onto a platform without the use of visual, olfactory, kinesthetic, or tactile senses. The ability of Hemicentetes to detect the platform was completely or partially impaired when their ears were plugged.
>
> As a tenrec searched the rim of the disc, it emitted tongue clicks of short duration having frequencies between 5,000 and 17,000 cps, and

lasting for 0.1 to 3.6 msec. Tenrecs produce tongue clicks when exploring strange places or fleeing, and in one arboreal type, while climbing along slender branches or shrubbery. (R2)

Shrews (species not specified). E.G. Gould (see "tenrecs" above) also tested shrews and provided evidence that they, too, can echolocate. This work was published in R24, but we have not examined it yet.

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BMT4 Mammal Behavior Implying the Existence of Other Unrecognized Senses

Description. Behavior of mammals suggesting that they possess senses unknown to human observers, as exemplified by: (1) foreknowledge of natural phenomena (earthquakes, weather); (2) the apparent detection of X-rays; and (3) the apparent transmission of hidden knowledge (telepathy).

Data Evaluation. Generally speaking, the data are unsatisfactory. Much is anecdotal (X1, X2, X3); some is rejected outright by most scientists as unreliable (X6). Mainstream-science literature recognizes (through publication in "acceptable" journals) only the possibilities of X-ray detection (X4) and genetic-change detection (X5). Rating: 3.

Anomaly Evaluation. The discovery and convincing demonstration of any sensory channel not now recognized by science would be a major event. Therefore, any data suggesting the existence of such channels is highly anomalous. Rating: 1.

Possible Explanations. The normal senses of many mammals (hearing, smell, sensitivity to slight vibrations and infrasound) are much more acute than they are in humans. These mammals may, therefore, be able to anticipate earthquakes and weather changes. Even X-rays may be accompanied by the creation of tiny amounts of detectable ozone.

Similar and Related Phenomena. Animal behavior prior to earthquakes (GQB1 in Earthquakes, Tides...); homing, navigation, and hunting senses of mammals (BHT2, BHT3, BHT4 all in Humans I); evidence for ESP among humans (Series-P catalogs).

Entries

X1. Possible earthquake-predicting senses. Down the centuries, humans have often observed that other animals sometimes behave strangely just prior to earthquakes. So common are these observations that H. Tributsch, in his book When the Snakes Awake, was able to compile a 14-page table of them covering the time span 373 BC to 1967 AD. (R4) There are doubtless many that Tributsch did not collect from the widely dispersed literature; and new anecdotes are added with every modern quake of appreciable size. In other words, the relevant anecdotes can easily overwhelm the researcher.

We have already explored this phenomenon is depth under GQB1 in Earthquakes, Tides,... We will only summarize briefly here with two short paragraphs.

The pre-quake behavior of animals that attracts human attention involves unusual restlessness. Dogs bark and howl; cats leave home; horses kick down their stalls; cattle crash through their fences; and even some humans have reported a curious irritability. Such tales are anecdotal and were it not for the sheer number of them and their internal consistency, scientists would ignore them. But it is now generally admitted that animals, with their superior senses, may be detecting premonitory earthquake effects.

Generally, it is thought that the affected animals are detecting sounds, ground vibrations, or odors emanating from the earth that we humans cannot sense. If this is all the phenomenon is, there would be no anomaly, but no one knows. Perhaps some of the animals are responding to electrostatic or magnetic forces---or even some pre-quake condition that we are completely unaware of. In any case, the matter is not yet settled and is, therefore, catalogable.

X2. Possible weather-predicting senses. Somehow, some animals seem to know when a storm is imminent. For example, the North American black-billed cuckoo will sometimes---not always---begin calling before a rainstorm, thus earning its popular name "rain crow." Mammals are not so vocal about the weather, but some do take special precautions prior to the onset of bad weather.

Short-nosed bandicoots. This marsupial seems to detect the approach of heavy rains, for it has been repeatedly observed enlarging its nest before a storm's onset. (R7)

Prairie dogs. The same sort of preparatory behavior is seen in prairie dogs before heavy rains arrive:

> On a number of occasions the larger members of the colony were observed to be loosening the earth around their mounds with their forefeet, then shovelling the soil upward with the hind feet. Other members worked within the burrow throwing out earth to aid in the building process. When the borders of a crater had been considerably raised the animals went to work tamping down the earth with their heads. This is an amusing process. They look like miniature goats, pounding the ground with the tops of their heads. These operations invariably took place before a rain, and the object was the construction of a circular dyke to prevent water running down the burrow. (R1)

Prairie dog checking on the weather!

X3. Possible lightning-predicting senses. A casual observation by P.F. Borrows forces one to wonder if some animals may be able to sense the build up of the ambient electrostatic field before lightning strikes.

Horses. Here is an interesting but far-from-conclusive anecdote from England, circa 1993, as related by P.F. Borrows:

> I was driving from Aylesbury to High Wycombe via Hampden during a thunderstorm. On an open hillside to the north of the valley, two horses were quietly grazing when suddenly, for no obvious reason, they bolted to the far end of the field. Within about 15 seconds of them moving, there was a lightning strike at the point where they had been standing. How interesting to reflect that more modern means of transport may also be able to detect the highly charged atmospheric state, but appear to be immobilised rather than spurred to self-preservation. (R8)

The reference to "more modern transport" involves previously discussed instances where impending lightning apparently stalled cars.

X4. A possible X-ray sense.

Cats. Despite seeming improbability, it has been scientifically established that cats can somehow detect the passage of X-rays through their bodies. The specific organ(s) involved, however, are not known. The experimental investigation of the phenomenon exposes specific parts of the cat's anatomy to 5-second, very-narrow-beam bursts of X-rays. The cats are conditioned to react when they sense the passage of the radiation.

The olfactory bulbs in the cats' heads seem to be the most sensitive area, but the phenomenon apparently involves more than a single organ.

> The question of how cats detect X-rays is certainly not completely settled. Animals deprived of their olfactory bulbs retained some sensitivity, particularly when the dose of X-rays was raised. It may be that there is more than one receptor; this view is supported by the findings of other workers, some of whom have noticed that sensitivity is apparently not even confined to the head but is spread throughout the entire body. (R2)

X5. The ability to detect slight genetic changes.

Mice. Nestled unobtrusively in a long review of how animals recognize close kin is the following statement:

> One tantalizing piece of experimental evidence is the apparent ability of mice to detect a single gene change (in the major histocompatibility complex) in an otherwise genetically identical partner. "No one knows how this works." (R5)

X6. Evidence for ESP in other mammals. While most research in parapsychology is focussed on human telepathy, psychokinesis, and related effects, there have also been some human-to-animal and animal-to-animal experiments. The very idea of an unrecognized information channel between animals of any kind is anathema to mainstream scientists. *All* research in parapsychology is viewed with great suspicion. Most scientists hold that it is rife with bad experimental designs, poor statistical analysis, and even outright fraud.

The suspect nature of parapsychological research persuades us to restrict our coverage of mammalian ESP, just as we limited the number of dog and cat homing anecdotes in BMT2.

Human-to-dog telepathy. A. Esser, at Rockland State Hospital, New York State, carried out some provocative experiments in the 1970s. The following is representative of these:

> A pet boxer was hooked up to an electrocardiograph in one soundproof room and its mistress was placed in another. Without giving the woman any warning, the experimenters sent a man into her room. As soon as the woman became scared, her boxer's heartbeat registered a violent acceleration. (R3)

The referenced paper (R3) in *Science Digest* contains a variety of similar experiments with animals apparently supporting the reality of animal ESP. Additional research in Europe is also cited.

Even though emanating from recognized institutions, this type of research is only very rarely found in mainstream scientific journals.

Rabbit-to-rabbit telepathy. Supporting the preceding remarks, the work described below was published in a foreign parapsychological journal. The results, if verified, would certainly represent a momentous scientific discovery. The experiment is described in an abstract by B. Thouvenin, as translated from the French:

> Our experimental study has tried to bring out the existence of a correlation, at a distance, between the physiological reactions of two rabbits from the same litter who had always lived together. We chose photoelectric plethysmography as being the least traumatic method for the rabbits and the one most capable of giving evidence of the physiological reaction specific to stress. Through this method, we studied the coincidences between the outsets of the two rabbits' emotional reactions. Added to the rabbits' isolation through distance, some experiments involved the setting up of sensorial and electromagnetic isolation boxes. We studied the coincidences occurring between the spontaneous emotional reactions of the rabbits as well as the coincidences occurring between the reactions provoked by small stimulae, such as the sound of a bell in one of the boxes. Two series of experiments out of four gave significant results, leading one to think that a

conscious or unconscious telepathic link does exist between two rabbits that have close links with each other. (R6)

References

R1. Anonymous; "Animal Weather Prophets," Scientific American Supplement, 86:187, 1918. (X2)
R2. Anonymous; "How Do Cats Smell Out X-rays?" New Scientist, 25:378, 1965. (X4)
R3. Wylder, Joseph; "Psychic Powers in Animals? Some Research Supports It," Science Digest, 85:73, May 1979. (X6)
R4. Tributsch, Helmut; When the Snakes Awake, Cambridge, 1982. (X1)
R5. Lewin, Roger; "Practice Catches Theory in Kin Recognition," Science, 223:1049, 1984. (X5)
R6. Thouvenin, Bernard; "A Study of Telepathic Phenomena among Rabbits," Revue Francaise de Psychotronique, 1:15, July-September 1988. As abstracted in Exceptional Human Experience, 9:47, June 1981. (X6)
R7. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X2)
R8. Borrows, P.F.; "Horses Bolt, Spurred by Lightning," Weather, 48:161, 1993. (X3)

BMT5 Curious Examples of Soaring and Parachuting Mammals

Description. Unexpected "flight" capabilities of mammals other than bats.

Data Evaluation. The gliding and soaring feats of flying squirrels (X1) have been well-observed by naturalists. Rating: 2.

The claimed parachuting talents of domestic cats (X2) are as yet only anecdotal in nature. Rating: 3.

Anomaly Evaluation. There is nothing anomalous in the observations recorded below. A rating of "curious" is all that is justified. Rating: 3.

Possible Explanations. None required.

Similar and Related Phenomena. The evolution of gliding and flight in mammals (BMA40, BMA41); gliding and parachuting frogs and reptiles (BRT).

Entries

X0. Cross reference. Bats are recognized as the only mammals capable of true flight. The evolution of this capability is treated in BMA41. In this catalog entry, we attend to other mammals that exhibit unusual talents for soaring and parachuting.

X1. Remarkable soaring capabilities. In an impressive display of parallel evolution, nature has created some 51 species of gliding mammals: 43 flying squirrels; 6 flying phalangers; and 2 colugos. All possess gliding membranes to some degree and use them in traveling in their wooded habitats. Here, again, the question of parallel evolution arises, just as it does among the microbats and megabats. For more complete coverage of this topic, see BMA40 and BMA41.

Our purpose here is to show that some mammalian gliders use their membranes to accomplish surprising aerodynamic feats. Mammalian gliding can go well beyond the uncontrolled flight of a child's paper airplane.

Giant flying squirrels. In Asia, naturalists have found six species of these highly arboreal mammals. When we include their tails, these animals may reach a meter in length; they may weigh up to 2.5 kilograms. When they become airborne, they are even more impressive---as squirrels go:

> They travel through the treetops in a squirrel-like manner, but when a branch or a tree is too distant to reach by an ordinary leap, they go to a high branch and leap toward the objective, extending the membrane as they spread their arms forward and out, and the legs backward and out. At first the glide is downward at an angle, but as they approach the objective, they ascend the last meter or so before alighting. Some glides of up to 450 meters [¼ mile] have been observed. These squirrels seem to have a basic knowledge of aeronautics, since at times they may ride on ascending currents of air coming up deep valleys. In flight they are actually capable of banking, and on a number of occasions they have been observed to make several banks in the course of a single glide. (R1)

Arrow-tailed flying squirrels. One of the eight species in this genera, *Hylopetes lepidus*, has been seen to glide over 135 meters. More interesting to the evolutionist is the observation that this species sometimes actually flaps its gliding membranes and can gain altitude during glides. (R1) One wonders if this characteristic could ultimately be refined into true flight.

X2. Surprising parachutists. Parachuting frogs are well-known to biologists. With their huge webbed toes and flattened bodies they can parachute to the ground and even glide between trees in the tropical forests. (BRT) Among the mammals, a very common pet also seems to have some degree of parachuting ability.

Domestic cats. The following, rather amusing item appeared in a New Zealand newspaper:

> Why is it safer for a cat to fall from a 32-storey building than from a seven-storey building?
>
> .....
>
> Just ask scientific and medical reporter Karl Kruszelnicki, whose theory is based on a study of 150 cats that plummeted from windows at different heights.
>
> Falling from 32 storeys, a cat had more time to work out a plan of action, because once it reached terminal velocity and stopped accelerating, it started to relax, he said in Sydney yesterday.
>
> Once the moggie [?] reached top speed of 100 kmh and realised it was not speeding up any more, it spread-eagled its limbs in the perfect position for maximum wind resistance.
>
> "Once it reaches the ground, the cat just kisses the ground on all four paws simultaneously and the shock is absorbed," Dr. Kruszelnicki told his bemused audience at the University of New South Wales during a talk organized by the Alumni Association.
>
> Of the 150 cats that fell from high-rise buildings in New York over a five-month period, 10 per cent died, with the chances of survival rising with the distance of the fall. (R2)

References

R1. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

R2. Anonymous; "High-Flying Cats Have the Big Drop Licked," The Dominion, September 17, 1992. Cr. P. Hassall. The Dominion is published in Wellington, New Zealand. (X2)

BMT6 Unusual Swimming Capabilities of Terrestrial Mammals

Description. The curious aquatic predilections and aquatic capabilities, or lack thereof, of some terrestrial mammals, when compared to those of closely related mammals.

Data Evaluation. The phenomena cataloged here are supported mainly by field observations of wild mammals. These curious facts about the aquatic preferences and capabilities of the great apes and elephants are well-documented in authoritative sources. Rating: 1.

Anomaly Evaluation. Evolutionists hold that life began in the sea and that, in due course, some marine creatures invaded the land and became adapted to terrestrial living. Later, some of the terrestrial mammals returned to the ocean and became cetaceans, sirenians, etc.; that is, today's marine mammals. This sea-land-sea scenario is presently widely accepted in science and, therefore, not anomalous. Not accepted is another event in the sequence: the return of marine mammals to land, making a sea-land-sea-land scenario. As we shall see below, at least two species may have had such a history. Evolutionists emphatically reject this latter scenario. For this reason, the observations and interpretations, as recorded here, are highly anomalous. Rating: 1.

Possible Explanations. Most mammals can swim well naturally or can be trained to do so. It is improper to construct radical evolutionary hypotheses based on a few aquatic preferences and exceptional capabilities.

Similar and Related Phenomena. See: Aquatic Ape Hypothesis in the Subject Indexes of Humans I, II, III and Mammals I, II.

Entries

X0. Background. Most terrestrial mammals can swim well enough when it is required. Many more, such as otters and muskrats, make their livings in the water. Still others normally thought of as terrestrial adapt readily to aquatic life. To illustrate, pigs on some South Pacific islands forage along coral reefs and become excellent swimmers. (R3) We have personally seen cattle swimming in a Belize lake, heads just out of water, browsing on aquatic vegetation. An extreme example of aquatic adaptation is the polar bear---now classed as a marine mammal---which is known to swim distances of 100 kilometers and more. (R5) Of course, none of the foregoing can be construed as being anomalous, but the swimming capabilities, or lack thereof, of other mammals may have evolutionary implications.

X1. Terrestrial mammals strongly adverse to water.

Great apes in general. Gorillas, orangutans, and chimpanzees cannot or at least are not known to swim. (R4) The only great ape that does not assiduously avoid water immersion is the pygmy chimpanzee, which has been seen wading in streams and snatching at fish. (R2)

It is interesting that the pygmy chimps, even more than the common chimps, seem close to humans in behavior and social structure. (R2) Follow-this tack, most humans readily learn to swim and take to aquatic sports enthusiastically. They can swim the English Channel and, in calmer waters, cover much greater distances. In this, humans diverge strongly from the great apes. This leads some writers, such as E. Morgan, to champion the Aquatic Ape Hypothesis, which holds that humans went through an aquatic stage in their evolution that the great apes did not experience. (R1)

X2. Terrestrial mammals that are "surprisingly" aquatic.

The reason for the word "surprisingly" will be evident below.

Elephants. Elephants and the sirenians (manatees and dugongs) share some interesting characteristics. They are both hairless (BMA14), like marine mammals in general; they both display marching teeth (BMA31). Indeed, elephants and sirenians are believed to be very close on evolution's tree. The sirenians are bona fide marine mammals, while elephants are usually conceived as totally terrestrial, although obviously appreciating baths and dunkings. It is, therefore, surprising to learn that elephants are amazing swimmers. In Walker's Mammals of the World, an Asian elephant is said to have swam 48 kilometers at speeds up to 2.7 kilometers/hour. (R4) Even more impressive is the statement by E. Morgan that elephants (surely Asian elephants) have voluntarily swum to offshore islands up to 300 miles from the mainland. (R1)

The implication of this that elephants, like the sirenians and cetaceans, returned to the sea, where life supposedly began, but for some reason again emerged and took up terrestrial life. This would be the same evolutionary route said to have been followed, much later, by the Aquatic Ape.

References

R1. Morgan, Elaine; The Aquatic Ape, New York, 1982 (X1, X2)

R2. Raeburn, Paul; "An Uncommon Chimp," Science 83, 4:40, June 1983. (X1)

R3. Wesson, Robert; Beyond Natural Selection, Cambridge, 1991. (X0)

R4. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1, X2)

R5. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X0)

BMT7 Remarkable Diving Capabilities of Distantly Related Mammals

Description. The ability of several distantly related mammals to dive to depths so great that major physiological modifications are required for their survival and their successful pursuit of prey.

Data Evaluation. The data below, although a mixture of both circumstantial observations and instrument recordings, are cited by several authorities on marine mammals in various guides. Nevertheless, objective data on these difficult-to-observe mammals are scarce, and more data are required, especially on the rarer species of whales. Rating: 2.

Anomaly Evaluation. In order for mammals to dive successfully to great depths, extensive physiological modifications must be in place: (1) Their bodies must be able to withstand crushing pressures; (2) Their circulatory systems must prevent the formation of nitrogen bubbles during ascent (the cause of the bends) and nitrogen poisoning (the cause of "rapture of the deep"); and (3) Their bodies must conserve oxygen during prolonged submersion. That these major biological changes have been successfully accomplished in both the cetaceans and seals is all the more remarkable, for these two orders of mammals are not closely related. Either parallel evolution or independent invention seems to have been at work. In this sense, the double evolution of deep-diving capabilities must be counted as just as remarkable as the repeated development of flight in animals. It is appropriate to paraphrase here our evaluation of the existence of functional wings in mammals (BMA41): Even though it is conceivable that random mutation and natural selection can produce deep-diving mammals once, even twice, we must view these superficial evolutionary scenarios with great suspicion. Two reasons: (1) The "half-a-wing" problem, or can viable, reasonable transitional forms exist? and (2) The complexity problem, or can random mutation really create in a coordinated way all the skeletal, neurological, chemical, and other biological innovations required by a deep-diving mammal?

Possible Explanations. See above.

Similar and Related Phenomena. Unusual swimming capabilities of mammals (BMT6); mammalian internal structures (BMI) and organs (BMO both in Mammals II) as modified for deep diving. See the Series-B subject indexes under: Complexity, Half-a-wing problem; Perfection problem.

Entries

X1. General observations. A mammal's diving capability is measured jointly by two figures: (1) the depth of the dive; and (2) the duration of the dive. The greater either of these numbers, the greater must be the animal's physiological modifications to cope with the intense pressures, lack of oxygen, cold, and darkness found at great depths.

The early estimates of the diving capabilities of marine mammals were circumstantial in nature because, once an uninstrumented marine mammal submerged, observers could only surmise where it went and what it did. In recent years, though, with the advent of precision sonar-tracking equipment and attachable instrument packages, much more reliable and much more impressive data have been obtained. (Usually, circumstantial, anecdotal data are the more fantastic.) We provide some selected data of both types below.

Sperm whales. The circumstantial data relevant to sperm whale dives were almost too amazing. At least fourteen times, as these whales pursued their prey (primarily large squid) in the dark, frigid depths, they became fatally entangled in submarine cables. One of these incidents occurred with a cable laying on the bottom at 1135 meters! (R3, R5) This figure was eclipsed by an apparent sperm whale descent to 3200 meters---almost 2 miles. The whale under observation was seen to dive and then reappear 82 minutes later. Whalers killed it and found a bottom-dwelling shark in its stomach. The water depth was well-known, but one had to infer that the shark was caught near the bottom. (R3-R5)

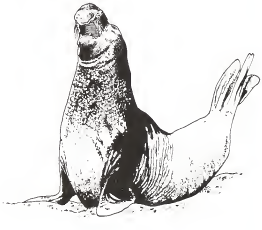
More objective are sonar-tracking data indicating sperm whales can reach at least 2500 meters. (R5) Hydrophone records bring the figure up to 2800 meters. (R3) In this context, one can hardly doubt that sperm whales really can dive as deep as 2 miles as inferred from surface observations.

Bottle-nosed whales. Impressive as the diving exploits of sperm whales are, the champion divers among the cetaceans are said to be the bottle-nosed whales. They are found mainly in very deep waters, where dives lasting as long as 2 hours have been reported. (R1, R5) With this breath-holding capability, they certainly have the potential for outdiving sperm whales. Unfortunately, these whales do not receive as much attention as the sperm whales, and we have no instrument readings to confirm the anecdotes.

Weddell seals. Most seals dive to only a couple hundred meters, but the Weddell seals go far deeper. Diving from their access holes in the Antarctic ice, Weddell seals are believed to travel 10-12 kilometers under the ice in their search for food. Their dives have been timed up to 93 minutes. (R10) Attached recording instruments reveal that they attain depths of up to 740 meters. (R10) In these sunless depths, even as they conserve energy and oxygen, they somehow manage to subdue Antarctic cod weighing up to 30 kilograms (66 pounds). (R5)

Elephant seals. The record-holders for dives among the seals, however, are not the Weddell seals but the elephant seals---both the northern and southern species. These animals with their grotesque noses can stay submerged for up to two hours. (R6) In fact, captives are even observed to sleep underwater. (R9) The elephant seals' breath-holding capability is consistent with their deep dives. Attached depth recorders prove that their feeding forays reach depths of 5120 feet (1561 meters) just short of a mile (R8). In 1989 this record was shattered when a male elephant seal was recorded reaching 1581 meters. (R6)

Thus, both seals and cetaceans, two groups of mammals well-separated taxonomically, have both solved the immense physiological problems attending very deep dives.



Elephant seals can dive to depths approaching one mile.

Humans (a cross reference). Of course, humans cannot even come close to emulating the diving performances of whales and seals. Nevertheless, unaided humans can propel themselves down to 80 meters and remain underwater for 3-4 minutes. (R2) Although humans cannot cope with the bends in rapid ascents and cannot resist great pressures, it is curious that we do seem to possess what is termed the "diving reflex", which is common to marine mammals. This reflex automatically causes the heart to slow down and begins the diversion of blood flow upon immersion in water. As far as is known, none of the other primates possesses this reflex. (R2) For more on this subject, see BHT21 in Humans I.

References

R1. Tributsch, Helmut; How Life Learned to Live, Cambridge, 1982. (X1)
R2. Morgan, Elaine; The Aquatic Ape, New York, 1982. (X1)
R3. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X1)
R4. Bright, Michael; The Living World, New York, 1987. (X1)
R5. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)
R6. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X1)
R7. Zimmer, Carl; "Portrait in Blubber," Discover, 13:86, March 1992. (X1)
R8. Golden, Frederic; "Hot-Blooded Divers," Sea Frontiers, 38:32, October 1992. (X1)
R9. Anonymous; "SIDS and Seals," Discover, 13:7, February 1992. (X1)
R10. Monastersky, Richard; "The Cold Facts of Life," Science News, 143: 269, 1993. (X1)

BMT8 Unusual Vocalizations in Mammals

Description. Mammal vocalizations that seem to have high semantic content, perhaps even the rudiments of language. Included are: so-called songs; codas; duets; choruses; animal "conferences," etc.

Data Evaluation. The vocalizations of the great apes and cetaceans have been subjects of high scientific interest and research. Many mammalogists have looked for traces of language in the utterances of chimpanzees, dolphin whistles, and humpback-whale "songs," but the searches have not been very fruitful. With these mammals, scientific observations are relatively abundant but on the negative side.

The vocalizations of other mammals, such as mice and seals, appear in the literature mainly as anecdotes. All that can be said here is that little systematic research has been done, and that casual observations suggest some semantic content in some cases. But there are no indications that languages exist. Crude signals and territorial vocalizations are common, but the information transmitted by them seems to be minimal. Rating: 3.

Anomaly Evaluation. The other mammals certainly communicate with one another, and even with humans and other species, via songs, whistles, barks, etc. They also duet and chorus, but not especially well when compared to humans and birds. That mammals communicate as well and as flexibly as they do is anomalous in the context of the paradigm that relegates the other mammals to the status of automatons. Our evaluation is based on this particular paradigm. Rating: 1.

The other related paradigm insists that only humans have developed true languages, with the requisite words, grammar, syntax, etc. This paradigm does not seem at risk from the data collected so far.

Possible Explanations. To various degrees, the other mammals are intelligent, communicating, problem-solving animals.

Similar and Related Phenomena. The human-mammal communication interface (BHX1 in Humans III); bird conferences and songs (BBT); many entries under "behavior" earlier in this volume (BMB2, 5, 6, 7, 15, 16, 21, 29, 36).

Entries

X0. Background. To a careful observer of nature, it is hard to believe that a major paradigm of science insists that animals cannot consciously and intelligently communicate with members of their own and perhaps even other species. Yet, this paradigm remains powerful among behaviorists, who hold animals to be mere automatons and creatures of instinct. D.R. Griffin, whose research has done much to undermine the paradigm, has restated it in the context of animal commumication:

> One reason that has discouraged ethologists from using the communicative behavior of animals as a source of evidence about their feelings and thoughts is a conviction that all animal communication is a direct result of internal physiological states that are not under any sort of conscious control. Animal communication is thus held to be comparable to human eye blinks, blushing, gasps of surprise, or groans of pain. These do of course serve to communicate to others the state of irritation of the eye, embarrassment, surprise, or pain. But they are not intentional signaling employed for some perceived purpose. I have called this general view of animal communication the "groans of pain" or GOP interpretation. (R34)

Our intent here is to categorize and present some cases of mammalian communication that seem to falsify the GOP interpretation stated by Griffin. Even such elementary vocalizations as canine barks, monkey screams, and dolphin whistles are probably sufficient to negate the unconscious-automaton paradigm, but mammal vocalizations may go far beyond these simple sounds. Humpback-whale "songs" and sperm-whale "codas," for example, may well betray some conscious intent to communicate much more information than possible with a dog's bark!

This catalog entry focuses on mammal communication employing the sound channel, including parts of the audio spectrum that humans cannot normally hear. Trying, as always, to avoid organizing our material according to extant theoretical preconceptions, we have identified three sorts of "vocalization": solo vocalizations; group "conferences," and choruses (including duets).

X1. Solo vocalizations. When a mammal utters a simple sound, it can mean many things. It can be: a signature signal or personal identification; an alarm; a call for help; a territorial statement; or a message with more semantic content, such as where to look for a rich lode of food or even the solution to a problem posed by a human trainer. Of course, not all solo vocalizations are anomalous. We will dwell mainly on those that challenge the GOP interpretation expressed in X0. In addition, there are many mammal messages that we have not yet deciphered and which remain mysterious. It is always difficult to get into the mind of another species.

House mice. Just about everyone now knows that whales "sing." In the rush to discover what whale songs are all about, several other "singers" have been bypassed. Musical mice, especially, were recognized long before humans became infatuated with the humpback whales' music. Much of the muscial-mice literature is over a century old. (R1-R4, R6-R8) Although mice do not seem to be as intelligent as whales, their singing capabilities are rather surprising and their purpose enigmatic. Mouse music does not seem to be territorial, like many bird songs; and it often occurs under strange circumstances. Mice even duet, though not proficiently. (See X3.)

Three anecdotes about musical mice are interesting enough to an anomalist to warrant inclusion here. (The literature contains many more.) Mice can do much more than squeak!

In 1871, W.O. Hiskey, of Minneapolis, wrote this charming letter to the American Naturalist:

> A communication in the Naturalist some time ago in regard to musical mice, prepared me for a phenomenon which recently came under my observation, which otherwise would have astonished me beyond conception. I was sitting a few evenings since, not far from a half-open closet door, when I was startled by a sound issuing from the closet, of such marvelous beauty that I at once asked my wife how Bobbie Burns (our canary) had found his way into the closet, and what could start him to singing such a queer and sweet song in the dark. I procured a light and found it to be a mouse!. He had filled an over-shoe from a basket of pop-corn which had been popped and placed in the closet in the morning. Whether this rare collection of food inspired him with song I know not, but I had not the heart to disturb his corn, hoping to hear from him again. Last night his song was renewed, I approached with a subdued light and with great caution, and had the pleasure of seeing him sitting among his corn and singing his beautiful solo. I observed him without interruption for ten minutes, not over four feet from him. His song was not a chirp, but a continuous song of musical tone, a kind of to-wit-to-wee-woo-woo-wee-woo, quite varied in pitch. (R3)

Our second anecdote also involves a canary, leading to the surmise that singing mice may be imitating birds.

> Some years since, while residing at Santa Fe, New Mexico, one of these vocal mice made its appearance in my house. The sounds were noticed some time before the animal was seen. As with Mr. Lee's mice, there was a canary-bird in the room, and for a time the notes coming from the wall were attributed to the canary. At last, however, the mouse would come out on the carpet seeking for crumbs, and there sing. The notes were almost identical with those of a canary. It would not trill so long, but in pitch and tone were identical---at least to an unmusical ear. The same filling and throbbing in the throat seen in a bird were also seen in the mouse while he sang. The sound was not sibilant, but strictly canorous with the pitch of an ordinary canary. After this mouse had furnished entertainment for a month to myself and family, I found him so tame I could touch him, and that he was utterly blind. (R8)

In our last anecdote (taken from a scientific journal), the mouse music is again associated with another source of music. Perhaps mice need only outside stimulation to sing!

> The reactions of a singing mouse to man-made music were observed for a 10-day period in March, 1940, in which time the mouse had established itself in a radio cabinet at my home in San Francisco. The mouse's voice was first noticed about a week after a swarm of mice invaded the apartment, probably attracted by the seeds placed on the window sills for birds. By the end of that week the hiding places of the mice were known, the radio being the favorite of many.
>
> It was suspected that one animal was a singing mouse after I failed in an attempt to tune out a melody that persisted during pauses in a musical program. When the song continued no matter where the dial was turned, it was obvious that the tune did not arrive over the air. Also, close listening proved that the song came from the upper compartment of the radio, containing the tubes, instead of from the loud speaker three feet lower down.
>
> .....
>
> The mouse was never heard except when music had been coming

> through the radio---never, that is, when the radio had been turned off for some time, nor during a drama or prolonged talk. Its relatively faint song was heard a few times *with* the radio music, and that it often accompanied the music, undetected, was suggested by the way its voice would carry on without a break when a selection came to an end. It generally sang straight through the announcer's interludes. When the radio was finally turned off the mouse's singing might continue for as long as three minutes. It once sang through every announcement in a full hour's program. (R10)

It is hard to imagine any survival value in a mouse's singing talent. Just the opposite is indicated, for the singing would surely catch the attention of predators.

Marmots (woodchucks). House mice are not the only singing rodents. R.A. Kellogg wrote to the *American Naturalist* that when a boy he owned a pet woodchuck that:

> "...sang like a canary-bird, but in a softer, sweeter note," His impression was, that it was a female. "I used to watch the pet very closely to see how it sang, as children are apt to do. There was a slight motion of the nostrils and lips, and consequently of the whiskers, with an air of unmistakably happy and serene enjoyment." (R5)

Of course, Kellogg could not really have known the woodchuck's state of euphoria. Nevertheless, it is reasonable to ask why the woodchuck sang at all. Was it for enjoyment, or was it like a cat's purring, or merely the random squeaks of a noisy automaton?

Prairie dogs. Prairie dogs are also rodents. They are not known to sing (so far), but they are good barkers. Intruders in a prairie-dog "town" always elicit warning barks as the animals disappear into their burrows. Certainly there is nothing anomalous in this, but C. Slobodchikoff, a biologist the the University of Northern Arizona, claims that the prairie-dog barks transmit more than simple warnings. Humans, dogs, hawks, all evoke *different* barks. In fact, the semantic content of the barks can be quite large.

> More impressive still, Slobodchikoff has found, is that prairie dogs discriminate among individual humans---or at least among members of his research team, who walked individually through a colony---of different height, weight, and clothing. All these distinctions are apparent not in the number or length of the barks but in their tonal qualities. For instance, the pitch may rise or fall more rapidly in response to one human than it does in response to another. (R30)

Slobodchikoff's findings are definitely inconsistent with the behaviorists' stance that animal warning signals carry no substantial semantic content.

White-lined sac-winged bats. These South American bats vocalize in a manner suggesting conversation.

> *S. bilineata* often and *S. leptura* rarely "sing" at their roosts with a cricket-like twittering and chirping, and both species chirp loudly during encounters with conspecifics while foraging. (R24)

African false vampire bats. On the other hand, the bat "songs" of these species seem more like the territorial songs of birds.

> During the March-April wet season, individuals spent considerable time "singing" establishing their exclusive foraging areas. The "song" consisted of four to nine high-intensity pulses, each with a sharp chip like that given by some passerine birds. (R27)

It would be unrealistic to assume that these are the only "singing" bats out of some 900 species known worldwide!

Vervet monkeys. We might expect that monkeys, being primates, would vocalize more meaningfully than bats and prairie dogs. To some degree this is true, but the increase in sophistication is not great.

Most intensively studied in this regard have been the vervet monkeys residing in Amboseli National Park, Kenya. What field researchers have done is to record the specific alarm calls made by these cat-sized monkeys in response to threats from leopards, martial eagles, and pythons---all fond of dining on the vervets. In real situations, the reaction of the monkeys differs according to the predator. A "leopard" alarm call sends the monkeys into the trees and out on the weak branches where a leopard cannot follow. When the "martial eagle" call is sounded, the vervets dive into dense foliage where they cannot be seen. The "python-is-near" call only causes the animals to look around and locate the snake, for they can easily outrun it.

In so-called "playback" experiments, no real predator is in the area. When a particular alarm call is played back from recordings, the vervets react exactly as they do when the threat is real. In this way, the researchers know that the call contains specific semantic content.

The three main "predator" vocalizations far from exhaust the vervet's vocabulary. They also emit specific sounds for (and respond just as specifically) the presence of baboons, hyenas, unfamiliar humans, etc. The vervet monkeys also possess a repertoire of "social grunts" that all sound pretty much the same to human observers. But when these grunts are analyzed spectrally, they are found to be different for each social situation, as when a dominant monkey approaches a subordinate and vice versa. (R13, R28, R34, R37)

A quotation from J. Diamond's The Third Chimpanzee suggests that we humans may have greatly underestimated the semantic contents of the vocalizations of the other mammals:

> Evidently vervets are much more finely attuned than we are to their calls. Merely listening to and watching vervets, without recording and playing back their calls, gave no hint that they had at least four distinct grunts---and possibly many more. as [R.] Seyfarth writes, "Watching vervets grunt to each other is really very much like watching humans engaged in conversation without being able to hear what they're saying. There aren't any obvious reactions or replies to grunts, so the whole system seems very mysterious---mysterious, that is, until you start doing the playbacks." These discoveries illustrate how easy it is to underestimate the size of an animal's vocal repertoire. (R28)

Despite the rather convincing field experiments with vervets, most animal behaviorists are skeptical. Most categorically deny that vervet calls contain elements of language. They remain convinced that a wide linguistic gulf separates language-using humans from all the other mammals which merely grunt or whistle suggestively!

Rhesus macaques. The communication capabilities of these monkeys have also been studied in the field. Specifically, a group of these young males of this species in a colony living on Cayo Santiago Island, off the coast of Puerto Rico, have been found to emit five well-defined types of screams in aggressive social encounters. These are designated as noisy, arched, tonal, pulsed, and undulating screams. Each scream is, in effect, a "word" that conveys specific information about the encounter to other members of the band, especially those whose help may be needed. (R28)

Elephants (Asian and African). Naturalists were surprised when they found (rather serendipitously) that elephants communicate via infrasound---sound at frequencies so low (roughly less than 20 Hz) that most humans do not perceive it. Of course, elephants also trumpet and otherwise send signals that humans can hear.

Actually, scientists have known for some years that elephants can perceive infrasound, but they did not realize that they could also vocalize in that part of the acoustic spectrum.

If, however, infrasound is intense enough, some humans can detect it as a vibration, say, of air against the face. So, when a researchers at the Washington Park Zoo, felt a rumbling sensation proceeding from an elephant, she acquired a low-frequency-sound recorder, and discovered that infrasound was emanating from the elephant's forehead. Further tests revealed that the elephant was generating the infrasound with its larynx. The sound then resonated in a hollow space in the forehead, making the forehead, in effect, a sounding board.

J. Downer, in his book Supersense, pointed out the ramifications of this revelation.

> This discovery explained observations that had puzzled elephant watchers. A herd of elephants is often widely scattered across open bush or woodland. Yet members of the group immediately come to the help of an individual in trouble and, if danger threatens, the whole herd may simultaneously move away, apparently silently. By communicating through infrasound calls, elephants can coordinate the movements of individuals several kilometers apart. (R20)

Infrasound generation and perception requires substantial physiological modifications, just as ultrasonic echoranging does in bats. See BMI and BMO in Mammals II for further discussion of this. Our purpose here is simply the recording of instances of unusual vocalizations. So far little has been discovered about the semantic content, if any, of elephant infrasonic calls.

Rhinos. Like elephants, these large African mammals also use infrasound for communication. (R31)

Okapis. During research on rhino infrasound communication at the San Diego Zoo, infrasound was discovered to be coming from an okapi. Further study proved that these relatives of the giraffe must also be added to the roster of mammals using infrasound for communication. As with elephants and rhinos, the infrasound channel should be very useful to okapis in their jungle environment. (R31) Long-wavelength acoustic energy travels long distances with little attenuation in the jungle environment. Indeed, given the advantages of infrasound, it will not be surprising if more terrestrial mammals are found using it.

Like the elephants, okapis (actually close relatives of giraffes) can communicate via infrasound.

Bearded seals. Arctic and Antarctic waters are filled with the sounds made by marine mammals. Among the Arctic seals, the bearded seal is one of the most vocal, and it has a sort of "song" that is worth recording here---as described by R.R. Reeves et al:

> The song is stereotyped and repetitive. It can last longer than a minute. As they sing, bearded seals dive slowly in a loose spiral, releasing bubbles and finally surfacing in the center of their activity. Native hunters in kayaks formerly stalked bearded seals partly by listening for them. The sound is audible in air at close range, but it can be heard fully and clearly by placing a paddle in the water and pressing an ear against the butt end. The function of the song is assumed to be related to courtship, possibly as advertisement or territorial marking. (R32)

Weddell seals. The repertoire of these Antarctic seals is complex and seemingly full of semantic content. From low frequencies (1-6 kHz) to as high at 70 kHz, they buzz, trill, and whistle. This sort of vocalization is not uncommon among sirenians and cetaceans. What is surprising with the Weddell seal is the power of the vocalizations. The sounds of diving Weddell seals can be heard easily by humans standing on ice several meters thick! Sometimes the sounds cause the ice to vibrate perceptibly. (R32)

With such power in their vocalizations, one wonders whether Weddell seals, like some cetaceans, can disorient, stun, or possibly kill their prey. As for the semantic content of Weddell-seal vocalizations, no one really knows.

Cetaceans in general. Virtually all of the cetaceans, both toothed and baleen species, vocalize. Humpback whales are well known for their strange, hour-long songs; the belugas or white whales deserve their name "sea canaries"; and dolphin whistles are familiar from the TV documentaries. The question at hand is not so much whether cetaceans can signal one another via sound, but whether their songs and squeaks are highly semantic in character, and whether they actually employ language as humans define it.

Two generalizations must be set down here: (1) Only the toothed whales seem to echolocate, so the "songs" of the humpback, a baleen whale, must have some other purpose; and (2) Sound in the ocean can travel great distances, making this medium ideal for vocalizing animals. The so-called SOFAR channel at about 1,500 meters depth can carry sound signals for thousands of miles with little attenuation. At these depths, any sound emitted by a cetacean is trapped in a two-dimensional, horizontal duct and is not subject to the usual inverse square law. (R11, R20)

Humpback whales. The intricate, hour-long "songs" of this mammal and the way in which these eerie emissions are used have convinced many marine biologists that humpbacks truly do communicate with one another. J. Downer has summarized the main features of the songs:

> The humpback's singing occurs mainly during the winter breeding season when hundreds of whales congregate. The songs contain up to eight themes, each one consisting of repeated phrases. A singing session may continue for 22 hours, incorporating many songs lasting from 8 to 20 minutes each. Again, the songs vary from group to group, but they also evolve over time. At the beginning of the season, portions of last year's song can still be heard. As the season progresses, additions, deletions and modifications create more complex compositions, each member of the group singing a similar song. The humpback's singing can be heard from 32 kilometers away and so probably helps to bring breeding individuals together. What other significance these songs have remains a mystery. (R2)

Mature male humpbacks seem to do most of the singing, and they seem to sing only when alone. When joined by a second humpack, the singing stops. All this *seems* to indicate that the humpback songs, despite their complexity and strange beauty may be nothing more than mating calls---something like many bird songs. But no one knows for certain; it is difficult to keep tabs on marine mammals and also hard to ascertain their sex when they are located. (R17, R18)

Another interesting feature of the humpback songs is the existence of different dialects around the Seven Seas. While the songs of the Hawaiian and Mexican breeding group are the same, they differ from those shared by the Cape Verde and West Indies breeding group. The Tonga population in the South Pacific sings in still another dialect. And so on in other regions. (R27)

The probability that the humpback songs carry information to other members of the species is high. If these strange songs are only mating calls, it would be disappointing---they are so lengthy, so complex, and so dynamic. But these characteristics do not make the songs anomalous. (Anyone who has heard a mockingbird sing all day *and* then all night, too, knows this!) The presence of language and high semantic content are the significant characteristics.

K.B. Payne, a well-known researcher of humpback songs, has wondered about the "deeper" aspects of humpback songs: How do the humpbacks remember 22-hour-long songs? What do the songs tell us about humpback thought processes and aesthetics?

> How do humpback whales remember the changes in their songs? One possibility is that whales, like human bards, sometimes use rhymes to help recall their lines in a long oral performance. Analysis of the songs shows that when they contain many themes, they also include rhymelike material, phrases with similar sounding endings that link dissimilar but adjacent themes. When songs contain few themes and presumably are not hard to remember, we do not hear this sort of material.
>
> What do the song changes, and the preference for novelty that they seem to reflect, mean in the life of humpback whales? What drives tomor-

> row's song to be just a little different from yesterday's, and all singers to keep up with the latest version? Can we speculate about this, and about whales' use of rhymes, without thinking of human beings and wondering about the ancient roots in nature and of even our aesthetic behavior? (R26)

Rhyming in humpback songs definitely implies, but does not prove, semantic structure consistent with language. Only humans are supposed to employ language. So, an anomaly may actually exist here, but so far it cannot be demonstrated to everyone's satisfaction.

Sperm whales. Much more research effort has been lavished on the humpback songs than on the even-more-mysterious "codas" emitted by sperm whales. Codas are sequences of clicks and pauses that have been likened to Morse Code. Each sperm-whale coda---and more than 20 have been identified---lasts several seconds. Some marine biologists feel that codas sound more like language than the much longer humpback songs. (R36) This suspicion is bolstered by a phenomenon called "duetting" in which two sperm whales emit codas alternately, as in human conversation. (See X3 for more on duetting and choruses.) In other words, codas seem to be more than simple territorial or "come hither" calls. Different dialects have also been noted in the codas of various sperm-whale populations. (R21)

Belugas or white whales. The vocalizations of the beluga, our "sea canary," are varied, to say the least. They are a mixture of echolocation clicks, whistles that seem to have some semantic content, and seemingly exuberant noise. That belugas do communicate via the sound channel can be seen in this quotation from M. Bright's The Living World:

> ...observers through the years have variously described white whale sounds as the mooing of cows, the gritting of teeth, human screams, rusty hinges, the ringing of bells, and the crying of babies. Most of the sounds are thought to be used for communication. Whalers have noticed that when one whale is harpooned all other white whales in the area, even including those in the next bay, disappear from the surface. The sounds must travel considerable distances and be picked up by whales miles away from the caller. (R19)

The harpooning mentioned above may only have elicited an alarm signal with no more semantic content that a prairie dog's yelp. Obviously, much more research needs to be done with belugas before anomalous signalling can be claimed.

Other whales. Anecdotes about and scientific descriptions of the vocalizations of other whale species---blues, fin whales, minkes, seis, etc.--- can be found in several of our references. (R15, R16, R20, R21, R27) These other whales, however, do not provoke as many questions about semantics and language as do the humpbacks and sperm whales.

We turn next to the dolphins, including the so-called killer "whales."

Dolphins in general. Writers on dolphin communication often do not state which of the many species of dolphins are involved. It is usually safe to assume that either common or bottle-nosed dolphins are the experimental subjects. We lump them all together here, except for the orcas, which are mentioned at the end.

None of the dolphins sing like the humpback whale, nor do any generate the enigmatic codas of the sperm whales. As a biological grouping, however, dolphins do emit a wonderful variety of sounds ranging from the high-frequency pulses used in echolocation to the familiar squeaks, whistles, pops, and barks. Dolphins are so friendly to humans and, like us, boast large brains that it is easy to assume that their elaborate vocal repertoire allows them to transmit complex messages among themselves. Perhaps they even have language of sorts? (R23)

Indeed, over 2,000 different whistles have been distinguished by dolphin researchers; but do these sounds represent 2,000+ different words? J. Cousteau has commented negatively on this question:

> Unfortunately, these signals are not always the same. Indeed, some of them seem to mean nothing at all, and those which have a precise meaning are quite few. Certain series re-

> cur insistently, but we are unable to affirm that identical signals correspond to identical situations. Animals living in captivity in aquarium tanks have a much smaller vocabulary than was originally believed. And, as for the "cries and grindings" that dolphins have been taught to make in the air, it is likely that they have no meaning at all for the dolphins. (R12)

Cousteau's stance on this matter can be understood from the analysis of a test that he and his crew made on one of the Calypso's famous expeditions. They captured a female dolphin, placed her in a floating tank, and then moved off, leaving the dolphin alone. The penned animal sent out persistent calls and soon her school returned, making additional dolphin sounds. But they could do nothing for the captive dolphin and eventually swam away. Manifestly, the penned dolphin did send out signals that were duly heeded, but was language involved? R.G. Busnel, a French scientist conversant with Cousteau's experiment, thinks not:

> The dolphin's sounds were merely relational acoustical signals. They were indeed signals, but they were composed of elements which cannot be broken down; and those elements cannot be assembled according to the rules proper to language, that is, into combinations.
>
> It is not impossible that, someday, dolphins may arrive at a true language. For the present, however, we have no proof either that dolphins speak in language, or that they are capable of doing so. (R12)

It is admitted by all that dolphins do emit unique "signature" whistles which serve to distinguish one dolphin from another, even when visual contact cannot be made. Dolphins are also good mimics and can repeat arbitrary computer-generated whistles. They can even apply these artificial signals in behavior experiments. Nowhere, though, is there any evidence of grammatical structure in dolphin vocalizations. (R23)

Of course, one is tempted to add that perhaps dolphins do not need language as humans have defined it!

All this is understandably discouraging to dolphin lovers, who admire the intelligence and sociability of these creatures. Even so, K.S. Norris, who has spent his whole life with dolphins, has been forced to conclude:

> Nothing I've yet been able to perceive in dolphin society suggests that they exceed the metaphor of other higher social mammals, but we shall keep looking, because nature says the votes aren't all in. As in many other higher mammals, isolated signals may be symbolic: a given sound indicating a given circumstance. That's about halfway to being a word. (R29)

Countering these negative indications, E. Morgan has quoted a paragraph from R.M. Martin's book Mammals of the Sea, which describes a dolphin experiment in which considerable detailed information seems to have been transmitted between physically isolated captured dolphins:

> The dolphin's incredible powers of communication---indispensible in the wild---have been demonstrated in a variety of often spectacular ways. Two dolphins---'A' and 'B'---completely isolated in separate pools, were able to communicate with each other and even relay information. Dolphin 'A' was able to tell dolphin 'B' the correct lever to manipulate in order to obtain a reward of fish after the information had been given by the experimenter only to dolphin 'A.' Many tasks and variations on this theme were accomplished by the dolphins with so much assurance that is was obvious they did indeed have a language of sorts. (R14)

The above result is certainly at odds with the opinions of other students of dolphins.

Killer whales or orcas. Orcas, which are really large dolphins, are now big attractions in marine parks. They have been studied intensively. In the wild, J. Ford and associates have followed the fortunes of some 350 orcas that make their living along the coasts of British Columbia and Washington State. This population is quite stable and is divided into north and south "communities", or pods, each with its own dialect. (R22, R35)

> Ford has been able to categorize the calls---the dialect---of each pod. He has found that, typically, a pod makes 12 discrete calls. All members of the pod can, and do, produce the full set of sounds. Ford says the system of calls is different, both quantitatively and qualitatively, from other whales and dolphins. (R22)

But Ford admits that orca vocalizations possess no grammatical structure. However, as successful mammals, they evidently transmit all the information between themselves that they need to. Perhaps a sophisticated language is not really needed to catch fish in the biologically rich waters that Ford's orcas inhabit. Perhaps mammals "evolve" languages only when it is important to their survival.

Two distinct communities of orcas speaking different dialects patrol the Northwest Coast of North America.

X2. Mammal conferences. So-called "conferences" are not common among the mammals, but we have found two species that do seem to get together to discuss things among themselves before taking action. Such discussions are usually vocal but may be accompanied by body language and other types of signals. Anthropomorphism enters here: humans call these meetings "conferences", but we do not really know what is going on. Researchers see the gatherings of animals and hear vocalizations; everything else is surmise.

Gorillas. Although most primatologists are convinced that the great apes do not employ language, gorillas at times do seem to converse with one another, as described by J. Diamond:

> It's suggestive that wild gorilla troops may be seen sitting together for a long time, grunting back and forth in seemingly undifferentiated gibberish, until suddenly all the gorillas get up and the same time and head off in the same direction. One wonders whether there really was a transaction concealed within that gibberish. (R28)

Dolphins. Generally speaking, dolphins are highly social mammals. They do things together. Such joint activity requires either a leader to follow and/or mutual decision making. Captured dolphins are sometimes seen to gather in their tank, beaks touching, vocalizing, and seemingly planning some mutual activity. (R23)

Wild dolphins do this, too. In their popular collection of "astonishing facts" about animals, W.D. Thomas and D. Kaufman wrote:

> It has often been observed throughout the seas that before dolphins initiate any group action they have a conference. A group of dolphins, called a pod, will float together just below the surface of the water, facing each other. They politely take turns vocalizing until a consensus in finally reached. (R25)

X3. Duets and choruses. Duetting and chorusing are well know in the avian world (BBT), but mammals other than humans do not seem awfully proficient at group singing. Coyotes, wolves, wild dogs, even domestic dogs will chorus together at night. A group of coyotes can create an eerie symphony amid the echoing cliffs of a western canyon. The choruses of members of the dog family are very likely only expressions of solidarity and territory ownership. Language does not seem to be employed at all. The phenomenon becomes more interesting to the anomalist when the music becomes more organized, with one animal responding to another, or accompanying another as in human duets. Some pairs and even larger groups of birds are astonishingly good at group singing. (BBT) But, can mammals match such avian performances?

We now look at some of our collected instances of mammalian duetting and chorusing. There are undoubtedly more examples waiting in the unexamined literature to be added to the list.

Mice. IN 1878, H. Lee was invited to the home of a medical friend to hear two musical mice sing a duet. Said mice were in the habit of performing in this way every night at 8 PM sharp in exchange for cheese, bits of bisquit, and other "muscine delicacies." Sure enough, at the appointed time, one of the pair, named "The Chirper," appeared before the human audience and produced some second-rate chirping. Soon, though, the real artist, called "Nicodemus" made an appearance and began to sing.

> The song to which the little creature gave utterance again and again in our full view was as sweet and varied as the warbling of any bird. It most resembled that of the canary, but the melody of the nightingale was occasionally introduced. Every note was clear and distinct, but withal so soft, so gentle, tender and pianissimo, that I can only compare it to the voice of a bird muffled by being heard through a down pillow. (R7)

Shortly, Nicodemus climbed a curtain and entered the nearby canary cage. The bird knew the mouse well and was quite content to let Nicodemus sing away from this vantage point and even partake of its bird seed.

> During his supper-time "Nicodemus" obliged us from the cage with several repetitions of his song, "The Chirper," down below on the carpet, occasionally coming in with a monotonous contralto accompaniment, and sometimes emitting a sound like the squeaking of a corkscrew through a cork. The two little songsters having done their best to please us, were rewarded with all that mice could wish for as components of a feast. and, after selecting the portions they severally preferred, gracefully retired. (R7)

Charming though the foregoing tale may be, it is crude duetting when compared to what humans and some birds can do. Still, that mice can sing at all is fascinating.

Dusky titi monkeys. These small primates are mostly found in Brazil. They seem to be better duetters than the house mice.

> These highly arboreal monkeys usually inhabit small home ranges. They have a rather rich vocal repertoire. A bonded male and female will produce a duet calling sequence, which has several elements including bellows and pants. Countercalling between adjacent social groups is involved in territorial defense. (R33)

Why do the bonded pair sing their duets? Many other species get along very well without duetting. Of course, this stimulates the question: Why do humans have such remarkable singing talents?

Indris. Indris are strikingly marked lemurs living on Madagascar. They sing in groups---loudly. The following is quoted from Walker's Mammals of the World:

> The most characteristic vocalization of the indri is a melodious song that can be heard by humans up to 2 km away. Often there are loud singing sessions by several members of a group, with each song lasting 40-240 seconds and consisting of a series of cries or howls. These calls probably function to unite groups, express territoriality, and convey information relative to age, sex, and reproductive availability of individuals. (R27)

Bowhead whales. S. Leatherwood et al state that, in the summer, these baleen whales engage in songlike choruses. (R16)

Sperm whales. In X1, the duetting of sperm-whale codas was mentioned. (R21)

Common dolphins. Dolphins also engage

in choruses, as D. and M. Caldwell discovered when they first acquired a group of common dolphins for communication research. K.S. Norris tells what happened:

> These dolphins traded whistles back and forth. Then the Caldwells noted that what was happening was more than two animals trading whistles. If one dolphin whistled and the second dolphin responded with a whistle near or at the end of the first dolphin's whistle, a chorus would ensue. But if the second animal responded too soon or too late, both would fall silent. (R29)

Apparently. something systematic, perhaps ritualistic, was occurring in the pattern of whistles.

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R2. Farr, John; "Singing-Mouse," The Zoologist, 15:5591, 1857. (X1)

R3. Hiskey, W.O.; "Singing Mice," American Naturalist, 5:171, 1871. (X1)

R4. Lockwood, Samuel; "Musical Mice," Popular Science Monthly, 1:323, 1872. (X1)

R5. Anonymous; "A Singing Marmot," Popular Science Monthly, 1:509, 1872. (X1)

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R7. Lee, Henry; "Singing Mice," Popular Science Monthly, 14:102, 1878. (X3)

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R11. Anonymous; "Singing Whales," Nature, 224:217, 1969. (X1)

R12. Cousteau, Jacques-Yves; "Voices in the Sea," International Wildlife, 5:36, March/April 1975. (X1)

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R14. Morgan, Elaine; The Aquatic Ape, New York, 1982. (X1)

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R16. Leatherwood, Stephen, and Reeves, Randall R.; Whales and Dolphins, San Francisco, 1983. (X3)

R17. Cowley, Geoffrey; "Rap Songs from the Deep," Newsweek, p. 63, March 20, 1989. Cr. J. Covey. (X1)

R18. Mortenson, Joseph; Whale Songs and Wasp Maps, New York, 1987. (X1)

R19. Bright, Michael; The Living World, New York, 1987. (X1)

R20. Downer, John; Supersense: Perception in the Animal World, New York, 1988. (X1)

R21. Wursig, Bernd; "Cetaceans," Science, 244:1550, 1989. (X1, X3)

R22. Dayton, Leigh; "Killer Whales Communicate in Distinct Dialects," New Scientist, p. 35, March 10, 1990. (X1)

R23. Wintsch, Susan; "You'd Think You Were Thinking," Mosaic, 21:34, Fall 1990. (X1, X2)

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R25. Thomas, Warren D., and Kaufman, Daniel; Dolphin Conferences, Elephant Midwives, and Other Astonishing Facts about Animals, Los Angeles, 1990. (X1, X2)

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R27. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1, X3)

R28. Diamond, Jared; The Third Chimpanzee, New York, 1991. (X1, X2)

R29. Norris, Kenneth S.; Dolphin Days, New York, 1991. (X1, X3)

R30. Henson, Robert; "Ugly Human at Two O'Clock," Discover, 13:18, June 1992. (X1)

R31. Bell, Laura; "Infrasound of Silence," Dallas Morning News, December 21, 1992. Cr. L. Anderson. (X1)

R32. Reeves, Randall R., et al; Seals and Sirenians, San Francisco, 1992. (X1)

R33. Redford, Kent H., and Eisenberg, John F.; Mammals of the Neotropics, vol. 2, Chicago, 1992. (X3)

R34. Griffin, Donald R.; Animal Minds, Chicago, 1992. (X1)

R35. Martin, Glen; "Killer Culture," Discover, 14:110, December 1993. (X1)
R36. Holden, Constance; "Do Whales Speak in Many Tongues?" Science, 263:753, 1994. (X1)
R37. Lewin, Roger; "I Buzz Therefore I Think," New Scientist, p. 29, January 15, 1994. (X1)

BMT9 Seismic Communication

Description. Intraspecies communication through vibrations in the ground or substrate

Data Evaluation. The usual mammal guides scarcely mention the phenomenon at hand. There do not seem to be any comprehensive studies of mammalian seismic communication. Rating: 3.

Anomaly Evaluation. Seismic communication is interesting and somewhat curious, but it cannot be considered anomalous. No biological laws are challenged and it does not strain one's credulity. Rating: 4.

Possible Explanations. None required.

Similar and Related Phenomena. Vocalization in mammals (BMT8); seismic communication among reptiles and amphibians (BRT) and arthropods (BAT).

Entries

X0. Introduction. All animals employ multiple communication channels, and mammals are no exception. Vocal communication is very common (BMT8). Communication via odors, as in scent marking and the emission of pheromones, is likewise widespread. Some of the unusual forms of behavior cataloged in the preceding chapter (stotting and tongue flashing, BMB32-X1 and BMB36-X7, respectively) also qualify as communication by "body language." To this category we can add: tail flashing (deer); rump flashing (pronghorns); pawing the ground (cattle); ear flattening (cats); and so on.

The only non-vocal signals remarkable enough to catalog here are those based on ground or substrate vibrations, which we term "seismic communication.' This form of signaling is well known among reptiles, amphibians, and the arthropods. It is rarer in mammals, although, as with infrasound, humans may just not be aware of all the signals being transmitted through the ground!

X1. General observations. Our list of mammalian seismic signalers is short and must be considered incomplete.

Pademelons. Pademelons are small wallabies.

> They have a habit, comparable to that of rabbits, of thumping on the ground with their hind feet, presumably as a signal or warning device. (R2)

Pademelons are marsupials, but they also have other parallelisms to placental rabbits, such as choice of food and the making of runways through the grass.

Rabbits. As alluded to above.

Mediterranean blind mole-rats. The three known species are clustered around the western Mediterranean from the Balkans to Libya.

> During the mating season the opposite sexes evidently locate one another through a unique production of seismic signals by drumming the flattened, bony, anterodorsal surface of the head against the burrow ceiling. (R2)

Agoutis. From Mexico south to Argentina, this common rodent uses seismic signals in an unusual manner.

> On encountering boas they sit at a distance and drum with a hind foot, attracting other family members, who join them in foot drumming until the snake moves off. (R1)

The habits of agoutis also resemble those of rabbits.

References

R1. Eisenberg, John F.; Mammals of the Neotropics, vol. 1, Chicago, 1989. (X1)

R2. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

BMT10 Mammals That Imitate Human Words

Description. The ability of a few mammals to utter sounds resembling specific human words. The "vocabularies" of such mammals are severely limited, and their pronunciations leave much to be desired.

Data Evaluation. "Talking" animals are mentioned mainly in popular publications, but we have found a few, weakly supportive references in the scientific literature. Obviously, this is not a robust phenomenon. Rating: 3.

Anomaly Evaluation. Mammals, especially domestic and laboratory mammals, can be trained to perform a wide range of "tricks," including vocalizations. There is nothing anomalous in this, so we relegate this phenomenon to the "curious" category. Rating: 4.

Possible Explanations. None required.

Similar and Related Phenomena. Singing mammals (BMT8); talking birds (BBT).

Entries

X0. Introduction. Parrots, mynas, and several other species of birds utter human words and, in some cases, even use them correctly. Even though mammals are usually considered more advanced on the evolutionary scale than the birds, they do not have the vocal equipment necessary to frame human words effectively. In contrast, birds possess remarkable equipment for vocalizing and can even sing two songs at the same time! Mammals may have the desire and intelligence to employ words, but they cannot utter them---at least not very many of them. Mammals certainly understand words and other human-generated signals and can act in response, as with "here" and "sit," to use elementary examples. Nevertheless, two-way vocal communication using human words is nigh impossible. Those mammals that do make sounds resembling words are very few, as are the words they can "speak."

X1. General observations.

Chimpanzees. Biologists maintain that chimpanzees are very closely related to humans. Among the mammals, therefore, one would expect chimpanzees to be the most loquacious. In this, chimps are disappointing.

> One early experiment to investigate the chimp's powers of verbal communication, set up by the American psycologists K.J. and Caroline Hayes, met with limited success. They tried to teach their chimpanzee Vicky to talk, and after six years of hard work the animal had learned to utter only four words---'papa', 'mama', 'cup', and 'up'. (R3)

Chimps, however, do much better communicating with humans in sign languages. (BHX1 in Humans III) Chimpanzee anatomy is simply not amenable to the forming of human language sounds.

Dogs. As in our discussion of pets that overcome formidable obstacles to find their ways home (BMT2), we find the popular literature full of stories about "talking" dogs. In their Living Wonders, J. Michell and R.J.M. Rickard have culled several from the popular press:

- In Torrance, California, Pepe, a chihuahua, repeats, "I love you," in a high-pitched, sing-song voice.
- In Dallas, Texas, there is a doberman called Lancer who also says, "I love you." Unfortunately, Lancer's "speaks" as though he had a mouthful of cotton.
- In Royston, England, Ben, a fox terrier, simulates the human voice with, "I want one."

Somewhat surprisingly, the scientific literature is not mute in the matter of "talking" dogs. Quoting from a 1912 issue of Science:

> Extensive comment has been made in the German and even in the American daily press on the reported conversational ability of "Don," a German setter seven years old belonging to the royal gamewarden Ebers at Theerhutte in Gardelegen. Numerous observers report that he had a vocabulary consisting of eight words, which he could speak if food were held before him and the following questions propounded: "Was heisst du?" "Don." "Was hast du?" "Hunger." "Was willst du?" "Haben haben." "Was ist das?" "Kuchen." "Was bittest' du dir aus?" "Ruhe." Moreover, he was said to answer categorical questions by "Ja" and "Nein"; and in reply to another question, to speak

the name, "Haberland." (R1)

German scientists investigated Don and his reported vocalizations. They concluded that Don had no idea of what he was "saying." In fact, it was very difficult for them to make out some of the claimed words.

> Mr. Pfungst concludes that the speech of Don is therefore to be regarded properly as the production of vocal sounds which produce illusions in the hearer. He calls attention to the fact that not even the number of syllables in any given "word" of Don's is constant. (R1)

From this we can only assert that a few rare dogs can crudely imitate human words without understanding them. A dog's "I love you." has no more significance than the words pronounced by the whip-poor-will!

Harbor or common seals. One unexpected mammalian imitator of the human word is a seal. In Walker's Mammals of the World, it is stated that an adult male harbor seal has learned to mimic a number of human words and phrases! (R4)

References

R1. Johnson, Harry Miles; "The Talking Dog," Science, 35:749, 1912. (X1)
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R3. Morgan, Elaine; The Scars of Evolution, London, 1990. (X1)
R4. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

The harbor seal (common seal) is said to imitate a few words of human speech.

BMT11 Tool Use and Manufacture

Description. The ability of some mammals to use tools and, in some cases, even manufacture them.

Data Evaluation. The scientific literature brims with observations of mammals using tools in the wild as well as descriptions of controlled experiments involving tools and captive mammals. Our references provide only a representative fraction of the large number available. Rating: 1.

Anomaly Evaluation. There are two justifications for this Catalog entry: (1) The once-widely-held belief that humans are the only tool-using and tool-making mammals. Many observations have undercut this paradigm. Nevertheless, some current publications (mostly popular) display a lingering amazement that other mammals really do employ tools! (2) The still-surviving paradigm stating that the other mammals are merely instinct-driven automatons. The spontaneous, innovative use of tools by several mammals challenges this assertion. Rating: 2.

Possible Explanations. Many of the other mammals are intelligent, creative creatures.

Similar and Related Phenomena. Mammalian intelligence (BMB5, BMB6); mammalian art (BMB10); mammalian use of lures (BMB15); collective hunting (BMB29).

Entries

X0. Introduction. Tool use among mammals other than humans is rudimentary; that is, it is mostly limited to such crude operations as prying insects out with a straw or smashing shellfish with rocks. More sophisticated use of tools can be encouraged in captive animals, and their suite of tools enlarged through demonstration. Released captives will even communicate their newly found skills to wild members of their species. Even so, by human standards, tool use by the other mammals is not impressive. In fact, in the wild, mammals survive very well without complex tools, which encourages one to ask what imperative would encourage them (and perhaps even primitive hominids) to invent anything sophisticated.

X1. General observations.

Chimpanzees. In 1977. G.G. Gordon, Jr., et al published a paper inquiring into the faculties and talents that anthropologists supposed make humans unique among the mammals. Tool use was the first talent that these scientists showed to be far from uniquely human. A short quote from their paper summarizes not only a bit of anthropological history but also the tool-using capabilities of the common chimpanzee.

> Man's distinction as a tool user was short lived, as reports of tool use in a variety of creatures such as birds and sea otters began to accumulate. Under pressure to refine our ideas, the next step was to declare man the only animal to engage in tool fabrication. Then it became clear that a number of different species also engage in tool manufacture. Free-ranging chimpanzees, for example, fabricate and use a variety of tools. These include implements for extracting insects from their nests (termite fishing), and ingeniously contrived sponge-like drinking tools used to remove water from hollow tree trunks during the dry season. [B.B.] Beck distinguishes between at least four different categories of tool fabrication by chimpanzees: (1) detachment of potential tools from the substrate; e.g. breaking off a branch; (2) subtraction of elements from objects; e.g. stripping off leaves and twigs from a branch; (3) combination of objects; e.g. joining sticks together; and (4) reshaping objects for functional purposes.
>
> The claim has been made that premeditated tool fabrication is uniquely human. But as evidence that it can be a consequence of planned, deliberate action in other species, several investigators have seen chimpanzees prepare collections of tools in advance of an intensive session of termite fishing. Moreover, when a particularly good tool is struck upon its owner will often retain it for use on other termite mounds. (R1)

While termite fishing is very popular, chimps also frequently employ rocks and clubs to crack the nuts of wild fruit. Chimpanzee mothers have even been observed teaching their offspring how to do this. (R5, R8) More interesting, though, is the actual manufacture of tools by captive chimpanzees. One chimp, the now-famous Kanzi, was shown how rocks, when hit together, could create sharp-edged fragments. These manufactured "tools" could then be used to cut the cord securing the lid of a box containing favorite food. Kanzi was eventually able to make his own cutting tools, cut cords, and liberate food. (R10)

Orang-utans. Wild orang-utans, much as wild chimpanzees do, occasionally find simple tools useful and so employ them. (R3, R4) This fact was a bit surprising to some primatologists who apparently considered orang-utans "less advanced" than chimps.

Scientists were even more startled when R.V.S. Wright taught a captive orang-utan how to make tools in an experiment similar to that described above with Kanzi. Wright's orang-utan was named Abang, and his experiments actually preceeded those involving Kanzi.

> Abang was shown how to strike flakes from a siliceous core with a hammerstone and then to use the flakes to cut the cord and open the box. In this second stage, after five fruitless sessions, the orang struck four flakes in three episodes and each time immediately picked up the flake and used to it cut the cord. (R2)

Baboons. Baboons are not classed with the apes and, consequently, not accorded comparable intellectual stature. Yet, baboons, too, know how to use simple tools. Captive baboons spontaneously apply tools (rods, etc.) to obtain distant food. (R6)

Titi monkeys. As South American monkeys (Cebidae), titis are sometimes considered intellectually inferior to Old World monkeys. Such ranking seems inaccurate when tool use is considered.

> A captive specimen of *C. personatus* exhibited considerable ingenuity; it was fond of cockroaches, and if these hid in a crevice, it used pieces of straw to pry them out. This individual also deliberately moved his sleeping box, presumably to obtain cockroaches that accumulated beneath. (R7)

Titis may not be as "quick" as orangs, but they *can* compete with baboons.

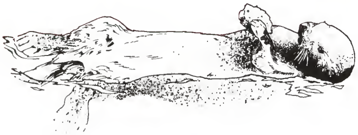
Capuchin monkeys. Like the titis, the capuchins are New World monkeys. They are well-known for their manipulative abilities. In the jungle, capuchins apply tools much as chimpanzees do in Africa. Captive capuchins, when given bone fragments, show surprising expertise, reminding one of how primitive hominids used bone tools. (R11, R12) G.C. Westergaard and S.J. Suomi summarized some of their relevant experiments with capuchins as follows:

> ...three of nine capuchin monkeys used bone fragments to crack hard-shelled nuts and to cut acetate. One of these monkeys used bone fragments as both "chisels" and "hammers" and used a stone to modify bone-fragment tools. To the best of our knowledge this is the first report of the use and modification of bone tools by nonhuman primates. The capuchins' behavior with bone tools was similar in form and function to hypothesized and reported stone tool-using and tool-making of early hominids and extant nonhuman primates. (R12)

Sea otters. Among the nonprimates, sea otters are most often cited as tool users. These engaging marine mammals capture sea urchins, slow-moving fish, crabs, and shellfish with their hands (not their mouths), often with the help of stone "tools." They ascend to the surface, roll over on their backs, and consume their catches. While floating on their backs, sea otters use their chests as dinner tables. They even have table "implements." (R7, R9)

> Stones are also carried to the surface and used as anvils resting on the otter's chest as it floats on its back and hammers shellfish or sea urchins against the hard surface. Riedman has observed much individual variability in the ways in which sea otters use stones or other objects such as shells as anvils against which to hammer recalcitrant shellfish. They sometimes keep a favorite stone tucked under the armpit for repeated use. (R9)

Sea otters also have a sort of pouch



Sea otters consume their catches while floating at the surface on their backs. Stones are often used to smash shellfish.

for carrying tools and food. (BMA49-X2)

Elephants. Elephants often seize sticks in their trunks and use them for scratching and even "drawing." (BMB10-X1) Less seldom, the trunk is employed for throwing objects. (R9)

Pocket gophers. These burrowing mammals sometimes hold stones in their paws to assist their digging. (R9)

Harvest mice. Captives will place objects, such as straws, aginst the side of their enclosure to facilitate escape. (R9)

Dwarf mongooses. To break eggs, this animal hurls them backwards between its hind legs at a hard surface. (R9)

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R2. Kitahara-Frisch, J.; "Apes and the Making of Stone Tools," Current Anthropology, 21:359, 1980. (X1)

R3. Galdikas, Birute M.F.; "Orang-utan Tool-use at Tanjung Puting Reserve, Central Indonesian Borneo (Kalimantan Tengah)," Journal of Human Evolution, 10:19, 1982. (X1)

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R5. Kortlandt, Adriaan; "The Use of Stone Tools by Wild-living Chimpanzees and Earliest Hominids," Journal of Human Evolution, 15:77, 1986. (X1)

R6. Westergaard, Gregory Charles; "Infant Baboons Spontaneously Use an Object to Obtain Distant Food," Perceptual and Motor Skills, 68:558, 1989. (X1)

R7. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1)

R8. Mason, Georgia; "Tool Training at the Chimp Academy," New Scientist, p. 20, May 11, 1991. (X1)

R9. Griffin, Donald R.; Animal Minds, Chicago, 1992. (X1)

R10. Rumbaugh, Sue Savage; "Ape at the Brink," Discover, 15:91, September 1994. (X1)

R11. Bunney, Sarah; "Captive Capuchins Are Talented Tool Makers," New Scientist, p. 15, March 5, 1994. (X1)

R12. Westergaard, Gregory Charles, and Suomi, Stephen J.; "The Use and Modification of Bone Tools by Capuchin Monkeys," Current Anthropology, 35:75, 1994. (X1)

R13. Sugiyama, Yukimaru; "Tool Use by Wild Chimpanzees," Nature, 367:327, 1994. (X1)

BMT12 Mammalian Engineering Works

Description. The construction by mammals (other than humans) of dams, canals, unusual shelters, and other engineering structures.

Data Evaluation. The engineering works of beavers are well-known to scientists and laymen alike. So, too, are the leaf tents constructed by some bats. Rodent-built dew collectors are on a less firm footing. There can be little doubt, however, that some mammals can and do build surprisingly sophisticated structures. Rating: 1.

Anomaly Evaluation. The conception, planning, construction, and maintenance of engineering structures directly challenge the behaviorists, who assert that all such works are only the consequence of instinctive actions. But, the more elaborate and ingenious the structures, the more behaviorism is at risk. Since scientists cannot get into the minds of other mammals, they cannot really know whether they are only automatons or not. Therefore, the assessment of the anomalousness of mammalian engineering has to be subjective. In cases where objective rating is impossible, as in evaluating the efficacy of random mutations and natural selection, a numerical rating is omitted.

Possible Explanations. The other mammals are not total automatons.

Similar and Related Phenomena. Other challenges to behaviorism (BMB2, BMB15, BMB16).

Entries

X0. Background. Many mammals build homes of a sort, whether they be burrows in the earth, grass nests, or simple shelters from the elements. A few go further and construct dams, bridges, and other "engineering" structures. Most of these works are too crude and elementary to excite the interest of the anomalist, but a few are big enough and sophisticated enough to warrant space here.

Of the six categories of engineering structures set out below, three are built by beavers: lodges, dams, and canals. Of course, beavers are generally recognized as second only to humans as mammalian engineers. But can even the impressive feats of beavers be considered anomalous? The answer has to be YES when one considers the stern dictum of the behaviorists. In discussing the constructions of the beavers, D.R. Griffin has repeated the uncompromising line advanced by the behaviorists.

> Many scientists disagree with Richard's conclusion that beaver know what they are doing, claiming that all their construction of burrows, lodges, canals, and dams result from genetically programmed action patterns that involve no conscious thinking or anticipation of the results of these activities. For example, after one of the most thorough studies of beaver behavior involving both free and captive animals, Wilsson concluded that even those actions that seem most intelligent can be explained as the result of genetically programmed motor patterns. (R11)

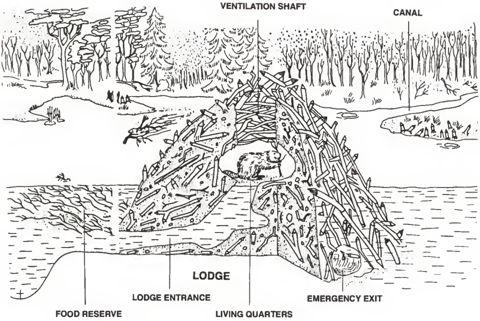
Griffin does not concur at all with these bleak, reductionist assessments of the behaviorists. In Griffin's view, no animals are automatons; all exhibit some intelligence and foresight. In our opinion, the data presented below tend to justify Griffin's position as far as mammals are concerned, but this is no more than opinion.

X1. Unusual houses and shelters.

Beavers. Beaver lodges are notable for their size and sophistication. Built of sticks and mud, the beaver lodge may rise 2 meters above the water surface and extend to a diameter of 12 meters. Walls are about a meter thick, thinning toward the top for purposes of ventilation. The "room" of the lodge is above the water surface and carpeted with leaves and vegetable materials. One or more underwater exits provide access to the pond without exposure to predators. (R5, R9) Beaver lodges are well-designed, but in terms of scope they pale in comparison to beaver dams and canals. (X2, X3)

Mountain beavers or sewellels. As long as beavers are under discussion, a few words about the so-called "mountain beavers" are in order. First, they are only distantly related to beavers (but they are also rodents), and they actually prefer the lower altitudes of the Pacific Northwest. Mountain beavers are much smaller than their namesakes---under a kilogram on the average---and the overall resemblance is slight. They do, however, build interesting "tents" of sticks over the entrances to their burrows for purposes of keeping out the rain that is so prevalent in their territory. (R2, R9)

Stick-nest rats. Australia boasts two species of these engineering rodents. Only about 20 centimeters long, the stick-nest rats build stick houses that may reach heights of 1.5 meters. Stones are placed on top to anchor these houses or "wurlies" against strong winds. Numerous tunnels thread through these large structures, which may be shared with bandicoots, penguins, and/



A typical beaver lodge with a canal or transportation channel shown in the upper right. (Adapted from R5) or snakes. (R9)

Pack rats. Most rodents of the American Southwest burrow into the earth to escape the desert heat. The pack rats of that region do not.

> Instead they build dens against trees or cacti or in caves and rock shelters; any portable material within 150 feet of the den can wind up in the construction. Pack rats will also fortify their dens with menacing pieces of spiny cholla cactus to fend off coyotes and other malefactors. The finished product can stand a redoubtable five feet tall and measure the same or more in diameter. (R12)

These large structures may represent the collective work of generations of pack rats. (Note: about 19 species of pack rats are found throughout North America. All build nests, but those of the Southwest are the most spectacular.) One also sees a parallelism between the structures of the Australian stick-nest rats and the American pack rats.

Mediterranean blind mole-rats. During the fall and winter, the females of these species construct so-called "breeding mounds."

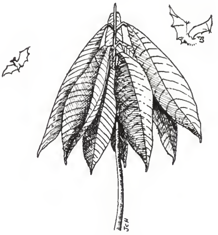
> These are elaborate structures, usually about 160 cm long, 135 cm wide, and 40 cm in height above the surface. They may even reach 250 cm in diameter and 100 cm in height. The mounds are solid domes of earth through which runs a labyrinth of permanent galleries with hard, smooth walls. The only loose, soft earth is the covering of the dome. In the center of each mound is a nest chamber about 20 cm wide and filled with dry grass, where the young are raised. Beneath this chamber and throughout the mound are rooms for storage and defecation. Each main breeding mound is surrounded by radial rows of smaller mounds, which are built and occupied by the males during the mating season. These smaller mounds are connected to the breeding mound by tunnels. (R9)

The breeding mound and its satellites resemble a miniature city!

The better-known naked mole-rats build far-reaching systems of tunnels. (BMB31)

Tent-building bats. Several species of tropical New World bats make clever shelters out of leaves. Some of the species involved in this engineering are: the tent-building bats, the neotropical fruit bats, and the white bat. (R7, R9) L.H. Emmons describes the basic technique:

> Bats of several genera in this subfamily [Stenodermatinae] make "tents" of large leaves, usually palms or palmettos, by biting the sides and ribs of a leaf in a characteristic pattern (forming a row of jagged holes, unlike the round holes drilled by insect larvae through rolled leaves), so that the sides of the leaf drop down to form a shelter. (R8)



Wigwam leaf shelter made by tent-making bats.

These bat tents are rather easy to spot in the jungle because of their tent-like form. The bats are careful not to kill the leaves outright by completely destroying their circulatory system. The tents thus remain useful for a few weeks. Note that aggressive hornets also appreciate bat-made tents and will sometimes usurp them. Bat tents are, therefore, to be approached with caution!

One of the tent-building bats, Uroderma bilobatum. has found a second, more elaborate way to make leaf shelters. C. Putnam elaborates:

> This species of bat was already known to make tent-like shelters out of single leaves. The wigwams, however, are more sophisticated structures built of several leaf tiers. [J.] Choe noticed that the bats gnaw part of the way through the tough central midrib of the leaves, so that the leaves bend downward under their weight. The leaves then overlap to form a conical teepee. (R13)

It is difficult to believe that the bats do not have some foresight and engineering sense to come up with this design.

X2. Dams.

Beavers. Beaver dams, while not particularly complex in concept, can be so large that they must be mentioned. The largest one we have seen mentioned in the literature had a length of 1,800 feet, a width of 18 feet, and a height of 9 feet. It is said that a horse and rider could have easily ridden across the stream along the top of the dam! (R4, R5)

X3. Canals.

Beavers. In addition to their lodges and dams, beavers often excavate impressive systems of canals, sometimes modifying the drainage of large tracts of land, especially in the northern tier of States and Canada. An old item found in the Eclectic Magazine remarked on these artificial waterways.

> A paper was recently read before the American Association for the Advancement of Science which stated that on the southern shore of Lake Superior in Marquette country, Wisconsin, were found remains of long canals and dams constructed by the beavers for the purpose of transporting their cuttings, consisting of trunks of trees two or three feet long, from the places where trees had fallen to their lodges. Some of these canals were 300, 400, and 500 feet long. They were generally three feet wide, with an average depth of three feet. In order to maintain a continuous depth of water, they made dams at certain distances, and followed the Chinese plan---to whom the lock was unknown---of drawing their cargo from one level to another. (R1)

X4. Mines.

Elephants. On the flank of Mount Eglon, in Kenya, at an altitude of 2,400 meters, is found a cave named Kitum. In the dark recesses of this cave, elephants find minerals that they crave, such as sodium sulfate. Access to such minerals is particularly important to the elepants browsing in the Mount Elgon region because the heavy rains leach important minerals from the soil. Elephants and other mammals, too, pick their ways through the cave's blackness to the sodium sulfide deposits. Using their tusks, the elephants gouge out lumps of the mineral, pulverize it with their molars, and swallow it.

Kitum cave may not be naturally formed. Some naturalists have suggested that the elephants themselves have dug it over the millennia in their never-ending search for minerals. (R6)

Interesting, but only surmise.

X5. Dew-catchers.

Mice (species not specified). In the Sahara, where water is so scarce, some mice pile up small heaps of rocks in front of their burrows. During the chilly nights, moisture collects on the stones. In the morning, the mice emerge and lick off the dew. (R10)

Australian native mice.

> This species P. chapmani builds low mounds of pebbles over its burrow systems, and P. hermannsburgensis may use these mounds after they are

constructed, The pebbles are of a uniform size and cover a large area, often a meter in diameter. The pebbles are probably collected both by excavation and from the surface. Some local mammalogists believe these are used as dew traps. (R9)

It is interesting that mice on opposite sides of the planet adopted the same strategy for collecting moisture from the atmosphere. Morphic resonance again? Or independent invention?

Ancient humans living around the Mediterranean used to construct much larger piles of rocks, which provided settlements with surprisingly copious quantities of water. (R10)

X6. Bridges.

Orang-utans. When confronted with a stream too wide to leap over, orangs have been observed to build crude bridges out of sticks. Orang-utans, like chimpanzees and gorillas, avoid getting wet if at all possible. (R3)

References

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R3. Galdikas, Birute M.F.; "Orang-utan Tool-use at Tanjung Puting Reserve, Central Indonesian Borneo (Kalimantan Tengah)," Journal of Human Evolution, 10:19, 1982. (X6)
R4. Tributsch, Helmut; How Life Learned to Live, Cambridge, 1982. (X2)
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R7. Timm, Robert, and Clauson, Barbara L.; "A Roof over their Feet," Natural History, 99:55, March 1990. (X1)
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R9. Nowak, Ronald M.; Walker's Mammals of the World, Baltimore, 1991. (X1, X5)
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R11. Griffin, Donald R.; Animal Minds, Chicago, 1992. (X0)
R12. Wright, Karen; "Revelations of Rat Scat," Discover, 14:64, September 1993. (X1)
R13. Putnam; "Designer Teepees for Panamanian Bats," New Scientist, p. 15, September 24, 1994. (X1)

FIRST-AUTHOR INDEX

SOURCE INDEX

SUBJECT INDEX

THE UNCLASSIFIED RESIDUUM

THE UNCLASSIFIED RESIDUUM WAS DEFINED BY WILLIAM JAMES, THE GREAT AMERICAN PHILOSOPHER, IN THESE WORDS:

> ***"ROUND ABOUT THE ACCREDITED AND ORDERLY FACTS OF EVERY SCIENCE THERE EVER FLOATS A SORT OF DUST-CLOUD OF EXCEPTIONAL OBSERVATIONS, OF OCCURRENCES MINUTE AND IRREGULAR AND SELDOM MET WITH, WHICH IT ALWAYS PROVES MORE EASY TO IGNORE THAN TO ATTEND TO .... ANYONE WILL RENOVATE HIS SCIENCE WHO WILL STEADILY LOOK AFTER THE IRREGULAR PHENOMENA. AND WHEN THE SCIENCE IS RENEWED, ITS NEW FORMULAS OFTEN HAVE MORE OF THE VOICE OF THE EXCEPTIONS IN THEM THAN OF WHAT WERE SUPPOSED TO BE THE RULES."***

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A Moi boy with a nine-inch tail

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- •Mirror-image twins
- •The sacral spot
- •The supposed human aura
- •Baldness among musicians
- •Human tails and horns
- •Human behavior and solar activity
- •Cycles of religiousness
- •Cyclicity of violent collective human behavior
- •Handedness and longevity
- •Wolf-children
- •The "Mars Effect"
- •Telescopic vision
- •Dermo-optical perception
- •Hearing under anesthesia
- •Human navigation sense
- •Asymmetry in locomotion
- •Sex-ratio variations

COMMENTS FROM REVIEWS

All I can say to Corliss is carry on cataloging.
NEW SCIENTIST

304 pages, hardcover, $19.95
52 illus., 3 indexes, 1992
548 references, LC 91-68541
ISBN 0-915554-26-7, 7x10

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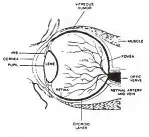
The second Catalog volume on human biological anomalies focuses upon the "internal" machinery of the body: (1) Its major organs; (2) Its support structure (the skeleton); and (3) Its vital subsystems (the central nervous system and the immune system).

TYPICAL SUBJECTS COVERED
- •Enigma of the fetal graft
- •Phantom limbs
- •Blood chimeras
- •Anomalous human combustion
- •Bone shedders
- •Skin shedders
- •"Perfection" of the eye
- •Dearth of memory traces
- •Sudden increase of hominid brain size
- •Health and the weather
- •Periodicity of epidemics
- •Extreme longevity
- •AIDS anomalies
- •Cancer anomalies
- •Human limb regeneration
- •Nostril cycling
- •Voluntary suspended animation
- •Male menstruation



Is the complexity of the human eye anomalous?

297 pages, hardcover, $19.95
40 illus., 3 indexes, 1993
494 references, LC 91-68541
ISBN 0-915554-27-5, 7x10

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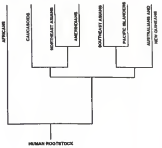
Completing our trilogy on human anomalies, this volume focuses on four areas: (1) the human fossil record; (2) biochemistry and genetics; (3) possible unrecognized living hominids; and (4) human interactions with other species and "entities."



DNA analysis divides modern humans into these seven major groups.

TYPICAL SUBJECTS COVERED
- •Neanderthal demise
- •Giant skeletons
- •Tiny skeletons
- •Hominid gracilization
- •Sudden brain expansion
- •Human chimeras
- •Sasquatch/Bigfoot, Alma, Yeti, and others
- •Human-animal communication
- •Humanity and Gaia
- •Anomalous distribution of human lice

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Nothing catches the human eye and imagination as quickly as a mysterious light. All down recorded history, scientists and laymen alike have been seeing strange lightning, sky flashes, and unaccountable luminous objects.

TYPICAL SUBJECTS COVERED

- Horizon-to-horizon sky flashes
- Episodes of luminous mists
- Mountain-top glows (Andes glow)
- Earthquake lights
- Ball lightning with tails
- Rocket lighting
- Lightning from a clear sky
- Ghost lights; ignis fatuus
- Darting streaks of light (sleeks)
- The milky sea and light wheels
- Radar-stimulated phosphorescence of the sea
- Double ball lightning
- Luminous phenomena in tornados
- Black auroras

Luminous display over Mt. Noroshi during earthquake swarm.

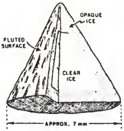
COMMENTS FROM REVIEWS

... the book is well-written and in places quite fascinating. SCIENCE BOOKS

248 pages, hardcover, $14.95
74 illustrations, 5 indexes, 1982
1070 references, LC 82-99902
ISBN 915554-09-7, 7 x 10 format

TORNADOS, DARK DAYS, ANOMALOUS PRECIPITATION; A Catalog of Geophysical Anomalies

Here is our "weather" Catalog. As everyone knows, our atmosphere is full of tricks, chunks of ice fall from the sky, tornado funnels glow at night. The TV weathermen rarely mention these "idiosyncracies".



Conical hailstones with fluted sides.

TYPICAL SUBJECTS COVERED

- Polar-aligned cloud rows
- Ice fogs (the Pogonip)
- Conical hail
- Gelatinous meteors
- Point rainfall
- Unusual incendiary phenomena
- Solar activity and thunderstorms
- Tornados and their association with electricity
- Multiwalled waterspouts
- Explosive onset of whirlwinds
- Dry fogs and dust fogs
- Effect of the moon on rainfall
- Ozone in hurricanes
- Ice falls (hydrometeors)

COMMENTS FROM REVIEWS

... can be recommended to everyone who realizes that not everything in science has been properly explained. WEATHER

202 pages, hardcover, $14.95
40 illustrations, 5 indexes, 1983
745 references, LC 82-63156
ISBN 915554-10-0, 7 x 10 format

EARTHQUAKES, TIDES, UNIDENTIFIED SOUNDS; A Catalog of Geophysical Anomalies

Quakes and monster, solitary waves and natural detonations; these are the consequences of solids, liquids, and gases in motion. In our modern technological cocoon, we are hardly aware of this rich spectrum of natural phenomena.

Sand craters created by earthquakes.

TYPICAL SUBJECTS COVERED

- Periodic wells and blowing caves
- Sun-dominated tides
- Immense, solitary waves
- Animal activity prior to earthquakes
- Earthquake geographic anomalies
- Earthquake electricity
- The sound of the aurora
- Musical sounds in nature
- Mysterious detonations
- Anomalous echos
- Slicks and calms on water surfaces
- Periodicities of earthquakes
- The vibrations of waterfalls
- Unusual barometric disturbances

COMMENTS FROM REVIEWS

... surprisingly interesting reading. NATURE

220 pages, paper, $14.95p
32 illustrations, 5 indexes, 1983
790 references, LC 83-50781
ISBN 915554-11-9, 7 x 10 format

RARE HALOS, MIRAGES, ANOMALOUS RAINBOWS; A Catalog of Geophysical Anomalies

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- Rainbows with offset white arcs
- Sandbows
- Offset and skewed halos
- The Brocken Specter
- The Alpine Glow
- Unexplained features of the green flash at sunset
- Fata Morgana
- Telescopic mirages
- Long-delayed radio echos
- Eclipse shadow bands
- Geomagnetic effects of meteors
- Intersecting rainbows
- The Krakatoa sunsets
- Kaleidoscopic suns

Shadow of Adam's Peak with glory and radial rays.

COMMENTS FROM REVIEWS

...all in all it's a fascinating book. SKY AND TELESCOPE

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569 references, LC 84-50491
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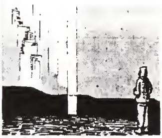

A low-level aurora descends below mountain peaks.

TYPICAL SUBJECTS COVERED

- Nocturnal lights and will o' the wisps
- Oceanic light wheels
- Non lunar tides
- Falls of ice, fish, grains, etc.
- Strange hums and hisses
- Unexplained mirages
- Low-level auroras
- Ball lightning
- Cloudless rain and snow
- The Barisal Guns and other "water guns"
- Freak whirlwinds
- Dark days, yellow days, etc.
- Anomalous solar and lunar halos

COMMENTS FROM REVIEWS

...fascinating reading may be found at almost any point in the book. BOOKLIST

...full of fascinating morsels. NATURE

431 pages, hardcover, $9.95
133 illustrations, index, 1983
References, LC 78-22625
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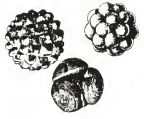
- Zimbabwe and Dhlo-dhlo
- Huge spheres in Costa Rica
- The Great Wall of Peru
- Ancient batteries and lenses
- Mysterious walls everywhere
- Pacific megalithic sites
- European stone circles and forts



Scottish carved stones from circa 1000 B. C.

COMMENTS FROM REVIEWS

...a useful reference in undergraduate, public, and high school libraries. BOOKLIST

792 pages, hardcover, $21.95
240 illustrations, index, 1978
References, LC 77-99243
ISBN 915554-03-8, 6 x 9 format

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- Immense craters
- Raised beaches
- Guyots (flat-topped seamounts)
- Island arcs
- Doubts about plate tectonics (continental drift)
- Mima mounds
- Drumlin anomalies
- Patterned ground
- Esker problems
- Lake walls and ramparts
- Crevicular structure
- Submarine canyons

Pyramid of frozen foam on the Bozenkill, New York State

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PURSUIT

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Journey here into ice caves, exhume Siberian mammoths, see animals perish in gas-filled valleys---a little media hype is justified here. But more serious questions involve the origins of oil, coal, and natural gas.

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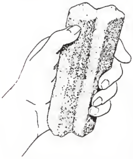
- Musical sands, ringing rocks
- Anomalies of oil's origin
- Ice caves, frozen wells
- Natural fission reactors
- Marine organisms and fossils found far inland
- Siberia's frozen mammoths
- Radiometric dating problems
- Anchor ice, frazil ice
- Violent lake turnovers
- Flexible rocks
- Origin of ocean water
- Skipping in fossil record
- Valleys of death

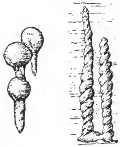


Prismatic sandstone from Missouri

335 pages, hardcover, $18.95
55 illustrations, 5 indexes, 1989
1260 references, LC 89-90680
ISBN 915554-23-2, 7 x 10 format

NEGLECTED GEOLOGICAL ANOMALIES; A Catalog of Geological Anomalies

Neglected but far from insignificant are the anomalies cataloged here. Do we really know how concretions and geodes form, where tektites come from, whence the immense deposits of superficial debris all over our globe?



Mace-shaped and sand-spike concretions from the Colorado delta.

TYPICAL SUBJECTS COVERED

- Concretions and geodes
- Tektites and microtektites
- Erratic boulders and gravels
- Polystrate fossils
- Bone caves and bone beds
- Giant basalt flows
- Natural glasses
- Surging glaciers
- Driftless regions
- Stretched pebbles
- Crystal inclusions
- Rarity of fossil meteorites and tektites
- Elevated erratics
- Stone rivers and rock glaciers

333 pages, hardcover, $18.95
80 illustrations, 5 indexes, 1990
1030 references, LC 90-60568
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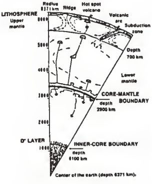
- Mysterious seismic reflectors
- Seismic velocity discontinuities
- Deep-focus earthquakes
- Incompleteness of the stratgraphic record
- Cyclothems and rhythmites
- Exotic terranes
- Compass anomalies
- Earth-current anomalies
- Problems of paleomagnetism
- Polarity reversals



Model of the earth's interior

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Crow "anting" with a lighted match

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- The problem of excess DNA
- Sea and lake serpents
- Unexplained senses of ants
- Water-breathing in mammals
- Life and thermodynamics
- Is evolution a tautology?
- Unusual behavior of animals
- Cryptobiosis or latent life

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...the collection is endlessly fascinating. NATURE
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References, LC 80-53971
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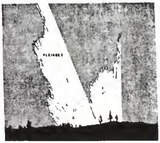

Unexplained rift in the zodiacal light.

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- Transient lunar phenomena
- Ephemeral earth satellites
- Venus' radial spoke system
- Relativity contradicted
- Cosmological paradoxes
- Changes in light's velocity
- Vulcan; the intramercurial planet
- Knots on Saturn's rings
- Bright objects near the sun
- The sun's problematical "companion star"
- "Sedimentary" meteorites
- Life chemistry in outer space
- Planet positions and sunspots

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103 illustrations, index, 1979
References, LC 78-65616
ISBN 915554-05-4, 6 x 9 format

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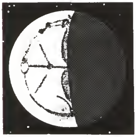

One drawing of the Venusian radial spoke system.

TYPICAL SUBJECTS COVERED

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- The Martian 'pyramids'
- Kinks in Saturn's rings
- Continuing debate about the Voyager life-detection experiments
- Neptune's mysterious ring
- Evidence of water on Mars
- The strange grooves on Phobos
- The two faces of Mars
- Lunar clouds, mists, "weather"
- Ring of light around the new moon
- Dark transits of Jovian satellites
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- Venus-earth resonance

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The author is to be commended for his brilliantly conceived and researched volume. SCIENCE BOOKS

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988 references, LC 85-61380
ISBN 915554-19-4, 7 x 10 format

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- The 'missing' solar neutrinos
- Pendulum phenomena during solar eclipses
- Observations of Planet X
- Meteorite geographical anomalies
- Meteorites from the moon
- Long fireball processions
- Very long duration meteorites
- Zodiacal light brightness changes

One of the many possible modes of solar surface oscillation.

COMMENTS FROM REVIEWS

It is an unusual book, nicely executed, and I recommend it highly...ICARUS

288 pages, hardcover, $17.95
66 illustrations, 4 indexes, 1986
874 references, LC 86-60231
ISBN 915554-20-8, 7 x 10 format

STARS, GALAXIES, COSMOS; A Catalog of Astronomical Anomalies

Did the Big Bang really begin the existence of all we know? Do we honestly know how the stars (and our sun) work? Can we rely on Newton's Law of Gravitation? According to this volume the answer seems to be: "Probably not!"

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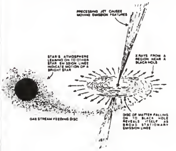
- Historical color change of Sirius
- Infrared cirrus clouds
- Quasar-galaxy associations
- The red-shift controversy
- Quantization of red shifts
- The quasar energy paradox
- Apparent faster-than-light velocities in quasars and galaxies
- Evidence for universal rotation
- Swiss cheese structure of universe
- Is the "missing mass" really missing?
- Superluminous infrared galaxies
- Shells around elliptical galaxies



Model of the mysterious star SS 433.

COMMENTS FROM REVIEWS

...it never fails to be interesting, challenging and stimulating. NEW SCIENTIST

246 pages, hardcover, $17.95
50 illustrations, 4 indexes, 1987
817 references, LC 87-60007
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SOURCEBOOKS

The first publications of the Sourcebook Project appeared in the 1970s. These were loose-leaf notebooks called "Sourcebooks." In these notebooks were reproduced articles and excerpts of articles dealing with anomalous phenomena. Although the Sourcebooks were superceded by the Handbooks and Catalogs, the continuing demand for them has encouraged us to keep most of them in print, as detailed below.

STRANGE UNIVERSE: vol. A2
W.R. Corliss, 286 pp., 1977, $16.95
Astronomical anomalies. Xeroxed text, original printed binder.

STRANGE PLANET
W.R. Corliss, Geological anomalies
vol. E1, 289 pp., 1975, $9.95
Printed text, printed binder
vol. E2, 275 pp., 1978, $16.95
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STRANGE PHENOMENA
W.R. Corliss, Geophysical anomalies.
vol. G1, 277 pp., 1974, $16.95
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STRANGE ARTIFACTS
W.R. Corliss, Archeological anomalies
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STRANGE MINDS: vol. P1
W.R. Corliss, 291 pp., 1976, $9.95
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PHOTOCOPIED CLASSICS

LEGENDARY ISLANDS OF THE ATLANTIC
W.H. Babcock, 196 pp., 1922, $12.95p

The title of this book immediately conjures up thoughts of Atlantis; but many other Atlantic islands were once thought to exist, were placed on maps, and then disappeared. The island of Brazil (or Hy Brazil) is one of these phantom islands. Babcock has written an engrossing, scholarly treatise, with many old maps, and hints of pre-Columbian contacts with the New World. Here follow some chapter titles: •Atlantis; •The Island of the Seven Cities; •The Problem of Mayda; •Estotiland and the Other Islands of Zeno; •The Sunken Land of Buss and Other Phantom Islands. This is a reprint of our xeroxed classic.

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H.H. Howorth, 1887, 498 pp., $19.95p

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DOUBT/FORTEAN SOCIETY MAGAZINE

During the 30s, 40s, and 50s, the work of Charles Fort was promoted by the Fortean Society. The Society initially published the Fortean Society Magazine, later changing its name to Doubt. These publications are delightful collections of Forteana of the period and also include reproductions of some of Fort's original notes. Curious and fun to read. All numbers are available in photocopied format bound as listed below.

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