organs are almost concealed by the spathe and bracts. Its nearest known ally is probably *H. rostrata*, Ruiz and Pavon, a native of Peru. Dr. Anthoine desires that this noble plant should bear the name of the Empress of Russia, which I have therefore attached to it.

HELICONIA MARIÆ, *Hook. f.* Foliorum vaginis truncum elatum efformantibus, lamina oblonga petiolata ampla, spicis longe pedunculatis pendulis, spathis crebre dense disticho-imbricatis rachin omnino velantibus late ovato-cymbiformibus recurvis obtusis, floribus bracteis inclusis glabratis.

Hab. Betami on the Sinu River (lat. 8° N.), State of Bolivar, in New Granada (*Dr. A. Anthoine*).

Truncus 3–4 metr., cum foliis 6 metr., etiam 10–15 centimetr., lævis, viridi-purpureus (*Anth.*). *Folia* oblonga v. lineari-oblonga, obtusa, 3–4 ped. longa, petiolo æquilonga, viridia. *Pedunculus* crass. digiti, curvus, glaber, siccus flexuosus, teres, intus vasibus mollibus farctus. *Spicæ* 1½ ped. longæ, 3–4 poll. latæ, lineares, obtusæ, compressæ. *Spathæ* 60–80, dense imbricatæ, reflexæ, valde concavæ, late ovato-cymbiformes, glabræ v. pubescentes, lateribus erectis, basin versus subcordatæ, marginibus undulatis, apice obtusiusculæ; infimæ rostratæ; inferiores 1–2 distantes, 4–5 unc. longæ, rachin pubescentem non tegentibus; cæteræ 2–2½ unc. longæ, rachin velantes; superiores inferiores amplectentes. *Flores* rubri (*Anth.*), in spatha singula 15–20, bracteis lineari-lanceolatis glabriusculis inclusi, receptaculo brevissimo in axilla spathæ inserti; apicibus perianthii tantum exsertis. *Bracteæ* albæ, spatha breviores, ovato-lanceolatæ, basi concavæ, exteriores vacuæ. *Pedicelli* ½″ longi, crassiusculi, villosuli, compressi. *Ovarium* trigonum. *Perianthium* 1″ long., foliolis extus subtomentosis. *Stylus* apice incurvus. *Antheræ* inclusæ. *Drupa* cærulea (*Anth.*), 3-cocca; coccis oblongis, compressis, basi antice fovea cupulæformi notatis, subrugosis, osseis, intus subrugosis. *Semen* erectum; testa membranacea, raphe annulari circumdata. *Albumen* subfarinaceum. *Embryo* axillaris, gracilis, extremitate radiculari paulo crassiore, germinatione foveam cocci perforante.

On the existence of two forms, and on their reciprocal sexual relation, in several species of the genus *Linum*.

By CHARLES DARWIN, M.A., F.R.S., F.L.S., &c.

[Read February 5, 1863.]

THE crimson *Linum grandiflorum* presents two forms, occurring in about equal numbers, which differ little in structure, but greatly in function. The foliage, corolla, stamens, and pollen (examined

dry, and distended with water) are alike in both forms. The difference is confined to the pistil: in the one form, which I will call "short-styled," the column formed by the united styles, and the short stigmas, together is about half the length of the whole pistil in the other and "long-styled" form. A more important distinction is, that the five stigmas in the short-styled form diverge greatly from each other and pass out between the filaments of the stamens, and thus lie within the tube of the corolla. In the long-styled form the elongated stigmas stand nearly upright, and alternate with the anthers. In this latter form the length of the stigmas varies considerably, their upper extremities projecting even a little above the anthers, or reaching up only to about their middle. Nevertheless there is never the slightest difficulty in distinguishing between the two forms; for, besides the difference in divergence, the stigmas of the short-styled form never reach even to the bases of the anthers. In the short-styled, the papillæ on the stigmatic surfaces are shorter, darker-coloured, and more crowded together than in the long-styled form: but these differences seem due merely to the shortening of the stigma; for in the varieties of the long-styled form with shorter stigmas, the papillæ are more crowded and darker-coloured than in those with the longer stigmas. Considering the slight and variable differences between the two forms of this *Linum*, it is not surprising that they have been hitherto overlooked.

In 1861 I had eleven plants growing in my garden, eight of which were long-styled, and only three short-styled. Two very fine long-styled plants grew in a bed a hundred yards off, and separated from the others by a screen of evergreens. I marked twelve flowers, and put on their stigmas a little pollen from the short-styled plants. The pollen of the two forms is, as stated, identical in appearance; the stigmas of the long-styled flowers were already thickly covered with their own pollen—so thickly that I could not find one bare stigma; and it was late in the season, namely, September 15th. Altogether, to expect any result from this trial seemed almost childish. From my experiments, however, on *Primula*, which have been laid before this Society ('Journal,' vol. vi. p. 77), I had faith, and did not hesitate to make the trial, but certainly I did not anticipate the full result. The germens of these twelve flowers all swelled, and ultimately six fine capsules (the seed of which germinated this year) and two poor capsules were produced; only four capsules shanked off. These

two plants produced, before and after and at the time of the trial, a vast number of flowers, but the germens of not even one swelled. All these flowers, though their stigmas were so densely covered with their own pollen, were absolutely barren.

The nine other plants, six long-styled and three short-styled, grew in the beds of the same flower-garden. Four of the long-styled produced no seed-capsules; one produced two; but the remaining long-styled plant grew so close to a short-styled plant that their branches touched, and this produced twelve capsules, but they were poor. The case was different with the short-styled plants. The plant which grew in juxtaposition with the long-styled plant produced ninety-four imperfectly fertilized capsules containing a multitude of bad seeds, with a moderate number of good seeds. The two other short-styled plants grew in a single clump, and were very small, being partly smothered by other plants; they did not stand very close to any long-styled plants, yet they yielded together nineteen capsules. These facts seem to show that the short-styled plants are far more fertile with their own pollen than the long-styled. We shall immediately see that this is the case in a slight degree. But I suspect that in this instance the difference in fertility between the two forms was in part due to a distinct cause. I repeatedly watched the flowers, and only once saw a humble-bee momentarily alight on one, and then fly away, as if it were not to its taste. If bees had visited the several plants, there cannot be a doubt that the four long-styled plants which did not produce a single capsule would have borne an abundance. But several times I saw small diptera sucking the flowers; and these insects, though not visiting the flowers with anything like the regularity of bees, would carry a little pollen from one form to the other, especially when growing close together; and the stigmas of the short-styled plants, diverging within the tube of the corolla, would be more likely than the upright stigmas of the long-styled to receive a small quantity of pollen when brought by small insects. From the much greater number of long-styled than of short-styled flowers in the garden, evidently the short-styled would be more likely to receive some pollen from the long-styled, than the long-styled from the short-styled.

In 1862 I raised thirty-four plants of this *Linum* in a hotbed; and these consisted of seventeen long-styled and seventeen short-styled forms. Seed sown later in the flower-garden yielded seventeen long-styled and twelve short-styled forms. These facts justify

the statement that the two forms are produced in about equal numbers. The first thirty-four plants were kept under a net which excluded insects. I fertilized heteromorphically fourteen long-styled flowers with pollen from the short-styled, and got eleven fine seed-capsules; these contained on an average 8·6 seeds per capsule, but only 5·6 were apparently good. It may be well to state that ten seeds is the maximum possible production for a capsule, and that our climate cannot be very favourable to this North-African plant. On three occasions I fertilized homomorphically the stigmas of altogether nearly a hundred flowers (but did not separately mark them) with their own pollen, but taken from separate plants, so as to prevent any possible ill effects from close interbreeding; and many other flowers were produced, which, as before stated, would get plenty of their own individual pollen; yet from all these flowers, borne by the seventeen long-styled plants, only three capsules were produced; one of these included no seed, and the other two together gave only five good seeds. Nor do I feel at all sure that this miserable product of the two half-fertile capsules from the seventeen plants, each of which must have produced at least fifty or sixty flowers, is really the result of their fertilization by their own pollen; for I made a great mistake in keeping the two forms under the same net, with their branches often interlocking, and it is surprising that a greater number of flowers were not accidentally fertilized.

Of the short-styled flowers I fertilized heteromorphically twelve with the pollen of the long-styled (and to make sure of the result I previously castrated the majority), and obtained seven fine seed-capsules. These included an average of 7·6 seeds, but of apparently good seed only 4·3 per capsule. At three separate times I fertilized homomorphically nearly a hundred flowers with their own-form pollen, taken from separate plants; and numerous other flowers were produced, many of which must have received their own pollen. From all these flowers borne on the seventeen plants, only fifteen capsules were produced, of which only eleven contained any good seed, on an average 4·2 per capsule. As remarked in the case of the long-styled plants, some even of these capsules were perhaps the product of a little pollen accidentally fallen from the flowers of the other form. Nevertheless the short-styled plants seem to be slightly more fertile with their own pollen, in the proportion of fifteen capsules to three, than the long-styled: the real proportional excess in fertility is probably a little greater, as the short-styled flowers, when not disturbed, do

not so surely receive their own pollen as do the long-styled. The greater self-fertility of the short-styled flowers was, as we have seen, also shown by the plants left to themselves, and but sparingly visited by insects, in the flower-garden in 1861, and likewise by those raised in 1862.

The absolute sterility (judging from the experiments of 1861, and which is hardly contradicted by those of 1862) of the long-styled plants with their own-form pollen led me to examine into its apparent cause; and the result is so curious that it will be worth while to give most of the experiments in detail. These experiments were tried on fresh plants, grown in pots and brought successively into the house.

First. I placed pollen from a short-styled flower on the five stigmas of a long-styled plant, and after thirty hours found them deeply penetrated by a multitude of pollen-tubes, far too numerous to be counted; the stigmas had become discoloured and twisted. I repeated this experiment on another flower, and in 18 hours found the stigmas penetrated by a multitude of long pollen-tubes. All this is what might have been expected, as this is a fertile or heteromorphic union. I likewise tried the converse experiment, and placed pollen from a long-styled flower on the stigmas of a short-styled flower, and in 24 hours found the stigmas discoloured, twisted, and penetrated by numerous pollen-tubes; and this, again, is what might have been expected, as this is a fertile or heteromorphic union.

Secondly. I placed pollen of a long-styled flower on all five stigmas of a long-styled flower on a separate plant: after 19 hours I rigorously dissected the stigmas, and found only a single pollen-grain which had emitted a very short tube. To make sure that the pollen was good, I took in this case, and in most other cases, pollen either from actually the same anther or from the same flower, and proved it to be good by placing it on the stigma of a short-styled plant, and seeing numerous pollen-tubes emitted.

Thirdly. Repeated last experiment, and placed own-form pollen on all five stigmas of a long-styled flower; and, after 19½ hours, not one single grain had emitted its tube.

Fourthly. Repeated the experiment, with the same result after 24 hours.

Fifthly. Repeated last experiment, and, after leaving pollen on for 19 hours, put an additional quantity of own-form pollen on all five stigmas. After an interval of exactly three whole days, I rigorously examined the stigmas, which, instead of being dis-

coloured and twisted, were straight and fresh-coloured; and only one grain had emitted quite a short tube, which could be drawn out of the stigmatic tissue without being ruptured.

The following experiments are more striking:—

Sixthly. I placed own-form pollen on three of the stigmas of a long-styled flower, and pollen from a short-styled flower on the other two stigmas. After 22 hours these two stigmas were discoloured, and slightly twisted, and penetrated by the tubes of numerous pollen-grains: the other three stigmas, covered with their own-form pollen, were fresh, and all the pollen-grains were loose; but I did not dissect the whole stigma rigorously.

Seventhly. Experiment repeated in the same manner, with the same result.

Eighthly. Experiment repeated, but the stigmas were carefully examined after an interval of only 5½ hours. The two stigmas with pollen from a short-styled flower were penetrated by innumerable tubes; but these were as yet short, and the stigmas themselves were not at all discoloured. The three stigmas covered with their own-form pollen were not penetrated by a single pollen-tube.

Ninthly. Put pollen of short-styled on one stigma, and own-form pollen on the other four stigmas; after 24 hours, found the one stigma somewhat discoloured, and twisted, and penetrated by many long tubes: the other four stigmas were quite straight and fresh; but on dissecting their whole lengths I found that three pollen-grains had protruded quite short tubes into the tissue.

Tenthly. Repeated the experiment, with the same result after 24 hours, excepting that only two own-form grains had penetrated the stigmatic tissue with their tubes, to a very short depth: the one stigma, which was deeply penetrated by a multitude of tubes from the short-styled pollen, presented a conspicuous difference in comparison with the other four straight and bright pink stigmas, in being much curled, half-shrivelled, and discoloured.

I could add a few other experiments; but those now given amply suffice to show that the pollen-grains of a short-styled flower placed on the stigmas of a long-styled flower emit a multitude of tubes after an interval of from five to six hours, and penetrate the tissue ultimately to a great depth, and that after twenty-four hours the stigmas thus penetrated change colour, become twisted, and appear half-withered. On the other hand, the pollen-grains of the long-styled flowers placed on their own stigmas, after an interval of a day, or even three days, do not emit their tubes, or at most only three or four grains out of a multitude emit their tubes; and these

apparently never penetrate the stigmatic tissue deeply, and the stigmas themselves do not become discoloured and twisted.

This seems to me a remarkable physiological fact. The pollen-grains of the two forms are undistinguishable under the microscope; the stigmas differ only in length, degree of divergence, and in the size, shade of colour, and approximation of their papillæ, these latter differences being variable and apparently simply due to the elongation of the stigma. Yet we plainly see that the two pollens and the two stigmas are widely dissimilar in action—the stigmas of each form being almost powerless on their own pollen, but causing, through some mysterious influence, by simple contact (for I could detect no viscid secretion), the pollen-grains of the opposite form to protrude their tubes. It may be said that the two pollens and the two stigmas by some means mutually recognize each other. Taking fertility as the criterion of distinctness, it is no exaggeration to say that the pollen of the long-styled *Linum grandiflorum* (and conversely of the other form) has been differentiated, with respect to the stigmas of all the flowers of the same form, to a degree corresponding with that of distinct species of the same genus, or even of species of distinct genera.

Linum perenne.—The dimorphism is here more conspicuous, and has been noticed by several authors. In the long-styled form the pistil is nearly twice as long as in short-styled; in the latter the stigmas are smaller and, diverging more, pass out between the filaments of the stamens. I could detect no difference in the size of the stigmatic papillæ; in the long-styled form alone the stigmatic surfaces turn round so as to face the circumference of the flower: but to this point we shall presently return. Differently from what occurs in *L. grandiflorum*, the long-styled flowers have stamens hardly more than half the length of those of the short-styled. The size of the pollen-grains is rather variable; after some doubt, I have come to the conclusion that there is no uniform difference between the pollen of the two forms. The long stamens in the short-styled form project to some height above the corolla, and, apparently from exposure to the light, the filaments are coloured blue. These longer stamens correspond in height with the lower part of the stigmas of the long-styled flowers; and the shorter stamens of the latter form correspond in the same manner in height with the shorter stigmas of the short-styled flowers.

I raised from seed twenty-six plants, which proved to be twelve long-styled and fourteen short-styled. They flowered well, but were not large plants. As I did not expect them to flower so

soon, I did not transplant them, and they unfortunately grew with their branches closely interlocked. All the plants were covered by a net, excepting one of each form. First, of the long-styled flowers, twelve were homomorphically fertilized by their own-form pollen, taken in every case from a separate plant; and not one flower set a seed-capsule: twelve other flowers were heteromorphically fertilized by pollen from short-styled flowers; and they set nine pods, each including on an average seven good seeds: as before, ten seeds is the maximum possible production. Secondly, of the short-styled flowers, twelve were homomorphically fertilized by own-form pollen, and they yielded one capsule, including only three good seeds; twelve other flowers were heteromorphically fertilized by pollen of long-styled flowers, and these produced nine capsules, but one was bad; the eight good capsules contained on an average exactly eight good seeds each.

The many flowers on the eleven long-styled plants under the net, which were not fertilized, produced only three capsules (including 8, 4, and 1 good seeds); whether, owing to the interlocking of the branches, these accidentally received pollen from the other form, I will not pretend to conjecture. The single long-styled plant which was uncovered, and grew close by the uncovered short-styled plant, produced five good pods; but it was a very poor and small plant.

The flowers borne on the thirteen short-styled plants under the net, which were not fertilized, produced twelve capsules (containing 5·6 seeds on average): as some of these capsules were very fine, and five were borne on one twig, I suspect that they had been visited by some minute insect which had accidentally got under the net and had carried pollen from the other form. The one uncovered short-styled plant yielded exactly the same number of capsules, namely, twelve.

From these facts we have some evidence, as in the case of *L. grandiflorum*, that the short-styled plants are in a very slight degree more fertile with their own pollen than are the long-styled plants. And we have the clearest evidence, from the result of the forty-eight flowers artificially fertilized, that the stigmas of each form require pollen from the stamens of corresponding height produced by the opposite form.

In contrast with the case of *L. grandiflorum*, it is a singular fact that the pollen-grains of both forms of *L. perenne* when placed on their own-form stigmas, though not causing fertility, yet emit their tubes; and these tubes I found, after an interval of eighteen

hours, had penetrated the stigmatic tissue, but to what depth I did not ascertain. In this case the inaction of the pollen-grains on their own stigmas must be due either to the tubes not reaching the ovules, or reaching them and not efficiently acting on them. In the case of *Lythrum Salicaria*, which I hope at some future time to lay before the Society, there are three distinct forms, each of which produces two kinds of pollen; but neither pollen, when placed on its own stigma, causes fertility, except occasionally and in a very moderate degree; yet the pollen-tubes in each case freely penetrate the stigmatic tissue.

The plants of *L. perenne* and of *L. grandiflorum* grew, as stated, with their branches interlocked, and with scores of flowers of the two forms close together; they were covered by an open net, through which the wind, when high, passed; and such minute insects as *Thrips* could not, of course, be excluded; yet we have seen that the utmost possible amount of accidental fertilization on seventeen long-styled plants in the one case, and on eleven plants in the other case, was the production, in each, of three poor capsules; so that we may infer that, when the proper insects are excluded, the wind does hardly anything in the way of carrying pollen from plant to plant. I allude to this fact because botanists, in speaking of the fertilization of plants or of the production of hybrids, often refer to the wind or to insects as if the alternative were indifferent. This view, according to my experience, is entirely erroneous. When the wind is the agent in carrying pollen, either from one separated sex to the other, or from hermaphrodite to hermaphrodite (which latter case seems to be almost equally important for the ultimate welfare of the species, though occurring perhaps only at long intervals of time), we can recognize structure as manifestly adapted to the action of the wind as to that of insects when they are the carriers. We see adaptation to the wind in the incoherence of the pollen, in the inordinate quantity produced (as in the Coniferæ, Spinage, &c.), in the dangling anthers well fitted to shake out the pollen, in the absence or small size of the perianth or in the protrusion of the stigmas at the period of fertilization, in the flowers being produced before they are hidden by the leaves, in the stigmas being downy or plumose (as in the Gramineæ, Docks, and other plants) so as to secure the chance-blown grains. In plants which are fertilized by the wind, the flowers do not secrete nectar, their pollen is too incoherent to be easily collected by insects, they have not bright-coloured corollas to serve as guides, and they are not, as far as I have seen, visited

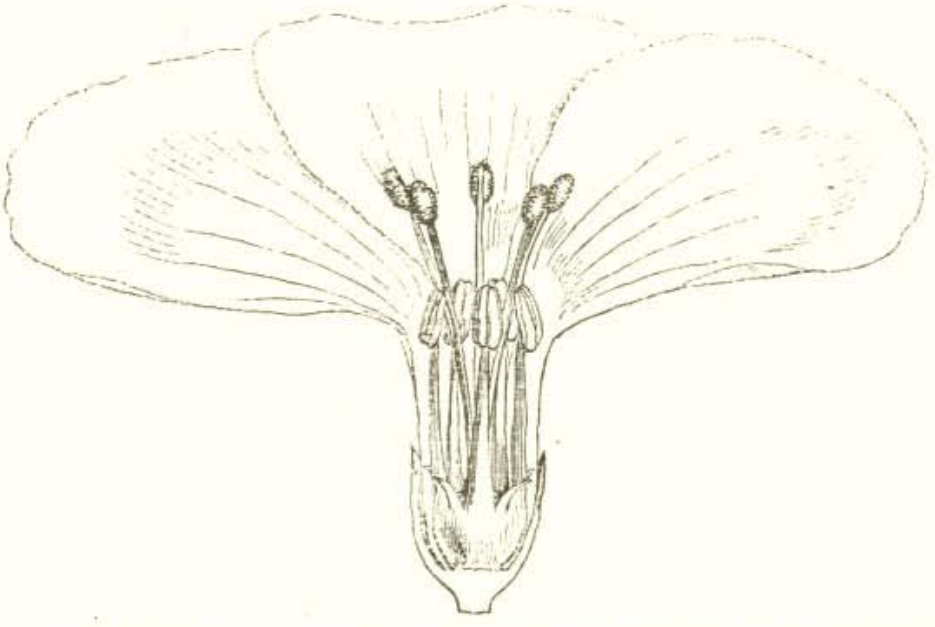
by insects. When insects are the agents of fertilization (and this is incomparably the more frequent case both with plants having separated sexes and with hermaphrodites), the wind plays no part, but we see an endless number of adaptations to ensure the safe transport of the pollen by the living workers. We can recognize these adaptations most easily in irregular flowers; but they do not the less occur in perfectly regular flowers, of which those of *Linum* offer an instance, as I will almost immediately endeavour to show.

I have already alluded to the rotation of each separate stigma in the long-styled form alone of *Linum perenne*. In the other species examined by me, and in both forms when the species are dimorphic, the stigmatic surfaces face the centre of the flower, and the furrowed backs of the stigmas, to which the styles are attached, face the circumference. This is the case, in the bud, with the stigmas of the long-styled flowers of *L. perenne*. But by the time the flower in this form has expanded, the five stigmas, by the torsion of that part of the style which lies beneath the stigma, twist round and *face the circumference*. I should state that the five stigmas do not always perfectly turn round, two or three often facing only obliquely towards the circumference. My observations were made during October; and it is not improbable that earlier in the season the torsion would have been more perfect; for after two or three cold and wet days the movement was very incomplete. The flowers should be examined shortly after their expansion; for their duration is brief, and, as soon as they begin to wither, the styles become spirally twisted together, and the original position of the parts is lost.

He who will compare the structure of the whole flower in both forms of *L. perenne* and *grandiflorum*, and, I may add, of *L. flavum*, will, I think, entertain no doubt about the meaning of this torsion of the styles in the one form alone of *L. perenne*, as well as the meaning of the divergence of the stigmas in the short-styled forms of all three species. It is absolutely necessary, as we now know, that insects should reciprocally carry pollen from the flowers of the one form to those of the other. Insects are attracted by five drops of nectar, secreted exteriorly at the base of the stamens, so that to reach these drops they must insert their proboscides outside the ring of broad filaments, between them and the petals. In the short-styled form of the above three species, the stigmas face the axis of the flower; and had the styles retained their original upright and central position, not only would the stigmas have presented their backs to insects as they sucked the flowers, but they

would have been separated from them by the ring of broad filaments, and could never have been fertilized. As it is, the styles diverge greatly and pass out between the filaments. The stigmas, being short, lie within the tube of the corolla; and their papillous faces, after the divergence of the styles, being turned upwards are necessarily brushed by every entering insect, and thus receive the required pollen.

In the long-styled form of *L. grandiflorum*, the parallel anthers and stigmas, slightly diverging from the axis of the flower, project only a little above the tube of the somewhat concave corolla; and they stand directly over the open space leading to the drops of nectar. Consequently when insects visit the flowers of either form (for the stamens in this species occupy the same position in both forms), they will get their proboscides well dusted with the coherent pollen. As soon as the insect inserts its proboscis to a little depth into the flower of the long-styled form, it will necessarily leave pollen on the faces and margins of the long stigmas; and as soon as the insect inserts its proboscis to a rather greater depth into the short-styled flowers, it will leave pollen on their upturned stigmatic surfaces. Thus the stigmas of both forms will indifferently receive the pollen of both forms; but we know that the pollen alone of the opposite form will produce any effect and cause fertilization.



Long-styled form of *L. perenne*, var. *Austriacum*, with the petals and calyx removed on the near side.

In the case of *L. perenne*, affairs are arranged a little more perfectly; for the stamens in the two forms stand at different heights,

and pollen will adhere to different parts of an insect's body, and will generally be brushed off by the stigmas of corresponding height, to which stigmas each kind of pollen is adapted. In this species, the corolla is flatter, and in the one form the stigmas and in the other form the anthers stand at some height above the mouth of the corolla*. These longer stigmas and longer stamens do not diverge greatly; hence insects, especially rather small ones, will not insert their proboscides between the stigmas or between the anthers, but will strike against them, at nearly right angles, with the backs of their head or thorax. Now, in the long-styled flowers of *L. perenne*, if each stigma had not rotated on its axis, insects in visiting them would have struck their heads against the backs of the stigmas; as it is, they strike against the papillous fronts of the stigmas, and, their heads being already charged with the proper coherent pollen from the stamens of corresponding height borne by the flowers of the other form, fertilization is perfectly effected.

Thus we can understand the meaning of the torsion of the styles in the long-styled flowers alone, as well as their divergence in the short-styled flowers.

One other point is worth a passing notice. In botanical works many flowers are said to be fertilized in the bud. This rests solely, as far as I can discover, on the anthers opening in the bud; no evidence is adduced that the stigma is at this period mature, or that, if then penetrated by pollen-tubes, it is not subsequently, after the expansion of the flower, acted on by pollen brought from other flowers. In the case of *Cephalanthera grandiflora* I have shown† by experiment that insufficient precocious self-fertilization, together with subsequent full fertilization, is the regular course of events. The belief that flowers of any plant are habitually fertilized in the bud, or are perpetually self-fertilized, is a most effectual bar to really understanding their structure. I am far from wishing to say that some flowers, in certain seasons, are not fertilized in the bud: I have reason to believe that some flowers are frequently fertilized without expanding; but my observations lead me to disbelieve that this is ever the invariable

* I neglected to get drawings made from fresh flowers of the two forms. Mr. Fitch has made the above sketch of a long-styled flower from dried specimens and published engravings: his well-known skill ensures accuracy in the proportional size of the parts; and I believe their relative position is true.

† Fertilization of Orchids, p. 108.

course with all the flowers of any species whatever. As it is difficult to prove without troublesome experiments the falsity of the belief of regular fertilization in the bud, I here notice this subject. An estimable and laborious observer*, resting his belief on the usual kind of evidence, states that in *L. Austriacum* (which is dimorphic and is considered by Planchon as a variety of *L. perenne*) the anthers open the evening before the expansion of the flowers, and that the long-styled stigmas are then almost always fertilized. He asks whether this precocious fertilization in the several species of *Linum* and in other plants is not one cause of the short duration of their flowers. Now we know positively that, so far from *Linum perenne* being fertilized by its own pollen in the bud, its own pollen is as powerless on the stigma as so much inorganic dust.

Linum flavum.—To recur to our more immediate subject, in the long-styled form of this species the pistil is nearly twice as long as in the short-styled form; and the stigmas are longer with the papillæ coarser. In the short-styled form the stigmas diverge and pass out between the filaments. The stamens in the two forms differ in height, and, what is singular, the anthers of the longer stamens are shorter; so that in the short-styled form both stigmas and anthers are shorter than in the other form. The pollen of the two forms does not differ. I have not been able to try any experiments on this species; but a careful observer, Mr. W. C. Crocker, intends proving their reciprocal fertility next summer. As this plant is propagated by cuttings, I have generally found that all the plants in the same garden belong to the same form. On inquiry I have never heard of its seeding in this country; but to anyone wishing to raise seedlings, in all probability the path is now open, namely, by carrying pollen from one form to the other.

I have now shown that three species of *Linum* are dimorphic, besides several races of *L. perenne*, esteemed by some botanists to be distinct species, such as *L. montanum*, *L. Sibiricum*, and *L. Austriacum*. According to Vaucher†, *L. Gallicum*, *L. maritimum*, and *L. strictum* are in the same manner dimorphic, as likewise is, according to Planchon‡, *L. salsoloides*. This latter botanist is the only one who seems to have been struck with the importance of the subject; and he acutely asks whether this dimorphism has not some influence on the manner of fertilization. We thus know of

* Études sur la Géograph. Bot., par Prof. H. Lecoq, 1856, tom. v. p. 325.

† Hist. Physiolog. des Plantes d'Europe, 1841, tom. i. p. 401.

‡ Hooker's London Journ. of Botany, 1848, vol. vii. p. 174.

seven dimorphic species of *Linum*; but as this structure has been overlooked in such common garden-flowers as *L. grandiflorum* and *L. flavum*, it is probably of frequent occurrence.

All the species, however, are certainly not thus characterized. I have examined many specimens of *L. catharticum*, and found in all that the stamens and stigmas were of nearly equal height and the same in all the plants. So, again, I looked, near Torquay, at many flowers of the wild *L. usitatissimum* or *angustifolium* (I know not which), and there was no trace of dimorphism. Again, I raised 111 plants from seed sent me from Kew, incorrectly named *L. Austriacum*; the plants were tall and straight, having a rather different aspect from the wild species seen at Torquay, with extremely fugacious blue flowers: in all these plants the stigmas stood on a level with the anthers or projected a very little above them. I protected the flowers from insects; but every one of the 111 plants produced plenty of seed. I mention this fact because it had occurred to me that possibly a species might be dimorphic in function, though not in structure.

Lastly, *Linum Lewisii*, which is ranked by Planchon as a variety of *L. perenne*, but which, now that we know the meaning of reciprocal dimorphism, surely deserves specific honours, must not be passed over. According to Planchon*, the same plant bears some flowers with anthers and stigmas of the same height, and others with styles either longer or shorter than the stamens; so that the same individual plant is trimorphic. This, as far as I know, is a unique case. From analogy we may pretty safely predict the function of the three kinds of flowers: those with stigmas and anthers of the same height will be self-fertile; those with these organs of unequal height will require reciprocal fertilization. A plant of *L. grandiflorum* or of the other dimorphic species, growing by itself, could no more perpetuate its race than could one sex of a diœcious plant, nor could any number of plants without the aid of insects. A single plant of *Linum Lewisii*, on the other hand, in all probability could propagate itself, even if no insects were present, as probably sometimes occurs in its Arctic home. If insects visited the plant, the flowers which were dimorphic would be fertile one with another or with those on any neighbouring plant. Thus the plant would receive the advantage of a cross.

* Hooker's London Journ. of Botany, 1848, vol. vii. p. 175. It is not improbable that the allied genus *Hugonia* is dimorphic; for (p. 525) one species is described "staminibus exsertis;" another has "stamina 5, majora, stylos longe superantia;" and another is furnished "stylis staminibus longioribus."

That this is an advantage, and is one great end gained by reciprocal dimorphism, I can entertain no doubt. That in some cases this dimorphism may be a step towards a complete separation of the sexes, I will not dispute; but good reasons could be assigned to show that there is no necessary connexion between reciprocal dimorphism and a tendency to dicecious structure. Although good is gained by the inevitable crossing of the dimorphic flowers, yet numerous other analogous facts lead me to conclude that some other quite unknown law of nature is here dimly indicated to us.

On the Form of the Vascular Fasciculi in certain British Ferns.

By Arthur H. Church, B.A. Oxon. Communicated by W. Francis, Ph.D., F.L.S.

[Read Dec. 18, 1862.]

The distribution of the vascular tissues in the stem and stipes of the British species of Ferns has been made the subject of much interesting and accurate study by Dr. Ogilvie*. His papers are to be found in the 'Annals and Magazine of Natural History' for December 1859 and November 1860. My own long-continued examination of the living plants has not enabled me to detect any but the most trivial mistakes in these full and admirable memoirs. I have therefore only to propose a few slight alterations in Dr. Ogilvie's conclusions, and to make one or two additional remarks on certain species and varieties which he omits to notice. The present communication may be deemed the first instalment of such supplementary observations. I may also here state that I

* The following list of papers includes nearly all those in which the vascular tissues of Ferns have been discussed:—

Presl. Tentamen Pteridographiæ. Pragæ: 1836.

Fée. Die Gefässbündel im Stipes der Farne. Pragæ: 1847.

Ogilvie, Dr. Ann. & Mag. Nat. Hist. 1859 and 1860.

Duval-Jouve, J. Etudes sur le Pétiole des Fougères. In Billot's Archives de la Flore de France; pp. 57 & 149.

King. On Sigillaria. Edinburgh Phil. Trans. 1844.

Leighton, Rev. W. A. Hints on a new character in Ferns. Phyt. n. s. i. p. 256.

Moore, T. The Vascular Bundles of the Stipes of Ferns. Phyt. n. s. i. p. 378.

Reichardt, H. W. Ueber der Gefässbündel Vertheilung im Stamme und Stipes der Farne. Denkschriften der Kaiserlichen Akademie der Wissenschaften, xvii^{ter} Band. Wien: 1859.