GENERAL SECTION OF THE TERTIARY ROCKS OF NEBRASKA.

Names.	SUBDIVISIONS.	Thickness.	LOCALITIES.	Foreign equivalents.
Loup River beds.	Fine loose sand, with some layers of limestone,—contains bones of *Canis*, *Felis*, *Castor*, *Equus*, *Mastodon*, *Testudo*, &c., some of which are scarcely distinguishable from living species. Also *Helix*, *Physa*, *Succinea*, probably of recent species. All fresh water and land types.	300 to 400 feet.	On Loup fork of Platte River; extending north to Niobrara River, and south to an unknown distance beyond the Platte.	Pliocene.
White River Group.	White and light drab clays, with some beds of sandstone, and local layers of limestone. Fossils, *Oreodon*, *Titanotherium*, *Chæropotamus*, *Rhinoceros*, *Anchitherium*, *Hyænodon*, *Machairodus*, *Trionyx*, *Testudo*, *Helix*, *Planorbis*, *Limnæa*, petrified wood, &c. &c. All extinct. No brackish water or marine remains.	1000 feet or more.	Bad Lands of White River; under the Loup River beds, on Niobrara, and across the country to the Platte.	Miocene.
Wind River Deposits.	Light gray and ash colored sandstones, with more or less argillaceous layers. Fossils, fragments of *Trionyx*, *Testudo*, with large *Helix*, *Vivipara*, petrified wood, &c. No marine or brackish water types.	1500 to 2000 feet.	Wind River valley. Also west of Wind River Mountains.	?.
Fort Union or Great Lignite Group.	Beds of clay and sand, with round ferruginous concretions, and numerous beds, seams and local deposits of Lignite; great numbers of dicotyledonous leaves, stems, &c. of the genera *Platanus*, *Acer*, *Ulmus*, *Populus*, &c., with very large leaves of true *fan-palms*. Also, *Helix*, *Melania*, *Vivipara*, *Corbicula*, *Unio*, *Ostrea*, *Potamomya*, and scales of *Lepidotus*, with bones of *Trionyx*, *Emys*, *Compsemys*, *Crocodilus*, &c.	2000 feet or more.	Occupies the whole country around Fort Union, — extending north into the British possessions, to unknown distances; also southward to Fort Clark. Seen under the White river Group on North Platte River above Fort Laramie. Also on west side Wind river mountains.	Eocene?

III. BOTANY AND ZOOLOGY.

1. *On the Various Contrivances by which British and Foreign Orchids are Fertilized by Insects, and on the Good Effects of Intercrossing.* By CHARLES DARWIN, M.A., F.R.S., &c. With illustrations. [34 figures, on wood.] London: Murray, 1862. 24mo, pp. 365.

Of all books relating to the realm of nature, perhaps the most attractive to old and young are those (such as the writings of Reaumur and Huber) which describe the habits and doings of insects. Here is a new volume of this class, bringing to view some of the numerous and most curious contrivances (a great part of them now first made known) through which insects are found to benefit the plants that nourish them. We all know how essential plants, and especially their flowers, are to the existence of the multitudinous swarms and tribes of insects; but it is hardly understood that the benefit is reciprocal—that, in the long run, insects are also essential to the continued existence of many, if not of most species of plants. "The object of the following work," the author states, "is to show that the contrivances by which Orchids are fertilized are as varied and almost as perfect as any of the most beautiful adaptations in the animal kingdom; and, secondly, to show that these contrivances

have for their main object the fertilization of each flower by the pollen of another flower." 'Adaptations'—many of them truly exquisite—and 'contrivances,' they may well be termed, being obviously as evincive of design as are analogous arrangements in the animal kingdom, from which intention is so irresistibly inferred. Indeed, had Mr. Darwin begun with this little book, and kept back a few theoretical inferences, it would have been a treasury of new illustrations for the natural theologians, and its author, perhaps, rather cannonized than anathematized, even by many of those whom his treatise on the origin of species so seriously alarmed. With how much reason, and where there may have been grounds for alarm, how far some of the positions assumed were safe and tenable, or wise, it is not our present business to consider. Our author remarks that this treatise affords him "an opportunity of attempting to show that the study of organic beings may be as interesting to an observer who is fully convinced that the structure of each is due to secondary laws, as to one who views every trifling detail of structure as the result of the direct interposition of the Creator." But the present book is almost wholly a record of observed facts, of curious interest, irrespective of all theories of origination, and perhaps as readily harmonized with old views as with new—with direct as well as with indirect creation.

The drawbacks to the general perusal and high enjoyment of this, to us so fascinating, little volume, are, first, that it demands some knowledge of botany, and the patience to master needful details, perhaps "too minute and complex for any one who has not a strong taste for natural history." But whoever will master the details, will be richly repaid for the trouble. Secondly, the Orchids illustrated are mainly British species; but several of them have close representatives in the United States, a few even are identical; and, with Darwin's treatise as a guide, the study of the fertilization of our own species will seldom be difficult, will even be all the more enticing for the chance of some novelty in the exploration of a new field. Whoever shall first study carefully the fertilization of the Orchids peculiar to this country, may hope to add something to what is now known upon this curious subject. Moreover, we are rich in the *Ophrydeæ*, or the proper Orchis tribe, with which this treatise commences, which are easy of observation, and yield to none in curious interest.

We have, indeed, only one true *Orchis* to represent the numerous European species; and this, the pretty *Orchis spectabilis*, just now in perfection throughout the northern part of the country, will be out of flower before these pages are in print. Next spring, Mr. Darwin's graphic account of the contrivance by which the pollen of one flower of *O. mascula* is made to fertilize the stigma of another flower, may be verified in all essential particulars upon our own species. The structure of the blossom being understood, or learned from the ordinary botanical works, it will be interesting to note how the pollen in each cell of the anther, tied up by delicate threads to a common stalk, although placed just above and tantalizingly close to the stigma, is incapable of reaching it; how the common stalk of each pollen mass is firmly attached to a sticky gland, belonging to the upper part of the stigma; how these two glands, or balls of viscid matter, standing side by side, are enclosed in a little pouch, which shelters the viscid balls from the air, and keeps them soft and moist; how the slightest touch of the closed pouch from above will rupture it, transversely along the top, so that the anterior part of the pouch, depressed by a slight force, will expose the sticky glands, but will rise and cover them again when the pressure is removed; how this apparatus stands projecting just over the posterior border of the entrance into the long, nectar-bearing tube or spur, which, moths, butterflies, bees, or other insects with long proboscis visit, to suck out the nectar; how a bristle, representing the proboscis, or a sharpened pencil representing the head of an insect, inserted into the spur, will, by depressing the pouch, come into contact with the glands; when their glutinous

matter, promptly hardening, like a cement, will adhere firmly to what they touch; and how, on withdrawal, one or both pollen masses, attached to the gland by their stalk or caudicle, will be drawn out of their cells and carried away; how, through a curious, probably hygrometic change of form or unequal contracility of the viscid gland, now attached to the object, the pollen-masses turn forward or become depressed, within a minute or so; and how, on returning the bristle or pencil-point to its former position, or inserting it into the nectar of another flower, the pollen will now be almost surely brought into contact with the broad viscid stigma situated just beneath the pouch and anther and the viscidity of the stigma is such, that sometimes the whole pollen mass will be left on it, but usually only a small part of it. For the elastic threads which bind the numerous packets of pollen to their common support or stalk, being weaker than the attachment of the gland to the proboscis or other object on the one hand, and than the cohesion of the pollen to the glutinous stigma on the other, some of these packets of pollen will be torn away from the mass and left on the stigma; others upon the stigma of the next flower visited, and so on.

The whole contrivance here is obvious and admirable. The hollow spur secreting nectar attracts insects, and will be habitually visited by those furnished with a proboscis adapted to reach the attractive liquid. The sticky glands are placed just where the probociss or the head of the insect must needs come in contact with them; and the protecting pouch preserves their viscidity (which here is quickly lost by drying) for the moment when it is turned to useful account. The pollen masses extracted from one flower must needs be conveyed to other flowers and other plants, and applied to their stigmas; and the cohesion of the packets of pollen, by their elastic threads, to the mass is so coördinated to the glutinosity of the stigma, as generally to ensure that the contents of the anther of one flower shall be distributed among the stigmas of several other and perhaps distant flowers, while it rarely, if ever, will reach its own. Here the closest hermaphroditism in structure subserves almost perfect diclinism in function.

We lose much in not having *Orchis pyramidalis* in this country; for its contrivances, as described by Mr. Darwin, are indeed exquisite. The figures that accompany Mr. Darwin's account render it very clear; without them a brief abstract may be hardly intelligible. The flower differs from that of other true Orchises in having two quite distinct oval stigmatic surfaces, separated by the pouch, which is here carried further downwards than usual, projecting into the nectary or spur a little below its orifice, which it partially closes. It is hollowed out on the under side in the middle, and the space is filled with fluid. The gland, or viscid disc, is single, in fact it answers to the two glands of an ordinary *Orchis* united into one, of the shape of a saddle, carrying on its flattish top or seat the stalks of the two pollen masses. "The disc is partially hidden and kept damp (which is of great importance) by the largely over-folded basal membranes of the two anther-cells. The upper membrane of the disc consists of several layers of minute cells, and is therefore rather thick. It is lined beneath with a layer of highly adhesive matter." When all is ready, if the lip of the pouch be depressed, for which the slightest touch suffices, "the under and viscid surface of the disc, still remaining in its proper place, is uncovered, and is almost certain to adhere to the touching object. Even a human hair, when pushed into the nectary, is stiff enough to depress the lip, or pouch, and the viscid surface of the saddle adheres to it. If, however, the lip be touched too slightly, it springs back, and re-covers the under side of the saddle."

"The perfect adaptation of the parts is well shown by cutting off the end of the nectary and inserting a bristle at that end, consequently in a reverse direction to that in which Nature intended moths to insert their proboscis, and it will be found that the rostellum (or pouch) may easily be torn or penetrated, but that the saddle is rarely or never caught. * * * Lastly, the labellum is

furnished with two prominent ridges, sloping down to the middle and expanding outwards, like the mouth of a decoy. These ridges perfectly serve to guide any flexible body, like a fine bristle or hair, into the minute and rounded orifice of the nectary, which, small as it is, is partially choked up by the rostellum. This contrivance of the guiding ridges may be compared to the little instrument sometimes used for guiding a thread into the fine eye of a needle.

"Now, let us see how these parts act. Let a moth insert its proboscis (and we shall presently see how frequently the flowers are visited by Lepidoptera) between the guiding ridges of the labellum, or insert a fine bristle, and it is surely conducted to the minute orifice of the nectary, and can hardly fail to depress the lip of the rostellum. This being effected, the bristle comes into contact with the now naked and sticky under-surface of the suspended saddle-formed disc. When the bristle is removed, the saddle, with the attached pollinia, is removed. Almost instantly, as soon as the saddle is exposed to the air, a rapid movement takes place, and the two flaps curl inwards and embrace the bristle. When the pollinia are pulled out by their caudicles, by a pair of pincers, so that the saddle has nothing to clasp, I observed that the tips curled inwards, so as to touch each other in nine seconds, and in nine more seconds the saddle was converted, by curling still more inwards into an apparently solid ball. * * * Of course this rapid clasping movement helps to fix the saddle with its pollinia upright on the proboscis, which is very important; but the viscid matter, rapidly setting hard, would probably suffice for this end, and the real object gained is the divergence of the pollinia. These being attached to the flat top or seat of the saddle, project at first straight up, and are nearly parallel to each other; but as the flat top curls round the cylindrical and thin proboscis, or round a bristle, the pollinia necessarily diverge. As soon as the saddle has clasped the bristle and the pollinia have diverged, a second movement commences, which, like the last, is exclusively due to the contraction of the saddle-shaped disc of membrane. . . . . This second movement is the same as that in *O. mascula* and its allies, and causes the divergent pollinia, which at first projected at right angles to the needle or bristle, to sweep through nearly 90 degrees towards the tip of the needle, so as to become depressed, and finally to lie in the same plane with the needle. In three specimens this second movement was effected in from 30 to 34 seconds after the removal of the pollinia from the anther-cells, and, therefore, in about 15 seconds after the saddle had clasped the bristle.

"The use of this double movement becomes evident if a bristle with pollinia attached to it, which have diverged and become depressed, be pushed between the guiding ridges of the labellum into the nectary of the same or another flower; . . . . for the two ends of the pollinia will be found to have acquired [as the accompanying figures show] exactly such a position that the end of the one strikes against the stigma on the one side, and the end of the other, at the same moment, strikes against the stigma on the opposite side. These stigmas are so viscid, that they rupture the elastic threads by which the packets of pollen are bound together; and some dark green grains will be seen, even by the naked eye, remaining on the two white stigmatic surfaces. I have shown this little experiment to several persons, and all have expressed the liveliest admiration at the perfection of the contrivance by which this Orchid is fertilized.

"As in no other plant, or indeed in hardly any animal, can adaptations of one part to another, and of the whole to other organized beings widely remote in the scale of Nature, be named more perfect than those presented by this Orchis, it may be worth while briefly to sum them up. As the flowers are visited both by day and night-flying Lepidoptera, I do not think it is fanciful to believe that the bright purple tint (whether or not specially developed for this purpose) attracts the day-fliers, and the strong foxy odor the night-fliers. The upper sepal and the two upper petals form a hood, protecting the anther and the stigmatic surfaces from the weather. The labellum is developed into a

long nectary, in order to attract Lepidotera; and we shall presently give reason for suspecting that the nectar is purposely so lodged that it can be sucked only slowly, in order to give time for the curious chemical quality of the viscid matter setting hard and dry. He who will insert a fine and flexible bristle into the expanded mouth of the sloping ridges on the labellum, will not doubt that they serve as guides, and that they effectually prevent the bristle or the proboscis from being inserted obliquely into the nectary. This circumstance is of manifest importance; for, if the proboscis were inserted obliquely, the saddle-shaped disc would become attached obliquely, and after the compounded movement of the pollinia they could not strike the two lateral stigmatic surfaces.

"Then we have the rostellum partially closing the mouth of the nectary, like a trap placed in a run for game; and the trap so complex and perfect, with the symmetrical lines of rupture forming the saddle-shaped disc above, and the lip of the pouch below; and lastly, this lip so easily depressed that the proboscis of a moth could hardly fail to uncover the viscid disk and adhere to it. But if this did fail to occur, the elastic lip would rise again and re-cover and keep damp the viscid surface. We see the viscid matter within the rostellum attached to the saddle-shaped disc alone, and surrounded by fluid, so that the viscid matter does not set hard till the disc is withdrawn. Then we have the upper surface of the saddle, with its attached caudicles, also kept damp within the basis of the anther-cells, until withdrawn, when the curious clasping movement instantly commences, causing the pollinia to diverge, followed by the movement of depression, which compounded movements together are exactly fitted to cause the ends of the two pollinia to strike the two stigmatic surfaces. These stigmatic surfaces are just sticky enough not to tear off the whole pollinium from the proboscis of the moth, but by rupturing the elastic threads to secure a few packets of pollen, leaving plenty for other flowers. But let it be observed that, although the moth probably takes a considerable time to suck the nectar of any one flower, yet the movement of depression in the pollinia does not commence (as I know by trial) until the pollinia are fairly withdrawn out of their cells; nor will the movement be completed, and the pollinia be fitted to strike the stigmatic surfaces, until about half a minute has elapsed, which will give ample time for the moth to fly to another plant, and thus effect a union between two distinct individuals."

Mr. Darwin subjoins a list of twenty-three species of Lepidoptera, to the proboscis of which the pollinia of *O. pyramidalis* have been found attached, four of them in more than one instance; a large majority carrying two or three pairs, one seven pairs, and another no less than eleven pairs, all invariably attached to the proboscis. A figure is given of the head and proboscis of an *Acontia*, bearing seven pairs of pollinia, attached one before the other, with perfect symmetry, as follows from the insertion of the proboscis having been guided by the ridges on the labellum; and he remarks that an unfortunate *Caradrina*, with its proboscis encumbered by eleven pairs, could hardly have reached the extremity of the nectary, and would soon have been starved to death. "These two moths must have sucked many more than the seven and eleven flowers, of which they bore the trophies; for the earlier attached pollinia had lost much of their pollen, showing that they had touched many viscid stigmas. * * * "In *O. pyramidalis* I have examined spikes, in which every single expanded flower had its pollinia removed. The 49 lower flowers of a spike from Folkstone (sent me by Sir Charles Lyell) actually produced 48 fine seed capsules; and of the 69 lower flowers in three other spikes, seven alone had failed to produce capsules." And pollen is often found on stigmas of flowers of Orchids which had not their own pollinia removed, while in others the pollinia had been carried away, but no pollen as yet left on their stigmas. "These facts show conclusively how well moths had performed their office of marriage priests."

Now, is it credible that all this admirable apparatus and these well-ensured

and beneficial results are undesigned? On the supposition that *Orchis pyramidalis* was independently originated as it is, it would not be credible, nor would any one, probably, ever think of raising the question. Although supposable, would the absence of design be much less incredible, on the assumption that the Orchis we have been considering was the progeny (remote or near) of some ancestor which, like several existing Orchises, had the two viscid discs in close apposition, and *that* the progeny of another, which, like most species, had them distinctly separate? it being premised that both the ancestral forms were as perfect in their structure, and as well adapted to their surroundings, as the species with which we have compared them actually are. But we have no desire nor particular occasion to reopen this question now.

To return to our Orchids. The plan or general structure of the flower is the same in all the *Ophrydeæ;* but the particular contrivance varies from species to species, and from one genus to another. One British plant of the tribe, the *Bee Ophrys*,—so various are the resources of nature—differing in this respect even from its congeners, is adapted for self-fertillization, without insect aid. And the way in which the same Orchid-structure ordinarily adapted to insect coöperation, is made to do its own work, and do it well, assisted only by a breath of wind, is abundantly curious.

In the genus *Habenaria*, or *Platanthera*, the anther-cells are more separated and divergent, so that the glands or viscid discs are carried one to each side of the broad stigma, and there is no pouch; but the sticky disc, in some of our species, looking like a little pearl button, is perfectly naked; and when the flower-bud opens, stands directly in the way of the head of a moth or bee, thrusting its proboscis into the nectar-bearing spur. And here the viscidity of the disc, or gland, is beautifully adapted to that state of things. For, although fully exposed to the air, instead of setting hard at once, as in *Orchis*, the disc retains its viscidity during the whole period of anthesis, awaiting the coming of the insect, and quite sure to stick fast to the side of the face of the first one that dips its proboscis into the attractive nectary. The closest analogues we have of the British *Habenaria chlorantha*, so interestingly described by Mr. Darwin, are our *Platanthera orbiculata*, which is not yet in blossom, and *P. Hookeri*, upon which (as our delighted pupils may testify,) Mr. Darwin's details of the contrivance for the fertilization and pretty sure intercrossing of the individuals of the British species may be verified. It is a pretty experiment to bring the head of a butterfly or bee into the proper position, and to see how deftly the disc on each side attaches itself to the eye of the insect, making the animal carry off the pollinia upon withdrawal and migration to another blossom, —to see the pollinia turn inwards and downwards by a double movement, each of about 40 degrees, so that when now applied to the same or another flower, the pollinia no longer will strike against the anther-cells from which they were extracted, but against the broad stigmatic surface below and between. These movements of depression and rotation are best observed, and the intention demonstrated, by applying the tip of the finger or a small slip of glass to the gorge of the flower, so extracting the pollinia, and noticing that the latter, if immediately returned, would be applied to the cells from which they were taken, but that, after the lapse of a minute or less, they have so changed their direction, that now a return of the finger to the same place will pretty surely bring the pollen into contact with the stigma.

In two particulars our *P. Hookeri* differs most obviously from *Habenaria chloranthi*: its anther cells are still more widely divergent, and the labellum is incurved instead of being dependent. And these two particulars seem as if designedly correlated. The nectary of the British species, with hanging labellum, is most accessible by a direct front approach; and an insect whose face would touch and extract both of its pollinia, might, in that position, fail to hit either of the more widely separated discs of *P. Hookeri*. But while a moth of sufficient size would press down the labellum of the latter, using it as a landing place, and probably extract both pollinia at once, smaller insects would have to approach on one or the other side of it, and so be sure to hit one pollinium.

Our *Platanthera bracteata*, which is early flowering, serves completely to exemplify Mr. Darwin's account of the mechanism of *Peristylus viridis* (except as to the early pouch for the viscid discs, which the specimens brought us are too advanced to show, but which are likely to confirm the genus *Peristylus)*; and the whole leaves scarce a doubt of the specific identity of the American and European plants, which botanists have strongly suspected.

Our Fringe Orchises and other Platantheras, blossoming later in the summer, will doubtless furnish interesting and varied illustrations of fertilization by insect aid; and we commend them, with Darwin's charming book as a guide, to all curious and interested observers. We have gone over two chapters only of this book, treating of one tribe of Orchids, and here we must drop it for the present, remarking that the five remaining chapters, so far as we have looked into them,—relating in part to tropical forms,—seem to be no less captivating than those which have give such new and surpassing interest to our most familiar Orchideous plants. A. G.

2. *Outlines of the Distribution of Arctic Plants*, with a map. By Jos. D. Hooker, M.D., F.R.S. (Extr. Linn. Trans., vol. xxiii, pp. 251–348. Read, June, 1860; issued, Oct. 1861.)

We have mentioned this important memoir already in the May number of this Journal, p. 404; have commented upon certain details as they came in the writer's way; and, in the concluding portion of the Report upon Dr. Parry's Rocky Mountain Collection, (which, from the press of other matter, is unavoidably deferred to the ensuing number,) other particulars and special botanical criticisms of this sort will find an appropriate place. Here, instead of such *minutiæ*, which only the systematic botanist could understand or care for, we wish to consider the general plan and character of a treatise upon which a vast amount of labor and knowledge has been lavished.

The immediate subjects of the treatise are the Arctic plants, of every phænogamous species known to occur spontaneously anywhere within the Arctic circle; the geographical distribution of which, so far as known, is carefully indicated: 1. Within the Arctic region, under the several divisions—Europe, Asia, W. America (Behring's Straits to the Mackenzie River), E. America (Mackenzie River to Baffin's Bay), and Arctic Greenland. 2. Without this circle, and under the general divisions of N. and Central European and N. Asiatic Distribution, with three longitudinal subdivisions; American Distribution, with appropriate subdivisions; S. European and African Distribution; Central and S. Asiatic Distribution. The theory upon which the facts are collocated and discussed, and which they are thought strongly to confirm, is that of Edward Forbes, which was completed, if not indeed originated by Darwin:—"first, that the existing Scandinavian flora is of great antiquity, and that previous to the glacial epoch it was more uniformly distributed over the Polar Zone than it is now; secondly, that during the advent of the glacial period this Scandinavian vegetation was driven southward in every longitude, and even across the tropics into the south temperate zone; and that, on the succeeding warmth of the present epoch, those species that survived both ascended the mountains of the warmer zones, and also returned northward, accompanied by aborigines of the countries they had invaded during their southern migration. Mr. Darwin shows how aptly such an explanation meets the difficulty of accounting for the restriction of so many American and Asiatic arctic types to their own peculiar longitudinal zones, and for what is a far greater difficulty, the representation of the same arctic genera by closely allied species in different longitudes. * * * Mr. Darwin's hypothesis accounts for many varieties of one plant being found in various alpine and arctic regions of the globe, by the competition into which their common ancestor was brought with the aborigines of the countries it invaded. Different races survived the struggle for life in different longitudes; and these races again, afterwards converging on

III. BOTANY AND ZOOLOGY.

1. *Dimorphism in the Genitalia of Flowers.*—Two principal kinds of this dimorphism have been noticed in a great number of instances, and put on record in various works; but the instances have not been collected and systematized, nor had the import of the most curious case been made out until it was recently elucidated by Mr. Darwin. There is, first, the dimorphism which Mr. Darwin has recently illustrated in his paper "On the two forms, or Dimorphic Condition, in the species of *Primula*," which was briefly noticed in the preceding number of this Journal (p. 285). This was here long ago named *diœcio-dimorphism* (see Flora N. America, ii, p. 38, etc.); a name which pretty well expresses the thing, as now understood, for these blossoms although hermaphrodite structurally are functionally as if diœcious, or nearly so, the end subserved being fertilization of the ovules of one flower by the pollen of another flower on another individual.

The diœcio-dimorphous species of *Plantago* had seemed to confuse this case with the next. That is, the short-stamened flowers appeared to be fertilized in the closed flower, and the long-stamened and generally sterile plants therefore to be generally useless. This could hardly be; and a recent observation on a single specimen (likely to be confirmed in others) shows the top of the style projecting from the tip of the closed corolla. This refers the case to the same category with *Houstonia*, *Primula*, &c., to which *P. prisella* and *P. heterophylla*, having the corollas of the short-stamened form open in anthers, and the stigma projecting, evidently belong. It is to be noted that dimorphism, both of this and of the following sort, is apt to be variable either in mode or in degree in different species of the same genus, and also that it seldom occurs in all the species of a genus, some of them being unaffected, while others in some genera are nearly polygamous or diœcious;—which is all very favorable to the conclusions that Mr. Darwin wishes to draw.

The second case, which equally belongs to structurally hermaphrodite flowers, is practically the reverse of the first. It is the case in which, besides the normal flowers of the species, which for the most part are rarely or sparingly fertile, other flowers are produced which never open, their development being as it were arrested in the bud, but which are very prolific of seed. Here the stigma is, and must needs be, fertilized by pollen from the anthers of the same flower, the two being shut up together in the same closed bud. The acaulescent Violets and the common wild species of *Impatiens* are good examples of the kind. In fact, here impregnation is effected as it were in the early bud;—wherefore we had indicated these as cases of *precocious fertilization*. Here the pollen is unusually active, sending out its tubes while still in the anther, and thereby in *Impatiens*, &c., attaching the anthers to the stigma. In the first case Nature takes great pains to secure the cross-fertilization of individuals of the species: in the other, on the contrary, she takes equal pains to secure self-fertilization. The end in the first case, as Mr. Darwin maintains, (we believe upon good philosophical grounds, now in the course of vindication by experiment) is to ensure the perpetuation of the species,

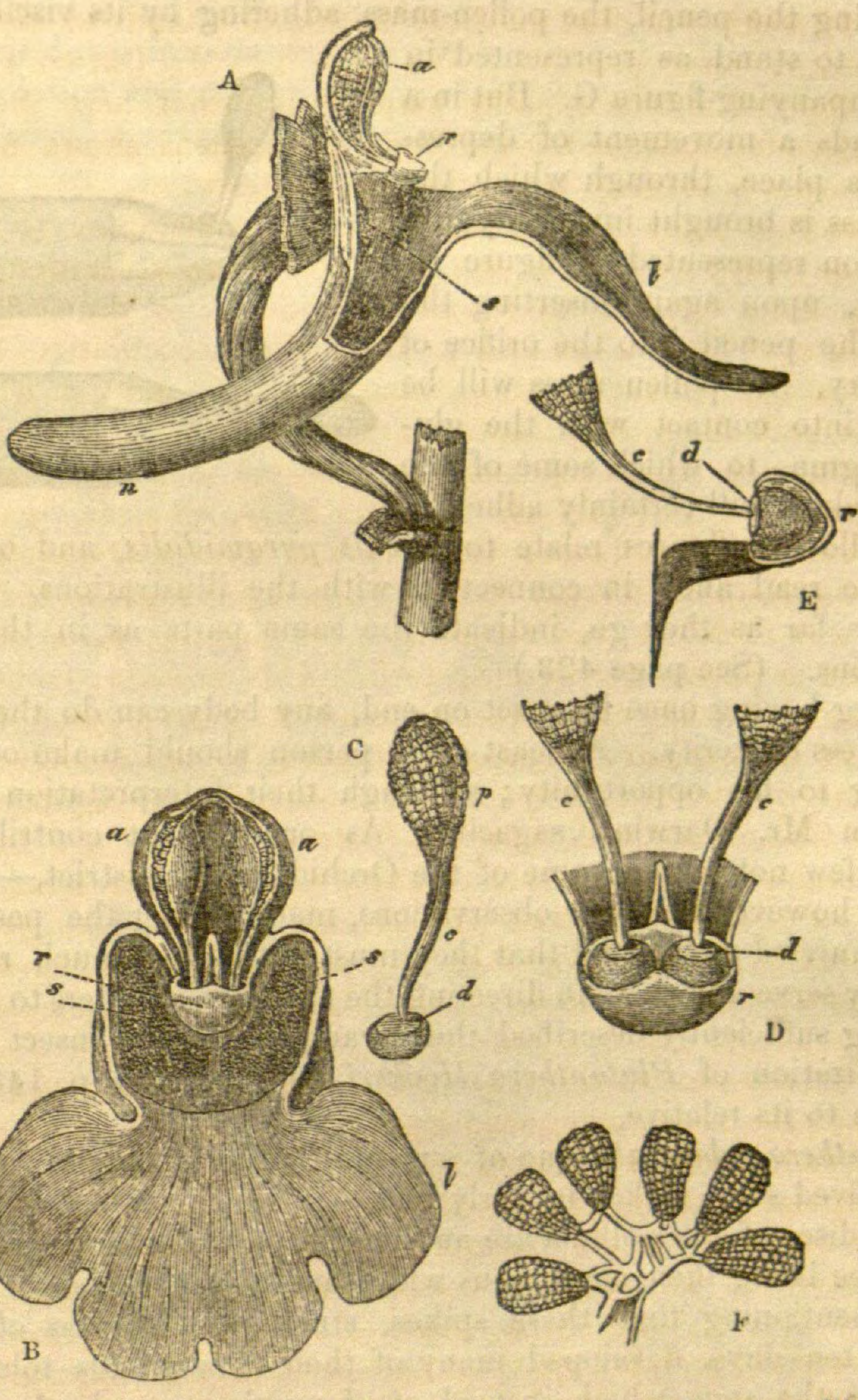
since close-breeding or continued self-fertilization tends to sterility, while wider breeding is recuperative. We leave it to Mr. Darwin's sagacity to ascertain the end in the opposite case, noting that here the most undoubted close-fertilization for indefinite generations shows no apparent tendency towards sterility, but rather the contrary.

From another point of view which we are accustomed to take, however, we may suppose that, as one result the cross-fertilization must needs be to keep down variation by repeated blendings, so the design of close-fertilization may be to allow and to favor the perpetuation of varieties. Self-fertilization, without selection, being just the condition which should most favor both the multiplication of new varieties and their preservation. That such would be the operation (as long ago expounded in this Journal, vols. xvii and xix) appears to us so clear, that we were somewhat surprised at finding that the reviewer of Darwin's *Primula*-paper in the Natural History Review (ii, p. 238) regards the separation of sexes, and therefore cross-fertilization, as favoring variation, and self-fertilization as necessarily inimical to it. This probably comes from not considering that while close-breeding tends to keep a given form true—in virtue of the ordinary likeness of offspring to parents—it equally and in the same way tends to perpetuate a variation once originated from that form, and also, along with selection (natural or artificial), to educe and further develope or confirm said variety. On the other hand, free cross-breeding of incipient varieties *inter se* and with their original types is just the way to blend all together, to repress all salient characteristics as fast as the mysterious process of variation originates them, and fuse the whole into a homogeneous form.

We will also remark (in reference to p. 236, line 31, and p. 238, line 3 et seq. of the above mentioned Review) that the Chestnut does exhibit manifest rudiments of stamens in its pistillate flowers; also that, on morphological grounds, we should look upon hermaphroditism, rather than the contrary, as the normal or primary condition of flowers, and enquire how and why so many became diclinous, rather than "how and why they ever became hermaphrodite." Forms which are low in the scale as respects morphological completeness may be high in the scale of rank founded on specialization of structure and functions. A. G.

2. *Fertilization of Orchids through the Agency of Insects.*—In our notice of Mr. Darwin's charming new work, in the July number of this Journal, we could not get beyond the first two chapters, relating to the *Ophrydeæ*, or the tribe to which the Orchises themselves belong. Those of our readers who, appreciating the treat to which they were invited, have been looking into our Orchideous flowers, will not be sorry to have us resume the subject.

In default of drawings from some of our own species, which we should prefer if we had them, we borrow the cuts with which the author illustrates the two British species (*Orchis mascula* and *O. pyramidalis*) with the account of which Darwin's book, and our abstracts, commenced. These figures should render those abstracts much more intelligible. The small letters denote the same thing in all the figures.



a, anther; *r*, rostellium; *s*, stigma; *l*, labellum; *n*, nectary; *p*, pollinium or pollen-mass; *c*, caudicle of pollinium; *d*, viscid disc of pollinium.

A, is a side view of a flower of *Orchis mascula*, with all the petals and sepals cut off except the labellum, of which the near half is cut away, as well as the upper portion of the near half of the nectary.

B. Front view of the flower, with all the sepals and petals removed, except the labellum.

C. One pollinium, or pollen-mass, showing the packets of pollen-grains, the caudicle, and the viscid disc.

D. Front view of the discs and caudicles of both pollinia within the rostellum, with its lip depressed.

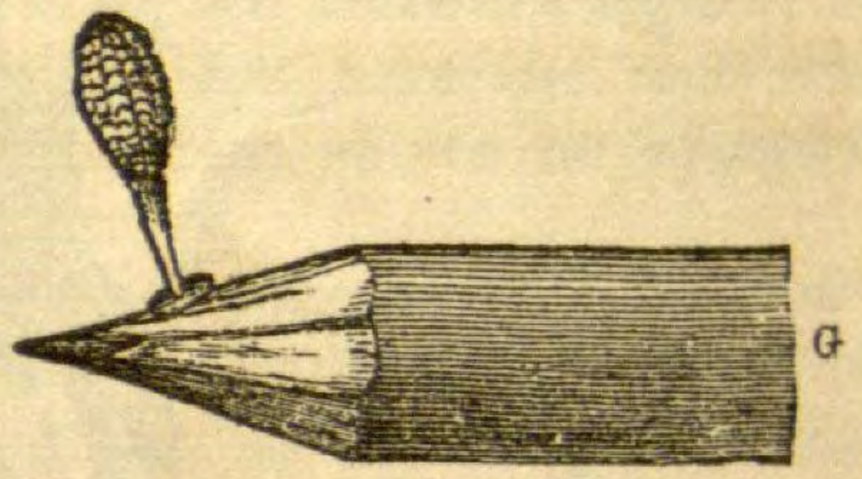
E. Section through one side of the rostellum with the included disc and caudicle of one pollinium.

F. Packets of pollen-grains, tied together by elastic threads, here extended.

The general structure of the flower in this species will be found to correspond very well with that of our *O. spectabilis*.

Now, supposing one of the pollen-masses to be removed from the flower by the insertion of the point of a pencil into the orifice of the nectary, on

withdrawing the pencil, the pollen-mass, adhering by its viscid disc, will be found to stand as represented in the accompanying figure G. But in a few seconds a movement of depression takes place, through which the pollen-mass is brought invariably into the position represented in figure H. And now, upon again inserting the point of the pencil into the orifice of the nectary, the pollen mass will be brought into contact with the glutinous stigma, to which some of the pollen-packets will certainly adhere.



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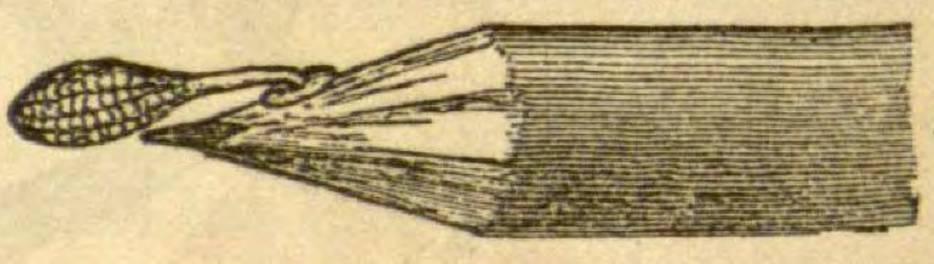


H

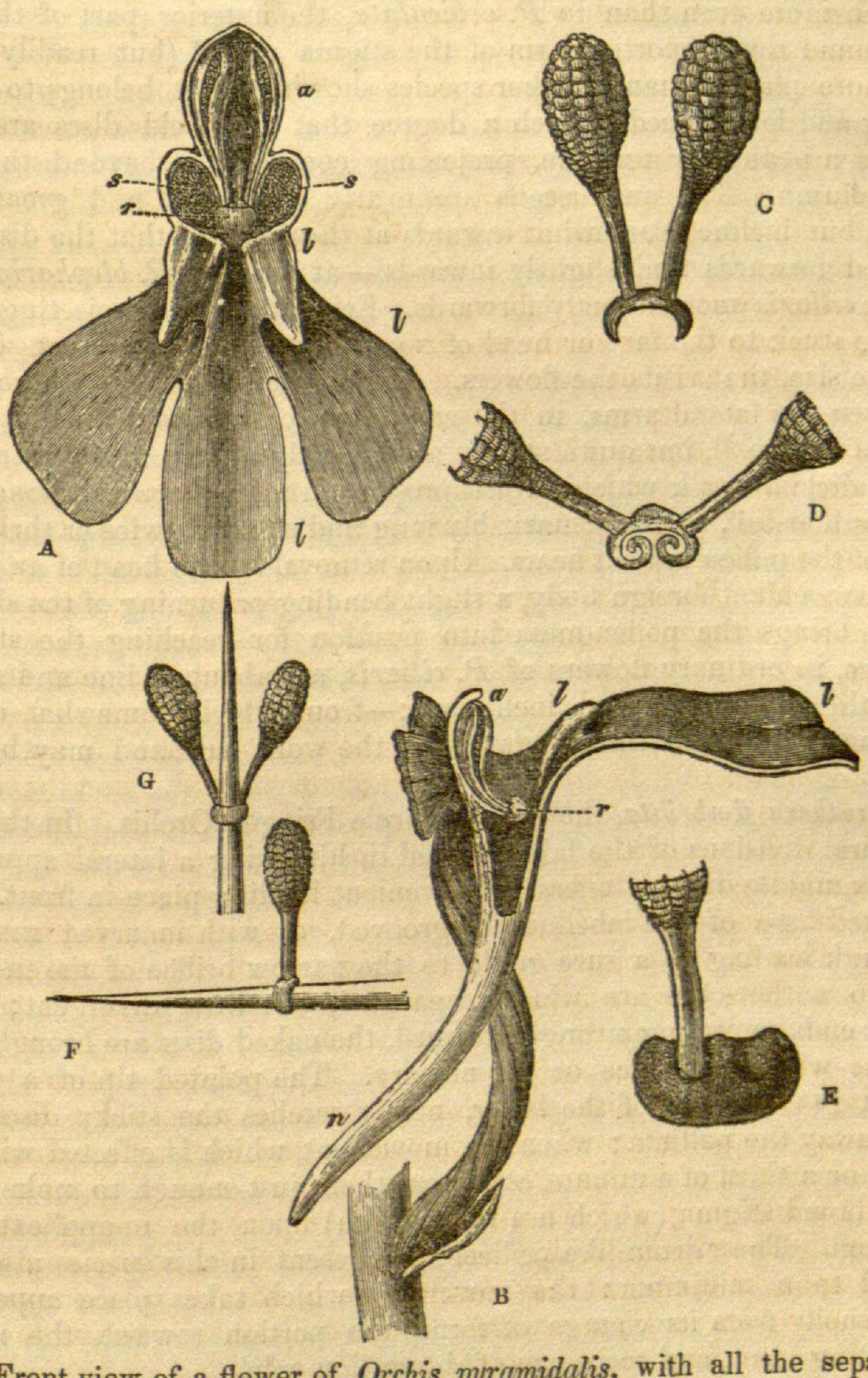
The following figures relate to *Orchis pyramidalis*, and our extracts should be read anew in connection with the illustrations. The small letters, as far as they go, indicate the same parts as in the foregoing illustrations. (See page 423.)

The egg having once been set on end, any body can do the feat, with more or less dexterity. At least every person should make observations according to his opportunity; although their interpretation will often task even Mr. Darwin's sagacity. As our present contribution, we proffer a few notes upon some of the Orchids of our district,—giving due warning, however, that our observations, made during the past summer, were so hurried and casual that they must not be too much relied upon. They may serve a purpose in directing the attention of others to the subject.

Having sufficiently described the arrangements for insect agency in the fertilization of *Platanthera Hookeri* (this volume, p. 143), we will now turn to its relative,

Platanthera orbiculata, one of our most striking species. Of this we first received some spikes in early bud,—in which state it is plain to see that the discs of the pollinia are an integral part of the stigma, their viscid surface being then continuous with that of the stigma. It may be worth mentioning that these spikes, stuck into a glass of water for eight or ten days, developed many of their flower-buds tolerably well, excepting the spur, which instead of elongating remained a scrotiform protuberance,—an 'arrest of development'—and at length sphacelated. The full-grown spur in this species being an inch and a quarter or an inch and a half long, and the divergent bases of the anther-cells so separated by the broad stigma that the viscid discs stand nearly a quarter of an inch apart, it is evident that fertilization is effected by the agency of large Lepidoptera or Hymenoptera. Self-fertilization is out of the question. Here the labellum is pendent, inviting a front approach, while the lateral petals, as is usual in this tribe, guard against a flank movement. The way in which the anterior portion of the anther-cells with the combined arms of the stigma taper and project forwards, so as to raise the discs on a sort of beak, a little in advance of the orifice of the nectary, is well exhibited in Hooker's figure of this species, in the Flora Bor. Amer.: but the discs do not look outwardly in the manner there represented. These, being affixed to the stalk of the pollen-mass laterally, by that intermediate body called the drum-like pedicel, (here developed perhaps even more than in *P. Hookeri*,) really look forward and inward—in fact are so placed that they will be sure to stick one to each side of the

head of a humble-bee or of a large moth that visits the flower, and thrusts its proboscis down into the spur so as to reach the nectar. The movements of rotation and depression in our flowering specimens (all received from a distance) were pretty slow, but distinct.



A. Front view of a flower of *Orchis pyramidalis*, with all the sepals and petals removed except the labellum.

B. Side view of the same, with the labellum longitudinally bisected, and with the near side of the upper part of the nectary cut away.

C. The two pollinia, attached to the saddle-shaped viscid disc, which answers to the two separate discs in *O. mascula* and other species of Orchis, &c.

D. The disc after the first act of contraction. with no object seized.

E. The disc seen from above, and flattened by force, with one pollinium removed,—showing the depression by which the second act of contraction is effected.

F. The pollinia removed by the insertion of a needle into the nectary, after it has clasped the needle by the first act of contraction: side view.

G. The same pollinia after the second act of contraction and depression.

Platanthera ciliaris and *P. blephariglottis*, the Yellow and the White Fringed Orchis, flowering after midsummer, are as similar in their arrangements for fertilization as in general appearance. Under the present point of view, they are chiefly remarkable for having their viscid discs projecting much more even than in *P. orbiculata*, the anterior part of the anther-cell and the supporting arm of the stigma united (but readily separable, more plainly than in other species showing what belongs to each) tapering and lengthened to such a degree that the viscid discs are as if raised on a pedicel or tentacle, projecting considerably beyond the rest of the column. The anther-cells are nearly horizontal, and greatly divergent, but inclined somewhat inwards at the end; so that the discs are presented forwards and slightly inwards,—at least in *P. blephariglottis*, or in *P. ciliaris* more directly forwards. Evidently these projecting discs are to be stuck to the face or head of some nectar-sucking insect, of appropriate size, that visits the flowers. The stigma, which is rather small, is between the lateral arms, in the same horizontal line with the discs: the discs are small, but quite sticky, and directly affixed to the extremity of a caudicle or stalk which, in just proportion to the forward elongation of the anther-cell, &c., is remarkably long and slender, twice or thrice the length of the pollen-mass it bears. Upon removal by the head of an insect or any convenient foreign body, a slight bending or turning of the slender caudicle brings the pollen-mass into position for reaching the stigma. The discs, in ordinary flowers of *P. ciliaris*, are about a line and a half apart; the slender spur an inch long;—from which somewhat of the nature and size of the insect adapted to the work in hand may be estimated.

Platanthera fimbriata, the earlier Purple Fringed Orchis. In this the two lateral divisions of the labellum aid in hindering a lateral approach, while its middle division offers a convenient landing-place in front. The contracted base of the labellum is grooved, or with incurved margins, the trough leading as a sure guide to the narrow orifice of the nectary. The two anther-cells are widely separated, but little divergent; their anterior ends projecting strongly forward, the naked discs are brought just into line with the orifice or the nectary. The pointed tip of a pencil brought to the orifice of the latter, neatly catches the sticky discs and brings away the pollinia; when the movement, which is effected within a quarter or a third of a minute, converges them just enough to make them hit the broad stigma (which lies rather high) upon the re-application of the pencil. The 'drum-like pedicel' is present in this species also, but reduced to a minimum: the movement which takes place appears to result wholly from its change of form, the portion towards the anther contracting most, and to be one of depression solely.

Platanthera psycodes, the later and small-flowered Purple Fringed Orchis, is so nearly related to the last as by many to be regarded as a variety of it. It is more decidedly sweet-scented; and the claw-like base of the labellum is only slightly grooved. A development of the sides of the column as a kind of guard protects the discs laterally in this as in several other species, especially the last and *P. lacera*, preventing all ready access to the nectary except from the front. A stout bristle, slid along the base of the labellum and into the nectary for some distance

will not touch the viscid discs, they lying a little too far back: but on pushing it down deep into the long and curving spur (only the lower half or quarter of which is filled with nectar) it has to be bowed back somewhat, when it catches the discs. So that before an insect can have drained the nectary, the pollinia will be affixed to the base or upper part of its proboscis, or to the forehead of an insect of smaller size. When extricated, the movement of depression is prompt—within a few seconds,—and on re-application the pollen is accurately brought in contact with the stigma. The discs in place look forwards and downwards. We find in this species and in *P. lacera* (both common species and flowering at the same time in the latter part of summer), that the nectar appears to be much more plentiful in the spurs of older than of freshly-opened blossoms, most so indeed in flowers which had their pollina removed and their stigma fertilized several days before, and which were becoming effete. In such flowers the spur was often half full in the present species, and sometimes almost full in *P. lacera*. But although little had dripped down to the bottom of the spur in freshly-opened blossoms, the walls were moistened with nectar throughout its length.

Platanthera lacera, the Ragged Orchis, like the last, must be very attractive to some insects, the pollen-masses are so generally removed from oldish flowers, and the stigma fertilized. The nectary can be approached only from the front, the sides being thoroughly guarded by a broad and thick shield on each side—the arms of the stigma much developed—above supporting the anther, while its inner and concave face bears the remarkably long and narrow viscid discs: posteriorly, on its upper margin, a sort of cellular crest is developed. These guards come forward in front to within half a line of each other at the level of the discs; while above and below the space is wider. The viscid disc which adheres to the inner face of each guard or arm of the stigma, instead of orbicular and small, is lanceolate in shape, with the anterior end broadest, the posterior end acute: it lies transversely, with a slight obliquity: it is as long as the stalk of the pollen-mass, which is directly attached to it near the middle, no 'drum-like pedicel' intervening. When detached by a probe or bristle brought in contact with the viscid disc, a movement of depression takes place, by which the stalk and pollinium are brought down so as to be nearly parallel to the disc, and close to it,—just in proper position to reach the stigma upon bringing the probe back again to the orifice of the nectary.

Platanthera dilatata. The general structure of the flower in this species we had occasion to describe in the preceding number of the Journal (p. 259): this need not be repeated. It accords wih *P. lacera* in having very large and strap-shaped viscid discs, but in no other respect. For in this the anther-cells are appoximate and nearly parallel; and the discs are parallel and vertical, approximate, and placed just over the back side of the narrow orifice of the spur, looking forwards; they are nearly as long as the pollen-mass and its stalk together; the latter is short and flat, and is attached to its disc just below the summit of the latter. No movement of depression or of rotation was detected. The throat of the flower is a narrow chamber, bounded by the connivent-erect bases of the parts of the perianth; and the stigma and the discs lie so low in this

chamber that fertilization cannot be effected without insect-aid, and this can be given only by means of a proboscis. We find accordingly that a pig's bristle cannot be thrust down to the bottom of the spur and withdrawn without bringing away one of the pollinia. But the anther-cells are very early dehiscent, and the pollinia are often dislodged as soon as the flower opens. Yet from the arrangement of the parts, we think they can never fall over upon their own stigma, as they habitually do in the allied—

—*Platanthera hyperborea.* We have elsewhere stated (this volume, page 260) this species readily, and so far as we could ascertain from a few specimens, regularly *self-fertilizes* and without extraneous aid. We have nothing important to add to the brief account of the structure and process already described,—except that the packets of pollen are looser and the threads that attach them to the caudicle weaker than usual; while the discs (which are oval and rather small) retain for a good while their viscidity. So that a fitting insect, on visiting the open flowers, in which the pollen-masses have already fallen over on to the broad stigma underneath, will yet catch one or both the discs upon his proboscis, carry off the pollinia (which may be readily detached from the stigma, leaving some packets of pollen behind), and apply them in succession to the stigmas of other flowers of other individuals, and thus effect occasionally the crossing which is so uniformly effected in most species of the tribe. If the rule holds here as elsewhere, that a stigma is more sensitive to the pollen of another flower than to that of its own, there will be no lack of sufficient crossing in this species, wherever proper insects abound; where they do not, it will be prolific without them. We have observed that this species is very fertile, usually maturing all its ovaries. *Natura non agit saltatim*, and is more flexible and diversified in her ways than we are apt to think: many other cases of occasional or habitual self-fertilization may be expected among Orchids.

Gymnadenia tridentata is an additional instance of the kind, as we have elsewhere intimated (p. 260, foot-note), and one apparently so remarkable that we hesitate to bring forward our too scanty observations until another summer affords an opportunity to test them. We may venture to say, however, that, although the anther-cells open before the flower expands, and the pollen-masses are often spontaneuosly dislodged, —the discs being still in place,—yet, so far as we can see, they cannot of themselves fall upon or reach the stigma beneath. To do this they must be conveyed, in the usual way, upon an insect's proboscis, and most probably they often are so conveyed from one flower to another. Also, the pollen-packets are still more loose and separable than in *Platanthera hyperborea;* many of them are found spontaneously detached in the full-grown flower-bud or freshly expanded blossom, lying upon the open anther and adjacent parts, and especially upon the naked-cellular tip of the narrow process of the rostellum which rises between the two discs, and upon the cellular summit of the process outside of each disc. These are soft, moist, and somewhat viscid. The pollen which falls upon them adheres there, *and sends down pollen-tubes freely into their substance.* So that they appear to act as stigmas; although the normal stigma is found in its proper place and of ordinary appearance underneath the discs.

Having room for only two or three more brief notes, one of them shall be upon—

—*Goodyera.* We can only refer our readers to Darwin's description of *G. repens*, which is common in all our northern forests. We confirmed before we read Mr. Darwin's conjecture (on p. 114) "that the labellum moves farther from the column in mature flowers, in order to allow insects, with the pollina adhering to their heads or probosces, to enter the flowers more freely." Except that, if we mistake not, it is the column which changes its position, rather than the labellum. All freshly-opened blossoms have the column so directed—a little bowed forwards—that the tip of the *disc and of the anther* are presented to view as you look into the narrow opening of the flower; and a proboscis or bristle, introduced, and following as it will the curvature of the lip-like or nozzle-shaped apex of the labellum, and passed down to its saccate nectar-bearing base, will inevitably hit the disc, and if detained a moment, will bring the pollinia away when withdrawn. On re-introduction, the pollina will not pass down to the stigma, but lodge on the upper side of the column, from whence they were taken. But on looking into older flowers of the same spike, still fresh and good, and whether their pollina have been extracted or not, the *stigma* is in full view, the summit of the column (we believe) being now turned somewhat upwards or backwards; and there is now room enough between it and the labellum for the pollinia to pass; indeed now the pollinia will regularly hit the stigma, to which packets of pollen will plentifully adhere. So, as bees, &c. are said to begin at the bottom of a spike and to proceed regularly upwards, the pollen taken by them from the flowers of any spike will never fertilize other flowers of that spike, but will be carried to another plant, where it will fertilize the lower blossoms ready for it,—from which spike in turn pollen will be carried off to fertilize the flowers of a third plant, and so on!

Goodyera pubescens, although specifically quite distinct, accords with *G. repens* in all the above particulars.

Spiranthes, both *cernua* and *gracilis*, confirm Darwin's account: the difference in the position of the parts—the disc and anther presented in the younger, the stigma in the older flowers, just as in *Goodyera*—is so very striking that we wonder how we overlooked it last year. Here, also, we suspect that it is the column, rather than the labellum, which changes its position, but we have not been able to demonstrate it.

We are obliged to defer all account of observations upon native Orchids of other tribes, except *Cypripedium*, upon which we must hazard a few remarks. Mr. Darwin has been able to examine only a few tropical species, and those incompletely. The North American species and the allied one of Northern Europe would probably have modified his conclusions. In none of our species is the pollen "so glutinous that it can be drawn out into threads."

In *C. acaule* it is granular, pulverulent, and almost dry, except the surface (laid bare by the sphacelation or deliquescence of the whole anterior face of the anther), which is as if freshly coated with sticky varnish, and so adhesive that a body of small surface brought in contact with it

will bring away a piece of pollen of corresponding size; one of larger surface, like the tip of the finger or the head of a fly, brings away the whole mass of pollen of one or both cells. In the wild plants we find that the pollen is often carried off, either bodily or piece-meal. The stigma is rather concave than convex, and is slightly viscid.

In *C. pubescens*, *parviflorum* and *spectabile*, the whole pollen (equally exposed by the destruction of the face of the anther after dehiscence) is pulpy but very little glutinous.

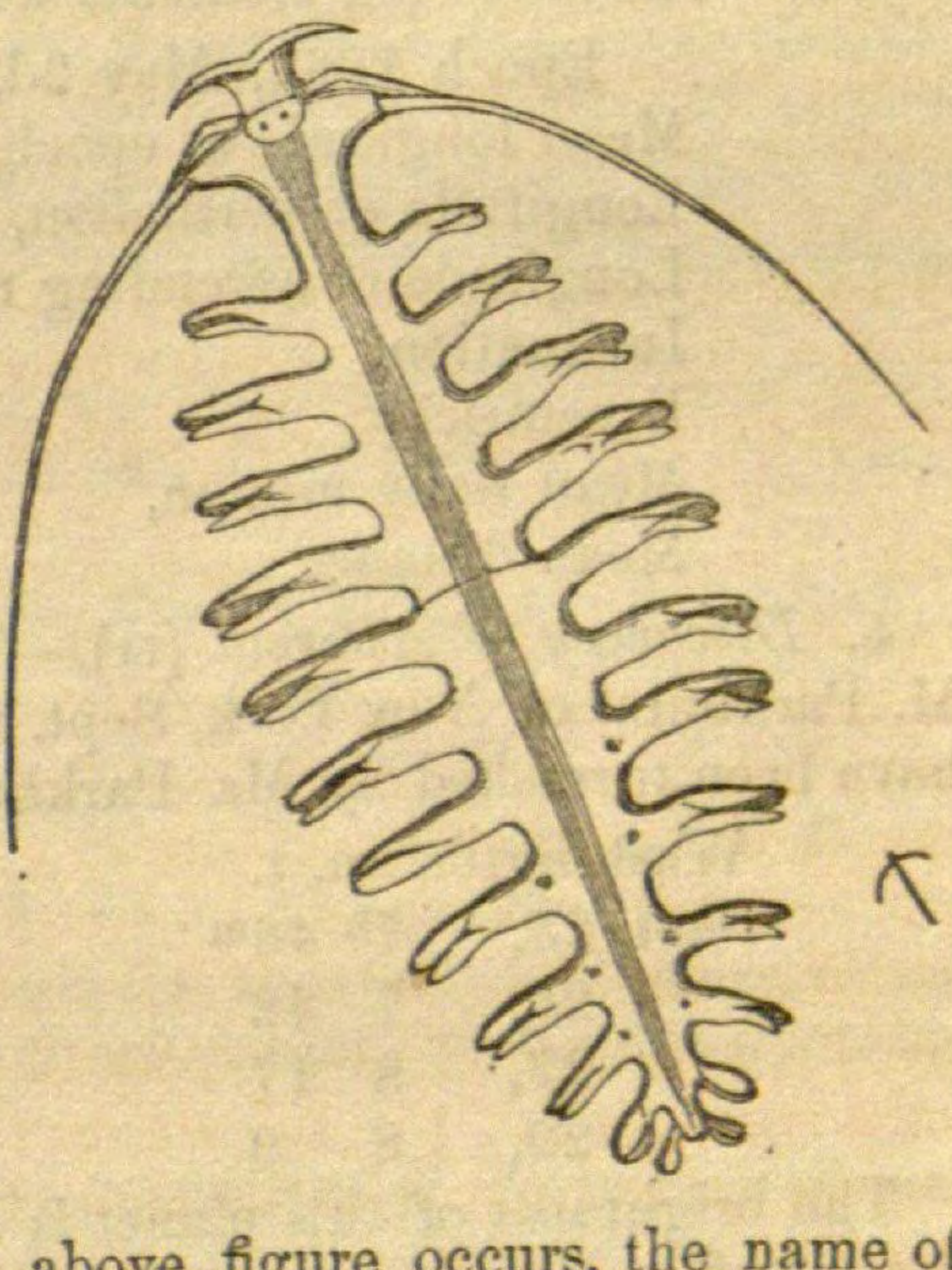
In all the species it is impossible that fertilization should be effected without extraneous aid. That aid may perhaps be given in the manner that Mr. Darwin supposes (but hardly in *C. spectabile*), that is, by a large insect inserting its proboscis into either of the lateral entrances at the base of the labellum, under the anther, and so thrusting some of the pollen forwards to the stigma, or more likely carrying some away to another flower, and leaving it on its stigma while attempting to gather the slight glutinous exudation that moistens the beard of long hairs which line the labellum underneath. But an attentive consideration of the arrangement in the species above mentioned, convinces us that the work is done by insects, such as flies, which crawl bodily into the flower. They may enter by one lateral opening, and so take a load of pollen upon the back of the head as they pass under the anther, which they would rub against the stigma, since they must crawl directly under it to feed on the nectar of the beard close underneath; and, escaping by the opening under the other anther, they would carry off some of its pollen to the flower of the next plant visited. But, although we have not been able to detect insects actually at work, we confidently gather from their traces, and from a variety of facts which we cannot here enumerate, that they ordinarily go in by the front entrance (even in *C. acaule*), crawl under the ample face of the stigma as they feed, where they cannot well avoid rubbing their heads or backs against the stigma, and passing on, make their exit by one of the lateral openings which now become visible to them, almost inevitably carrying off pollen on their head or shoulders as they escape, which pollen they would convey to the stigma of the next flower. Now the stigma offers no slight confirmation of this hypothesis, in a structure which has never before been noticed, but which is very striking in *C. spectabile*, &c., and most admirably adapted to the end in view. That is, the broad stigma, instead of being smeared with glutinous matter, as in ordinary Orchids, is closely beset with minute, rigid, sharp-pointed papillæ, all directed forwards,—so that the surface, when magnified, is like that of a wool-card of the olden time; and any pollen which an insect, working its way upwards to the base of the labellum, carries upon its head or back (to which alone it could be expected to adhere) would be neatly *carded* off by and left upon the stigma. The beauty of these adaptations can be appreciated only by actual inspection of the parts or of a series of figures.

We cannot close without an expression of gratitude to Mr. Darwin for having brought back teleological considerations into botany. So difficult is the study of functions in plants, so impossible often to find out the use or meaning of the various modifications of organs, and so unscientific and foolish the conjectures which are apt to be hazarded upon the

subject, that Geoffroy's saying, 'science knows nothing of intention in nature' had well nigh become a conceded, even if unexpressed principle in natural history, especially in botany. Under the study of homologies —so fertile in excellent results—botany and even zoology have become almost exclusively morphological. In this fascinating book on the fertilization of Orchids, and in his paper explaining the meaning of dimorphism in hermaphrodite flowers, Mr. Darwin,—who does not pretend to be a botanist—has given new eyes to botanists, and inaugurated a new era in the science. Hereafter teleology must go hand in hand with morphology, functions must be studied as well as forms, and useful ends presumed, whether ascertained or not, in every permanent modification of every organ. In all this we *faithfully* believe that both natural science and natural theology will richly gain, and equally gain, whether we view each varied form as original, or whether we come to conclude, with Mr. Darwin, that they are derived;—the grand and most important inference of *design in nature* being drawn from the same data, subject to similar difficulties, and enforced by nearly the same considerations, in the one case as in the other. A. G.

ZOOLOGY—

3. *Upon a new species of Tomopteris.*—This minute worm, of which a magnified figure (made by Prof. Dana while in the East Indies) is here given, agrees in generic characters, (as they are stated by Grube, in *Die Familien der Anneliden,*) with *T. onisciformis*, from the figure of which however, (published by Quoy and Gaimard, in the *Ann. des Sci.*, 1re Sér., T. x,) it differs very markedly. It will be seen that, in the want of a tail, it corresponds to what Carpenter and Claparède—as reported by Dr. Leuckart, *Wiegm. Arch.*, 1860–61—have regarded as the young condition of *T. onisciformis;* but the minute size of the specimen, in connection with the absence of the anterior pair of bristles, which are also reported to characterize the young, make it highly improbable that we have here an immature form. Prof. Dana having very kindly placed at the disposal of the writer his occasional observations upon the Annelids made during the Wilkes Exploring expedition, among which the above figure occurs, the name of *Tomopteris Danæ* is proposed for this new species. It was found by him in the Sooloo sea in Jan., 1842. In his notes it is remarked that "the fingers of each arm do not fold against one another; they constitute a forked extremity to the arm, the forks lying nearly in the same vertical plane and diverging about 60°." W. C. M.



November 3, 1862.