FERTILISATION OF ORCHIDS.

On the Various Contrivances by which British and Foreign Orchids are Fertilised by Insects, and on the good Effects of Intercrossing. By CHARLES DARWIN, M.A., F.R.S. London: John Murray. 1862. 8vo. pp. 365.

THERE IS NOTHING IN NATURE apparently so chaste as a garden of flowers. Who would believe that the timid blushing things were all coquetting with one another, and with the bees and butterflies? We have heard of modern books on the "language" and "sentiment" of flowers, which, doubtless, let one into some of their secrets; but the truth was pretty well understood in the old times before us. A single passage will suffice from the "Génie du Christianisme" of the eloquent Chateaubriand:

"One often sees in a profound calm, at the dawning of Aurora, the flowers of a valley motionless on their stems; they recline in various attitudes, and look towards every point of the horizon. At this very moment, when all appears so tranquil, a mystery is accomplished; nature conceives, and these plants are so many young mothers turned towards the mysterious region from whence comes their fecundity. The sylphs have sympathies less aërial, communications less imperceptible; the narcissus consigns her virgin progeny to the streams, the violet confides to the zephyrs her modest posterity, a bee collects honey from flower to flower, and unconsciously fertilises a whole meadow; a butterfly bears an entire nation on its wing. The loves of the plants, however, are not equally tranquil; some are stormy, like the passions of men: it requires a tempest to marry, on their inaccessible heights, the cedar of Lebanon to the cedar of Sinai; while, at the foot of the mountain, the softest wind suffices to produce a voluptuous commerce among the flowers."

Dr. Kurt Sprengel says the flowers spread out their petals on purpose to attract insects, and we quite believe it, for curiosity is strong in the soul of nature. A boy's kerchief, waving on the heath, will lure the kestrel from the sky; and a light dress will attract, as we have seen, a multitude of winged atoms (*Trichopteryx* of the entomologist) out of the viewless air. If we may believe Mr. Darwin, there is even a race between certain flowers, as to which can stick themselves out most, so as to tax the energies of their admirers to the last degree. In the woods of Madagascar the *Angræcum* expands its large six-rayed blossoms, like stars formed of snow-white wax, with green nectaries of 11½ inches in length, hanging down beneath. As only the lower inch and a-half of their nectaries is filled with honey, *there must be moths with tongues of proportionate length*; and if the tongues of these moths are growing longer by "natural selection," the whip-like nectary of the Orchid also elongates and "still troubles each moth to insert its proboscis as far as possible in order to drain the last drop of nectar."

In pursuance of his promise to substantiate by facts the speculation upon the "Origin of Species," Mr. Darwin has now given us in a special volume the result of numerous and careful examinations of a particular tribe of plants, selected for study because (like the pigeons among domesticated things) it promised to afford very favourable evidence. Long ago it was noticed by Robert Brown, and still earlier by Sprengel (1793) that the structure of orchideous flowers was often such that the seed could not be fertilised except by the assistance of insects. This is the case not only with the British species, but also with those superb hothouse plants which form the chief attraction and ornament of our early flower-shows; they will not set a seed without artificial assistance. In the whole tribe, consisting of 433 genera, and about 6000 species, fertilisation is almost invariably left to insects; and "the contrivances by which it is effected are as varied and almost as perfect as any of the most beautiful adaptations in the animal kingdom." The author's second purpose is to show that these contrivances have for their main object the fertilisation of each flower by the pollen of another flower. So far we believe Mr. Darwin is quite successful. "Intercrossing" appears to be so important, that it may be regarded as a law of nature; and illustrations are to be met with at every step. Mr. Darwin himself has shown us that the common red clover of the fields requires to be visited by the humble-bee; and that the exotic *Lobelia fulgens* in this part of England is never visited by insects, and consequently, from its peculiar structure, can never form any seeds. That the common fig requires "caprification," has been known from the most remote antiquity. The flowers of the wood sanicle cannot be fertilised by their own pollen, for another reason—because the pistils are mature before the stamens, which is not uncommon in the order *Umbelliferæ*. A similar circumstance promotes intercrossing amongst the insect tribes. Every collector will have observed that the females of certain butterflies, such as the golden-brown Fritillaries (*Melitæa* and *Argynnis*) appear a fortnight before the males; and it is strange to see the fresh and brilliant courtiers pursuing old and battered virgins, who have doubtless wandered far away from their birthplace and the companionship of near relations. Provisions of the same kind may be traced among the shell-fish, whether they be free wanderers like the snail, fixtures like the oyster, or imprisoned like the rock-borers,

> Each in his narrow cell for ever laid.

The purpose of this law is as unquestionable as the fact, if we may judge by the result; for the species of animals and plants equally degenerate when free intercommunication is restricted. The knowledge of these circumstances is the foundation of the improved modern management of stock, and it would be well for humanity if we acted upon it ourselves, and made the laws of consanguinity more stringent. The medical profession is well aware that alliances between near relations not only aggravate the hereditary tendencies, but produce others, such as deafness, and cataract, and idiotcy, in families not ordinarily subject to these calamities. On the other hand, the inevitable consequence of intercrossing must be the elimination of individual peculiarities, and the maintenance of the normal character of the species or race. We apprehend that all the races of plants and animals which are confined to islands or mountain summits, or isolated in other ways, are becoming more specialised and tending towards extinction; while those of a vagabond character are daily on the increase. Let us be thankful that we live in pre-Manchester-millennial times, while so many of the marvels of creation remain to us, and thorns, and briars, and cotton-grounds have not wholly possessed the earth.

To come back to the Orchids; how shall we account for the strange forms of these insect-seeming flowers? R. Brown imagined that some resembled bees, in order to deter insects from visiting them. We should have thought it was for a contrary reason; but Mr. Darwin says he has never seen an insect visit the bee-ophrys, and he doubts the statement of Mr. Price that it is attacked by the humble-bee. For ourselves, we should be content with the Oriental fancy, that flowers are the souls of departed butterflies. But there is another explanation, at which we can only hint, as it forms part of a more general question. Those who are interested in the subject may consult the "Horæ Entomologicæ" of Macleay, and Strickland's paper on "mimetic" resemblances. Mr. Darwin doubts whether the numberless structures which exist in nature, for no obvious use, could have been created for the sake of mere variety and beauty, and seems to regard these functionless organs and fanciful resemblances as the "touches" which "make the whole world kin." The advocates of "unity of design" in creation will claim them as so many proofs of the correctness of their views. They will say, with Emerson, to the Rhodora,

> Why wert thou here, O rival of the rose!
> I never thought to ask, I never knew;
> But, in my simple ignorance, suppose
> The self-same Power that brought me here brought you.

Although we can boast of nothing at all comparable with the magnificent epiphytal orchids of tropical forests, which grow on boughs overhanging streams that are ascended only by canoes, yet for the purposes of scientific inquiry we are by no means badly off. The woods and chalky pastures of Kent are especially rich in orchids, and Mr. Darwin says that nine genera, including thirteen species, grow within a mile of his house. The structure of the flower is essentially the same in the whole tribe. Three coloured sepals, answering to the *calyx* of other flowers, alternate with three petals, of which one is different from the rest. This one should be uppermost, but owing to a twist in the supporting stalk (formed by the *germen*, or immature fruit), it usually hangs down, and is called the lip (*labellum*). It is generally furnished with a tubular spur, or nectary, projecting backwards, and sometimes resembles the dark velvety body of an insect, while the lateral petals stand out like wings. The *labellum* is often tripartite, owing to the combination with it of two of the next triad of organs—the outer whirl of stamens. The third stamen is the only one usually developed, but there are indications of an inner set, two of which become fertile in the slipper orchids. This single stamen is combined with the pistil to form the "column," which rises up from the centre of the flower. Of the three stigmas two are confluent, and the third forms a little beak (*rostellum*) projecting over them, and carrying a *viscid disk*, to which the anthers adhere. These fifteen floral organs are arranged three within three, in alternating order, and their relation may be ascertained by tracing, as Mr. Darwin has done, the course of the fifteen bundles of spiral vessels which always proceed upwards from the six groups surrounding the ovarium.

"It is very doubtful," says Mr. Darwin, "whether these details will be endured by the general reader;" but without them we cannot refer to a few of the special contrivances exhibited by our British Orchids, and which some of our readers may wish to verify next spring. Any one who has examined with the microscope the pollen of an orchis (such, for example, as the early flowering species whose crimson bloom is made to contrast with the golden cowslips in our butter-shops!) will have noticed that instead of forming fine light dust, as in other flowers, it consists of two waxy masses (or *pollinia*), each composed of a multitude of packets of pollen-grains, like cartridges, or like the *spermatophora* of the cuttle-fish. The *pollinia* have long tails which become attached to the viscid disk of the *rostellum*, and assume the function of stalks. Placed thus close above the stigma, the pollen of the orchis would never reach its destination if left to itself. Covered by a bell-glass the flowers wither without producing a seed. But if an insect should alight on the *labellum* and push its proboscis into the nectary, the viscid bases of the pollinia (one or both) are sure to stick to it, and when withdrawn from the flower, and exposed to the air, this sticky substance has the peculiar quality of setting hard and dry in a few minutes. The proceeding of the fly may be imitated with a pointed pencil, to which the pollen masses will adhere, and if watched for half a minute they will be observed to bend down upon the pencil

till they touch it—a movement which looks as if it were spontaneous, but is really hygrometric, and may be repeated by alternate wetting and drying in some cases. The object of this movement of the pollinia refers to their usual position on an insect's tongue, for if they diverged from it they would never be of any use, but by falling close they become inserted with the tongue into other flowers, and portions of their pollen are detached by adhering to the stigmatic surfaces of the pistils. They can thus be applied to and will fertilise many flowers.

In the "pyramidal orchis" the *pollinia* are attached to a single saddle-shaped disk, and always removed in pairs. At the sides of the nectary the *labellum* is furnished with little projecting plates, compared to the "instrument sometimes used for guiding a thread into the fine eye of a needle." These compel the proboscis of a moth—or a fine bristle inserted between them—to enter the minute orifice of the nectary, and depress the lip of the *rostellum*, which partially closes it, "like a trap placed in a run for game." When withdrawn it removes the disk and attached *pollinia*, and when pushed into another flower the *pollinia* will be found to have acquired the right position to strike against the stigmatic surfaces which are only sticky enough to break their elastic threads and tear off part of the pollen, leaving plenty for other flowers. Mr. Westwood has taken humble and hive bees with the *pollinia* attached to them; and similar observations have been made in France. But the butterflies and moths are the chief fertilizers of the common British orchids. Mr. Bond has taken twenty-three species of *Lepidoptera* with the *pollinia* of the pyramidal orchis attached to their tongues. A large majority of these moths and butterflies had two or three pairs of *pollinia* attached to them, and invariably to the proboscis. An *Acontia* had seven, and a *Caradrina* no less than eleven pairs, presenting an extraordinary arborescent appearance. "The unfortunate moth, with its proboscis thus encumbered, would soon have been starved to death." Many species of orchids with dull or inconspicuous flowers, attract the visits of insects by their scent, like the leafless "bird's-nest orchis," with its sickly-looking bloom, and the little "musk orchis," with small green flowers, hidden in the grass of the chalk downs, which emits a strong musky smell, especially towards nightfall. But there are some, like the fly-ophrys, which have no honey, and whose flowers are inconspicuous and scentless. It is difficult to conjecture what attraction these offer, or what creature visits them, and in fact they are very seldom fertilized. Mr. Darwin has examined several hundred individual flowers, and found that less than half had one or both the pollen-masses removed, and the proportion of seed-capsules produced was even less. When transplanted from their native haunts they set no seed. Some of our native orchids (*e.g. morio, fusca*, and *maculata*,) have a nectary with no honey, and Sprengel calls them "sham nectar-producers," but Mr. Darwin refuses to admit so "gigantic an imposture." He believes that the walls of the nectary, being juicy and sweet, are punctured by insects, as in the case of *Mormodes* and some other foreign orchids. In our greenhouses insects often bite holes through the nectaries to get at the honey, a bad habit, which would lead to the extinction of the species, if invariably followed in their native homes. These observations throw a new light on the causes of the rarity of species. The fine *Orchis fusca* of the Kent woods is not very attractive to insects, and is often imperfectly fertilised; the same has been remarked of its relative, *O. militaris*, in Germany. The fragrant *Gymnadenia* grows equally in meadows and on the chalk-downs; and it is a pretty little experiment to push a fine bristle into the narrow mouth of the nectary, and observe how certainly the *pollinia* are withdrawn. The butterfly orchis, with conspicuous white flowers, depends for its fertilisation on the larger nocturnal *Lepidoptera*, and moths have been taken with one eye covered and blinded by its viscid disk. In the broad-leaved *Epipactis* of our southern and western counties, the structure is such that an insect would not push against the anthers till it was in the act of backing out of the flower. Mr. Darwin found a spike with nine open flowers, from the whole of which the *pollinia* were removed, with one exception, in which a fly, too small for the task, had become glued to the stigma and there miserably perished. One of the prettiest British orchids, called the "fragrant lady's tresses" (*Spiranthes autumnalis*), has the tubular flowers arranged in a spire. It secretes abundant nectar, and the labellum is channelled, but the passage is so narrow when the flower first opens, that only a fine bristle can be passed down it, in which state, although the *pollinia* may be removed, the flower cannot be fertilised; afterwards a wider passage is found to the stigmatic surface. Mr. Darwin watched a colony of these flowers, and saw two kinds of humble-bees visit them. He caught one with *pollinia* attached: it had removed those of five flowers, and left portions of three of them on the stigmas of other flowers. The bees alight at the bottom of the spike, and crawl up it spirally; from the highest flowers they carry away the *pollinia*, and convey them to the more fully expanded lower blossoms of another plant. The twayblade (*Listera ovata*) is fertilised by small *Hymenoptera*. As soon as the flower opens, if the crest of the *rostellum* be touched ever so lightly, even with the thinnest hair, a large drop of viscid fluid is instantaneously expelled, and invariably catches the tips of the loose *pollinia*. This fluid sets hard in two or three seconds, and so rapid is the explosion, that when produced by a needle, it is not easy to avoid bringing away the *pollinia* also. These flowers secrete abundant nectar, and are much visited by small *Hymenoptera* and two-winged flies. They were observed when crawling into the youngest flowers to retreat suddenly, with the pair of bright yellow *pollinia* sticking to their foreheads: and in one case an extremely minute insect, not so large as one of the *pollinia*, was found vainly struggling, with its whole head buried in the hardened cement.

The bee-ophrys is the only British orchid in which there is any arrangement for the purpose of self-fertilisation, and the case is perplexing to Mr. Darwin in an unparalleled degree. The pollen masses have long, slender, and flexible stalks, by which they hang down and vibrate in the slightest breath of air, so as to strike against the viscid stigma, and are there secured. R. Brown, who first observed this peculiarity, thought it was common to the species of the genus *Ophrys*, but it is not so in the spider-ophrys, nor yet in *O. arachnites*, which is sometimes considered a variety of the bee.

We can only refer to a few of the foreign orchids which the author has examined in fresh bloom through the liberality of metropolitan florists. The diversity of the contrivances, almost all adapted to favour the intercrossing of distinct flowers, seems to be exhaustless. In many the *labellum* is suspended by a slender and elastic strap, and is sometimes fringed, so as to vibrate with the slightest breath of air; it is said to be sometimes irritable, as in the Australian *Calana*, which, when an insect alights upon it, suddenly shuts up against the "column," and incloses its prey as it were in a box. In *Dendrobium* the filament of the anther is elastic, so as to shoot out the pollen-mass, when disturbed by an insect, in such a manner that it may rebound and adhere to the stigma. The superb *Cattleya* may be fertilized by the humble-bee, for Sir W. Trevelyan has caught one in his hothouse, where the *Cattleya* was in flower, with its whole back smeared, and four *pollinia* attached, ready to be conveyed to other flowers. In *Masdevallia fenestrata* the sepals cohere, leaving only a narrow opening or window on each side, where a small insect might enter, or a large one insert its proboscis: "some new and curious contrivance has here to be made out!" In the magnificent tribe of *Vandeæ*, including many showy genera, like *Oncidium*, *Aërides*, and *Phalænopsis* (of which those ladies who can afford it make bridal wreaths), the pollen forms waxy masses, united to the *rostellum* at an early period of growth, and removed by insects, together with the disk. *Calanthe* has eight pollen-masses radiating from one disk, which may be withdrawn by inserting a needle into the mouth of the nectary. In *Mormodes* the pedicle of the *pollinium* is so elastic as to straighten and recurve with an instantaneous rebound, swinging up an inch or two, and if no object is in the way (such as an insect) it falls down, and generally alights and sticks on the crest of the *labellum*. Twelve or fifteen minutes elapse, after ejection, before the pedicle again straightens and the anther-case drops off, and within such an interval it is almost certain that an insect would leave one plant and fly to another. The American genus *Vanilla* is cultivated for its pods in the East Indies and Tahiti, but does not fruit without artificial aid when removed from its own home and the insects specially adapted for its fertilisation. Lastly, the *Catasetum* presents nothing to attract insects, and no means of attaching its disks, but the *rostellum* has two processes like *antennæ*, of which the right hangs down and is apparently functionless, while the left is held up. The slightest touch applied to this left-hand antenna causes the *pollinia* to be shot out with a force sufficient to carry them a distance of two or three feet. The most successful fertilisers of orchids have never set the fruit of *Catasetum*, nor has it been found with seeds in Essequibo. But Sir R. Schomburgk states that he has seen the flowers of *Catasetum* growing on the *same plant* with those of two other supposed genera, *Monacanthus* and *Myanthus*. It is, therefore, now regarded as the male flower; and the second (known to produce abundant fruit) as the female form of the same plant; while the third, differing equally from the others in appearance, combines the characters of both sexes, as in ordinary orchids. The *pollinia* of *Catasetum* are shot out like a blunt arrow, with an adhesive point, and seem expressly intended to be discharged at some downy moth, which, disturbed by the blow, will fly with them sooner or later to the female plant. Mr. Darwin believes the genus *Acropera* also to be a sterile plant, and that the fertile form is yet unknown. "All the parts of the flower seem contrived that it should never be fertilised." The widely-disseminated tribe of slipper-orchids, of which we have one British species (the *Cypripedium*, or lady's-slipper), differ from all the rest far more than any others differ. One author regards them as the "record of a former and more simple state of the order." But they appear as much to require the aid of insects.

In conclusion, Mr. Darwin illustrates the "struggle for existence," by contrasting the extraordinary fecundity of some orchids with the comparatively insignificant share they take in the general herbage. *Epipactis grandiflora*, one of the least vulgar ornaments of limestone woods, produces 6000 seeds to the capsule, or 24,000 to the plant. The smaller seeds of the common spotted orchis are quite as numerous, and 30 capsules may be found on a spike, containing altogether 186,000 seeds, enough, if all grew, to cover an acre of ground rather more closely than they could flourish. At this rate of increase, "the great grandchildren of a single plant would nearly clothe with one uniform green carpet, the entire surface of the land throughout the globe."

Tennyson, who appears to have been much impressed by facts of this kind, and who anticipated Mr. Darwin in the expression of them, calls this "an evil dream" of Nature's:

So careful of the type she seems,
So careless of the single life,
That I, considering everywhere
Her hidden purpose in her deeds,
And finding that of fifty seeds
She often brings but one to bear—
I falter where I firmly trod.

But we must leave the reader to supply the rest from his own "In Memoriam." The reflections of the poet are more modest than those of the philosopher, but scarcely more satisfactory. We listen vainly in either case for the true "cadence with which the intellectual ear can feel satisfied."