



of pollen here required by each stigma for the production of the inordinately enormous seeds, the comparative scarcity of pollen observable in many of the orders, and the extreme proximity of the anther to the stigma, which the organization of the flowers always necessitates, so that self-fertilization would naturally be looked for as habitual. And for these reasons—1st. That the precise nature of the pollen would seem to depreciate transportal so too hazardous; and 2nd, that the organic structure of the flower would seem peculiarly to fit it for a perfectly safe self-impregnation. If, therefore, the statement that "self-fertilization is a rare event in the orchids" be accepted as clearly proved, the fact may certainly be used as a powerful argument in the demonstration that there must be something equivalent to Nature in the process; and, indeed, Mr. Darwin believes that he can clearly show, by various ingenious experiments and observations, that to avoid it where it seems especially practicable, Nature has recourse to some very subtle and beautiful contrivance. We are now in a position to understand the full title of the work, which is as follows:—"On the various Contrivances by which British and Foreign Orchids are fertilized by Insects, and on the good effects of Intercrossing."

The main object will be seen to be the affording evidence as to the existence of a general law to the effect that organic beings require a cross with another individual. But incidentally, secondary points are aimed at—such as the elucidation of several points of interest connected with the physiology of the singular family of orchids, and the exposition of some beautiful contrivances tending to exalt the value of the whole vegetable kingdom. Underlying, however, all other designs is the never before sight of by the distinguished writer before us, of incantating his belief that the free admission of secondary laws in the structure of organic beings neither tends to debase the interest of the naturalist in the subject-matter of his studies, nor to shake for a moment his allegiance to the great Creator of the universal whole.

A general law of nature can, of course, only be proved to exist by the accumulation of an immense amount of facts, collected from every available source of knowledge, so that this treatise on orchids, if widely accepted by botanists, can only rank as a contribution towards the establishment of the rule Mr. Darwin contemplates he has discovered. It must, however, be remembered that Mr. Darwin himself, in his "Monograph of the *Cypripedium*," has already solved one great difficulty in the admission of the law as regards the animal kingdom, by proving, in the case of *ovipositors*, that two individuals, though both are self-fertilizing hermaphrodites, do sometimes cross. It is the opinion of Mr. Darwin that throughout the vast orchidous order the act of fertilization is almost invariably left to insects, and that their agency is chiefly directed to the transportal of pollen from one flower to another. He does not consider this statement rash, because he believes it to be clearly deduced from the examination of a great number of British and exotic genera scattered through the main tribes, which generally have a nearly uniform structure.

Certainly all those who follow Mr. Darwin through his lucid and interesting details, will be disposed to give the fullest importance to his conclusions; but at the same time it is obviously true that the experience of no one observer, however gifted, can be safely received as absolutely determinative, still tested by other independent minds, and more especially by minds

unsharpened by a previous theory. The botanical world of a Darwin demands the credit of a Lindley, a Hooker, a Benthams. Ordinary readers will await the assay with deep interest, and will be guided by its results. So early as 1793, the German botanist Sprengel, in his curious work, "The Secret of Nature Discovered," had announced his belief that the agency of insects was necessary for the fertilization of orchids; but then he was apparently under the impression that the assistance, when given, was to enable any one particular flower to fertilize itself. This, therefore, was no anticipation of Mr. Darwin's view.

Robert Brown, again, and Dr. Hooker, and many others, had previously expressed, more or less fully, a general belief in the necessity of insect agency in the fertilization of orchids; but none seem to have insisted on the extreme importance of the admission, and none, more especially, seem to have recognized it to be the pith of the whole matter, that the insect should convey the pollen or pollen apparatus from the anther of one plant to the stigma of another.

It will scarcely be expected that any detailed account should here be given of the delicate contrivances Mr. Darwin has remarked, nor any abstract offered of the evidence by which he conceives insect agency and the nature of their operations to be fully demonstrated. All the singular clearness of Mr. Darwin's own style, and the aid of Mr. G. B. Sowerby's accurate diagrams, are required to make the subject fully intelligible in the volume itself. Still, a few points must be mentioned, both as specimens of the valuable information supplied, and as indications, we may hope, to our readers to refer to the fountain-head. It will be known to those who have examined the *Cypripedium* group that the pollen-masses are furnished at their lower end with a caudicle, coarsely attached to a viscid disc. This disc forms a portion of the rostellum, an extraordinary organ which may be considered as a modification of the stigma. In most British orchids the ball of viscid matter lies just underneath a small piece of membrane which is removable from the rostellum, carrying with it, when it is removed, the caudicle and pollen-masses attached. Mr. Darwin shows that insects entering the flowers in search of nectar get themselves attached to the viscid balls and carry out membrane and pollen together. It is clear that if the pollinia remained exactly in the same angle as regards the proboscis of the insect, when carried to another flower they would hit the part of that flower corresponding to the place they had occupied in the original flower. But owing to a nicely-regulated contracting power in the little piece of membrane lying between the ball of adhesive matter and the extremity of the caudicle, the pollinia are depressed with such exactitude as never to fail to hit the stigmatic surface of another flower. The movements of the pollinia vary with the position of the stigma.

In most of the species of *Orchis* the stigma lies directly beneath the anther-cells, and the pollinia in consequence, when adhering to the insect's proboscis, are simply depressed vertically. In *Orchis pyramidalis*, the two viscidities are confluent, and form a single middle-formed disc; this will clearly a brittle when inserted into the flower, and both pollinia can then be withdrawn from their anther-cases; and as here there are two lateral and inferior stigmas, the pollinia move downwards and outwards, diverging at the proper angle, by a very curious mechanism, so as to strike the two lateral stigmas. *Habenaria*, again, having its stigmatic surface beneath and between two widely separated anther-cells, the pollinia, in this case,

move downwards, but at the same time converge. The stigmas are very viscid, but not so viscid as, when touched, to pull the white pollinia of the insect's head; yet sufficiently viscid to break the elastic threads by which the packets of pollen-grains are tied together, and leave some of them on the stigma. A careful examination of growing flowers shows partial removal of the pollinia. These pollinia cannot be shaken out, because they are so closely embedded in their anther-cells, as to be held there by their viscid matter in flat pouch-formed rostellum. Living plants placed under a bell glass do not lose their pollinia—do not, of course, therefore set seed. These are curious mechanical contrivances for adjusting the position of the pollinia on the proboscis of insects, so as to enable them to strike stigmatic surfaces. And yet, plainly as these facts show the necessary and constant agency of insects, it is exceedingly difficult to surprise them at their useful means. "I have been in the habit," says Mr. Darwin, "for twenty years of watching orchids, and have never seen an insect visit a flower, excepting butterflies, twice visiting *Orchis pyramidalis* and *Gymnadenis conopsea*." The pollinia, however, are frequently found adhering to the proboscis of insects; and instances are given of an anther which had seen pair, and a caudicle no less than eleven pairs, of the pollinia of *Orchis pyramidalis* attached, giving their proboscis an extraordinary arborescent appearance. In the two cypripes alone, as far as Mr. Darwin has seen, are these special and perfectly efficient contrivances for self-fertilization, combined, however, in the most paradoxical manner, with manifest adaptations for the occasional transport by insects of the pollinia from one flower to another, as in the other species of the same genus.

The description of *Cypripedium grandiflorum* is highly interesting. The plant forms a curious and exceptional case, and the theory appears in a measure at fault. But the difficulties are cleared up with great skill; whether, however, to the conviction of all, will in time be seen. *Cypripedium* belongs to the tribe of *Nasturtium*, whose pollen-masses have no true caudicles, and whose pollen-grains, with one exception, are not collected into packets. The absence, moreover, of the rostellum, and the absolute separation of the grains of pollen, seem to indicate in *Cypripedium* a degradation of structure. The anther opens whilst the flower is in bud, and partly enclose the pollen, which stands in two almost free upright pillars, each nearly divided longitudinally into two halves. These two feeble pillars rest against the upper sharp edge of the stigma, and, to keep themselves from falling, drive down numerous pollen-tubes into the surface of the stigma. The flower is upright and well protected internally from wind, so that the pollen-pilars are not blown down, nor do they fall down from their own weight. Experiment has shown that in plants protected from insects these pollen-pilars remain upright. During the maturity of the flower, there is a curious entrance in the labellum, suitable for insects; and this entrance, when fertilization has taken place, closes up, and includes the organs of fructification. Now this is a singular state of things; because, though self-fertilization must in a certain measure take place, for the pollen-tubes literally penetrate the stigma to support the pollen-pilars from falling, yet it appears necessary that insect should enter, and topple over the upper half of the pollen-pilars as to the stigmatic surface; and, as Mr. Darwin believes, themselves smeared over with the grains, carry portions of the pollen of one flower to another.