

LONDON, SATURDAY, MAY 24, 1862.

LITERATURE

On the Various Contrivances by which British and Foreign Orchids are fertilised by Insects, and on the Good Effects of Interbreeding. By Charles Darwin, M.A. With Illustrations. (Murray.)

No order of plants has been more diligently studied and more zealously collected and cultivated, of late years, than the Orchids. Linnaeus was acquainted with only about 100, out of which he threw all those which grow upon trees, about one-fourth, into his solitary genus *Epidendrum*. There are now known no less than 433 genera, and probably about 6,000 species.

The cause of our vastly-extended knowledge of this order of plants is due, not merely to the progress of botany in general, but principally to the existing fashionable fancy for cultivating Orchids. What tulips once were at Haarlem, Orchids bid fair to become in England. The striking beauty of their flowers, and the rich and peculiar fragrance of many of them, lend an additional charm to their singularity and comparative rarity. Then, the grotesqueness of their growth, and the reversal of the natural condition of plants in the case of those Orchids which grow in the air, and which flourish vigorously without touching the bosom of the great mother of vegetation, combine to invest them with a glory all their own in the eyes of amateurs already overstocked with ordinary plants. How instantly do many of them catch the eye of the visitor to their glazed mansion as they depend from the roof, instead of rising from the floor,—suspended, perhaps, by a single wire, and relying on the attenuated air alone for their few and simple wants! Give them but a little moisture in their encompassing moss, only shield them from the cold winds and rapid alternations of English temperature, and they are ready to delight you with all their varied blossoms in due season.

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human amateurs,—namely, destructive insects. These remorselessly devour any Orchid on which they can harbour. Cruikshank has executed a clever tailpiece, in which he represents the opening of a box of these coveted plants sent from Mexico to an English cultivator. Expectation is at the highest as the lid of the box is removed, when out crawl two monstrous cockroach-like depredators, who have feasted and fattened upon the rare exotics during the voyage,—to the infinite disgust of the disappointed amateur, and the infinite distaste of the surrounding servants, who at once seize household implements and hasten after the receding beetles, now too fat to escape destruction.

To the great majority of collectors and cultivators, Orchids only appeal by the external beauty of their flowers; and with this such a philosopher as Mr. Darwin has no concern, at least in this book. Could one but sail over to Mexico in peace, and without fear of being despoiled or murdered, the glorious show of native Orchids would seem sufficient to reward the adventurer. Could one but light on that most splendid of all the splendid species of Stanhopea, the Tiger-like *Stanhopea*, growing (as the first specimen was found by an English explorer) in the cleft of an aged tree in a deep and dismal glen, one would delight in the strong contrast of its strangely tigrine blossoms with the sombre shadows around. Looking at it even in the artificial surroundings of our home orchid-houses, the flower seems so oddly to simulate the tiger-skin that one might fancy it has been developed, according to the Darwinian theory, out of some primordial tiger who had been rewarded by a floral apotheosis for abstinence from carnivorous diet. Powerfully fragrant, too, are these largest of orchidaceous flowers, and furnished with a fleshy lip of so fantastic a figure that it rather appears to have been carved out of ivory or modelled by a wax-flower artist, than a merely natural production. Then, further, one might discover in one of those dark ravines which abound in the neighbourhood of Xalapa, as another Englishman did, a fine *Peristeria*, one species of which (*Peristeria elata*) is, in respect of habit, one of the most striking orchidaceous plants in our home collections, where it flourishes unrivalled in the huge size of its leaves and pseudo-bulbs, and unfolds a flower famous for the resemblance it bears to a dove, from which circumstance the superstitious inhabitants of its native land style it “*el Spirito Santo*.” The partiality, indeed, of the Mexicans for their own orchidaceous flowers displays itself in their alacrity at religious festivals and solemnities to adorn with them the altars of their churches. In their country botanical is supplanted by religious nomenclature; and our coldly-designated *Laelia autumnale* becomes the “*Flor de los Santos*” of the admiring Catholics.

To behold again the gorgeous *Laelia* flowering in the cooler districts of Guatemala, and planted in the front of cottage-doors, would be a sight to a lover of these plants. The finest specimens grow out of the crevices of rocks where they are sheltered from the north winds, and some of the plants have bulbs twenty-two inches high, with flower-stems four yards in length.

The simulations of animal forms which Orchids so strangely take have imparted to them a grotesque attractiveness. There is indeed a much greater uniformity in the orchidaceous blossoms of the Old World than in those of the New, and therefore the most striking grotesqueness is visible in the Orchids of other countries. An importation of selected flowers from the Tropics would bring before us most beautiful floral mimicries of grasshoppers, mosquitoes,

dragon-flies and various moths. The remarkable vegetable-butterfly of Trinidad has blossoms which, being poised at the ends of long elastic holders, flutter gaily in the wind, and appear, to employ Coleridge's words, “impatient of that fixture by which they seem differenced in kind from the flower-shaped *Psyche* that flutters with free wing above them.” A clerical amateur of Orchids once noticed a singular proof of the close resemblance of a plant to an insect. A particular species of Orchid is so like a certain and uncommon species of fly, that one of the latter was observed to settle for days together upon a blossom of the unconscious plant, doubtless in the belief that it was enjoying the society of one of its own kind. Although for several subsequent summers the fly was missing while the flower bloomed, yet at length it returned and settled for some successive days on the simulative blossom, apparently as contented as with an entomological companion.

But birds as well as insects are the objects of orchidaceous mimicry. The swan is especially resembled by one *Orchis*, while the spread eagle, pelicans and doves are represented by others—to say nothing of wings, feathers, beaks and bird-bills. Remoter resemblances have been traced to tigers, leopards, lynxes, bulls, rams and monkeys; and even man himself is travestied in the *Man-Orchis*. A slight stretch of fancy would also aid the geologist in discerning floral likenesses of extinct animals. In fact, a great orchid-house, if frequently visited, and at appropriate seasons, would seem like a comic theatre, where Nature is relaxing herself from her more serious labours by conjuring up and combining the most laughable and yet most beautiful mockeries of her own diverse handiwork. An illustrator of these plants has enumerated many minor articles which, in addition to animals, the flowers of orchids imitate, and they are—“Masks, cowls, hoods, caps and helmets; swords, spurs, crests, pikes, arrows and lances; whiskers, eyelashes, beards, bristles, tails, horns and teeth; combs, slippers, buckets, trowels, pouches, saddles, &c.” Besides the flowers, the mimicking propensity also in part extends itself to the leaves and pseudo-bulbs, and some leaves are inscribed with a near approach to Arabic characters.

From the before-mentioned fact, that 6,000 species of these plants are now known, it may be imagined that the natural provision for their reproduction is strikingly efficient. Of this Mr. Darwin has testified from his own observation:—

“I was curious to estimate the number of seeds produced by Orchids; so I took a ripe capsule of *Cephalanthera grandiflora*, and arranged the seeds as equably as I could in a narrow hillock, on a long ruled line; and then counted the seeds in a length, accurately measured, of one-tenth of an inch. They were 83 in number, and this would give for the whole capsule 6,020 seeds; and for the four capsules borne by the plant 24,000 seeds. Estimating in the same manner the smaller seeds in *Orchis maculata*, I found the number nearly the same, viz., 6,200; and, as I have often seen above 30 capsules on the same plant, the total amount will be 186,300,—a prodigious number for one small plant to bear. As this Orchid is perennial, and cannot in most places be increasing in number, one seed alone of this large number, once in every few years, produces a mature plant. I examined many seeds of the *Cephalanthera*, and very few seemed bad. To give an idea what the above figures really mean, I will briefly show the possible rate of increase of *O. maculata*: an acre of land would hold 174,240 plants, each having a space of six inches square, which is rather closer than they could flourish together; so that, allowing 12,000 bad seeds, an acre would be thickly clothed by the progeny of a single plant. At the same rate of increase, the grandchildren would

cover a space slightly exceeding the island of Anglesea; and the great-grandchildren of a single plant would nearly (in the proportion of 47 to 50) clothe with one uniform green carpet the entire surface of the land throughout the globe."

It is with their reproduction and its natural mechanism that Mr. Darwin concerns himself in this volume. What may be his sensibility to the beauty of their blossoms and the oddity of their mimicries, he affords no opportunity of conjecturing. All that a perusal of his pages enables us to affirm is, that in the gardens of green and gladsome Kent Mr. Darwin has been peacefully and pleasantly engaged in studying the fertilization of Orchids, while half Europe has been studying the arts of destruction. To him Armstrong artillery and iron-plated ships are of little account. While thousands of his countrymen have been anxiously inquiring whether any possible projectiles will pierce any possible iron plates, Mr. Darwin has with equal solicitude considered whether the proboscis of an insect can pierce the pollinium of an Orchid. Pleasant indeed is the philosopher's peaceful diligence in searching for floral nectar, while half the world is experiencing or dreading the bitterness of war. He suspected that nectar must be secreted by our common Orchids; and now, saith he,—

"As soon as many flowers were open, I began to examine them for twenty-three consecutive days: I looked at them after hot sunshine, after rain, and at all hours; I kept the spikes in water, and examined them at midnight and early in the morning; I irritated the nectaries with a bristle, and exposed them to irritating vapours; I took flowers which had quite lately had their pollinia removed by insects, of which I had independent proof on one occasion by finding within the nectary grains of some foreign pollen; and I took other flowers which, from their position on the spike, would soon have had their pollinia removed; but the nectary was invariably quite dry."

The main object of the book is to show that self-fertilization is a rare event with Orchids, and that their fertilization is generally the work of insects. To establish this view Mr. Darwin has made numerous and patient observations, and has enjoyed the freely-acknowledged succour and sympathy of several botanists and special cultivators of this order of plants. He is, however, from the first haunted with the idea that he cannot render this book endurable to general readers—"I fear, however, that the necessary details will be too minute and complex for any one who has not a strong taste for natural history;" and he commences his first chapter with this admonitory advertisement,—“First, for the genus *Orchis*. The reader may find the following details rather difficult to understand; but I can assure him, if he will have patience to make out this first case, the succeeding cases will be easily intelligible.” Intelligible they may be, but not easily, for the subject itself is not merely scientific, but naturally obscure; and should the reader not previously have bestowed any attention upon it, he must give Mr. Darwin a patient reading and persevering attention. When viewed scientifically, this volume is a good botanical monograph, with an entomological aspect. Popularly it has hardly any place, and would require interpretation at every page to the reader who knows not the rudiments of floral botany. Even those who know something of floral botany would be a little perplexed with the chapter “On the Homologies of Orchids.”

Some few principal points, however, may perhaps be sufficiently clear, and they are full of interest. From the structure of most of the British species of the genus *Orchis*, it is inferred that all these species absolutely require the

aid of insects for their fertilization. This is obvious from such an arrangement of the organs that the pollen-mass (pollinium) and other connected parts are too closely embedded to be shaken out by violence. Somehow, the precious pollen must be transferred; the little grains, so reproductive when properly applied, would be useless in their original position. They are there with all their natural fertilizing qualities, but they must be elsewhere before these can be serviceable. What is to transport them if they cannot be shaken out by a gentle violence? Try Mr. Darwin's experiment, and you will arrive at his conclusion. He covered one plant under a bell-glass before any of its pollinia had been removed, and he left three adjoining plants uncovered. Frequent examinations disclosed the fact that some of the pollinia were daily removed from the uncovered plants until nearly all were gone, while all the pollinia remained firm in the cells of the glass-covered plant. Other observations tend to a like result. From all of them it may be inferred that there probably is a proper season for each kind of Orchid, and that insects cease from their visits to it after the proper season has passed, and the regular secretion of nectar has ceased.

The evidence of insect visitation is not derived from their detection in the flowers; and it is a curious circumstance that, although Mr. Darwin has been in the habit for twenty years of watching Orchids, he has never seen an insect actually visit a flower, excepting, indeed, some butterflies on two occasions. We are to look for the evidence of their visitations, not by attempting to detect the insects in the act, but by discovering the stolen goods, the pollinia, upon their bodies. Bees, perhaps, do not habitually visit the common British species of Orchid; but pollinia have been observed in several instances attached to moths, and a list is given of twenty-three species of Lepidoptera which had the pollinia of *Orchis pyramidalis* attached to their probosces. Two of these moths were overlaid with their spoils, and must have sucked a large number of flowers.

Nectar is the special attraction to orchid-visiting insects. It is abundantly secreted by many exotics in our hothouses. From the nectary of one species crystals of sugar of considerable size have been taken at Sevenoaks. The nectar-secreting apparatus of *Coryanthes* is admirable; two little horns near the strap-like junction of the labellum with the base of the column secrete so much limpid nectar, having a slightly sweet taste, that it slowly distils, and a single flower will in all secrete about an ounce weight. The most remarkable appendage is that of the deeply-hollowed end of the labellum, which hangs some way down, exactly beneath the two little horns, and catches the drops as they fall, precisely like a bucket suspended some way beneath a dripping spring.

All such nectarine preparations the insects instinctively apprehend, and while the flowers smell sweet, the abundant nectar contained in the nectaries is highly seductive to the Lepidoptera. In the case of two species of Orchids there is so nicely adapted an arrangement, that for once Mr. Darwin becomes imaginative, and exclaims, “A poet might imagine, that whilst the pollinia are borne from flower to flower, adhering to a moth's body, they voluntarily and eagerly place themselves, in each case, in that exact position in which alone they can hope to gain their wish and perpetuate their race.”

The special adaptation of parts for the fertilization of *Listera ovata* is clearly unfolded, and worth attentive study:—

“The anther-cells open early, leaving the pollen-

masses quite loose, with their tips resting on the concave crest of the rostellum. The rostellum then slowly curves over the stigmatic surface, so that its explosive crest stands at a little distance from the anther; and this is very necessary, otherwise the anther would be caught by the viscid matter, and the pollen for ever locked up. This curvature of the rostellum over the stigma and base of the labellum is excellently well adapted to favour an insect striking the crest when it raises its head, after having crawled up the labellum, and licked up the last drop of nectar at its base. The labellum, as C. K. Sprengel has remarked, becomes narrower where it joins the column beneath the rostellum, so that there is no risk of the insect going too much to either side. The crest of the rostellum is so exquisitely sensitive, that a touch from a most minute insect causes it to rupture at two points, and instantaneously two drops of viscid liquid are expelled, which coalesce. This viscid fluid sets hard in so wonderfully rapid a manner that it rarely fails to cement the tips of the pollinia, nicely laid on the crest of the rostellum, to the insect's forehead. As soon as the rostellum has exploded, it suddenly curves downwards till it projects at right angles over the stigma, protecting it in its early state from impregnation, in the same manner as the stigma of *Spiranthes* is protected by the labellum clasping the column. But as in *Spiranthes* the labellum after a time moves from the column, leaving a free passage for the introduction of the pollinia, so here the rostellum moves back, and not only recovers its former arched position, but stands upright, leaving the stigmatic surface, now become more viscid, perfectly free for pollen to be left on it. The pollen-masses, when once cemented to an insect's forehead, will generally remain firmly attached to it until the viscid stigma of a mature flower removes these encumbrances from the insect, by rupturing the weak elastic threads by which the grains are tied together—receiving at the same time the benefit of fertilization.”

Amongst the most remarkable Orchids are the *Catasetidæ* (a sub-family of the numerous *Vandææ*); and of these, the most complex genus, *Catasetum*, is curiously constructed in the arrangements for reproduction. Let Mr. Darwin describe what he has noticed:—

“A brief inspection of the flower shows that here, as with other Orchids, some mechanical aid is requisite to remove the pollen-masses from their receptacles, and to carry them to the stigmatic surface. We shall, moreover, presently see that the three following species of *Catasetum* are male plants; hence it is certain that their pollen-masses must be transported to female plants, in order that seed may be produced. The pollinium is furnished with a viscid disc, in this genus of huge size; but the disc, instead of being placed, as in other Orchids, in a position likely to touch and adhere to an insect visiting the flower, is turned inwards and lies close to the upper and back surface of a chamber, which must be called the stigmatic chamber, though functionless as a stigma. There is nothing in this chamber to attract insects; and even if they did enter it, it is hardly possible that the disc should adhere to them, for its viscid surface lies in contact with the roof of the chamber. How then does Nature act? She has endowed these plants with, what must be called for want of a better term, sensitiveness, and with the remarkable power of forcibly ejecting their pollinia to a distance. Hence, when certain definite points of the flower are touched by an insect, the pollinia are shot out like an arrow which is not barbed, but has a blunt and excessively adhesive point. The insect, disturbed by so sharp a blow, or after having eaten its fill, flies sooner or later to a female plant, and, whilst standing in the same position as it did when struck, the pollen-bearing end of the arrow is inserted into the stigmatic cavity, and a mass of pollen is left on its viscid surface. Thus, and thus alone, at least three species of the genus *Catasetum* are fertilized.”

The unusually large flower of *Catasetum saccatum* has a peculiar and remarkable provision:—

"From the large size of the flower, more especially of the viscid disc, and from its wonderful power of adhesion, we may safely infer that the flowers are visited by large insects. The viscid matter sticks so firmly when it has set hard, and the pedicel is so strong (though very thin and only one-twentieth of an inch in breadth at the hinge), that to my surprise it supported for a few seconds a weight of 1,262 grains, that is, nearly three ounces; and it supported for a considerable time a slightly less weight. When the pollinium is shot forth, the large spike-like anther is generally carried with it. When the disc strikes a flat surface like a table, the momentum from the weight of the anther often carries the pollen-bearing end beyond the disc, and the pollinium is thus affixed in a wrong direction, supposing it to have been attached to an insect's body, for the fertilization of another flower. The flight is also often rather crooked. But it must not be forgotten that under nature the ejection is caused by the antennæ being touched by a large insect standing on the labellum, which will thus have its head and thorax placed near to the anther. A rounded object thus held is always accurately struck in the middle, and, when removed with the pollinium adhering to it, the weight of the anther depresses the hinge of the pollinium; and in this position the anther readily drops off, leaving the balls of pollen free and in a proper position for the act of fertilization. The utility of so forcible an ejection may be to drive the soft and viscid cushion of the disc against the hairy thorax of a large hymenopterous insect, or the sculptured thorax of a flower-feeding beetle. When attached, assuredly no force which the insect could exert would remove the disc and pedicel; but the caudicles are ruptured without much difficulty, and thus the balls of pollen would be left on the viscid stigmatic surface of a female flower."

Notwithstanding the immense seed-produce of Orchids, the greatest care is taken throughout this vast order, with its more than 400 genera and its 6,000 species, that the pollen shall not be wasted; and yet, if we admit all Mr. Darwin's views, the act of fertilization is, with few known exceptions, left to insects. Nor can this assertion be regarded as rash after the examination of so many British and exotic genera scattered throughout the main tribes, which generally have a nearly uniform structure. The present investigator's object is to show the numerous adaptations which render it certain that in the cases specified the pollen of one flower or one plant is habitually transported to another flower or plant; and as such transference increases the risk of loss, it at the same time necessitates and explains the extraordinary care bestowed on the contrivances for fertilization.

So far, we have been desirous to let Mr. Darwin speak for himself on his own specially-chosen topic; and we have done little more than select, with some care, those portions which form the most striking and interesting illustrations. His concluding paragraph will afford a glimpse of his inference from the whole subject:—

"Considering how precious the pollen of Orchids evidently is, and what care has been bestowed on its organisation and on the accessory parts;—considering that the anther always stands close behind or above the stigma, self-fertilisation would have been an incomparably safer process than the transportal of the pollen from flower to flower. It is an astonishing fact that self-fertilisation should not have been an habitual occurrence. It apparently demonstrates to us that there must be something injurious in the process. Nature thus tells us, in the most emphatic manner, that she abhors perpetual self-fertilisation. This conclusion seems to be of high importance, and perhaps justifies the lengthy details given in this volume. For may we not further infer as probable, in accordance with the belief of the vast majority of the breeders of our domestic productions, that marriage between near relations is likewise in some way injurious,—that some unknown

great good is derived from the union of individuals which have been kept distinct for many generations?"

In looking through the volume, we do not readily perceive how it can confirm the author's well-known peculiar views. In his Introduction Mr. Darwin says:—"In my volume 'On the Origin of Species,' I have given only general reasons for my belief that it is apparently a universal law of nature that organic beings require an occasional cross with another individual; or, which is about the same thing, that no hermaphrodite fertilizes itself for a perpetuity of generations. Having been blamed for propounding this doctrine without giving ample facts, for which I had not in that work sufficient space, I wish to show that I have not spoken without having gone into details. I have been led to publish this little treatise separately, as it has become inconveniently large to be incorporated with the rest of the discussion on the same subject." Perhaps the full application is yet to come in that great work which Mr. Darwin is presumed to have in hand.

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The simulations of animal forms which Orchids so strangely take have imparted to them a grotesque attractiveness. There is indeed a much greater uniformity in the orchidaceous blossoms of the Old World than in those of the New, and therefore the most striking grotesqueness is visible in the Orchids of other countries. An importation of selected flowers from the Tropics would bring before us most beautiful floral mimicries of grasshoppers, mosquitoes,

dragon-flies and various moths. The remarkable vegetable-butterfly of Trinidad has blossoms which, being poised at the ends of long elastic holders, flutter gaily in the wind, and appear, to employ Coleridge's words, “impatient of that fixture by which they seem differentiated in kind from the flower-shaped Psyche that flutters with free wing above them.” A clerical amateur of Orchids once noticed a singular proof of the close resemblance of a plant to an insect. A particular species of Orchid is so like a certain and uncommon species of fly, that one of the latter was observed to settle for days together upon a blossom of the unconscious plant, doubtless in the belief that it was enjoying the society of one of its own kind. Although for several subsequent summers the fly was missing while the flower bloomed, yet at length it returned and settled for some successive days on the simulative blossom, apparently as contented as with an entomological companion.

But birds as well as insects are the objects of orchidaceous mimicry. The swan is especially resembled by one Orchid, while the spread eagle, pelicans and doves are represented by others—to say nothing of wings, feathers, beaks and bird-bills. Remoter resemblances have been traced to tigers, leopards, lynxes, bulls, rams and monkeys; and even man himself is travestied in the Man-Orchid. A slight stretch of fancy would also aid the geologist in discerning floral likenesses of extinct animals. In fact, a great orchid-house, if frequently visited, and at appropriate seasons, would seem like a comic theatre, where Nature is relaxing herself from her more serious labours by conjuring up and combining the most laughable and yet most beautiful mockeries of her own diverse handiwork. An illustrator of these plants has enumerated many minor articles which, in addition to animals, the flowers of orchids imitate, and they are—“Masks, cows, hoods, caps and helmets; swords, spurs, crests, pikes, arrows and lances; whiskers, eyelashes, beards, bristles, tails, horns and teeth; combs, slippers, buckets, trowels, pouches, saddles, &c.” Besides the flowers, the mimicking propensity also in part extends itself to the leaves and pseudo-bulbs, and some leaves are inscribed with a near approach to Arabic characters.

From the before-mentioned fact, that 6,000 species of these plants are now known, it may be imagined that the natural provision for their reproduction is strikingly efficient. Of this Mr. Darwin has testified from his own observation:—

“I was curious to estimate the number of seeds produced by Orchids; so I took a ripe capsule of *Cephalanthera grandiflora*, and arranged the seeds as equally as I could in a narrow hillock, on a long ruled line; and then counted the seeds in a length, accurately measured, of one-tenth of an inch. They were 83 in number, and this would give for the whole capsule 6,020 seeds; and for the four capsules borne by the plant 24,000 seeds. Estimating in the same manner the smaller seeds in *Orchis maculata*, I found the number nearly the same, viz., 6,200; and, as I have often seen above 30 capsules on the same plant, the total amount will be 186,300,—a prodigious number for one small plant to bear. As this Orchid is perennial, and cannot in most places be increasing in number, one seed alone of this large number, once in every few years, produces a mature plant. I examined many seeds of the *Cephalanthera*, and very few seemed bad. To give an idea what the above figures really mean, I will briefly show the possible rate of increase of *O. maculata*: an acre of land would hold 174,240 plants, each having a space of six inches square, which is rather closer than they could flourish together; so that, allowing 12,000 bad seeds, an acre would be thickly clothed by the progeny of a single plant. At the same rate of increase, the grandchildren would

cover a space slightly exceeding the island of Anglesea; and the great-grandchildren of a single plant would nearly (in the proportion of 47 to 50) clothe with one uniform green carpet the entire surface of the land throughout the globe."

It is with their reproduction and its natural mechanism that Mr. Darwin concerns himself in this volume. What may be his sensibility to the beauty of their blossoms and the oddity of their mimicries, he affords no opportunity of conjecturing. All that a perusal of his pages enables us to affirm is, that in the gardens of green and glad Kent Mr. Darwin has been peacefully and pleasantly engaged in studying the fertilization of Orchids, while half Europe has been studying the arts of destruction. To him Armstrong artillery and iron-plated ships are of little account. While thousands of his countrymen have been anxiously inquiring whether any possible projectiles will pierce any possible iron plates, Mr. Darwin has with equal solicitude considered whether the proboscis of an insect can pierce the pollinium of an Orchid. Pleasant indeed is the philosopher's peaceful diligence in searching for floral nectar, while half the world is experiencing or dreading the bitterness of war. He suspected that nectar must be secreted by our common Orchids; and now, saith he,—

"As soon as many flowers were open, I began to examine them for twenty-three consecutive days: I looked at them after hot sunshine, after rain, and at all hours; I kept the spikes in water, and examined them at midnight and early in the morning; I irritated the nectaries with a bristle, and exposed them to irritating vapours; I took flowers which had quite lately had their pollinia removed by insects, of which I had independent proof on one occasion by finding within the nectary grains of some foreign pollen; and I took other flowers which, from their position on the spike, would soon have had their pollinia removed; but the nectary was invariably quite dry."

The main object of the book is to show that self-fertilization is a rare event with Orchids, and that their fertilization is generally the work of insects. To establish this view Mr. Darwin has made numerous and patient observations, and has enjoyed the freely-acknowledged succour and sympathy of several botanists and special cultivators of this order of plants. He is, however, from the first haunted with the idea that he cannot render this book endurable to general readers—"I fear, however, that the necessary details will be too minute and complex for any one who has not a strong taste for natural history," and he commences his first chapter with this admonitory advertisement,—“First, for the genus *Orchis*. The reader may find the following details rather difficult to understand; but I can assure him, if he will have patience to make out this first case, the succeeding cases will be easily intelligible.” Intelligible they may be, but not easily, for the subject itself is not merely scientific, but naturally obscure; and should the reader not previously have bestowed any attention upon it, he must give Mr. Darwin a patient reading and persevering attention. When viewed scientifically, this volume is a good botanical monograph, with an entomological aspect. Popularly it has hardly any place, and would require interpretation at every page to the reader who knows not the rudiments of floral botany. Even those who know something of floral botany would be a little perplexed with the chapter ‘On the Homologies of Orchids.’

Some few principal points, however, may perhaps be sufficiently clear, and they are full of interest. From the structure of most of the British species of the genus *Orchis*, it is inferred that all these species absolutely require the

aid of insects for their fertilization. This is obvious from such an arrangement of the organs that the pollen-mass (pollinium) and other connected parts are too closely embedded to be shaken out by violence. Somehow, the precious pollen must be transferred; the little grains, so reproductive when properly applied, would be useless in their original position. They are there with all their natural fertilizing qualities, but they must be elsewhere before these can be serviceable. What is to transport them if they cannot be shaken out by a gentle violence? Try Mr. Darwin's experiment, and you will arrive at his conclusion. He covered one plant under a bell-glass before any of its pollinia had been removed, and he left three adjoining plants uncovered. Frequent examinations disclosed the fact that some of the pollinia were daily removed from the uncovered plants until nearly all were gone, while all the pollinia remained firm in the cells of the glass-covered plant. Other observations tend to a like result. From all of them it may be inferred that there probably is a proper season for each kind of *Orchis*, and that insects cease from their visits to it after the proper season has passed, and the regular secretion of nectar has ceased.

The evidence of insect visitation is not derived from their detection in the flowers; and it is a curious circumstance that, although Mr. Darwin has been in the habit for twenty years of watching Orchids, he has never seen an insect actually visit a flower, excepting, indeed, some butterflies on two occasions. We are to look for the evidence of their visitations, not by attempting to detect the insects in the act, but by discovering the stolen goods, the pollinia, upon their bodies. Bees, perhaps, do not habitually visit the common British species of *Orchis*; but pollinia have been observed in several instances attached to moths, and a list is given of twenty-three species of Lepidoptera which had the pollinia of *Orchis pyramidalis* attached to their probosces. Two of these moths were overlaid with their spoils, and must have sucked a large number of flowers.

Nectar is the special attraction to orchid-visiting insects. It is abundantly secreted by many exotics in our hothouses. From the nectary of one species crystals of sugar of considerable size have been taken at Sevenoaks. The nectar-secreting apparatus of *Coryanthes* is admirable; two little horns near the strap-like junction of the labellum with the base of the column secrete so much limpid nectar, having a slightly sweet taste, that it slowly distils, and a single flower will in all secret about an ounce weight. The most remarkable appendage is that of the deeply-hollowed end of the labellum, which hangs some way down, exactly beneath the two little horns, and catches the drops as they fall, precisely like a bucket suspended some way beneath a dripping spring.

All such nectarine preparations the insects instinctively apprehend, and while the flowers smell sweet, the abundant nectar contained in the nectaries is highly seductive to the Lepidoptera. In the case of two species of Orchids there is so nicely adapted an arrangement, that for once Mr. Darwin becomes imaginative, and exclaims, “A poet might imagine, that whilst the pollinia are borne from flower to flower, adhering to a moth's body, they voluntarily and eagerly place themselves, in each case, in that exact position in which alone they can hope to gain their wish and perpetuate their race.”

The special adaptation of parts for the fertilization of *Listera ovata* is clearly unfolded, and worth attentive study:—

“The anther-cells open early, leaving the pollen-

masses quite loose, with their tips resting on the concave crest of the rostellum. The rostellum then slowly curves over the stigmatic surface, so that its explosive crest stands at a little distance from the anther; and this is very necessary, otherwise the anther would be caught by the viscid matter, and the pollen for ever locked up. This curvature of the rostellum over the stigma and base of the labellum is excellently well adapted to favour an insect striking the crest when it raises its head, after having crawled up the labellum, and licked up the last drop of nectar at its base. The labellum, as C. K. Sprengel has remarked, becomes narrower where it joins the column beneath the rostellum, so that there is no risk of the insect going too much to either side. The crest of the rostellum is so exquisitely sensitive, that a touch from a most minute insect causes it to rupture at two points, and instantaneously two drops of viscid liquid are expelled, which coalesce. This viscid fluid sets hard in so wonderfully rapid a manner that it rarely fails to cement the tips of the pollinia, nicely laid on the crest of the rostellum, to the insect's forehead. As soon as the rostellum has exploded, it suddenly curves downwards till it projects at right angles over the stigma, protecting it in its early state from impregnation, in the same manner as the stigma of *Spiranthes* is protected by the labellum clasping the column. But as in *Spiranthes* the labellum after a time moves from the column, leaving a free passage for the introduction of the pollinia, so here the rostellum moves back, and not only recovers its former arched position, but stands upright, leaving the stigmatic surface, now become more viscid, perfectly free for pollen to be left on it. The pollen-masses, when once cemented to an insect's forehead, will generally remain firmly attached to it until the viscid stigma of a mature flower removes these encumbrances from the insect, by rupturing the weak elastic threads by which the grains are tied together—receiving at the same time the benefit of fertilization.”

Amongst the most remarkable Orchids are the *Catasetidæ* (a sub-family of the numerous *Vanderi*); and of these, the most complex genus, *Catasetum*, is curiously constructed in the arrangements for reproduction. Let Mr. Darwin describe what he has noticed:—

“A brief inspection of the flower shows that here, as with other Orchids, some mechanical aid is requisite to remove the pollen-masses from their receptacles, and to carry them to the stigmatic surface. We shall, moreover, presently see that the three following species of *Catasetum* are male plants; hence it is certain that their pollen-masses must be transported to female plants, in order that seed may be produced. The pollinium is furnished with a viscid disc, in this genus of huge size; but the disc, instead of being placed, as in other Orchids, in a position likely to touch and adhere to an insect visiting the flower, is turned inwards and lies close to the upper and back surface of a chamber, which must be called the stigmatic chamber, though functionless as a stigma. There is nothing in this chamber to attract insects; and even if they did enter it, it is hardly possible that the disc should adhere to them, for its viscid surface lies in contact with the roof of the chamber. How then does Nature act? She has endowed these plants with, what must be called for want of a better term, sensitiveness, and with the remarkable power of forcibly ejecting their pollinia to a distance. Hence, when certain definite points of the flower are touched by an insect, the pollinia are shot out like an arrow which is not barbed, but has a blunt and excessively adhesive point. The insect, disturbed by so sharp a blow, or after having eaten its fill, flies sooner or later to a female plant, and, whilst standing in the same position as it did when struck, the pollen-bearing end of the arrow is inserted into the stigmatic cavity, and a mass of pollen is left on its viscid surface. Thus, and thus alone, at least three species of the genus *Catasetum* are fertilized.”

The unusually large flower of *Catasetum saccatum* has a peculiar and remarkable provision:—

"From the large size of the flower, more especially of the viscid disc, and from its wonderful power of adhesion, we may safely infer that the flowers are visited by large insects. The viscid matter sticks so firmly when it has set hard, and the pedicel is so strong (though very thin and only one-twentieth of an inch in breadth at the hinge), that to my surprise it supported for a few seconds a weight of 1,262 grains, that is, nearly three ounces; and it supported for a considerable time a slightly less weight. When the pollinium is shot forth, the large spike-like anther is generally carried with it. When the disc strikes a flat surface like a table, the momentum from the weight of the anther often carries the pollen-bearing end beyond the disc, and the pollinium is thus affixed in a wrong direction, supposing it to have been attached to an insect's body, for the fertilization of another flower. The flight is also often rather crooked. But it must not be forgotten that under nature the ejection is caused by the antennæ being touched by a large insect standing on the labellum, which will thus have its head and thorax placed near to the anther. A rounded object thus held is always accurately struck in the middle, and, when removed with the pollinium adhering to it, the weight of the anther depresses the hinge of the pollinium; and in this position the anther readily drops off, leaving the balls of pollen free and in a proper position for the act of fertilization. The utility of so forcible an ejection may be to drive the soft and viscid cushion of the disc against the hairy thorax of a large hymenopterous insect, or the sculptured thorax of a flower-feeding beetle. When attached, assuredly no force which the insect could exert would remove the disc and pedicel; but the caudicles are ruptured without much difficulty, and thus the balls of pollen would be left on the viscid stigmatic surface of a female flower."

Notwithstanding the immense seed-produce of Orchids, the greatest care is taken throughout this vast order, with its more than 400 genera and its 6,000 species, that the pollen shall not be wasted; and yet, if we admit all Mr. Darwin's views, the act of fertilization is, with few known exceptions, left to insects. Nor can this assertion be regarded as rash after the examination of so many British and exotic genera scattered throughout the main tribes, which generally have a nearly uniform structure. The present investigator's object is to show the numerous adaptations which render it certain that in the cases specified the pollen of one flower or one plant is habitually transported to another flower or plant; and as such transference increases the risk of loss, it at the same time necessitates and explains the extraordinary care bestowed on the contrivances for fertilization.

So far, we have been desirous to let Mr. Darwin speak for himself on his own specially-chosen topic; and we have done little more than select, with some care, those portions which form the most striking and interesting illustrations. His concluding paragraph will afford a glimpse of his inference from the whole subject:—

"Considering how precious the pollen of Orchids evidently is, and what care has been bestowed on its organisation and on the accessory parts;—considering that the anther always stands close behind or above the stigma, self-fertilisation would have been an incomparably safer process than the transportal of the pollen from flower to flower. It is an astonishing fact that self-fertilisation should not have been an habitual occurrence. It apparently demonstrates to us that there must be something injurious in the process. Nature thus tells us, in the most emphatic manner, that she abhors perpetual self-fertilisation. This conclusion seems to be of high importance, and perhaps justifies the lengthy details given in this volume. For may we not further infer as probable, in accordance with the belief of the vast majority of the breeders of our domestic productions, that marriage between near relations is likewise in some way injurious,—that some unknown

great good is derived from the union of individuals which have been kept distinct for many generations?"

In looking through the volume, we do not readily perceive how it can confirm the author's well-known peculiar views. In his Introduction Mr. Darwin says:—"In my volume 'On the Origin of Species,' I have given only general reasons for my belief that it is apparently a universal law of nature that organic beings require an occasional cross with another individual; or, which is about the same thing, that no hermaphrodite fertilizes itself for a perpetuity of generations. Having been blamed for propounding this doctrine without giving ample facts, for which I had not in that work sufficient space, I wish to show that I have not spoken without having gone into details. I have been led to publish this little treatise separately, as it has become inconveniently large to be incorporated with the rest of the discussion on the same subject." Perhaps the full application is yet to come in that great work which Mr. Darwin is presumed to have in hand.

North America. By Anthony Trollope. 2 vols. (Chapman & Hall.)

SOME thirty years ago Mrs. Trollope wrote a book on America which amused the public in London and offended that of New York. It was not a wise book; but then it had no pretension to gravity or philosophy; and the results of its sly satire and frank exposure were said to be a very considerable improvement in the outward aspects of American manners. Whittling and expectation were not put down; but they were laughed at on both sides of the Atlantic, and were understood to be local and ludicrous peculiarities. Some American ladies were, for the first time, told that spittoons are not seen in London drawing-rooms, and American gentlemen became aware that visitors at the Clarendon do not usually sit with legs out of window. But when these things were new to the New York and Boston mind, it was held to be an unpardonable crime to speak of them; and we think we are justified by the fact in saying that the clever and spiteful author has never been forgiven for her fun.

Mr. Anthony Trollope went to America, we think, with a full sense of his mother's sins weighing upon him. He wanted to write a light book, and he knows that a light book must contain a good deal of salt and pepper—rather more salt and pepper than sober truth; but the feeling that the Trollope family owe a good turn to America restrained the riot of his humour when it would otherwise have had full sway and mastery, very much to the loss of the customary effects. But he is aware of this result of his plan. There is no self-deception. No traveller ever understood the limits of his power better than Mr. Trollope. Not having the knowledge of many kinds necessary to the production of a serious work on North America—and not having the disposition to indulge in that grotesque and ludicrous style for which the passing peculiarities of American character offer so many temptations—he has been content to take a middle place, in the way of the good old travellers, who were willing to describe what they saw without venturing on "appreciations." Unable to be a philosopher, he will not descend to be a satirist. If he cannot be a De Tocqueville, he will not be a Marryat.

We are glad to have such a man as Mr. Trollope travelling for us in such a temper. We have had too many humourists, and perhaps too many political doctors, on the American ground. We have heard a good deal of late

about American institutions; and we shall now be glad to see, through the eyes of an intelligent observer, a little more of American men and women,—and even of American children—if such should be found for us. On this last point of the American children Mr. Trollope is rather doubtful, as will here be seen:—

"And then the children,—babies, I should say if I were speaking of English bairns of their age; but seeing that they are Americans, I hardly dare to call them children. The actual age of these perfectly civilized and highly educated beings may be from three to four. One will often see five or six such seated at the long dinner-table of the hotel, breakfasting and dining with their elders, and going through the ceremony with all the gravity and more than all the decorum of their grandfathers. When I was three years old I had not yet, as I imagine, been promoted beyond a silver spoon of my own wherewith to eat my bread and milk in the nursery, and I feel assured that I was under the immediate care of a nursemaid, as I gobbled up my minced mutton mixed with potatoes and gravy. But at hotel life in the States the adult infant lisps to the waiter for everything at table, handles his fish with epicurean delicacy, is choice in his selection of pickles, very particular that his beef-steak at breakfast shall be hot, and is instant in his demand for fresh ice in his water. But perhaps his, or in this case her, retreat from the room when the meal is over, is the *chef-d'œuvre* of the whole performance. The little precocious, full-blown beauty of four signifies that she has completed her meal,—or is 'through' her dinner, as she would express it,—by carefully extricating herself from the napkin which has been tucked around her. Then the waiter, ever attentive to her movements, draws back the chair on which she is seated, and the young lady glides to the floor. A little girl in Old England would scramble down, but little girls in New England never scramble. Her father and mother, who are no more than her chief ministers, walk before her out of the saloon, and then she—swims after them. But swimming is not the proper word. Fishes in making their way through the water assist, or rather impede, their motion with no dorsal riggle. No animal taught to move directly by its Creator adopts a gait so useless, and at the same time so graceless. Many women, having received their lessons in walking from a less eligible instructor, do move in this way, and such women this unfortunate little lady has been instructed to copy. The peculiar step to which I allude is to be seen often on the Boulevards in Paris. It is to be seen more often in second-rate French towns, and among fourth-rate French women. Of all signs in women betokening vulgarity, bad taste, and aptitude to bad morals, it is the surest. And this is the gait of going which American mothers,—some American mothers, I should say,—love to teach their daughters! As a comedy at an hotel it is very delightful, but in private life I should object to it."

Afterwards we read:—

"I must protest that American babies are an unhappy race. They eat and drink just as they please; they are never punished; they are never banished, snubbed, and kept in the background as children are kept with us; and yet they are wretched and uncomfortable. My heart has bled for them as I have heard them squalling by the hour together in agonies of discontent and dyspepsia. Can it be, I wonder, that children are happier when they are made to obey orders and are sent to bed at six o'clock, than when allowed to regulate their own conduct; that bread and milk is more favourable to laughter and soft childish ways than beef-steaks and pickles three times a day; that an occasional whipping, even, will conduce to rosy cheeks? It is an idea which I should never dare to broach to an American mother; but I must confess that after my travels on the western continent my opinions have a tendency in that direction. Beef-steaks and pickles certainly produce smart little men and women. Let that be taken for granted. But rosy laughter and winning childish ways are, I fancy, the produce of bread and milk."

But as the child is, so will the man be. Mr.