INSECTIVOROUS PLANTS.*

SINCE some animals derive their whole supplies of food, as well as many other useful things, from the vegetable kingdom, it might be held to be fair that the animal should in its turn contribute to the support of the plant. In point of fact it does so; for by respiration, excretion, and decay, all the material obtained by the animal is returned to the air, the waters, or the earth, in a state to be again utilized by vegetable organisms. This seems, in the nature of things, quite proper; but when we learn that there are plants which capture, destroy, and devour living animals, we are somewhat startled. The fact excites the same unpleasant emotions which we feel in thinking of a fair child seized in the voracious jaws of a sluggish and ungainly crocodile; or of some bold diver, hopelessly entangled in the lithe, adhesive tentacles of a huge cuttle-fish; or of the simple and guileless, falling a prey to the arts of hardened deceivers. In these cases the low seem to have an undue advantage over the high, the evil over the good. Such things caused the elder Mill to doubt the benevolence of God, and his son to doubt His omnipotence. Exceptional facts they no doubt are, but very strange, and their significance as parts of the order of nature must be worth seeking; though we need not sympathize with that grim satisfaction with which some modern scientists gloat over and dilate on them as phenomena explicable only on the hypothesis of a heartless and ceaseless struggle for existence as the sole principle of nature. We do not say that Darwin, in the work before us, betrays such a spirit. He regards the facts from the point of view of a true naturalist, and it is only now and then that he even hints at the "advantage" in the struggle of life which the carnivorous plants may be supposed to have. The book is not even an exhaustive account of the subject to which it relates, as it omits to notice some kinds of insectivorous plants, as, for example, the common *Sarracenica*, or Indian Cup, and it is little more than a record of experiments and observations, with very few remarks on the general truths to which they lead.

* "Insectivorous Plants," by Charles Darwin, M. A., F. R. S., etc. New York: D. Appleton & Co. 1875.

Insectivorous plants may be defined to be those which by some means or other capture living insects, and then profit by their digestion or decay, in aiding their own growth. These plants belong to a limited number of natural families, though they reckon numerous species, and singularly enough they are for the most part plants of small stature and uninviting aspect, and poorly provided with means of nourishment by roots; as if in compensation for their carnivorous powers and propensities. A considerable proportion of them are also inhabitants of marshy grounds, or are aquatics; and they not infrequently have peculiar odors and acrid properties, as if in consequence of their peculiar food.

Their means for capturing insects are in the main of four kinds: viscid secretions, mechanical movements of parts, cunningly constructed traps, and pitfalls with water at the bottom in which the insects are drowned. The captured insects may either be actually digested by a fluid exuded from the plant, or the products of their decay may be merely absorbed by the surface or by special organs projecting from it. Darwin's observations, as detailed in this work, relate chiefly to two natural families, the *Droseraceæ*, or Sun-dews, and the *Lentibulaceæ*, or Bladder-worts, both of which are very extensively distributed geographically, and whose means of capturing their prey are viscid secretions, irritable and moving parts, and spring traps.

Probably most observant persons have noticed the common Sundew, *Drosera rotundifolia*, which is common to Europe and America, and may often be seen growing in great abundance on damp flats, or by the sides of ditches. Its most conspicuous parts are the round leaves, about the size of five-cent pieces; spread out close to the ground, and covered with long, reddish hairs, each of which, if closely examined, will be found to have at its extremity a little rounded head or bulb, which is a gland exuding a clear glutinous liquid which usually forms a drop surrounding it. This has given rise to the generic name, from the Greek *droseros*—dewy, and to the English name Sun-dew, as well as to the Latin appellation, *Ros solis*, which appears in the Italian name Rossoli, given to a liqueur in the preparation of which this plant is said to be employed. Few observers, however, in looking at this humble plant, would suspect, any more than Darwin seems at first to have done, that it is a plant of prey, though the facts that it collects insects and that its hairs close on and detain them have been long known.

Darwin's account of the general mode of action of this curious plant as a capturer of insects, is well worthy of quotation; and we shall present it in an abbreviated form, premising that he call the hairs of the leaf, "tentacles."

If a small organic or inorganic object be placed on the glands in the center of a leaf, these transmit a motor impulse to the marginal tentacles. The nearer ones are first affected, and slowly bend toward the center, and then those farther off, until at last all become closely inflected over the object. This takes place in from one hour to four or five or more hours. A living insect is a more efficient object than a dead one, as in struggling it presses against the glands of many tentacles. The inflection takes place indifferently in the light and darkness; and the plant is not subject to any nocturnal movements of so-called sleep.

If the glands on the disk are repeatedly touched, although no object is left on them, the marginal tentacles curve inward. So again if drops of various fluids, for instance, of saliva or of a solution of any salt of ammonia, be placed on the central gland, the same result quickly follows. The tentacles in the act of inflection sweep through a wide space. I have seen, says Mr. Darwin, the much reflected tentacles of a leaf which stood upright move through an angle of not less than 270°. The bending part is almost confined to a short space near the base; but a rather larger portion of the elongated exterior tentacles becomes slightly incurved; the distal half in all cases remaining straight. Not only the tentacles, but the blade of the leaf often, but by no means always, become much incurved, when any strongly exciting substance or fluid is placed on the disk. Drops of milk, and of a solution of nitrate of ammonia or soda, are particularly apt to produce this effect. The blade is thus converted into a little cup. The length of time during which the tentacles, as well as the blade, remain inflected over an object placed on the disk, depends on the vigor and age of the leaf and, according to Dr. Nitschke, on the temperature. But the nature of the object is by far the most important circumstance. I have repeatedly found, Mr. Darwin says, that the tentacles remain clasped for a much longer average time, over objects which yield soluble nitrogenous matter, than over those, organic or inorganic, which yield no such matter. After from one to seven days, the tentacles and blade re-expand, and are then ready to act again. The secretion from the glands is extremely viscid, so that it can be drawn out into long threads when an object, such as a bit of meat or an insect, is placed on the disk of a leaf. As soon as the surrounding tentacles become considerably inflected, their glands pour forth an increased amount of secretion.

It is a still more important fact that when the tentacles become inflected, owing to the central glands having been stimulated mechanically, or by contact with animal matter, the secretion not only increases in quantity, but changes its nature, and becomes acid. This acid is of a different nature from that contained in the tissue of the leaves. I have observed, he says, the same leaf, with the tentacles closely inflected over rather indigestible substances, such as chemically prepared caseine, pouring forth acid secretion for eight successive days. When an insect alights on the central disk, it is instantly entangled by the viscid secretion, and the surrounding tentacles after a time begin to bend, and ultimately clasp it on all sides. Insects are generally killed, according to Dr. Nitschke, in about a quarter of an hour, owing to their tracheæ being closed by the secretion.

Whether insects alight on the leaves by mere chance, as a resting place, or are attracted by the odor of the secretion, Mr. Darwin does not venture a decided opinion; but from various observations he suspects that the odor is attractive. That the glands possess the power of absorption, is shown, he says, by their almost instantaneously becoming dark colored when given a minute quantity of carbonate of ammonia. The absorption of animal matter from captured insects explains how Drosera can flourish in extremely poor peaty soil—in some cases where nothing but sphagnum moss grows, and mosses depend altogether on the air for their nourishment. The pedicels of the central tentacles, and the petioles, contain chlorophyl, so that, no doubt, the plant obtains and assimilates carbonic acid from the air. Nevertheless, considering the nature of the soil, he believes that the supply of nitrogen would be exceedingly limited, or quite deficient, unless the plant had the power of obtaining this important element from captured insects. We can thus, he thinks, understand how it is that the roots are so poorly developed. It appears that they serve only to imbibe water; though no doubt they would absorb nutritious matter if present in the soil. His conclusion is that a plant of Drosera, with the edges of its leaves curled inward, so as to form a temporary stomach; and with the glands of the closely inflected tentacles pouring forth their acid secretion, which dissolves animal matter, afterward to be absorbed; may be said to feed like an animal. But, differently from an animal, it drinks by means of its roots: and it must drink largely, so as to retain many drops of viscid fluid round the glands, sometimes as many as two hundred and sixty, exposed during the whole day to a glaring sun.

This general statement is followed by an elaborate investigation of the structures and their action, extending over a large portion of the work. Into this we cannot enter; but it is sufficiently apparent that an insect, or other foreign body, touching the tentacles, may adhere to their viscid secretion. The tentacles are then stimulated to bend, so as to inclose the object, and at the same time to exude a larger quantity of liquid, which becomes acid in its nature, and has the precise properties of the gastric juice of an animal. Digested by this, the animal matter is absorbed by the glands, and finally the tentacles open and spread themselves again in quest of new victims. It further appears that the irritation of one tentacle stimulates others in its vicinity to act, and that narcotics and stimulants act on these singular hairs very much as they would do on the nerves and muscles of an animal. More recent observations by Borden Sanderson and Tait, have rendered the similarity between the contractile power of Drosera and that of muscle, and between its digestive power and that of the animal stomach, even more striking. Various other species of Sun-dew are then examined, and other plants of the same family, as the aquatic *Aldrovanda* and the still more remarkable *Dionea Muscipula*, Venus' Fly-trap, whose insectivorous habit has long been known, and has been described by several English and American botanists. Ellis noticed this as early as 1768, and it was more fully described by Curtis in 1834, though many of its more interesting details have been worked out by Canby and others, more recently. The *Dionea*, unlike the Drosera, is limited to a single species, and this apparently to the eastern part of North Carolina. Why it has profited so little by its powers, while Drosera numbers about one hundred species scattered over all parts of the earth, does not clearly appear.[1] Dionea has marvelous sensitiveness, closing its leaves when its tentacles are touched even with a hair; though, like Drosera, it is altogether insensible to the heaviest shower of rain, or the strongest wind. Like Drosera, it secretes an acid digestive liquid, by which its food is dissolved and prepared for absorption.

Leaving the Sun-dews and their allies, and passing to the Bladderworts, the common *Pinguicula*, or Butterwort, is found to capture small insects by the viscid secretion on its leaves. It can also, in a slow and clumsy manner, roll up the edges of its leaf so as to inclose these insects, and it secretes a gastric juice for their digestion. But its ally, the *Utricularia*, or proper Bladder-wort, far excels it in its contrivances for capturing insects, and is altogether a chef-d'œuvre

[1] Darwin supposes it to be verging on extinction, but perhaps it may be only beginning its career.

in the way of a trapper. There are many species of Utricularia, and a number of these have been examined by Darwin, Cohn, and others, while Mrs. Treat of New Jersey has very successfully studied one of our American species. Utriculariæ, being aquatic, capture water insects, crustaceans, and worms, and they effect this by means of the bladder-like organs attached to their leaves, which, though at one time believed to be mere floats, are now known to be traps of most complex structure. These organs, as they occur in *U. neglecta*, may be thus described. The bladders are small hollow vesicles, each attached by a small stalk, and with a mouth or aperture at the opposite end, having a number of long hairs or bristles, arranged so as to form a funnel-shaped approach to the aperture. Immediately within the aperture is a transparent, elastic and flexible valve or door, easily opened by pressure from the outside, but closing tightly against a collar or projection of the wall of the bladder when the pressure is removed. The valve is also furnished with four bristles attached to its free margin, and has numerous absorbent glands on its surface. Structures of this kind are also abundantly dispersed over the interior of the bladder. The whole apparatus, as Darwin observes, presents an "extraordinarily complex appearance" under the microscope.

These structures being so arranged, minute aquatic creatures, by what induced we do not know, make their way into the narrow aperture of the sac, and are entrapped by the closing of the valve. They soon die, and are rapidly decomposed and dissolved in the water contained in the bladders, which is apparently absorbed with its soluble contents by the glandular processes on the inner surface of these organs. It would seem, however, that in this case there is no true digestion, but merely a rapid putrefaction of the contents of the bladders. In a species from South Africa, belonging to an allied genius, *Genlisea*, the bladders are provided, not with an elastic valve, but with several series of bristles, pointing inward, and capturing aquatic animals on the principle of an eel-trap, but by an arrangement much more complex.

Without dwelling longer on the curious details of this singular subject, let us inquire as to its significance, if it has any, in a general way. To the mind of Darwin this presents itself in only one aspect —that of advantage in the struggle for existence. He remarks on this, that the insect-capturing powers of Droseraceæ account for their wide diffusion and numerous species, and for their capacity to grow on very poor soil (p. 357). This is no doubt true; but when he proceeds to state that these plants must have acquired their powers gradually, and by a modification of the ordinary powers of secretion and spontaneous motion possessed by other plants, he goes beyond that which the facts warrant. On this hypothesis, one sees no reason why any or all plants having glandular hairs might not have competed with Drosera in its profitable business. Nor is it possible to understand how the presumably unprofitable hairs and secretions could have been produced, before the invention of their profitable use. Nor can we explain how the equally curious Dionea has failed to spread itself over the earth as well as Drosera. On the contrary, such marvelous structures and habits suggest at once the idea of adaptation and contrivance, and this so strongly that our author himself occasionally expresses it unconsciously, though obviously more wary in this respect than in some previous works.

But we are likely to be told that the idea of design only places those who decline to follow the Darwinian hypothesis, on the other horn of the dilemma, which, according to some, all nature presents to the theist. Are we to say that this cruel capturing of insects is part of the plan of a beneficent Creator; and in any case, is it not a poor and mean idea of such a being which can allow him to be occupied in constructing mere fly-traps, however ingenious and curious: The first of these difficulties is the more serious, for, explain it as we may, we cannot fully understand why death and destruction were permitted to form a part of the scheme of nature. Yet we fail equally to understand how it would have been possible to construct a world of material organisms without their being subject to decay and removal; and all that we can expect is that their removal should be effected in the ways least painful and injurious. That this object was had in view in the construction of the insectivorous plants is plain, for they are not machines for torturing, but for rapidly killing their prey, so that they come within the general law of nature in this respect. Nay, in the case of Dionea, there is even, according to Darwin, a contrivance for the benefit of the small insects which would be comparatively of little service, which he compares to "the large meshes of a fishing-net allowing the small and useless fry to escape;"—so there is some care, even here, for the interests of the small and feeble.

But are we not making the Architect of the universe a mere mechanist or artificer? Nay, more, are we not reducing him to the level of the constructor of an ingenious toy, when we represent him as forming the little utricle of a Bladderwort, which, if a trap more complex than any the most cunning workman can construct, as

Darwin affirms, is nevertheless a mere trap, and this for very small game? The fallacy which lurks in this objection is so patent, that did not one meet with it almost every day gravely urged by apparently serious writers, it might be dismissed with contempt.

It assumes that attention to the minute in nature is in some way less elevated than attention to the great; that, for example, it might be worthy of the Creator to attend to the structure and movements of a world but not to those of an atom. Yet it is evident that, in the view of Omnipotence, the planet and the particle may be equally small; and a Creator who could construct worlds or mountain masses, but pay no attention to atoms or minute structures, would, when his work came to be carefully examined even by us, prove to be no deity but a mere rude mechanist. Mr. Darwin does not degrade himself, in the eyes of men of science, by devoting laborious days to the study of a leaf of Sun-dew; and probably even Tyndall would object to being held as infinitely contemptible, because he could condescend to inquire and reason about atoms. It is essential to practical religion to believe that the hairs of one's head are all numbered, and that not one can fall without the knowledge of our Father; and it is as essential to any conceivable form of rational theism, that God should give attention to the minutest things, even to those vastly too small for mortal ken, as that he should care for systems of worlds. Therefore the construction of a hair of Drosera is no more unworthy the attention of God than the creation of a sun; or the arrangements for its movement, than those for the revolution of a planet. When we find Darwin throughout this book using the words "astonishing," "surprising," to express his feeling in presence of these remarkable properties of plants, we cannot fail to perceive that, rightly viewed, they are as well fitted to excite our own wonder and reverence as those greater operations of the Almighty which are usually held to be better suited to stimulate such sentiments. Of course it is not necessary in either case to imagine the Creator sitting at his work-bench, and laboriously patching together his work like a human machinist. On the contrary, the great cause for wonder is that he makes it grow, by the mere exertion of the will expressed in his Almighty word. The lessons that we may learn from the curious plants to which Darwin has so well directed attention, we may, with the above cautions, leave to the thoughts of the reader. But when he closes his long and elaborate investigation of Drosera with the words, "We see how little has been made out in comparison with what remains unexplained and unknown," we have an admonition to humility and patient inquiry which may well serve us as a closing thought. These words occur at the end of a tersely written record of experiments and observations extending over 270 pages. The whole of these experiments and observations relate to the structure and functions of a little leaf a quarter of an inch in diameter, and they are the work of one of the most accomplished naturalists of our time, extending over a period of fifteen years, and assisted by many specialists in the chemical and physiological questions involved. Yet the impression remains in his mind that, after all, little has been made out compared with what remains unexplained and unknown, even in relation to this almost inappreciable fragment of the great system of nature. There can surely be no plainer lesson than this, either to those who affect to believe any part of nature unworthy of God, or to see in the universe no evidence of design.