Mr. Darwin's Last Book—His Experiments and Observations on "Flower Traps."

The London publisher, Mr. John Murray, has just brought out a work by Mr. Charles Darwin entitled *Insectivorous Plants*. We have recently published several articles on this subject, which in just at present attracting a large share of attention in the scientific world. Mr. Darwin's views are necessarily extremely interesting, on account of his position as the head of the evolutionist school. In this new work his thorough method of investigation appears to excellent advantage.

The number of insectivorous plants is not very large, and more than one-half of Mr. Darwin's new volume is taken up with an account of his experiments upon a single species of the Drosera, the *Drosera rotundifolia*, or common sundew. During the summer of 1860 Mr. Darwin tells us that he was surprised by finding how large a number of insects were caught by the leaves of this plant, which he found growing upon a heath in Sussex. He gathered by chance a dozen plants, bearing fifty-six fully or expanded leaves, and on thirty-one of these dead insects or remains of them adhered, and he adds that no doubt many more would have been caught afterwards by these same leaves, and still more by those as yet not expanded. On one plant all six leaves had caught their prey; and on several plants very many leaves had caught more than a single insect. On one large leaf he found the remains of thirteen insects. Flies are captured much oftener than other insects. Mr. Darwin found nothing larger than a small butterfly among these insects, but he cites a well-authenticated instance of a large living dragon fly having been discovered with its body firmly held by two leaves.

As the sundew is extremely common in some districts, Mr. Darwin remarks that the number of insects thus annually slaughtered must be prodigious. He was soon satisfied that, unlike the horse-chestnut, the sticky ends of which cause the death of insects without receiving any perceptible advantage, the drosera was excellently adapted for the special purpose of catching insects. The subject, therefore, seemed to him well warranting investigation. The results, he tells us, proved highly remarkable, the more important ones being firstly, the extraordinary sensitiveness of the glands to slight pressure and to minute doses of certain nitrogenous fluids, as shown by the movements of the so-called hairs or tentacles; secondly, the power possessed by the leaves of rendering soluble or digesting nitrogenous substances, and of afterwards absorbing them; thirdly, the changes which take place within the cells of the tentacles when the glands are excited in different ways.

The following brief description of the plant under investigation is given by Mr. Darwin:—It bears from two or three to five or six leaves, generally extended more or less horizontally, but sometimes standing vertically upward. The leaves are commonly a little broader than long. The whole upper surface is covered with gland-bearing filaments or tentacles, as he calls them, from their manner of acting. The glands were counted on thirty-one leaves. Many of these were of unusually large size, and the greatest number of glands found was 260, the least 180, giving an average of 192. The name of sundew is given to the plant from the fact that the glands are commonly surrounded by large drops of extremely viscid secretion which glitter in the sun.

It would, of course, be extremely unsatisfactory, and, indeed, impossible, to attempt to present within these limits anything approaching a complete review of the numberless experiments which Mr. Darwin made upon this or any of the other plants whose characteristics he spent so much time in investigating. We shall, therefore, content ourselves with briefly touching upon the most important of the results. Mere marked difference in the greater length of time during which the tentacles remain inflected over bodies yielding nitrogenous matter than over those which did not yield such matter. The smaller particles of glass, cinders, etc., when placed on the outer tentacles called them to bend; but to effect this they must sink through the secretion and actually touch the surface of the gland with some one point. In one experiment a little bit of thin human hair, 8-1000 of an inch in length, and the pressure of which could not have exceeded the millionth of a grain, sufficed to induce inflection, and even smaller particles produced the same result, as could be seen through a lens. Yet particles even larger than this bit of hair cause no sensation when placed on the tongue, one of the most sensitive parts of the human body. This, however, Mr. Darwin says is not so remarkable as might at first sight appear, when it is remembered how very sensitive the organs of smell are in the human being, and even more so in the deer, whose power of detecting the presence of the hunter under favorable conditions at astonishingly long distances is proverbial. It is also very remarkable that the glands of the Drosera are insensible to the weight and repeated blows of drops of rain, and also to the effect of high winds. They are thus saved from much useless movement. At the same time they are exquisitely sensitive to the slightest pressure for a few seconds, and this capacity is manifestly of service to the plant in capturing small insects. Even gnats if they rest on the glands with their extremely delicate feet are quickly and securely embraced.

The experiments by which Mr. Darwin claims to have demonstrated that the leaves, of the Drosera are capable of true digestion and that the glands absorb the digested matter are, of course, by far the most interesting and important, and we quote from Mr. Darwin as follows:—

"The gastric juice of animals contains, as is well known, an acid or ferment, both of which are indispensable for digestion, and so it is with the secretion of Drosera. When the stomach of an animal is mechanically irritated it secretes an acid, and when particles of glass or other such objects were placed on the glands of drosera the secretion, and that of the surrounding and untouched glands, was increased in quantity and became acid. But, according to Schiff, the stomach of an animal does not secrete its gastric ferment, pepsine, until certain substances, which he terms pepsinogenes, are absorbed; and it appears from my experiments that some matter must be absorbed by the glands of Drosera before they secrete their ferment. That the secretion does contain a ferment which acts only in the presence of an acid on solid animal matter was clearly proved by adding minute doses of hydrochloric acid, which entirely arrested the process of digestion, this immediately recommencing as soon as the alkali was neutralized by a little weak hydrochloric acid. Certain trials made with a large number of substances also found that those which the secretion of Drosera dissolves completely or partially, or not at all, are dissolved in exactly the same manner by gastric juice. We may therefore conclude that the ferment of Drosera is closely analogous to, or identical with, the pepsin of animals.

"The substances which are digested by Drosera act on the leaves very differently. Some cause much more energetic and rapid inflection of the tentacles, and keep them inflected for a much longer time than do others. We are thus led to believe that the former are more nutritious than the latter, as is known to be the case with some of these same substances when given to animals, for instance meat, in comparison with gelatine. As cartilage is so tough a substance, and is so little acted on by water, its prompt dissolution by the secretion of Drosera, and subsequent absorption, is, perhaps, one of the most striking cases. But it is not really more marked difference in the greater length of time during which the tentacles remain inflected over bodies yielding nutritious matter than over those which did not yield such matter. The smaller particles of glass, cinders, etc., when placed on the outer tentacles called them to bend; but to effect this they must sink through the secretion and actually touch the surface of the gland with some one point. In one experiment a little bit of thin human hair, 8-1000 of an inch in length, and the pressure of which could not have exceeded the millionth of a grain, sufficed to induce inflection, and even smaller particles produced the same result, as could be seen through a lens. Yet particles even larger than this bit of hair cause no sensation when placed on the tongue, one of the most sensitive parts of the human body. This, however, Mr. Darwin says is not so remarkable as might at first sight appear, when it is remembered how very sensitive the organs of smell are in the human being, and even more so in the deer, whose power of detecting the presence of the hunter under favorable conditions at astonishingly long distances is proverbial. It is also very remarkable that the glands of the Drosera are insensible to the weight and repeated blows of drops of rain, and also to the effect of high winds. They are thus saved from much useless movement. At the same time they are exquisitely sensitive to the slightest pressure for a few seconds, and this capacity is manifestly of service to the plant in capturing small insects. Even gnats if they rest on the glands with their extremely delicate feet are quickly and securely embraced.

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Various other salts and acids were experimented with, and very interesting results were reached, but our space forbids further mention of these or of the conclusions which Mr. Darwin reached regarding the mechanism of the movements of the Drosera and the nature of the motor impulse. The following paragraph closes the discussion of this part of his subject, which gives the results of studies which were prosecuted for fifteen years:—

"I have now given a brief recapitulation of the chief points observed by me with respect to the structure, movements, constitution, and habits of *Drosera rotifundelia*; and we see how little has been made out in comparison with what remains unexplained and unknown."

Six other species of this same plant, "some of them inhabitants of distant countries," were examined by Mr. Darwin, chiefly to determine whether they caught insects. This seemed necessary, he says, because the leaves of some of the species differ to an extraordinary degree in shape from the rounded ones of the plant so fully described. His conclusion was that "most, and probably all, the species of Drosera are adapted for catching insects by nearly the same means."

The "Venus fly-trap" (*Dionea muscipula*) was the next of the insectivorous plants studied by Mr. Darwin, and as it is found only in the eastern parts of North Carolina its characteristics are, perhaps, more interesting to American readers than are those of the plant just described. The Venus fly trap has small roots, probably serving mainly, as in the case of the Droseras, for the absorption of water—a peculiarity, as has been stated, of all insectivorous plants. The leaves are bi-lobed, and the two lobes stand at rather less than a right angle to each other. Three minute pointed processes or filaments, placed triangularly, project from the upper surfaces of both. These filaments are remarkable from their extreme sensitiveness to a touch, as shown not by their own movement but by that of the lobes. The margins of the leaf are prolonged into sharp, rigid projections, that Mr. Darwin terms spikes, into each of which a bundle of spiral vessels enters. The spikes stand in such a position that when the lobes close they interlock like the teeth of a rat-trap.

With reference to the very sensitive filaments mentioned above, Mr. Darwin writes as follows:—

"It is scarcely possible to touch them ever so lightly or quickly with any hard object without causing the lobes to close. A piece of very delicate human hair, two and a half inches in length, held dangling over a filament, and swayed to and fro so as to touch it, did not excite any movement. But when a rather thick cotton thread of the same length was similarly swayed, the lobes closed. Pinches of fine wheaten flour, dropped from a height, produced no effect. The above-mentioned hair was then fixed into a handle and cut off so that one inch projected, this length being sufficiently rigid to support itself in a nearly horizontal line. The extremity was then brought by a slow movement laterally into contact with the tip of a filament, and the leaf instantly closed.

"On another occasion two or three touches of the same kind were necessary before any movement ensued. When it is remembered how flexible a fine hair is, some idea may be formed of how slight must be the touch given by the extremity of a piece one inch in length moved slowly. If a minute insect alights with its delicate feet on the glands of Dionea, it is caught by the viscid secretion, and the slight though prolonged pressure gives notice of the presence of prey, which is secured by the slow bending of the tentacles. The sensitive filaments of Dionea, on the other hand, are not viscid, and the capture of insects can be assured only by the acute sensitiveness to a momentary touch, followed by the rapid closure of the lobes.

"The Venus fly-trap does not close its lobes for the falling rain, nor for the wind,