(*From the Daily Review of July 16.*)

MR DARWIN'S NEW BOOK.

INSECTIVOROUS PLANTS. By Charles Darwin, M.A., F.R.S. London: John Murray. 1875.

THE charm of all Mr Darwin's work lies in the admirable skill with which he lays before the reader an overwhelming number of facts, the lucid manner in which he draws conclusions therefrom, and the frankness with which he states objections, practical and theoretical, to those conclusions. In these points this, his most recent work, is no exception. Seldom have we perused a volume in which minutiæ of experiments and details of observations are more excellently recorded, and where the train of reasoning by which we are led to conclusions so opposed to all preconceived ideas is so clearly set forth.

The subject, "Insectivorous Plants," is one which for some years past has been prominently before the public. The discovery in 1873, by Dr Burdon Sanderson, that in the leaf of Venus' Fly-trap (*Dionæa muscipula*) a normal electric current exists, which, upon irritation of the leaf, is disturbed in a manner similar to what takes place during the contraction of muscle in animals, and the address on carnivorous plants by Dr Hooker before the British Association at Belfast, have been greatly instrumental in directing public attention to the matter, so that at present the daily papers and scientific journals abound with records of the doings of those "vegetable sportsmen," as they have been happily styled. Mr Darwin now gives us the results of an investigation, extending over fifteen years, into the phenomena exhibited by these plants—results which illustrate most strikingly the keen and accurate powers of observation of the veteran philosopher. We will briefly, and as much as possible in Mr Darwin's own words, indicate one or two of the salient features of the work.

The insect-catching power of the well-known round-leaved sundew (*Drosera rotundifolia*) first drew Mr Darwin's attention to this subject, and the major portion of the book is occupied with a record of investigations into the phenomena exhibited by it. But we have also an account of the insectivorous propensities in all the other genera of the sundew family, as well as in many plants belonging to other families,—in such plants as the butterworts (*Pinguicula*) and the bladderworts (*Utricularia*). All are shown to be insect-catchers, not only on land but also in the water, the mechanical process differing, however, in the several genera, "all dissolve animal matter by their secretion, which contains an acid together with a ferment almost identical with the pepsin of the gastric juice in animals, and afterwards the digested matter is absorbed." In the case of *Drosera rotundifolia* it is shown that a sensitiveness is located in the glands at the extremities of the tentacles which cover the upper surface of the leaf, whereby upon either direct (*i.e.*, each gland is stimulated) or indirect (*i.e.*, only certain glands) stimulation, whether by continued mechanical irritation, slight pressure, contact with organic or inorganic bodies, heat, &c., a motor impulse is transmitted down the tentacles by which, in periods of time varying from ten seconds to some hours, according to the stimulus, each tentacle bends from its base towards the centre of the leaf, and coincident with this, the glands secrete more copiously, and the secretion becomes acid. Here, then, is a new fact of great physiological importance, that an influence can be transmitted from one portion of a leaf to a gland situated at the extremity of a tentacle on another portion by which the secretion from the gland is modified. It is only recently, as Mr Darwin states, that a corresponding fact in the physiology of animals has been established. Accompanying, though not dependent on, this motion of the tentacles, a change in the contents of the cells of the tentacles is observed. "If the tentacles of a young yet fully matured leaf that has never been excited or become inflected be examined, the cells forming the pedicels are seen to be filled with homogeneous purple fluid. The walls are lined by a layer of colourless circulating protoplasm. . . . If a tentacle is examined some hours after the gland has been excited by repeated touches, or by an inorganic or organic particle placed on it, or by the absorption of certain fluids, it presents a wholly changed appearance. The

tentacles, or by an inorganic or organic particle placed on it, or by the absorption of certain fluids, it presents a wholly changed appearance. The cells, instead of being filled with homogeneous purple fluid, now contain variously shaped masses of purple matter, suspended in a colourless or almost colourless fluid. . . . By whatever cause the process may have been excited, it commences within the glands, and then travels down the tentacles." This constitutes the phenomenon of aggregation, and its elucidation by Mr Darwin, along with the subsequent process of re-dissolution, is a masterpiece (Chap. III.) The appearances in the cells after aggregation are most curious. The small masses of aggregated matter are of the most diversified shapes, and "incessantly change their forms and positions, being never at rest;" the layer of white granular protoplasm flows along the walls, around the aggregated masses, "at an irregular rate, up one wall and down the opposite one," sometimes ceasing. This process of aggregation sometimes commences in the glands within ten seconds after stimulation—usually, however, after a longer interval—and thence travels down the pedicels. "It was interesting," continues Mr Darwin, "to observe the process momentarily arrested at each transverse partition between two cells, and then to see the transparent contents of the cell next below almost flashing into a cloudy mass." Inflection of the tentacles having taken place, we are shown how they remain so for a longer or shorter period, according to the nature of the stimulus, and in this connection the important fact is proved, that they remain closed longest when organic matter, with soluble nutrient matter, is the stimulant. The tentacles slowly re-expand, and with this occurs the re-dissolution of the cell contents. "The little masses of aggregated matter are all re-dissolved, and the purple fluid becomes as homogeneous and transparent as it was at first. The process of re-dissolution travels upwards from the bases of the tentacles to the glands, therefore in a reversed direction to that of aggregation." As one reads the account of this wonderful phenomena, one naturally speculates as to the causes and nature of the process, and the most natural explanation seems to be that it is dependent on the inflection of the tentacles or the increase of the secretion of the glands, or on the absorption of additional fluid. Mr Darwin, however, shows most clearly it is independent of all these, and concludes that the process is "one of molecular change, transmitted from the glands."

Some very dexterously performed experiments show how extremely sensitive to pressure are the glands, the incredibly small portion of human hair of the 8·1000th of an inch in length, and weighing only 1·78740ths of a grain, or ·000822 millegramme, being sufficient to cause inflection of the tentacle. This extreme sensitiveness of the glands to pressure, Mr Darwin points out, "is of the highest service to the plant; for if the delicate feet of a minute struggling insect press even so lightly on the surface of two or three glands, the tentacles bearing these glands soon curl inwards and carry the insect with them to the centre."

Around the observations on the power of dissolving, and of afterwards absorbing, solid animal matter, possessed by plants, the chief interest in the book naturally centres, and on this point we are not left in doubt; but it is most clearly proved that the leaves are capable of true digestion, and that the digested matter is absorbed. What is perhaps the most remarkable point is, that the secretion, which is poured out copiously by the glands upon stimulation, contains an acid belonging to the acetic series (probably propionic, or a mixture of acetic and butyric acids), and in addition, a ferment which is closely allied to the pepsin of the gastric juce in animals. The exact nature of the food is apparently of little moment to the plant and beyond a great desire exhibited for phosphorus, any substance containing nutritious matter is received—thus meat, cartilage, bone, enamel of teeth, &c., are

all digested, although at a different rate. Nor does the plant confine itself to animal food, but dissolves equally well the substance of seeds and pollen grains. Mr Darwin has experimented with a great number of acids, salts, alkaloids, &c., with a view mainly of determining whether they have an effect similar to their effect on animals; but, as he says, a special pharmacopeia would be necessary to describe their various, sometimes almost capricious, effects. Amongst the most remarkable, however, we note the rapid action of salts of ammonia, and also that the poison of the cobra snake does not in the least check but rather stimulates the spontaneous movements of the protoplasm in the cells of the tentacles. From these experiments he concludes that the plants do not include any diffused matter analogous to nerve tissue. In Chapter X., where Mr Darwin discusses the sensitiveness of the leaves, and the transmission of the motor impulse, his great power of argument and subtlety of reasoning are prominently illustrated. The sensitiveness is shown to be located only in the glands and the underlying cells. On stimulation "the motor impulse, as it spreads from one or more glands across the disc, enters the base of the surrounding tentacles, and immediately acts on the bending place. It does not, in the first place, proceed up the tentacles to the glands, exciting them to reflect an impulse to their bases. Nevertheless an impulse is sent up to the glands, as their secretion is soon increased and rendered acid, and then the glands being thus excited send back some other influence (not dependent on increased secretion, nor on the inflection of the tentacles), causing the protoplasm to aggregate in cell beneath cell. This may be called a reflex action, though probably very different from that proceeding from the nerve ganglion of the animal, and it is the only known case of reflex action in the vegetable kingdom." And then he continues:—"About the mechanism of the movements and the nature of the impulse we know very little. . . . But the hypothesis which agrees best with the observed facts is that the motor impulse is allied in nature to the aggregating process, and that this causes the molecules of the cell-walls to approach each other in the same manner as do the molecules of the protoplasm within the cells, so that the cell-walls contract." . . "The re-expansion of the tentacles is largely due to the elasticity of their outer cells, which comes into play as soon as those on the inner side cease contracting with prepotent force; but we have reason to suspect that fluid is continually and slowly attracted into the outer cells during the act of re-expansion, thus increasing their tension." Having treated most exhaustively the phenomena observed in drosera, Mr Darwin proceeds to treat of the Venus' Flytrap (*Dionæa muscipula*), which is perhaps more familiarly known as an insect-catcher, the movements in the leaves being so clearly seen. This plant is quite as insectivorous as drosera, but the organs connected with the process are much more differentiated, and the process itself is brought about in a different manner, having a relation to the difference in habit of the plants. The sensitiveness resides here in the upright filaments, three on each lobe of the leaf, and upon stimulation motion takes place throughout the whole leaf. On the difference in the sensitiveness of those two plants Mr Darwin remarks—"A gland of drosera may be hit once, twice, or even thrice without any effect being produced, whilst the continued pressure of an extremely small particle excites movement. On the other hand, a particle many times heavier may be laid on one of the filaments of dionæa with no effect; but if touched only once by the slow movement of a delicate hair the lobes close, and this difference in the nature of the sensitiveness of these two plants stands in manifest adaptation to their manner of capturing insects. For if a minute insect alights with its delicate feet on the glands of drosera, 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. On the other hand, the sensitive filaments of dionæa are not viscid, and the capture of insects can be assured only by their sensitiveness to a momentary touch, followed by the rapid closure

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No one who peruses this book can fail to be impressed with the magnitude of the work and its great scientific importance. It marks, indeed, an epoch in the history of botanical physiology, and opens up a wide field of research wherein may be looked for an elucidation of many of those problems which now occupy the minds of physiologists. Whilst wondering at the many new facts thus brought to light, we know not whether to be more astonished at the facts themselves or at the untiring industry and the intellectual power of the man who has so ably elucidated them.

Literature.

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