

ON DROSERA ROTUNDIFOLIA.

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Of the remarkable class of insectivorous plants (of which *Drosera* is one of the most interesting) several species have been carefully observed by me for some years past. The subject was first brought to my notice, with all the freshness of novelty, in the admirable address delivered by Sir Joseph Hooker, before the Botanical Section of the British Association, convened at Belfast in August, 1874.

I then resolved to investigate for myself, as far as was practicable, the remarkable phenomena about which I had been hearing, and forthwith supplied myself with specimens of *Dionæa muscipula*, *Drosera capensis*, and *Saracenia purpurea*, from Messrs. Henderson, of London; whilst Lady Dorothy Neville very courteously lent me living specimens, also of *Saracenia flava* and *Drosera dichotoma*, from the magnificent conservatories she at that time possessed at Dangstein, near Rogate.

It is principally, or indeed almost entirely, to *Drosera rotundifolia* that my remarks in this paper will apply.

Though long ignorant of the remarkable functions possessed by this plant, it had been a special favourite with me from early boyhood, associated as it was with sundry pleasant wanderings in various romantic districts in Scotland, Wales, and in both the north and south of England.

The quaintness of its leaves and their brilliant sanguinary colouring, its snow-white little flowers (which it is rather shy, by the way, in developing properly), the way in which it seems to shun the more busy haunts of man, the viscid, transparent, dew-like, glistening drops with which, even in the hottest weather, its radiating clusters of leaves were

always besprinkled, imparted to it, even then, a sort of mysterious charm, which a further acquaintance served only immensely to enhance, till at last I cordially agreed with those botanists who consider *Drosera* as one of the most interesting members of the vegetable kingdom. There are several genera of the *Droseraceæ*, differing from each other considerably in appearance and size, of which one genus only, containing three species, viz.: *D. rotundifolia*, *D. intermedia*, and *D. anglica*, is indigenous to the United Kingdom of Great Britain and Ireland.

D. rotundifolia and *D. intermedia* abound in certain parts of Hampshire, as for instance the boggy portions of Woolmer Forest, Short Heath, near Kingsley, and other places. I am not aware if *D. anglica* has ever been found in Hampshire, but according to Townsend's *Flora of Hampshire* it occurs in the adjoining county of Dorset, in the neighbourhood of Swanage and Studland.

The leaves of *D. rotundifolia*, somewhat resembling a racket or battledore in shape, lie pretty close on the boggy soil, and radiate from a common centre, and are generally about five or six in number. Their whole upper surface is abundantly covered with gland-bearing filaments or tentacles,—on a average, say, of some 200 or so on each leaf. Spiral vessels, accompanied by simple vascular tissue, branch off from the vascular bundles in each leaf, and run up through the tentacles into the terminal glands.

These glands, with the exception of those borne on the outermost marginal tentacles, are of an oval form and of nearly uniform size,—viz., about the one hundredth of an inch in length. Their structure, says Darwin, is remarkable, and their functions are complex, for they secrete, absorb, and are variously affected by different stimulants. They consist of an outer layer of small polygonal cells, containing a purple fluid matter. Within this there is a layer of somewhat differently shaped cells, filled likewise with purple fluid, but of a rather different tint, and variously affected by the chemical re-agent chloride of gold. In the centre of the mass of the tissues of the glands there exists a group of elongated cylindrical cells fitted together, of unequal lengths, and all enveloped by a spiral line, which can be teased out as

a distinct fibre. These latter cells are filled with a limpid fluid, which after long immersion in alcohol deposits much brownish matter. The extreme marginal tentacles are of a slightly different form; their bases are broader and the glands more elongated, and lie embedded on the upper surface merely of the tentacle, instead of standing (as do the others), all round the apex. Every possible transition, however, between these two forms may be noticed on a leaf. The purple fluid, moreover, which fills the cells of the *glands* differs considerably in its nature from that in the cells of the *pedicels*, by which the former are supported. For when a leaf is placed in hot water the gland cells become quite white and opaque, whereas the cells of the pedicels are rendered a bright red, with the exception of those cells close beneath the glands, the *green* matter with which these latter are filled becoming a yet brighter green.

I will now proceed to describe briefly the action of these several parts of *D. rotundifolia* (and it is the same in all the other species), and of the manner in which insects are captured, and, indeed, in which various nitrogenous and albuminous substances are disposed of. In lectures which I have given on this subject the description was accompanied by large drawings, which unfortunately cannot now be re-produced. If a small fly or minute cube of hard-boiled white of egg, or a fibre or two of meat be placed on the viscous glands in the centre of one of the racket-shaped leaves, these presently transmit a sympathetic motor impulse to all or nearly all the marginal tentacles likewise. The shorter and nearer tentacles, as might be expected, are the first that are influenced and slowly and almost imperceptibly bend in towards the centre of the leaf; then those that are farther off are in turn affected, until at length nearly all the filaments become closely inflected over the substance submitted to them. This takes place in from one to perhaps five or six hours, according to the freshness and vigour of the plant, and the stimulative properties of the material placed on the leaf glands. It is remarkable, too, that if even saliva or a drop of a solution of any salt of ammonia be placed on the glands the contractions above described will take place, sometimes even in less than thirty minutes. The influence

exerted on the tentacles and the leaf itself is often so potent, that not only do all the tentacles become inflected over their prey, but even the leaf itself is contracted round the object, in the form of a cup. If the extraneous substance be placed quite on one side of the leaf, then only the tentacles on that half or so of the leaf will be concerned in the process of capture and digestion.

And now, under these circumstances, not only does the secretion produced from the glands of the tentacles increase in *quantity*, but its *quality* also is changed and becomes acid. In fact, the secretion possesses the properties of the *gastric juices* of the higher animals. The cubes of white of egg for instance become changed into a transparent jelly, which is presently absorbed by the plant. The inner tissues of small flies or tiny beetles are softened by the same process, and similarly digested and absorbed, whilst the harder outer portions of the insect remain of course unaffected; and when the tentacles have accomplished their work they slowly re-expand, and are soon inclined for another meal if young and fresh. Meanwhile, the exposed exuviae of the first meal dry up and are blown away by the wind; the glands again secrete in quantity their glistening, viscid, transparent fluid, and the tentacles are ready to clasp a new object.

The absorption and assimilation of albuminous and nitrogenous matter from captured insects or other food explains how *Drosera* can flourish as it does in extremely poor peaty soil, or simply perched on a clump of *Sphagnum* (Bog Moss), as I have not unfrequently observed; and how it is that the very feebly developed roots of the plant, consisting of merely two or three villous filaments, are sufficient for their purpose, when thus otherwise supplemented by animal food, through the leaves.

It is wonderful how sensitive are the tentacles to the most minute particles (even though they afford no nourishment) that are submitted to the outer glands. For instance, atoms of human hair (as Darwin observed, and as I have myself proved), not more than the $\frac{1}{50}$ th of an inch long, if placed on the glands of two different tentacles on the opposite sides of a leaf, will cause those tentacles to be inflected half way to the centre in rather more than an hour, all the other

tentacles round the leaf remaining motionless. In order, however, to excite such a movement, it is necessary in the case of *Drosera* that the particles should actually *rest* upon the glands; for a *touch* merely, twice or even thrice repeated from a solid body is not sufficient to produce this effect. And this circumstance must no doubt be of service to the plant, for in stormy weather the glands could hardly escape being touched by contiguous blades of grass or sedge, &c. Neither do drops of water, either in the form of natural or imitation *rain*, affect the tentacles, though the spherules of water, observes Darwin, must often strike the glands with considerable force.

But there is another phenomenon in connexion with the movements of the prey-devouring or otherwise sensitive tentacles—of microscopic minuteness, indeed, but yet of deep interest to the physiologist,—which we will next proceed to mention. Darwin calls it the *aggregation* of protoplasm within the cells of the tentacles. I will describe it nearly in his own words:—"If a tentacle be examined closely some few hours after its gland has been excited to inflection, 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. The tentacles consequently now have a *mottled* appearance, which is so conspicuous that it is visible through a weak lens, or even sometimes to the naked eye. By whichever cause—by irritation or feeding with suitable food—the phenomenon be produced, it commences within the *glands*, and then travels *downwards* within the tentacles.

Strange to say, shortly after the tentacles have re-expanded the little masses of aggregated protoplasm are all re-dissolved, and the purple fluid within the cells becomes as homogeneous all throughout them, and as transparent as it was before, the re-dissolution travelling *upwards*, in the reverse direction to that of aggregation."¹ I have myself distinctly verified the process. The little masses whilst aggregated are of the most diversified forms and incessantly change their shapes, being never at rest; whilst also the colourless fluid in which they

¹ Darwin.

float flows along by the sides of the cells, *up* one side of their walls and *down* the other, presenting a wonderful scene of vital activity.

Some of the readers of this paper may have seen the same kind of phenomenon under the microscope, in the surging flow of the jelly-like protoplasm, in the long hollow tubes or cells of the aquatic characeous plant *Nitella translucens*, which I have had under observation for many years, and which I described at length in the pages of the "Intellectual Observer," vol. ix, page 352, for 1866; only in this latter case the phenomenon is on a hundred, or indeed a thousand times the scale, often, to what it is in the cells of *Drosera rotundifolia*.

The physiologist will, however, recognise how much there is in common, in this matter of protoplasm and its movements, between not *man* and other *animals* merely, but between man and the *vegetable kingdom*, all proclaiming in their wonderful and beautiful details one plan and master mind—a wonderful continuity, may we not say?—in the realms of nature!
