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IS THE VALVE OF UTRICULARIA SENSITIVE?

By MRS. MARY TREAT.

FOR several months past I have been working on different species of utricularia, and during this interim Mr. Darwin's book on *Insectivorous Plants* has appeared. It is so comprehensive, and the experiments have been so carefully conducted, that it seems presumptuous for any to attempt to differ in the least from his conclusions; and in the main a careful experimenter can not differ from him. But there are a few of the points which he has treated in his chapter on utricularia in regard to which my observations and experiments have led me to conclusions somewhat different from his.

My notes and memoranda have been jotted down during the progress of my work, and I have such a mass of material collected that I find it difficult to make a selection. A magazine article must necessarily be brief; so but few experiments can be given in detail.

These plants — utricularia — grow in water or wet places. (It takes its name from "utricle," a little bag or bladder.) When growing in water they have long floating stems and usually finely dissected leaves, and along the stems, among the leaves, are often numerous little utricles. In some species we find long stems wholly destitute of leaves — simply clusters of utricles scattered along the stems.

FIG. 1.— FLOWERING STEM OF UTRICULARIA INFLATA.

The species that I most closely observed were *Utricularia inflata*, *U. vulgaris*, *U. clandestina*, *U. intermedia*, *U. stricata*, *U. gibla*, *U. purpurea*, *U. cornuta*, and *U. subulata*. Most of these species vary slightly, and a few considerably, in the construction of the utricle. I have selected two of the most widely dissimilar species that I have examined for illustration, *U. inflata* and *U. purpurea*. Fig. 1 represents a portion of *U. inflata*, natural size. This species, unlike the others, has a whorl of white, spongy, inflated petioles encircling the flowering stem, which are branched at the apex, and bear a few thread-like divisions on which are scattered a few utricles; these light spongy petioles give the plant a very elegant appearance, and their main office seems to be to float the plant at the time of flowering. The flowers are of a bright yellow color, and from five to ten on each slender stem. It grows in rather deep, still water. I have taken it from ponds of quite pure water with a depth of from eight to ten feet.

FIG. 2.—UTRICLE OF UTRICULARIA INFLATA.

Fig. 2 represents a young utricle of *U. inflata* magnified about fifty diameters. The antennæ, as Mr. Darwin calls the long, branched prolongations of the utricle, are not fully expanded, and are not as long as in most specimens. The mouth or orifice is just beneath the long antennæ, and within this orifice is situated the valve or trap by means of which the plant captures its prey.

The manner in which the utricle is developed has been observed by some of the most able naturalists of our time. Through the kindness of Professor Asa Gray, Professor Goodale, of Harvard University, has sent me a condensed translation from the German of Schacht "On the Development of Utricularia Vulgaris," and as this species grows with us, and does not differ materially from the development of the utricle of *U. inflata*, I gladly give it a place here:

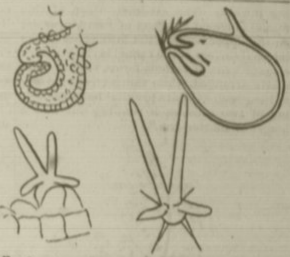

FIG. 3.—COPIED FROM SCHACHT, SHOWING EARLY STAGES OF THE UTRICLE, AND THE GLANDS FOUND ON THE INNER SURFACE OF THE UTRICULARIA VULGARIS.

"According to Schleiden, in the sinuses of the leaves there appears a minute cornet-shaped body, from which there is developed, little by little, the stalked utricle, whose external opening is closed by a beard at the mouth. According to Benjamin, some segments of the leaf remain backward in developing. They do not elongate; on the contrary, they broaden and extend at their base, forming a relatively narrow neck, on which appears a little sphere, which is fastened by a short stalk to the axis of the leaf. Often one can follow the different steps by observing on a single leaf their development from the base to the tip. The utricle, which at first is filled with cytoblast, becomes by rapid absorption changed to an air-vessel. By its further extension in all directions the utricle approximates more and more to its future form. It becomes flattened, and assumes the form of a stomach, the stalk is at the *pylorus*, the opening at the *cardia*. On the greater curvature both walls come together as if at a seam. The opening of the perfect utricle is, according to Benjamin, provided with a little flap turned inward, which he calls the *valve*. This valve appears in the earliest state of the utricle as merely a cluster of dark cross stripes.....The side walls of the young utricle grow rapidly; the air cavity which they contain becomes thereby greater. The edge of the lateral walls approach each other and bend inward; the original opening becomes closed, and exhibits the dark stripes described by Benjamin. The flap on the valve consists of the wall bent inward on that part of the utricle turned away from the stalk. On the side turned toward the stalk the edge is not so strongly developed.....The full-grown pouch presents itself as a roundish and somewhat laterally compressed body, which above is continuous by one angle with the stem, while the other exhibits an orifice which forms a little funnel project-

ing inward. The external orifice of this funnel is closed by a rim of beard growing on the upper border; the lower part of the internal surface of the funnel is clothed with elegant hairs of various forms, but very regularly arranged, while the internal surface of the pouch exhibits peculiar hairs consisting of two cells, each running out into a longer or shorter arm."

FIG. 4.—END OF GROWING BRANCH OF THE UTRICULARIA PURPUREA (NATURAL SIZE).

Fig. 4 represents the end of a growing branch of *U. purpurea*. Here we have a species that diverges widely from all of the others that I have examined, and as Mr. Darwin gives no account of any similar species, I shall dwell more upon its manner of growth and structure. The finest specimens of this plant that I have found were growing in deep, still water. The stems are long, sometimes two feet or more in length, and these stems or branches radiate in every direction, so that one plant often covers quite a large surface of water. At the points where the branches radiate, naked flowering stems shoot up, and stand above the water, and bear at the top three or four violet-purple flowers. The leaves—if they can be called leaves—are scattered along the submerged stems in whorls of five or six, the branch always maintaining the same number that it starts with. The leaves are decompound, and in a healthy plant each division is terminated by a utricle.

All over the stems and leaves and outer surface of the utricle are thickly scattered

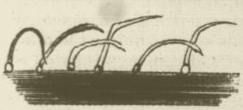

FIG. 5.—SECTION OF STEM WITH CURVED HAIRS.

curved hairs (Fig. 5), and these hairs seem to serve a twofold purpose: they arrest or capture both animal and vegetable decaying matter—apparently food for the plant, which they seem to absorb. With all of these mouths so thickly scattered over the outer surface of the plant, we wonder why the utricles are needed as reservoirs of food, but here they are, and in great numbers, and larger than in most other species, and they capture living animals. Fig. 6 rep-

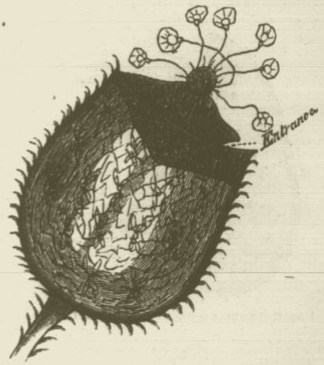

FIG. 6.—MAGNIFIED UTRICLE OF UTRICULARIA PURPUREA.

resents a much enlarged utricle of this species. Here we find no antennæ, nor the least semblance of any; and the valve, instead of sinking into the orifice or mouth, projects above it. According to naturalists, the valve of all species of utricularia is formed of two layers of small cells, and is simply a continuation of the larger cells which form the wall of the utricle. It is fast on all sides except on the margin marked "Entrance" in the figure; and here the two edges fit close together, and are always closed, except when something touches them in precisely the right way, when they suddenly open, and close again as quickly, and not often does it miss its prey. The valve is s

large in this species, and projecting out and above the mouth as it does, it is not a difficult matter to cut it free and spread it out so as to examine its structure. We do not find glands on its surface, as we do in the other species. It seems as if all the energies of the plant had gone to construct the elegant cluster that crowns the summit of the valve, situated on the point where the valve doubles; it consists of a globular body which supports from twelve to fifteen beautiful, transparent, glassy-looking glands, the use of which is not clear to me.

Over the inner surface of the utricle—like the other species—are scattered numerous glands, which Mr. Darwin has named quadrifid processes, from the fact that the glands radiate from a central cell in the form of

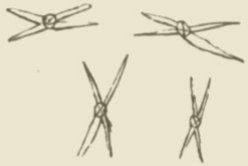

FIG. 7.—QUADRIFID PROCESSES.

arms, four in number (Fig. 7). In this species the arms are about of equal length. Near the valve, and close to where the walls of the utricle join together, we find cells with only two arms—bifid processes—and intermingled with these we occasionally see a cell with only one arm, no way different from the others except in the lesser number of arms. Mr. Darwin says these glands are absorbents, but he doubts if they ever secrete. Around the edge of the valve that extends into the utricle is a thick fringe of hairs or glands, all pointing inward, and so do not prevent any thing from entering through the valve; but we can see that they prevent an exit. These are all the glands I find in this species, except a few oblong ones, which have no pedicels, and are imbedded in the smaller cells near where the valve lies.

In order to make it clear how my observations were conducted, I will state that I had a tub of water in which were growing the various species of utricularia. When I wished to experiment with any particular species, I took such species from the tub and placed it in a small vessel of clear water. I also had other tubs of water, for the purpose of securing the eggs of the mosquito and chironomus. The eggs of the mosquito are deposited in large clusters, which float on the surface of the water. The eggs of chironomus are deposited in a jelly mass of matter, and fastened by a little thread to something, to prevent them from sinking too low in the water. These masses of eggs are very conspicuous to the educated eye, one species producing a mass as large as a good-sized pea; the jelly is quite transparent, so the eggs can be distinctly seen with the naked eye. After the eggs are hatched, the young chironomus larvæ remain in the jelly for a day or two, feeding on it until they are large and strong enough to venture out into the great world of water, where they can secure their own livelihood.

It can be seen how quickly and easily I could swarm a small vessel of water with the larvæ of the mosquito and chironomus by transferring to the vessel these masses of eggs. After this long but necessary digression, I will return to the valve of the utricularia.

Mr. Darwin says (*Insectivorous Plants*, page 407): "To ascertain whether the valves were endowed with irritability, the surfaces of several were scratched with a needle or brushed with a fine camel's-hair brush so as to imitate the crawling movements of small crustaceans; but the valve did not open." And farther on he adds: "On three occasions minute particles of blue glass (so as to be easily distinguished) were placed on valves while under water. On trying gently to move them with a needle they disappeared so suddenly that, not seeing what had happened, I thought that I had flirted them off; but on examining the bladders they were found safely inclosed. The same thing occurred to my son, who placed little cubes of green boxwood (about $\frac{1}{60}$ of an inch) on some valves; and thrice in the act of placing them on, or while gently moving them to another spot, the valve suddenly opened and they were ingulfed." The same thing occurred to me several times when I was gently moving minute particles of various substances on the edge of the valve—it suddenly opened and took them in; which helped to confirm me in the belief that the valve was sensitive, and that the sensitiveness was of a special nature. But not upon these experiments did I wholly base my inference; it was based more upon observations made upon the growing plant and the living larvæ. By putting a spray of the plant and water under a low power of the microscope I could thus bring several utricles into the field, with numerous mosquito larvæ. If the tail of one of these larvæ happened to come in contact with the valve, the valve was almost sure to open and ingulf the larva, often leaving its head sticking out, as is seen in Fig. 8. I have a large number of these utricles with mosquito larvæ caught in this way. When the larva is thus caught it never struggles; the part of the body that is within the utricle seems paralyzed, and the larva dies much sooner than one that is wholly within the utricle; and this is the more singular from the fact that when the larva is not caught and held in the valve, but has passed through

the forked tail brushes against the valve it causes it to open, and the force above alluded to carries the larva into the utricle. And this is the fact with all of the species of utricularia that I have experimented with, except in the case of *U. purpurea*. In this species the valve does not seem to be so sensitive as in the others. A slight brush of the tail of a mosquito larva does not cause the valve to open; it takes a more vigorous blow with the head; hence, in this species, the mosquito larva is almost always caught head first.

I have a number of alcoholic specimens of the mosquito larvæ, with only the head caught in the valve; the larva had grown too large to admit the first joint of the body through the orifice. Many of these specimens I put in alcohol while the larvæ were still living; others I observed until they were dead. With the head only caught in the valve, and the rest of the body sticking out, it was left free to thrash about, and it seemed the more the victim struggled, the closer the valve fitted about the head. A half-grown mosquito larva thus caught could sway the utricle from side to side, and make considerable demonstration that could be seen with the unassisted eye, but I never saw one escape.

Even here Mr. Darwin's argument would hardly hold good, that the head serves as a wedge, for the valve opens just as quickly as in the other species when the blow is hard enough, and the mosquito larva never goes poking about using its head as a wedge. But the chironomus larva not only swims and wriggles, but it uses its brush-like feet, and crawls along the leaves and stems of the plants, and often feeds on the hairs or bristles about the entrance of the utricle, which I find in all of the species except in *U. purpurea*. So this larva looks more like using its head as a wedge, but, as we have seen, it is not at all necessary for it to use its head in this manner.