

XI.—*On the Architectural Instincts of Melicerta ringens, an Animal of the Class Rotifera.* By P. H. GOSSE, Esq.

(Read January 16, 1850).

AMONG all the aspects in which we regard the inferior animals, perhaps there is not one more fascinating than that in which we see them reflecting, as in a mirror, those actions in man which are the result of reason or experience. The architectural instinct of animals, in particular, by which they are impelled to form structures for the protection of themselves or their progeny, affords some of the highest treats which the naturalist knows. We hear with curiosity that the man-like orangs of West Africa and of Borneo construct rude huts among the branches of trees, in which they dwell; and the elaborate masonry of the beaver has been a theme of admiration for ages. The nests of birds, the waxen cells of bees, and the papery edifices of wasps, render these the most interesting of animals, as exhibiting in beautiful prominence parental foresight and care, as well as constructive skill. But there is another class of animal structures of so ambiguous a character that we scarcely know how to name them; we are in doubt whether the ingenious artificer should be denominated a mason or a tailor; whether he has made a house or a garment. I will not speak of the investing shell of the snail, or the valves of the oyster, nor yet of the tubes of the beautiful organ-pipe coral (*Tubipora musica*), for these are deposited secretions rather than constructions. The larvæ of the clothes-moths (*Tineadæ*), however, cut off the fibres of our textile fabrics, and weave them into a case of cloth; the caddis-worms, so familiar to anglers (the larvæ of the *Phryganeadæ*), collect little stones, shells and other extraneous bodies lying at the bottoms of streams, and, fixing them with a glutinous fluid from their mouths, form them into curious cylindrical cases; and I have, in America, seen the caterpillar of a moth (of the genus *Oiketiscus*), which cuts off the slender stems of plants and the foot-stalks of leaves, and, dividing them into short lengths, builds up piecemeal, by the aid of its silk, a tube, around its body. These edifices all serve their owners for tents, into which they can retire, or which they can leave at will; while by the nature of their lining,

and by the closeness of their investiture, they may be considered as clothing.

The subject of the present paper is of this class of animal artificers. It is an animalcule, so minute as to be with difficulty appreciable by the naked eye, inhabiting a tube composed of pellets, which it forms and lays one by one. It is a mason, who not only builds up his mansion, brick by brick, but makes his bricks as he goes on, from substances which he collects around him, shaping them in a mould which he carries upon his body.

Neither the animal itself nor its architectural habit is any new discovery; both the one and the other were made known at a very early period in microscopical science. The illustrious Leeuwenhoek discovered the species at Delft, in 1703, and described its appearance and manners in the *Phil. Trans.* (v. 176, abridged edition). It was afterwards noticed by many observers; until, at length, in the magnificent work of Prof. Ehrenberg, its past history was detailed, and enriched by the addition of his own most admirable observations.

As, however, my own observations on this animal were made before I had seen those of either of these illustrious microscopists, and as, in the most interesting part of its economy, they disagree with the conclusions of the latter, and add something to those of the former, I shall commence with a brief description from my own notes.

Attached to the roots of *Lemna*, or the narrow leaves of *Chara*, *Nitella*, *Ceratophyllum*, and other sub-aquatic plants, may often be observed a tube, a little wider at the top than at the bottom (Plate XII., fig. 4). It stands erect, being fixed by the base, which is sometimes dilated; the mouth being uppermost. This tube is of a dark yellowish or reddish brown hue, and is found to be composed of a multitude of round pellets, set very regularly in a sort of mosaic, apparently agglutinated by a cement insoluble in water. The upper part or rim, is usually irregular, as if broken off with a ragged edge (fig. 2, a).

But while we gaze, a curious object is slowly protruding from this tube. A complicated mass of transparent flesh appears, involved in many folds, displaying at one side a pair of hooked spines (fig. 2, b), and at the other, two slender truncate processes, projecting horizontally (fig. 2, c). As it exposes itself more and more, suddenly two large rounded disks are expanded, around which, at the same instant, a wreath of cilia is seen performing its surprising motions (fig. 4, d). Often the animal contents itself with this degree of exposure, but sometimes it protrudes farther, and displays two other smaller leaflets opposite to the former, but in the same plane, margined with

cilia in like manner (fig. 1, *e, e*). The appearance is now not unlike that of a flower of four unequal petals; from which resemblance, Linnaeus, who compared it to a ringent, labiate corolla, gave it the trivial name *ringens*, by which it is still known. On each petal we see a white line, probably a nervous thread, running parallel with the margin, to which many short lines radiate from it.

But the eye is involuntarily drawn from the petals themselves of this living flower, to the beauty of the coursing cilia (fig. 1, *f, f*): these appear to chase each other in ceaseless race along the margin, running down and up the sinuous divisions of the petals, now relaxing, now refreshing, their speed. This progression of the ciliary waves is now explained; but while we gaze upon them, we find it easy to forgive the error of Colombo and Dutrochet, who maintained that the teeth actually ran around the margin of the stationary wheel. There is a remarkable phenomenon in the ciliary course in this genus, which I have observed also to characterize *Limnias*, *Megalotrocha*, and a species which has occurred to me, belonging to an undescribed genus; but which does not occur to nearly the same extent in the *Rotifera* generally. Each cilium appears thickened in one or two places in a very regular manner, forming thick black spots, which run along the course, and produce a very striking effect. I conjecture that each cilium is alternately either dilated and attenuated, or else bent nearly in the line of vision at these points (so as to appear thick by perspective), and straightened, in rapid succession.

Below the large petals on the ventral aspect, and just above the level of the projecting respiratory tubes, is a small circular disk, or aperture, within the margin of which a rapid rotation goes on (fig. 1, *g*). This little organ, which seems to have hitherto escaped observation, I can compare to nothing so well as to one of these little circular ventilators, which we sometimes see in one of the upper panes of a kitchen-window, running round and round, for the cure of smoky chimneys.

The gizzard, or muscular bulb of the cesophagus (fig. 1, *h*), is always very distinct, and its structure is readily demonstrated. It consists of two sub-hemispherical portions, or jaws, each of which is crossed by three developed teeth, which are succeeded by three or four parallel lines, as if new teeth might grow from thence. The teeth are straight, slender, swelling towards their extremity, and pointed. These armed hemispheres work on each other, and on a V-shaped, or tabuliform apparatus beneath, common to most of the *Rotifera*, but in this genus very small.

Below the gizzard are seen several sub-globose sacculate viscera, which the opacity of the case forbids to trace down; they are doubtless the commencement of a constricted stomach, with its accessory basal vesicles (pancreatic or biliary?); as I have traced the passage of coloured food through them (as far as the margin of the tube permitted vision), in the form of a constricted canal. On one occasion, the accidental desertion of its case by an individual enabled me to submit the latter to compression, and to discover that the anal orifice is situated near the middle of the body, on that side on which the little curved horns (fig. 2, *b*) are placed, and consequently opposite to that which is furnished with the respiratory tubes (*e*) and the little rotating organ (fig. 1, *g*). The pellets composing the case are very regular in form and position; in a fine specimen (about $\frac{1}{8}$ inch in length when fully expanded, of which the tube was $\frac{1}{8}$ inch) I could count about fifteen longitudinal rows of pellets at one view, which might give about thirty-two or thirty-four rows in all.

Such was the amount of my acquaintance with this beautiful form, on the 17th of November last. On that day a fine specimen fell under my observation, attached to a submerged moss, from a pond at Hackney. I had the great pleasure of seeing this individual engaged in the building of its case, and at the same time of discovering the use of the curious little rotatory organ on the neck. When fully expanded, the head is bent back at nearly a right angle to the body, so that the disk is placed nearly perpendicularly, instead of horizontally; the larger petals, which are the frontal ones, being above the smaller pair.* Now below the large petals (that is, on the ventral side), as in *Limnias* (fig. 3), &c., there is a projecting angular chin (*i*), which is ciliated, and immediately below this, in *Melicerta*, is the little organ in question (fig. 1, *g*). It appears to form a small hemispherical cup, and is capable of some degree of projection, as if on a short pedicle. On my mixing carmine with the water, the course of the ciliary current was readily traced, and formed a fine spectacle. The particles are hurled round the margin of the disk, until they pass off in front through the great sinus (fig. 1, *j*), between the larger petals. If the pigment be abundant, the cloudy torrent for the most part rushes off, and prevents our seeing what takes place; but if the atoms be few, we see them swiftly glide along the facial surface (fig. 3, *k*), following the irregularities of outline with beautiful precision, dash round the

* I made no drawing of *Melicerta* in this position, but the figure of *Limnias* is sufficiently like to illustrate the peculiarity spoken of.

projecting chin (*i*), like a fleet of boats doubling a bold headland, and lodge themselves one after another in the little cup-like receptacle beneath. The action of the cilia which perform this transport is clearly seen; and I believe that they are continuous from the great sinus to the cup. The contents of the cup are whirled round with great rapidity, and it was while looking at this spectacle, that the notion occurred to me, that the pellets of the case might be prepared in this receptacle. Dr. Mantell, in his interesting 'Thoughts on Animalcules' (p. 60), had informed us that the pellets are coloured with admixed pigment; but he supposed with Dr. Ehrenberg, whose observations I shall presently quote, that they were expelled from the orifice of the rectum.

I now watched the animal with eager expectation, and presently had the satisfaction of seeing it bend forward its head as I had expected, and after a second or two raise it again, when I saw that the little cup had lost its contents. It immediately began to fill again; and when it was full, and the contents were consolidated by rotation, aided probably by the admixture of a salivary secretion, it was again bent down to the margin of the case, and emptied of its pellet. This process I saw repeated many times in succession, until a goodly array of dark red pellets were laid upon the yellowish brown ones, but very irregularly. After a certain number were deposited in one part, the animal would suddenly turn itself round in its case, and deposit some in another part. It took from two and a half to three and a half minutes to make and deposit a pellet. Some atoms of the floating carmine now and then passed down the œsophagus into the gizzard, and thence into the stomach; but these were quite independent of, and unconnected with, the pellets, which were composed exclusively out of the torrent that had passed off the disk. On one occasion the cup was brought down to the margin, but, from some cause or other, failed to deposit its pellet: it was raised for a moment, and then a second attempt was made, which was successful.

Professor Ehrenberg, however, thus speaks of the phenomenon in question:—"According to my own observations, the tubes are composed of little lenticular bodies, which the animal (as Leeuwenhoek indistinctly saw, but I distinctly discovered) separates from the posterior intestinal orifice (*aus der hintern Darmmündung*) and glues fast with the same. Therefore the tube is always of the same height as this part of the animal. These granules are not extraneous bodies, like those on the tube of *Phryganea*, nor are they excrement; but a

peculiar gummy substance, which hardens in water, mingled, however, with the latter."—('Die Infusions-thierchen,' p. 406.)

I know not what to think of this discrepancy. It is scarcely possible that the experience and power of observation of so excellent a naturalist could have been at fault in a matter, which he himself says he distinctly saw; and his general care and accuracy forbid us to doubt that what he saw he has correctly recorded. Are there then two modes of effecting the same object in the same animal? This is scarcely imaginable. Or, are there two species, closely allied, but differing in this part of their organization and economy? From one or two other slight differences which I have observed, this may be just possible: at any rate it should be borne in mind in future observations.

The venerable Leeuwenhoek thus describes what he saw, which seems to me sufficiently distinct. "I viewed one of these animals a good while together, and observed several times, one after another, that when the animalculum thrust out its body from the sheath or case, and that the wheel-like or indented particles moved in a circle, at the same time, out of a clear and transparent place, a little round particle appeared, which without nicely viewing could hardly be perceived; which particle growing larger, moved with great swiftness, as it were about its own axis, and continued without any alteration in its place, till the animal had drawn part of its body back into its sheath; in doing which it placed the said round particle on the edge of its sheath, which thus became augmented with a round globule; and whereas the animalculum had placed the said globule on the east part of its sheath, another time it fixed it on the south or north side; by which means the sheath was regularly increased on all sides."—Phil. Trans. iv. 43 (abridged edition).

I would again observe that I had not the slightest acquaintance with these observations, till some time after I had made the whole of my own; which were recorded with the animal before my eye.

DESCRIPTIONS OF PLATE XII.

- Fig. 1. *Melicerta ringens*, protruded and fully expanded; with the upper part of its tube. Magnified 300 diameters.
- c. One of the respiratory (?) tubes.
 - cc. The occipital petals of the disk.
 - ff. The frontal petals.
 - g. The pellet-cup.
 - h. The gizzard and intestine, as these viscera appear after the animal has been fed upon carmine.
 - j. The frontal sinus.
- Fig. 2. The same unexpanded, viewed laterally. Magnified 300 diameters.
- a. The tube, formed of pellets.
 - b. The occipital spines.
 - e. The respiratory (?) or antennal processes.
- Fig. 3. *Limnias Ceratophylli* (magnified 300 diameters), introduced to show the form of
- i. The projecting chin; and
 - k. The horizontal face.
- Fig. 4. *Melicerta ringens*, partially expanded, viewed in front, with the whole tube shown. This is much less magnified. In the first three figures the lower part of the tube is not drawn.
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Fig. 1.

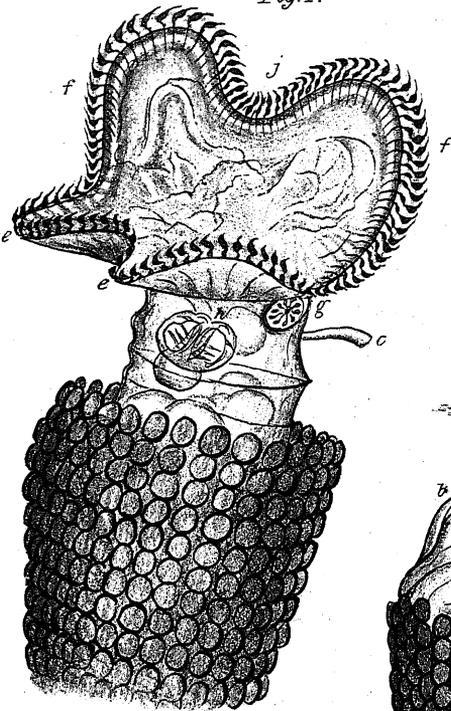


Fig. 3.

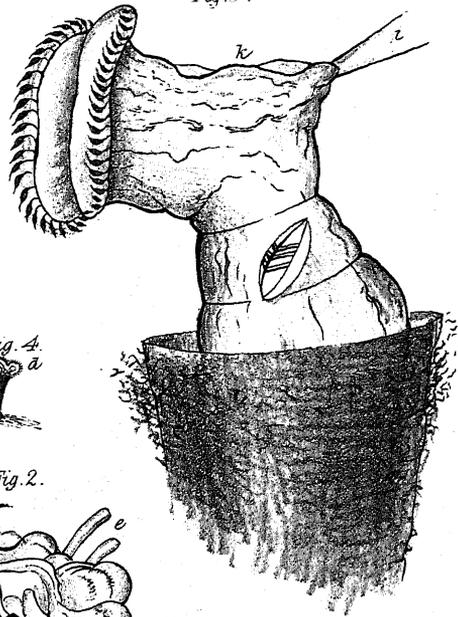


Fig. 4.



Fig. 2.

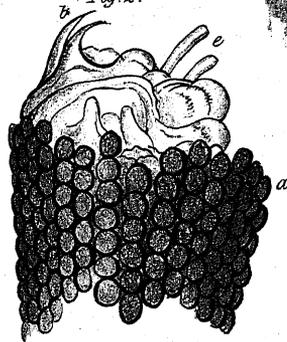


Fig. A.

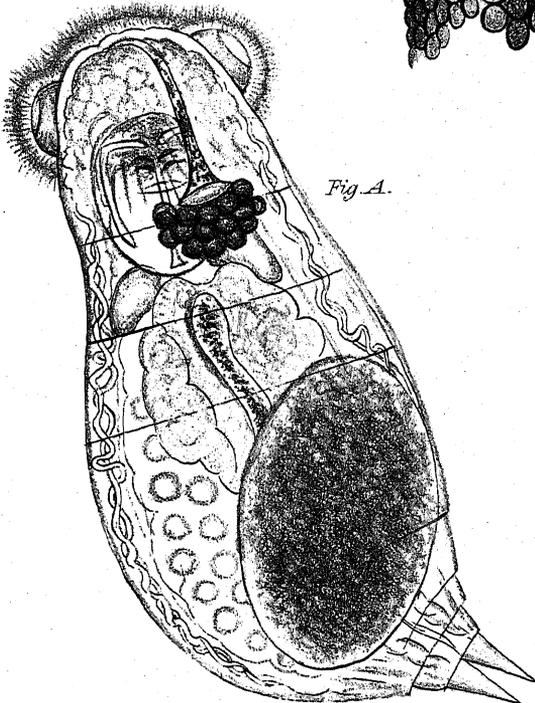


Fig. B.

