THE STRUCTURE OF THE MOUTH IN THE LARVA OF DYTISCUS.

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As has long been known, the larva of Dytiscus, called in England the water-tiger, sucks the juices of its prey by means of a small canal which perforates its long sickle-shaped mandibles. No other opening into the head is evident, and authors are agreed in describing the creature as mouthless. Thus Westwood says, "The mouth is remarkably constructed, being destitute of the ordinary aperture, so that the insect may be, and indeed has been, described as wanting a mouth;"[1] and again Lacordaire calls the mouth "complètement close, se compose d'un menton . . . et de mandibules falciformes, aiguës, sans dents, creuses et percées d'une petite ouverture près de leur extrémité."[2] De Geer, as quoted by Westwood,[3] indeed "suggested that the insect must be provided with some other means of taking food, as he observed one of the larvae not only suck the juices of an aquatic wood-louse, but also devour, by small degrees, all its solid parts." No writer has, however, shown anatomically how the food passes from the mandibular, into the alimentary canal, or, except De Geer, even seen reason to guess the existence of an oral aperture until Meinert, a few years since in a short paper,[4] stated that he had forced the contents of the alimentary canal out from under the clypeus, as well as from the mandibular openings. Moreover he passed a hair into the mandible and saw it enter the head, through the basal mandibular opening, and I therefore presume he understood the modus operandi of sucking, as I shall state it below, although he gives no anatomical particulars, and did not see the mouth-lock.

Passing now to the water-tiger itself, a cursory inspection will detect the oval opening on the inside of the mandibles near their tip (see the left mandible in figure 1); from this opening a canal leads along the inner surface to a basal opening on the

[1] Mod. Classif. of Insects. I, 100. [2] Coleoptères I, 407. [3] *Loc. cit.*

[4] Om Mundens Bygning hos Larverne af Myrmeleontiderne, Hemerobierne og Dytiscerne. Videnskab. Meddelelser fra Naturhist. Foren. Kjobenhavn, 1879-80, I, p. 69

upper surface (figure 1, *o.*) first noticed by Westwood. A fine hair, as stated by Meinert, can easily be passed from one opening into the other, clearly demonstrating the canal. This evidently

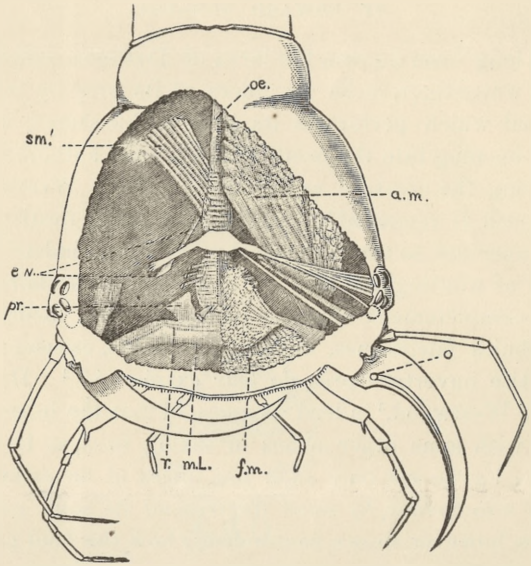

Fig. 1. × 6. Head of larva from above, the epicranium removed to show the interior. In the centre is seen the white brain with the optic lobes on either side sending nerves to the eyes as shown on the creature's left. On this side is also drawn the antennal nerve, and one of the antennal muscles attached to the top of the endocranium, and lying between the antennal and optic nerves. Under these parts passes the great adductor of the mandible (*a. m.*) which has been removed on the right side, only a piece of its tendon being figured. *oe.*, Oesophagus, gradually expanding into the pharynx, one of the posterior series of suspensory muscles of the latter (*s. m.*[1]) being shown on the right. On the right in front of the brain are also the roots of four anterior suspensory pharyngeal muscles. *pr.*, Process from the floor of the mouth for attachment of the large muscle which is drawn in place on left side. *r.*, Ridge on the roof of the mouth, to which the frontal muscle (*f. m.*) is attached, the latter shown in place on the left. *m. l.*, The anterior boundary of the mouth. *en.*, Endocranium. *o.*, Basal opening of the mandibular canal.

originated as a deep furrow along the inner edge, which is now closed by the growth of a very thin septum. If we peer or pry into the narrow but deep slit between the clypeus and labium, we do not discover any trace of a mouth, but the slit apparently

ends in a perfectly closed seam. A section through the middle of the head will, however, at once clear up the whole mystery, showing that the upper and lower lips are locked together by a dovetail joint, the character of which is plainly shown by figures 2, 3, and 4, (*m. l.*) This mouth-lock extends the whole width of the head from the base of one mandible to the other, and if we open and close the mandibles we see that, while the basal opening of the mandibular canal is exposed when the mandibles are extended (see the *left* mandible — *right* side of the cut — in figure 1), it is brought into the corner of the mouth when the mandibles are closed (see the *right* mandible in figure 1), and these being natu-

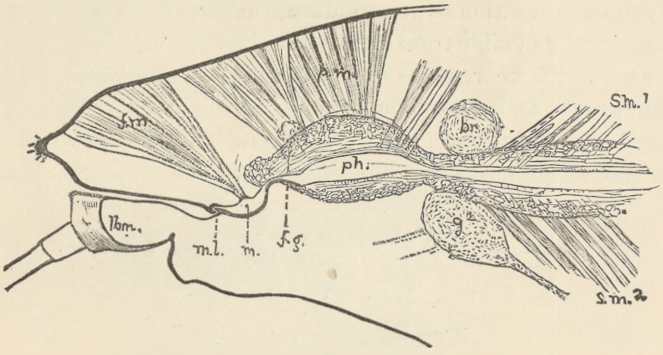

Fig. 2. Longitudinal section through middle of head, × 18, showing the mouth-lock (*m. l.*), the mouth cavity (*m.*) with its thick floor, and the ridge in its roof for the insertion of the frontal muscle, *f.m.* *ph.*, Pharynx with its muscular investments and its suspensory muscles, the two posterior series *s. m.*[1] and *s. m.*[2], behind the brain, *br.* *g*,[2] The suboesophageal ganglion. *f. g.*, Frontal ganglion. *p. m.*, Muscle attached to mouth process. *lbm.*, Labrum with base of labial palpus.

rally in this position when buried in the body of a victim, the water-tiger sucks up the former's blood as a man inhales the smoke of a pipe stuck in the side of his mouth.

The mouth cavity is of small diameter, and somewhat crescent-shaped, as shown in figure 1, where the roof is exposed from above on the right side. The roof is formed of a flexible membrane, while the floor is heavier and rigid (see figures 2 and 4). Along the middle of the roof runs a hard chitinous ridge (figures 2 and 4, *r.*) to which, on each side of the head, a powerful muscle

(the *frontal muscles*, figures 1 and 2 *f. m.*) is attached. The contraction of this muscle of course draws up the mouth roof, and thus forms part of the pumping mechanism we should expect to find in a sucking insect. The mouth floor on either side sends a process (figs. 1, 4, *pr.*) backwards and upwards into the cranial cavity, serving for the attachment of another powerful pair of muscles (*pr. m.* figure 2, shown, but not lettered, in figure 1) lying just behind the frontal muscles, concerning whose function I am yet in doubt. They may be concerned in one, two, or perhaps all, of three operations, namely, to open the mouth lock, to tighten its grip, or to draw the middle portion of the mouth floor away from the roof. This last action is rendered possible from the fact that, while the mouth is held rigidly in position by the solid attachment of its corners, there is apparently a flexible transverse suture just beyond the process on either side. There remains only one muscle connected with the mouth proper, and that is a small transverse one crossing just above the opening of the pharynx, its function being to close the latter and to compress the mouth cavity. The muscles already

Fig. 3. Longitudinal section through the mouth lock, × 125. *m*, Mouth.

described evidently are competent of themselves to account for the sucking powers of the animal, but they are probably seconded by the action of the pharyngeal muscles.

The pharynx (*ph.* in the figures) open into the mouth between the two processes above mentioned. In sections it is strongly defined by the junction of its delicate cuticular lining with the much thicker cuticle of the oral cavity, and also by its muscular investment, composed of annular and longitudinal fibers (see figure 2). Like the pharynx, which I have already described in the case of the Lepidoptera,[1] it is hung in the cranium by suspensory

[1] Anniv. Memoirs, Bost. Soc. Nat. Hist.

muscles. One pair of these is attached at the anterior end of the pharynx, on either side of the frontal ganglion. (See figure 1, where the frontal ganglion and the *nervus recurrens* is represented by dots, see also figure 2. *f. g.*) Three other muscles on each side, lying close together, are inserted just before the brain.

The pharynx contracts to pass through the nerve collar (figures 1 and 2), but expands again behind it, as large as before, and then gradually contracts towards the oesophagus (figs. 1 and 2). Between the annular muscular bands of this hind part of the pharynx, are inserted on each side, a dorsal and a ventral series of slender suspensory muscles. The dorsal series (see figure 1, and figure 2, *s. m.*[1]) passes between the layers of the great adductor of the mandibles and is attached to the epicranium ; while the ventral series (figure 2 *s. m.*[2]) is attached to the posterior branch of the slender

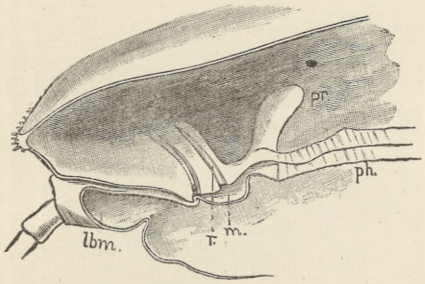

Fig. 4. Interior view of right half of head, × 18, showing the narrow slit between the clypeus and the labrum (*lbm.*) bounded behind by the mouth lock. *m.*, the mouth with the ridge (*r.*) in its roof, and the process (*pr.*) arising from its floor. *ph.* the cuticular lining of the pharynx.

endocranium. Figure 1 shows the upper end of the right endocranial process, its posterior branch passing out of sight behind the dorsal suspensory series ; on the left side of the head the antennal muscles can be seen attached to the upper end of the left endocranial process.

Behind these suspensory muscles the pharynx passes into the oesophagus, which can be distinguished by want of muscular investment. The pharynx, as described, is by no means peculiar

to the water-tiger, as I shall have occasion to show in another paper, and it may here be remarked that the pharynx in insects should be defined as the muscular portion of the alimentary canal between the mouth and the oesophagus, which is hung in the cranium by special suspensory muscles; it therefore resembles the rectum at the opposite end of the alimentary tract, likewise muscular and often suspended by muscles from the abdominal walls.

In conclusion we find that the water-tiger, far from being mouth less as ordinarily assumed, has in fact a very wide mouth, though its lips are closely locked together by a dove-tailed groved joint developed for this purpose. Whether this joint can be unlocked by the animal itself, is another question, which I cannot answer-though De Geer's observation, above quoted, makes this probable. It is at all events easy to open the mouth by manipulation with a pair of forceps.