

Examining now the legs in our two typical insects, we see that while the hind pair in each are fringed with hair, and compressed so as to become natatorial, this modification is carried out most completely in *Dytiscus*; again, whilst the first two pairs are near together in the brown beetle, and the third is placed much farther back, thus giving plenty of room for an extended backward and forward movement in swimming, those of its black cousin are much more regularly disposed. There is a curious point about the hind legs that deserves notice. In beetles, generally, the legs are attached to the body by a rounded joint, which is "let in" to a corresponding perforation in the chitinous armature with which their under surface is protected, and is capable of more or less free movement therein, an arrangement which permits motion of the legs in various directions. If now the hind legs of *Dytiscus* be compared with those of other beetles, this basal joint seems to be wanting, and the leg therefore seems to have one joint fewer than usual. But it will be observed that each leg is attached to a broad plate (Fig. 2), the pair of which stretch right across the body, and are prolonged in the centre into a bifid spine, which is differently shaped in different species.

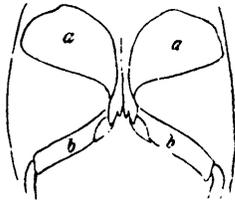


Fig. 2. Part of hind-legs of *Dytiscus*. a. Coxa; b. thigh.

Now these plates are really the much-expanded and greatly-modified *coxae*, or basal joints above-mentioned. Their enormous enlargement provides a large area for the attachment of the muscles that move these limbs, and thus enables vigorous and powerful strokes to be made, though their immobility considerably impairs the freedom of movement of the limbs, and in fact limits it to the horizontal strokes which are most useful in swimming. The *coxae* of *Hydrophilus* also are considerably enlarged, but do not attain the proportions of those of *Dytiscus*. The former, moreover, may be said to paddle rather than swim, moving its legs alternately, while the latter moves them both together, like a frog. Thus, in every respect *Dytiscus* is of the two much the better adapted for an aquatic life. Though the smaller insect, too, it has been known to attack and make a meal of its black cousin.

The distinctive peculiarities which characterise these two insects are exemplified more or less clearly in the majority of the members of the two groups. A large number of the *Philhydrida*, however, have ordinary ambulatory legs, and, indeed, are more given to crawling over subaqueous plants than to independent swimming, and some of the *Hydradephaga* even are somewhat similarly circumstanced, while the *Gyrinida*, which also belong to this group, are, as we have already seen, an exceedingly aberrant family.

A practical difficulty now suggests itself. Here are air-breathing creatures which spend their existence almost wholly in the water; how is their respiration to be conducted? It is well-known that the air necessary for the oxygenation of an insect's blood is taken in, not at the mouth, or any other part of the head, but through certain openings in the sides, which lead by short tubes to two long ones running the whole length of the body and

sending out branches to the different parts. If an insect be cut open, these tubes appear as so many minute silvery threads, branching sometimes like the roots of a tree. Most of the spiracles, or entrances to these tracheal tubes, are, in beetles, situated on the upper surface of the back, under elytra and wings. The back is flat, and the elytra being somewhat arched, but fitting closely to the body at their outer edges, except at the extreme apex, a hollow chamber is thus formed over the spiracles, which can be filled with air, but to which the water has no access. In order to breathe, therefore, the insect repairs to the surface, and, thrusting the tip of its body just out of the water, with head sloping obliquely downwards, balances itself by means of its outstretched oars, whilst it receives the outer air into its air-chamber. The supply thus taken in enters the spiracles as required, and is sufficient to meet the demands of the insect for some time, so that it is perfectly free to enjoy its subaqueous life till the complete vitiation of this store renders another visit to the surface necessary. An advantage following this arrangement is that the wings are always kept dry and ready at any moment to bear their owner *per auras*, if the spirit of migration should come upon it. A similar arrangement holds good for the bugs described in the last paper, as well as for the *Gyrinida*.

The larvæ of these two great water-beetles are elongate, six-footed creatures, with powerful jaws (Fig. 1), presenting no sort of resemblance to the beetles themselves; both are carnivorous and extremely voracious, dealing destruction to great numbers of their companions in pond-life. The ordinary spiracles being aborted, their respiration is conducted through certain projections at the tip of the tail, which are thrust above the surface to imbibe air. Having passed a comparatively short life in the larval condition, the insect quits the water, and, forming a cell in the damp margins of the pond, there effects its change to the pupal state. In due time the beetle is produced from this, at first soft and pale, but acquiring, after a few days' exposure to the air, its normal colour and consistency. The female *Hydrophilus* forms a marvellous sack for the reception of her egg. It is composed of a gummy substance, the secretion of which is effected not in or near the mouth, but the other end of the alimentary canal. A tough, papery bag is formed, which carries a long spoke, and is attached to subaqueous plants. The eggs, about fifty in number



Fig. 1.—Larva of *Hydrophilus piceus*.

are regularly placed side by side within this, and are thus protected from the attacks of such aquatic creatures as might feel disposed to try the taste of beetles' eggs.

Another of the *Philhydrida*, a much smaller insect, of yellowish-brown colour, called *Spercheus emarginatus* (Fig. 2), which used to be found at Whittlesea Mere, and was supposed by many to have become extinct as a British species until recently rediscovered by Mr. T. R. Billups at a certain spot in the neighbourhood of South London, forms a bag which the mother carries about on the under surface of her body. This insect, both in the larval and perfect state, is described by the

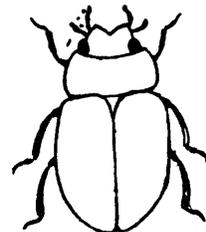


Fig. 2.—*Spercheus emarginatus*.