

THE
NORTHERN MICROSCOPIST
AND
MICROSCOPICAL NEWS.

An Illustrated Journal of Practical Microscopy.

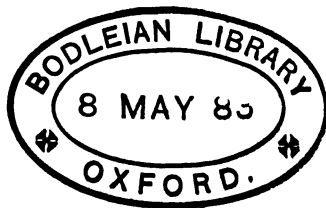
EDITED BY

GEORGE E. DAVIS,

F.R.M.S., F.C.S., F.I.C.,

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VOL. II.



LONDON:
DAVID BOGUE, 3, ST. MARTIN'S PLACE,
TRAFALGAR SQUARE, W.C.

MANCHESTER: TUBBS, BROOK, & CHRYSAL.

1882.

THE NORTHERN MICROSCOPIST.

No. 1.

JANUARY.

1882.

THE EPHEMERIDÆ, OR MAY-FLIES.

BY W. BLACKBURN.

Concluded from page 290.

THE circulation of the blood and pulsation of the dorsal vessel are very well seen in these larvæ, on account of their transparency. The dorsal vessel extends nearly the whole length of the body, and is furnished at regular intervals with valves, dividing it into chambers, one chamber to each segment of the body, through which the blood moves towards the head. At the posterior extremity of each chamber, a central valve allows the blood to enter from the adjoining chamber, while external openings receive the blood from the interspaces of the surrounding tissues. The dorsal vessel divides in the head into two branches, through which the blood flows into the open cavities of the body. The corpuscles of the blood, by which this motion is observed, are oblong, somewhat "oat-shaped," when viewed in one direction, but approaching more to the circular form when seen in another direction.

Sir John Lubbock traced the life-history of a *Cloëon* from the egg to the imago, and we learn much concerning the growth and development of the Ephemeridæ from his instructive record. *Cloëon* is a small British genus, very common in still water, that makes its appearance as an imago from May to October. Fig. 61. When it escapes from the egg, it is about $\frac{1}{6}$ of an inch in length. Its antennæ are $\frac{1}{7}$ of an inch in length, and consist of thirteen segments. It has two tails of nineteen segments each. It has neither gills, spiracles, nor tracheæ. Respiration must, therefore, be effected through the integument. It is provided from the first with six legs, in which the tibiæ and tarsi are firmly united. The tarsi are jointless, and terminate in a single claw, the same as in the other genera. There are five eye spots visible, all similar to each other. Swimming is effected by jerks of the abdomen upwards and downwards. In this motion the tails assist. When any small creature comes in contact with *Cloëon*, the tails are immediately advanced in

front, as if for the purposes of defence or sensation. The larger larvæ, such as *Ephemera*, never advance the tails in this manner.

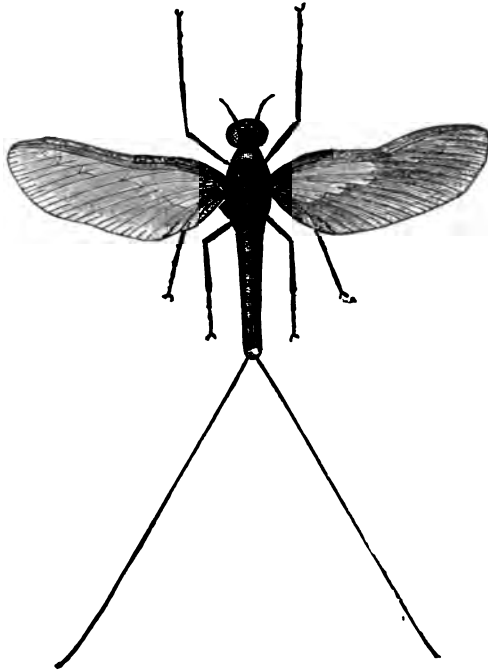


Fig. 1. Female Imago. $\times 2\frac{1}{2}$.

In from two to three days *Cloëon* casts its first skin. In so doing, it does not, as is usually the case with these larvæ, split the skin of the thorax, but extricates itself through the top of the head. The orifice is very small, and the skin left is very perfect. After moulting, the length of the body is found to be $\frac{1}{10}$ th longer than at birth. The antennæ and tails are also slightly longer. The antennæ possess the same number of joints as before, and the tails one more joint, the extra length being principally found in the first segment of the tails, and the third segment of the antennæ. The posterior angles of the second to the sixth abdominal segments are slightly produced, indicative of the position of the subsequent gills. A minute knob appears between the two tails, the rudiment of the middle tail.

In a few days the second moult takes place. The antennæ are now found to have increased in length, and to consist of two more

segments, viz. : fifteen. The tails are also longer, and consist of four more segments, viz. : twenty-four. The eyes have become differentiated, the posterior pair being larger than the rest, so that the distinction between the oculi and ocelli is now observed. The oculi, however, have not yet any facets. The posterior angles of the second to the sixth abdominal segments are less produced than before, but each has a small oval appendage at its extremity, the first appearance of branchiæ. The middle ones are the most developed. The other gill-bearing segments now have their posterior angles elongated, in preparation for the remaining gills, which make their appearance after the next moult. No tracheæ have yet made their appearance.

In two or three days the larva casts its third skin, when the tails and antennæ are found to be longer, and to consist of more segments than before. In this state, the five intermediate pairs of gills begin to vibrate. Tracheæ are now seen in these gills, and communicate with two longitudinal trunks in the body. After the next moult the first pair of gills begin to vibrate. The seventh pair never vibrate in this genus. After the fifth moult, the antennæ were found to contain two segments less in number than in the preceding state, two fresh ones having been produced, and four others having coalesced. The posterior eyes now consist of dark spots on a pale ground.

After the sixth moult, the larger gills have small lobes attached to them, which eventually form double gills. The seventh pair remain single in this genus. The two lateral tails now consist of thirty-two segments, and the central knob has expanded into a tail of six segments. The antennæ consist of two more segments, the third segment having divided into three. After the next moult, the middle tail consists of twelve segments, and after another moult of eighteen segments. The third segment of the antennæ has again divided into four parts, and the posterior dorsal angles of the meso and meta-thorax are slightly produced in preparation for the wing-cases of the nymph.

Some of the larvæ arrived at the tenth state in September, about twenty-five days after leaving the egg ; they then took about a week before re-moulting. This period, however, much depends upon the temperature, as the larva moults much more seldom in winter, and there is then less difference in the growth between the moults. Sir John Lubbock found that in January, February, and March, Cloëon took from fourteen to thirty days before re-moulting.

After the thirteenth moult, a secondary lobe appears on the first pair of gills. In the fifteenth state, the rudimentary wing-cases cover the metathorax. In the seventeenth state, the secondary lobes of the anterior gills are almost as large as the primary ; the tails consist of more than sixty segments, and are covered with a

fringe of hair. In the eighteenth state, the wing-cases cover the first abdominal segment, and the body is one-third of an inch long. In this state the sexes can be distinguished. Between the large compound eyes of the male, may be seen, on the top of the head, a series of dots, the rudiments of the facets of the large pillared eyes. Rudimentary forceps may also be seen, and in the female small ovaries. In the twentieth and last state of the nymph, the wing-cases extend to the third abdominal segment. The small antennæ of the subimago can be seen within the larger antennæ of the nymph, lying loosely in their sheath, the soft tissue having become absorbed around them; whilst beyond the new antennæ, the old ones retain their usual consistence. The two lateral tails of the nymph now appear darker than the middle one, the subimago tails being visible inside them, whereas the contents of the middle tail have been absorbed. The four-jointed tarsus of the subimago can also be seen within the single joint of the nymph. The ovaries of the female now occupy nearly the whole length of the abdomen, and consist of two cylindrical bodies, each of which consists of a great number of minute egg-tubes. Each of these egg-tubes is divided into two chambers; the upper one long and narrow, contains vitellogenous cells, the lower, oval in form, contains oil globules. The mouth consists of a pair of mandibles with saw-like projections on the upper edge, prolonged internally into a molar plate; a pair of maxillæ, with two-jointed palpi; a labium, with three-jointed palpi, and a bi-lobed labrum.

The insect now quits the water, and becomes a subimago, and in doing so, it sheds, for the first time, the inner membrane of the tracheal trunks, which is usually cast by other larvæ at each moult. It drops its abdominal gills, and breathes through spiracles. After a short time, it extricates itself from its additional skin, which it leaves very perfect behind it, the wing-cases being in a state of collapse at the sides of the thorax. It is now an imago, and appears brighter, lighter, and more adapted for a denizen of the air. Sir John Lubbock names his species "*Chloëon dimidiatum*." The male has four large compound eyes, the upper pair being raised on broad columns, pushing the lateral pair low down at the sides of the head. In front of these, the three simple eyes are placed triangularly on the forehead, the upper two being elevated on short pedicels. The mouth is without any external opening. Curtis dissected the mouth of an *Ephemerella danica*, and was able to discover the rudiments of maxillæ, labrum, and two sets of palpi.

Nearly two hundred species of these insects, British and foreign, are already known. The British, however, are restricted to ten genera, containing thirty-seven species, according to the following classification of Mr. Eaton.

British Ephemeridæ.		
<i>Genus.</i>	<i>Species.</i>	
EPHEMERA	3	} 4 wings and 3 tails.
LEPTOPHLEBIA.....	4	
POTAMANTHUS.....	1	
EPHEMERELLA	1	
BAETIS	9	} 4 wings and 2 tails.
HEPTAGENIA	8	
CENTROPTILUM	2	
SIPHLURUS.....	2	
CÆNIS	4	} 2 wings and 3 tails.
CLOEON	3	
		} 2 wings and 2 tails.

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In ascertaining the genus to which any specimen belongs, note the following peculiarities: the presence or absence of hind wings and middle tail, (the female may have the middle tail when it is absent in the male); the nature of the neuriation of the large wings, whether the longitudinal nervures are many and complex, or few and simple; whether the transverse nervures are numerous or not, especially in the costal and sub-costal areas; whether the interneural veinlets of the terminal margin, if present, are continuous with the longitudinal or with the transverse nervures, or are separate from both, and, if separate, are they single or in pairs? The general character of the neuriation only need be considered, not particular details. The wings of *Ephemera* and *Cloëon* illustrate some of these peculiarities. The hind wings may be small, as in *Ephemera*, or mere rudiments, as in *Baetis* and *Centroptilum*. Next examine the tarsi, to ascertain whether there is a fifth joint, and the relative proportions of the joints, and the form of the claws. Note the comparative length of the tarsi, tibiæ, and femora in both sexes; in what respect the compound eyes of the male differ from those of the female; the form and number of joints of the male forceps, usually three or four, but in some genera only two, and in *Cænis* jointless.

Another item of importance is the attitude assumed by the subimago during repose. The forelegs may be elevated or on the ground, held together or separated; the tails may be nearly parallel or spread out; the wings may be elevated or depressed. The subimago state may last for some hours, or be quitted immediately, or be the permanent state of the female.

The characteristics of the nymph must be considered. The head may be armed, to enable it to form burrows in the mud,

like Ephemera and Cænis. It may swim actively like Cloëon and Baetis; or creep, like Leptophlebia and Ephemerella. The form and position of the gills must be noted; and also the mouth, with the number of joints on the palpi, and the form of the legs, antennæ, and tails.

The species are determined by slight modifications of structure, combined with variations in colour and markings. The three species of Ephemera, viz: *E. danica*, *vulgata*, and *lineata*, may be readily recognised by the difference in the marks on the abdomen.

Most authors on Entomology have described a few species of the Ephemeridæ, and have mixed up their names in almost hopeless confusion. The best works for the student are F. J. Pictet's "Histoire Naturelle des Insectes Néuroptères: famille des Ephémérines," which has not been translated into English; and the Rev. A. E. Eaton's "Monograph on the Ephemeridæ," published by the Entomological Society, in which the descriptions of the genera and species are in Latin. The latter is the best work for classification, the principles and nomenclature of which I have adopted in this paper.

Specimens of the Ephemeridæ found in museums are often dried up beyond recognition, their soft bodies becoming changed in form as well as colour. In the British Museum they are kept in a cabinet, which contains about two hundred specimens, British and foreign; they have been arranged by Mr. Eaton. To preserve the imago, he recommends it to be dipped in dilute spirits, and then transferred to a tube partly filled with water, to which a drop or two of glycerine should be added each day until the tube be full. A drop of acetic acid will prevent fungoid growth. A few of the specimens in the national collection, contributed by Mr. Eaton, are preserved in this way.

The microscopist will find this family of insects one of absorbing interest, many of them being of exquisite beauty.

W. BLACKBURN.
