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the short dark days we now have and the drawbacks connected with hunting in rain and snow render it extremely difficult to find them. Notwithstanding this, the student should not neglect any opportunity that may arise, for there is always the possibility of meeting with something to repay him for any hardship he may undergo. The dead leaves (if not the living) are covered with marvellous organisms without number, every one of which is deserving of careful examination, and thus he will obtain ample material for pleasant study during the long nights of winter when comfortably seated by his fire-side with his microscope before him.

On reviewing my notes of the year, I find a crowd of interesting plants belonging to the family to which I have called the special attention of my readers altogether overlooked. This is the result of an absolute necessity, nor was it my wish to enter upon the impossible task of referring to all the members of the innumerable family. My desire has been to be a guide and a help to the microscopic students of the North, with especial reference to those of the Manchester Microscopical Society, and in this character I have been careful to refer chiefly to the results of my personal explorations and discoveries.

It has been a pleasure to me to have had an opportunity of calling the attention of my fellow-students to so interesting a study in THE NORTHERN MICROSCOPIST, and I have the further satisfaction of believing that the time I have bestowed upon the subject has not been spent in vain.

THOS. BRITTAIN.

THE EPHEMERIDÆ, OR MAY-FLIES.*

BY W. BLACKBURN.

THESE insects are a family of the Subulicorn Neuroptera, to which division of the Order the Dragon-flies also belong. The name—"*Subulicornes*"—was given to them by Latreille, on account of the antennæ having the shape of an awl. The term "May-fly" is restricted scientifically to the genus Ephemera, the type of which is the May-fly of the angler. It is, however, popularly applied to the entire family. The May-fly differs from the Dragon-fly in

* An Abstract of a Paper read before the Manchester Microscopical Society on October 6th.

NOTE.—Mr. McLachlan in his catalogue of British Neuroptera, 1870, places the Ephemeridæ amongst the Pseudo-neuroptera, between the Stone-flies (*Perlidæ*) and the Dragon-flies.

having an abortive mouth, in the smallness or absence of hind-wings, and the two or three long filaments that form the tail. As it lives in the imago state seldom longer than a day, it does not require food; and, therefore, has no jaws or mouth adapted for prehension or mastication. It leaves these instruments behind it in the water when it emerges from its last aquatic skin; for the larva lives a considerable time in the water previous to attaining the winged form, the time varying with the genus from a few months to about two years.

The Ephemeridæ possess both compound and simple eyes. The antennæ consist of two rather large basal joints surmounted by a bristle, indistinctly jointed, with a somewhat bulbous base. The abdomen has ten segments. The first segment is immoveably attached to the metathorax, and is often of the same colour. This has led some entomologists to describe them as possessing only nine abdominal segments; but the fact that this segment belongs to the abdomen, and not to the thorax, is proved by its possessing, in some of the larvæ, the first pair of aquatic gills, all of which are abdominal, and are thrown off when the insect quits the water; whereas the appendages of the thorax are retained by the imago. The ninth segment is furnished in the male with a pair of forceps or claspers, with which he embraces the female, and the oviducts in the female terminate in openings between the seventh and eighth ventral segments. The legs are short and slender, the front pair the longest; the male has this pair much longer than the female, and advanced more in front of the head. The tarsi have four or five joints, the fifth joint being sometimes nearly obsolete and immoveably attached to the tibia. The anterior wings are large, and never folded; the posterior, if present, small or rudimentary only. In the large wing the costa is "united by a stout cross-veinlet to the radius near the base"; "subcosta uninterrupted at the nodus." The caudal setæ, or tails, are composed of many joints. In some genera the middle tail is absent in the imago; the larvæ, however, all possess three tails. The tails act as balancers during flight. After ascending by the action of the wings, the insect succumbs to the attraction of gravitation, and, during its descent, the tails assist in supporting the abdomen. The male has usually longer tails than the female. His compound eyes are also larger than hers; and in some genera he is provided with a second pair, raised on large pillars on the top of the head. The female never has these pillared eyes. The three ocelli, or simple eyes, are, however, found in both sexes. The male is usually smaller and of darker colours than the female.

These insects are usually described as undergoing quadruple metamorphosis, because when they first appear with wings, they are encased in a thin pellicle which covers the whole body, includ-

ing the wings, and which gives them a dull appearance. In this state, which is called variously by the names *pro-imago*, *pseudimago*, or *subimago*, they fly or crawl to the nearest resting place, to divest themselves of this garment; and anglers have related that, as they sat upon the banks of some stream, on a quiet summer evening, they have found the rims of their hats covered with these "fairy-like" skins of the subimago. It is often asserted that the casting of this additional skin is peculiar to the Ephemeridæ. This is doubtless a mistake; for Newman, Westwood, and others have observed the Dragon-fly and other insects quit a double-skin on attaining the perfect state; but the subimago skin of the May-fly is retained longer than that of other insects.

These insects, however, undergo no true metamorphosis, in the ordinary acceptation of that term. They are born with six legs, two antennæ, and two tails, and almost all the changes they undergo during growth are developmental. The nymph gradually acquires wing-cases, which it uses for purposes of respiration in the water, and is similar in all other respects to the larva that has no wing-cases. When the nymph becomes a subimago, it leaves its long antennæ, jaws, and abdominal gills, and sometimes its middle tail, behind it, with its cast skin, and we find in their place short antennæ, an aborted mouth, and spiracles; but equally important changes take place during the growth of the larva, when it is not supposed to be passing through metamorphosis, and it might be more properly described as undergoing *multiple* metamorphosis, inasmuch as a change of structure is apparent after every moult. Growth and development visibly take place at the same time. There is no inactive state analogous to that of the pupa of the Lepidoptera; the quiescence of that order of insects being necessary on account of their inability to take food during the change of the mandibulate mouth of the caterpillar into the suctorial mouth of the butterfly.

Although the Ephemeridæ pass so short a portion of their lives in the air, their life-history upon the wing is one of considerable interest. The alimentary canal is straight and inflated with gas, which renders these insects very light, and in some genera their soft and feeble muscles render them incapable of strong flight, so that they are often blown about by the wind. In some localities, when atmospheric conditions have been more than usually favourable for their leaving the water, clouds of these insects may be seen hovering in the air, each seeking the final object of its existence, the perpetuation of the species. Their dead bodies have sometimes been found so thickly upon the ground in some parts of Italy, that they have been carted away and used as manure. Swammerdam, the Dutch naturalist, who was the first to investigate with accuracy the anatomy of a May-fly, described a species that

frequents the rivers of Germany and Holland, which made its appearance in great swarms regularly in June. Réaumur, also, on the banks of the Marne, saw countless numbers of these insects in the middle of August. He describes them as filling the air more completely than the thickest fall of snow. Dr. Hagen describes those of the genus Cœnis as being so plentiful sometimes in Prussia that they are used to feed the pigs. Other observers of undoubted veracity have testified to having witnessed similar phenomena. In the British Islands, however, we have nothing analogous to this; although these insects are occasionally found in great numbers under peculiarly favourable circumstances. The *Ephemerica danica*, the May-fly of the angler (Fig. 58), has been seen on the river Dove in such numbers, in the subimago state, as almost to cover the water where it was from twenty to thirty feet broad.

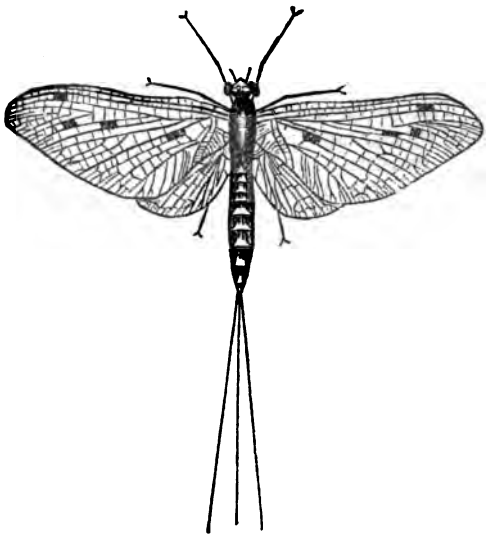

Fig. 58. Imago. × 1½

The swarms of these insects, when they occur, consist mostly of males. Being filled with gas, no food ever being found in the alimentary canal of an imago, the male insect is extremely light. The female, whose ovaries occupy about two-thirds of the abdomen, and must necessarily add to her weight, doubtless finds her powers of prolonged flight more restricted than the male. Besides, she is much engaged in depositing her eggs, after fecundation, in clusters on the surface of the water; for, as they extrude from the oviduct, she is constantly skimming along the surface of the water in order to detach them, becoming at the same time an easy prey to the trout. Having deposited her eggs, she returns to the swarm, and then betakes herself to the water a second time, where she deposits more eggs. She repeats this process until all the eggs are disposed of, after which exhausted nature succumbs, and she dies. In some genera, however, she deposits all the eggs at once, and her life is then much shorter. The life of the male is equally short.

The female, with her ovaries full of eggs, is the insect that the fish prefers; and the wise angler tries to delude his victim with a seductive imitation, which he calls a "Grey Drake." His "Green Drake" is the female subimago, and the "Bastard Drake" the male subimago. All these belong to *Ephemera danica*. The "dun flies" of the angler are mostly Ephemeridæ in the subimago state.

The larvæ and nymphæ are provided with longer antennæ and shorter tails than the imagines. The mouth is well developed, and consists of a pair of mandibles, sometimes prolonged into frontal horns, a pair of maxillæ, with palpi of two or three joints, a labrum, and a labium, with labial palpi. Their food consists of diatoms and other protophytes, mixed with mud; occasionally with protozoa, and in some genera entomostraca, and even minute larvæ, in addition. They either swim or crawl among water-plants

Fig. 59.
Nymph of Ephemera.

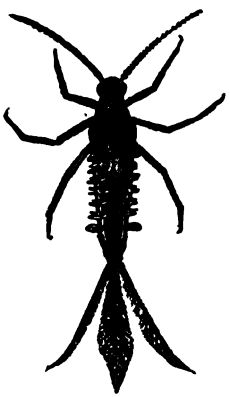

Fig. 60.
Nymph of Clöeon.

or hide under stones. Some genera, however, form horizontal burrows in the mud, in which they find warmth during the winter and security during repose, and from which they sally forth only in quest of food.

All the British genera have external branchiæ, usually consisting of a pair of single or double plates to each of the first seven segments of the abdomen. These gills are lance-shaped, leaf-shaped, oval, or divided into threads. They are sometimes provided with a fringe of membranous threads round the margin, as in Ephemera. (Fig. 59.) Heptagenia, which frequents very cold streams and the rapids of rivers, has seven leaf-shaped gills on each side, each with a bundle of threads attached to its root, the analogue

of a perfect gill. Ephemerella has only the fourth to the seventh segments furnished with gills, the smallest number amongst British genera. Cœnis, with six single gills on each side, all well fringed, has those on the third segment large enough to cover the four hinder pairs, the second segment being without gills.

Baetis and Centroptilum have seven single gills on each side; Cloëon (Fig. 60.) has six double and the seventh single; in these three genera they are oval and without fringe. Siphlurus has two double and five single gills on eachside, without fringe. Ephemera is often described as having only six pairs of double lance-shaped gills, all fringed. It has, however, another pair, very small and plain, on the first segment, sometimes concealed by the wing-cases. Minute branches of the tracheæ run through the gills, and when these are fringed, each filament receives a single branch.

(To be continued.)

NORTHERN SOCIETIES.

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LEEDS. No Microscopical Society in existence.

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