

INSECTS OF HAWAII

A Manual of the Insects of the Hawaiian Islands, including an Enumeration of the Species and Notes on their Origin, Distribution, Hosts, Parasites, etc.

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VOLUME 6

EPHEMEROPTERA-NEUROPTERA-TRICHOPTERA
AND SUPPLEMENT TO VOLUMES 1 TO 5

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Division **EXOPTERYGOTA** Sharp, 1898, continued from Volume 5

Since Volume 2 of this series was published, the identity of a newly established immigrant species of Ephemeroptera has been recorded. The order was not previously known in Hawaii. Its proper place in *Insects of Hawaii* is just before the Odonata in Volume 2.

Order **EPHEMEROPTERA** (Leach) Haeckel, 1896

(*ephemeron*, a mayfly, living but a day; *ptera*, wings)

- Odontota* Latreille, 1806.
- Ephemerida* Leach, 1817.
- Ephemerina* Burmeister, 1829.
- Anisoptera* Leach, 1835.
- Agnatha* Meinert, 1883.
- Plectoptera* Packard, 1886.
- Archipterygota* Börner, 1909.

The Mayflies

The early name *Odontota* is undesirable for use for this order because of the chance of confusion with Odonata. Comstock followed Leach in the use of *Ephemerida*, as did Essig in 1942. Tillyard followed Packard's use of *Plectoptera*, but this is undesirable for reasons in addition to the resemblance to *Plecoptera*. Imms followed Haeckel and used *Ephemeroptera*, and I believe that this form of the old Leach name is desirable because it conforms with most of the other ordinal names which end in *ptera*. It would be better if all ordinal names had the same suffix.

Head hypognathous, moderate in size, short, transverse, free. Mouthparts vestigial or aborted in adult; mandibles rudimentary or absent; maxillae vestigial, but small, palpi usually present; labium reduced, with vestigial palpi in some forms. Eyes large, larger in males than females; in some forms the eyes of the males are divided; three ocelli present. Antennae short, setiform, with two basal segments and a terminal, indistinctly multi-segmented filament. Thorax generalized, mesothorax always larger than pro- or metathorax, extraordinarily large in

some forms. Legs variable, usually weak except for the fore pair, which are elongated in males of some species; not adapted for active walking; tarsi one- to five-segmented; claws simple or modified. Wings held vertically above body when at rest, triangular, hind wings reduced or absent; venation primitive, many species with numerous intercalary or accessory veins and cross-veins giving a characteristic net-like effect, the intercalary veins often with their origins detached from the normal positions of forking, the veins following a convex and concave alternating pattern, thus giving the fore wings a corrugated or pleated appearance (see Tillyard, 1926, for a detailed discussion of venation). Abdomen slender, 10-segmented; cerci strongly developed as a pair of very long, multi-segmented, thread-like, terminal filaments, and usually with a third similar, median, caudal filament; spiracles on segments one to eight. Terminalia: in male with segmented "claspers" and double aedeagus; no ovipositor in female, oviducts opening separately into vulva between ventrites seven and eight.

Metamorphosis incomplete. Eggs of many types, many remarkable in form; deposited in water. Some forms discharge their eggs in two masses, some wash them off the abdomen and into the water in small clusters, and others descend under water to deposit eggs in batches under stones, etc. Some species are known to lay several thousand eggs per female. The first stage naiads have no gills, but a pair of gills arises at the first molt, and a pair or two of additional gills may develop at each successive molt until most species have seven pairs. The number of molts may be great. The naiads are multiform and have varied habits; their compound eyes and ocelli are both developed and the caudal appendages are long and conspicuous. Most species are herbivorous, but some few are carnivorous. Some naiads lead a free, exposed, roaming life; others spend most of their time concealed beneath stones and other objects, some live in masses of debris or in sand or mud, and others dig burrows. When the naiad reaches maturity it rises to the surface of the water where, usually in a matter of a few moments, a winged sub-imago bursts from the nymphal shell and flies away. This sub-imago is enclosed in a delicate pellicle and has milky-colored wings. It flies to an object where it can rest, and there, after only a few minutes or several hours, it sheds the pellicle and emerges as a fully formed adult, usually with hyaline wings and sexually functional. This spectacular feature is unique among insects. The adult may then live for only a few hours to a few days. Some species emerge at dusk, shed their pellicles, mate, deposit their eggs, and die before the next day dawns. This is why the mayflies are called ephemerids. Many species develop in enormous numbers, and countless millions may arise from the surface of a small lake. Mating takes place in the air, and their "mating dance" flights are a characteristic feature of their life histories. Oviposition proceeds immediately following fertilization.

Mayflies form one of the most important foods of fresh-water fish. Many artificial flies used by trout fishermen have mayflies as models. In England, a land of keen fishermen, the relationship between mayfly and trout is a subject of intensive study and books have been written on the subject. In New Zealand, where there are numerous, fine species of mayflies, the introduction of trout has brought some ephemerids close to extinction.

Some species create a nuisance by swarming to lights in overwhelming numbers, and the naiads of one species have been reported damaging submerged wooden structures in Siam by burrowing into hard wood, somewhat in the manner of teredos (see Vejabhongse, 1937:53).

Ephemeroptera are widespread over the continents, and the number of known species approximates 1,500. Tillyard (1926) recorded 20 known species in Australia and the same number in New Zealand. One apparently endemic species occurs in Samoa, and from Fiji westward the numbers of species increase rapidly until the well-developed faunas of Indonesia are reached. There are no native mayflies east of Samoa in Polynesia; a single, immigrant species represents the order in Hawaii. Mayflies go far back in the fossil record to the Lower Permian.

Edmunds and Traver, in their new suprageneric classification (1954:236), divide



Figure 1—*Caenis nigropunctata* Klapálek, female. Honolulu; expanse, 9 mm. Note the eggs adhering to right side of abdomen. The anal filaments of the male are much longer than those of the female and are about three times as long as the length of a wing.

the order into five superfamilies: Heptagenioidea (=Siphonuroidea, Baetoidea), Leptophlebioidea, Caenoidea, Ephemeroidea and Prosopistomatoidea. Only the Caenoidea is represented in Hawaii.

Superfamily CAENOIDEA

This superfamily contains two families, one of which is now represented in Hawaii.

Family CAENIDAE Klapálek, 1909

This family contains small species whose fore wings are milky and have few cross-veins, the subcosta is free and separated from the radius, the anterior median (MA, sometimes called R_{4+5} or M) is forked, and the hind wings are absent. Each sex has three caudal filaments. The naiads are unusual because the first pair of gills are each greatly enlarged to form specialized operculum-like structures which conceal the following five gills. This forms a protective device to guard the functional respiratory gills and is correlated with the muddy environment frequented by the naiads.

Genus CAENIS Stephens, 1833

This genus has representatives in many regions.

Caenis nigropunctata Klapálek (fig. 1).

Caenis nigropunctata Klapálek, 1904:104.

Oahu.

Immigrant. Originally described from Java and known also from Sumatra, Bali and the Philippines. The first specimens of this species found in Hawaii were obtained by C. E. Pemberton on July 29, 1944, from an assortment of insects collected in an east-bound airplane at Honolulu, and it is presumed that the specimens entered the aircraft at Honolulu. On August 9, 1944, W. M. Herms and T. C. Russell collected a series of the species at a light trap at Pearl City, near Honolulu. In January, 1945, it had spread to the University of Hawaii, where it was found by D. D. Jensen, and in June, 1948, F. A. Bianchi found it abundant at lights at Kailua, Oahu, on the opposite side of the island.

The naiads have not been found in Hawaii, but they must be abundant. I regret that I cannot illustrate the naiad here.

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