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 de-
tached 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 en-
closed 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 arti-
ficial 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

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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 (=Siphtonuroidea, 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 R₄₅ 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 func-
tional 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.
EPHEMEROPTERA LITERATURE CONSULTED

BERNER, Lewis.

COMSTOCK, J. H.

EATON, A. E.

EDMUNDS, G. F., and J. R. TRAVER.

IMMS, A. D.

KIMMINS, D. E.


KLAPÁLEK, Fr.

MORGAN, Anna H.

NEEDHAM, J. G.

— J. R. TRAVER and YIN-CHI HSU.

TILLYARD, R. J.


ULMER, Georg.

VEJABHONGSE, NAI PRAYOON.