

Family-Level Key to the Stream Invertebrates of Maryland and Surrounding Areas



*Third Edition
August 2003*

*Maryland Department of Natural Resources
Chesapeake Bay and Watershed Programs
Monitoring and Non-Tidal Assessment Division*

CBWP-MANTA-EA-99-2 (revised 2003)



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Published August 2003



PRINTED ON RECYCLED PAPER

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Acknowledgments

Walter Butler, and Rita Bruckler of Maryland Department of Natural Resources (DNR) provided invaluable editorial support and technical advice for the 3rd Edition. Dan Boward and Ann Schenk, also of DNR, oversaw the compilation and printing of this Edition, as well.

Illustration and Photograph Credits

Permission for use of all color photographs was granted by Dr. Leonard Smock, of Virginia Commonwealth University, Richmond, Virginia and the North American Benthological Society (NABS). Contributing photographers are listed below. This document also uses many line drawings and half-tones from previously-published books and keys on benthic macroinvertebrates. The majority of those are used by permission of Academic Press, Inc., a subsidiary of Harcourt Brace, and were taken from Thorp and Covich's "*Ecology and Classification of North American Freshwater Invertebrates*" or from "*Pond and Stream Safari*" by permission of Cornell Cooperative Extension.

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Joann Wheeler, of Maryland DNR, provided original line drawings contained in the following sections and couplets: Section 2, couplets 1 and 2; Section 3, couplet 1a; Section 6, couplet 9; Section 7b, couplet 6b; Section 7b, couplet 16b; Section 7c, couplet 1.

Kerry LaBelle, of Maryland DNR, provided original line drawings contained in the following sections and couplets: Section 7b (larvae), couplet 5a and 5b; Section 7b (adult), couplet 4a; Section 7b (adult), couplet 6a; Section 7d, couplet 1a; Section 7d, couplet 13a.

Kerry LaBelle and Ellen Friedman, of Maryland DNR, provided color photographs contained in the following sections and couplets: Section 3a, couplet 2a; Section 6, couplet 8a; Section 7b (adult), couplet 1a; Section 7c, couplets 9a, 10a, 10b, 17a, 19a, 20a; Section 7d, couplets 9a, 15a; Section 7h, couplets 4a, 4b, 7a; Section 7 i, couplets 2a, 2b, 4a, 4b, 6a, 7a, 8a, 8b; Section 7j, couplet 1a, 3a, 3b, 4a, 7a, 8a, 8b, 10a, 11b.

Additional color photography by: Larry Serpa, Dave Penrose, Janice Smith, Shawn Staton, Bob DiStefano, Rich Merritt, Steve Solada, Arturo Elosegui, J.C. Hodges, Jr., Howell Daley, G. Gruyer, Michael Higgins, and DeClan McCabe.

Family-Level Key to the Stream Invertebrates of Maryland and Surrounding Areas

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“What's the use of their having names,” the Gnat said, “if they won't answer to them?” “No use to them,” said Alice; “but it's useful to the people that name them, I suppose. If not, why do things have names at all?”

— Lewis Carroll from *Through the Looking Glass*

Section 1

Introduction

In 1994, the Maryland Department of Natural Resources (DNR) began characterizing the biological condition of its freshwater streams statewide. As part of these efforts, the Maryland Biological Stream Survey (MBSS) has sampled streams and gathered data on benthic macroinvertebrates, fish, physical habitat, and selected water chemistry from Garrett County to the Eastern Shore. There is broad interest in increasing the involvement of the public and improving the accessibility of the MBSS results. This taxonomic identification key has resulted, in part, from a response to that interest.

Humankind's need to categorize and classify objects in nature is as old as our quest to understand our surroundings. Classification serves to organize diversity (in our case, biological diversity) into units or groups that can be managed by the human mind, and around which other knowledge can be organized and interpreted. Taxonomic keys serve as a type of “expert” system by which biological classification can be done by those who are not experts in the identification of particular plants or animals. This key was developed to help in the family-level identification of stream macroinvertebrates of Maryland; we also hope that it will help improve the awareness, appreciation, and recognition of stream biology and contribute to its protection.

Scope of the Key

As is common practice in developing keys, especially for higher taxonomic levels, such as family or order, much of the key's structure, the characters used, and many of the illustrations, are taken and adapted from existing works on invertebrate taxonomy and ecology (Merritt and Cummins 1996, Thorp and Covich 1991, Peckarsky et al 1984, Burch 1982). Much effort was made to convert technical taxonomic and morphological terminology to more broadly understood language, or to provide clear definitions. The taxonomic groups that are included are those benthic macroinvertebrates that are either known to occur in Maryland from the sampling results of the MBSS, or likely to occur from the national and regional taxonomic literature cited above. As such, it should also be useful for identifying macroinvertebrates from samples gathered from non-tidal streams in surrounding states.

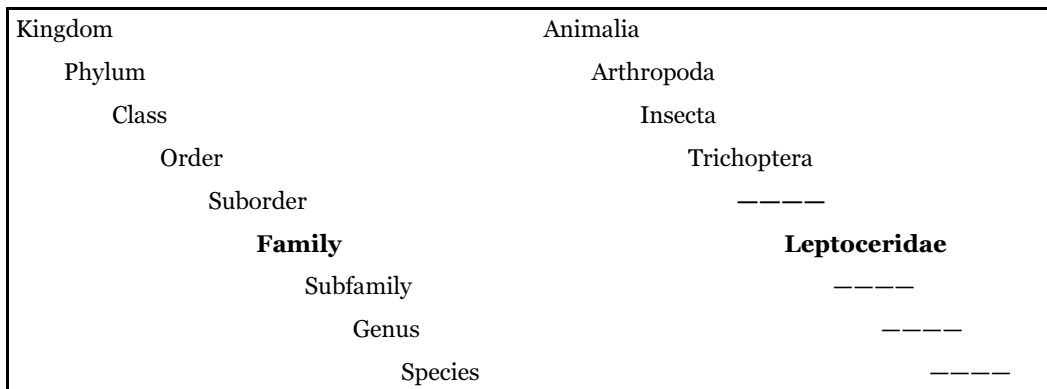
Most groups are keyed to the family level, particularly those that are *most commonly* collected by stream monitors and ecologists. However, this key will NOT allow identification of, for example, Annelida beyond Oligochaeta and Hirudinea; or any taxonomic level of the *flying adult* stages of groups such as mayflies (Insecta: Ephemeroptera), caddisflies (Insecta: Trichoptera), or dragon- and damselflies (Insecta: Odonata) that are rarely caught when stream sampling. It also does not help in the identification of egg or pupal stages. Some of the anatomical features described in the key may be visible to the naked eye or by use of a hand lens; however, it will be necessary to use a dissecting microscope with a magnifying power of 50-100x to identify many of the characteristics. Users of this key should assume that some sort of magnification will be needed to identify, with confidence, most of the organisms in the key.

Using the Key

Aquatic insects, like all organisms, are classified using a specific hierarchical arrangement with various named levels. A group of organisms at any level is called a *taxon* (or, in the plural, *taxa*).

This key is primarily concerned with *family-level* classification. However, some groups are only keyed to class or order level. As an example, within the family Leptoceridae, there are several genera and within each of those genera are one or more species. The following table illustrates the taxonomic hierarchy used to classify animals—a system developed by Carolus Linnaeus in the 18th century. You can read the table below as follows:

Leptoceridae is a family within the order Trichoptera →
Trichoptera is an order within the class Insecta →
Insecta is a class within the phylum Arthropoda →
Arthropoda is a phylum under the kingdom Animalia.



In some instances, the taxonomic levels of “suborder” and “subfamily” may be used, but are rare in this key. Within the key, each taxonomic **order** of organisms (for example, Trichoptera) is separated into several numbered **couplets**, consisting of an “a” and a “b” (see the example on the next page). Once you have identified the taxonomic order of an organism (for example, Trichoptera), use the key to identify the **family** of the organism (for example, Leptoceridae). Always start with couplet # 1 within any order. The organism you are trying to identify will match the description in either the *a* or *b* half of the couplet—but not both.

It will be easier to understand the terminology describing body parts if some Latin conventions are kept in mind. Specifically, in Latin, a singular noun is not made plural by adding an “s.” Rather, an “i,” “a,” or “ae” are substituted for a plural ending. For example, the plural of the word *antenna* is *antennae*.

If the description keys to a family (as in 4a below), you have identified that organism. If the description doesn’t key to a family, go to the next couplet indicated (as in #4b below which directs the taxonomist to couplet #5). The key also contains a brief paragraph about each family immediately after the specimen’s identity is resolved. These *family facts* provide additional information on the habitat and habits of the organisms.

- a. Antennae long (at least 6 times as long as wide) and/or sclerites on mesonotum (middle back) lightly pigmented except for a pair of dark curved lines; hind legs longer than others

← if the organism is described by this half (a) of couplet #4, then the organism keys to (is a member of) the caddisfly family called *Leptoceridae*

..... **Leptoceridae**

4

These larvae are diverse in case construction, habitat and feeding behavior, though they are generally omnivorous. [M/5/7/C]

← additional details or “family facts”— see below for instruction on deciphering the bracketed information

- b. Antennae not more than 3 times as long as wide; no sclerotized lines

← if the organism is described by this half (b) of couplet #4, then move on to couplet #5

..... 5

The *family facts* described above contain information on the habitat and habits of the organisms. The information in the brackets provide more specific detail about the general pollution tolerance and relative abundance of the family as well as estimates of the number of genera in Maryland and northeastern North America. The legend below provides instruction on how to read this information.

<i>General pollution tolerance of family</i>	<i>Estimated number of genera found in Maryland streams</i>	<i>Estimated number of genera found in northeastern North American streams</i>	<i>Relative abundance of family in Maryland streams</i>
[M/	5/	7/	C]
<i>H = high</i> <i>M = medium</i> <i>L = low</i>			<i>A = abundant</i> <i>C = common</i> <i>R = rare</i>

The tolerance of aquatic organisms to environmental pollution is often estimated on a scale of 0 to 10, with 0 being extremely sensitive to pollution and 10 being extremely tolerant of pollution. For purposes of this key, families with a tolerance value of 0-3 are considered to have a low (L) tolerance to pollution. Families with values of 4-6 are considered to have moderate or medium (M) tolerance and families with values of 7-10 are considered to have high (H) tolerance. Tolerance categories are based on values listed in Appendix A of Stribling et al (1998).

Using the example provided for the trichopteran family *Leptoceridae*, this family has a medium tolerance to pollution. Within the family, there are an estimated 5 genera in Maryland and 7 in northeastern North America. The state estimate comes from several years of stream sampling by the Maryland Biological Stream Survey (MBSS) (Stribling et al [1998]); the northeastern North America estimate is taken from Peckarsky et al (1984). Lastly, *Leptoceridae* are common in Maryland streams.

The relative abundance of families is based on qualitative consensus within the Maryland DNR on how geographically widespread a family is, as well as its typical occurrence in large or small numbers. In some cases an “X” will appear in one or more spaces within the brackets, indicating that the information is not known or available. If there are no brackets associated with a family, the information is unknown or unavailable.

Section 2

Key to the Major Taxa

This section is an introductory key to the major taxonomic groupings identified in this manual. Use this section to determine where to go next in classifying an organism. For example, if the organism keys to couplet 6a in this section (snail or limpet), your next stop is Section 4, Key to Snails and Limpets (Gastropoda).

Photographs and illustrations of many of these groups are contained within the specific family-level keys. For example, to find photos of various Gastropoda, look in Section 4 of the key

- 1
 - a. Flattened or cylindrical worms, laterally symmetrical, with only a single ventral opening to the digestive tract, non-segmented
 *Flatworms,*
 phylum **Platyhelminthes,**
 class **Turbellaria**

GO to Section 8, Aquatic Worms,
 Group Descriptions Without Keys

- b. Not as above
 2

- 2
 - a. Flattened unsegmented worms with an extendable proboscis (like a harpoon from the mouth). When preserved, they tend to contract into a round shape with an extended proboscis.
 *Ribbon Worms,*
 phylum **Nemertea**

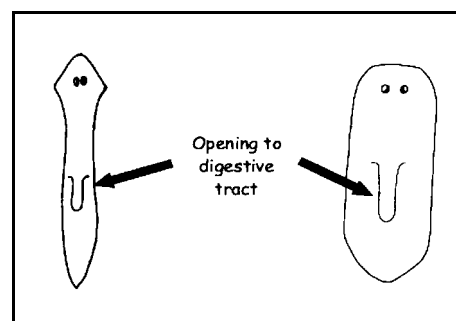
GO to Section 8, Aquatic Worms,
 Group Descriptions Without Keys

- b. Not as above
 3

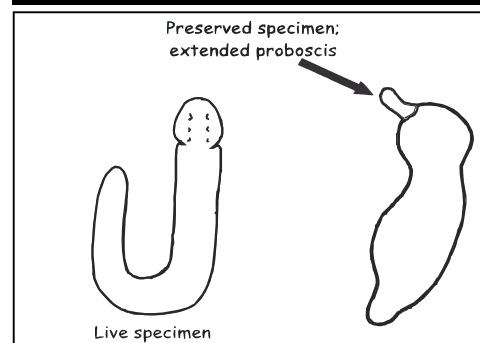
- 3
 - a. Legs and tentacles absent; non-segmented worms
 4

- b. Legs, segmentation, tentacles or hard shell present
 5

Turbellarian worms (1)



Nemertean worms (2)

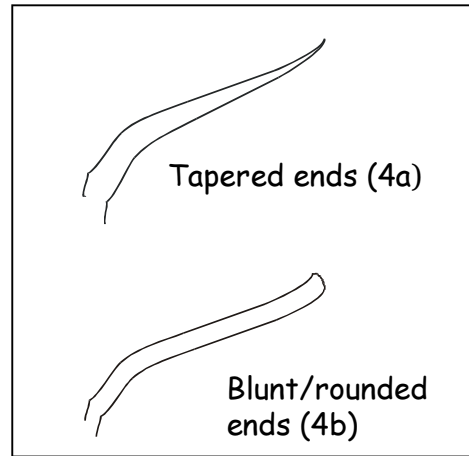


- a. Cylindrical body tapered at both ends, most less than 1 cm long
 *Roundworms*, phylum **Nematoda**

GO to *Section 8, Aquatic Worms, Group Descriptions Without Keys*

- 4 b. Ends blunt or rounded, longer than 1 cm (up to 1 m) and 0.25 to 3 mm in width
 *Horsehair Worms*, phylum **Nematomorpha**

GO to *Section 8, Aquatic Worms, Group Descriptions Without Keys*



- a. Soft-bodied with a hard shell and no legs (snails, clams, mussels)
 phylum **Mollusca**...6

- 5 b. Body not enclosed in a shell, may have jointed legs or prolegs or segmented body. If neither, then head with paired mandibles
 7

- a. Body enclosed in a single shell, usually spiralled
 *Snails and Limpets*, class **Gastropoda**

6 GO to *Section 4, Key to Snails and Limpets (Gastropoda)*

- b. Body enclosed between two hinged shells
 *Clams and Mussels*, class **Bivalvia**

GO to *Section 3, Key to Mussels and Clams (Bivalvia)*

- a. Adults and most larval stages with legs; if larvae without legs or prolegs, then head with paired mandibles
 phylum **Arthropoda**

GO to *Section 5, Initial Couplet to Arthropoda*

- 7 b. Legs absent in all life stages, segmented body
 *Segmented Worms*, phylum **Annelida**

GO to *Section 8, Aquatic Worms, Group Descriptions Without Keys*

Section 3

Mussels and Clams (*Bivalvia*)

Many families of *Bivalvia* have common names. These names are given in the key immediately before the Latin name.

- a. Shell with lateral teeth (longer ridges inside the shell near the hinge) only on one side of pseudo-cardinal teeth (pointed nobs nearest the hinge); adults generally > 25 mm
..... *Freshwater Mussels, Unionidae*

1

The Unionidae are diverse and abundant in suitable habitat of lakes, rivers and ponds. [X/X/23/C]

- b. Shell with lateral teeth on both sides of cardinal teeth; size variable
..... 2

- a. Shell large (adults usually 25-50 mm), thick and massive with prominent concentric growth rings, hinge of shell with serrated lateral teeth
..... *Asian Clams, Corbiculidae*

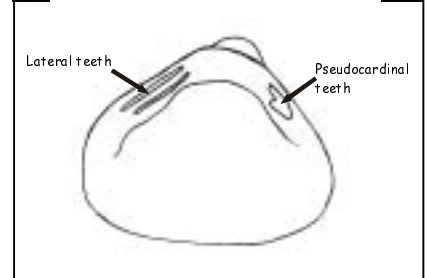
The Asian clam (genus Corbicula) is not native to Maryland. [M/1/1/C]

2

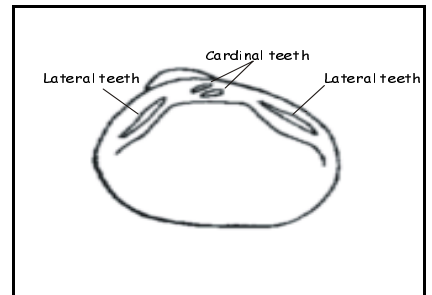
- b. Shell small (adults usually < 25 mm), thin and usually fragile
..... *Freshwater Clams, Sphaeriidae*
(a.k.a. Pisidiidae)

The Sphaeriidae are also known as "fingernail clams" because of their size and translucent shell. [H/2/3/C]

Unionidae (1a)



Corbiculidae and Sphaeriidae (1b)



Corbiculidae (2a)



Corbiculidae's serrated lateral teeth (2a)



The zebra mussel, a freshwater mussel in the family **Dreisseneidae**, has not yet been found in Maryland. However, it is easily transported and biologists should be watchful in order to control the spread of this troublesome exotic species. It is recognizable from dark and light striped patterns on the 5-40 mm shell.

Dreisseneidae (zebra mussel)



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Section 4

Snails and Limpets (*Gastropoda*)

Snails and limpets do not have widely used common names.

- 1**
- a. Animal with an operculum (disk that seals the shell opening like a door, it may be well inside shell or missing) 2
 - b. No operculum present 6

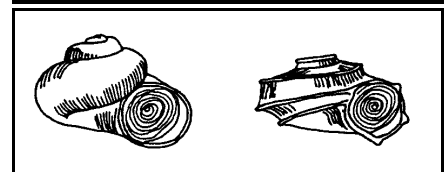
- 2**
- a. Shell as wide or wider than high, spire sunken or slightly raised with each whorl; operculum round and multi-spiral, round mouthed snails; shell < 8mm **Valvatidae**

This family is represented by a single genus (Valvata) containing several species in Maryland. They are egg laying hermaphrodites (with both male and female organs on each individual). [X/1/1/R]

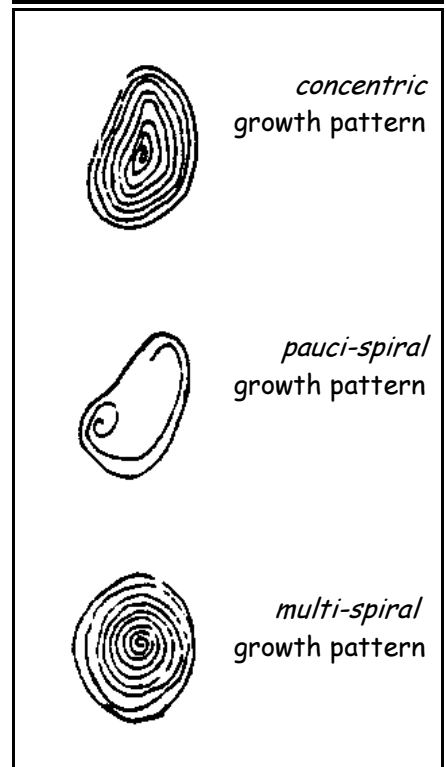
- b. Shell higher than wide; shell small to large; spire depressed to elongate, operculum varied (multi-spiral, pauci-spiral or concentric); size varies 3

- 3**
- a. Operculum with a multi-spiral or pauci-spiral; whorls flattened or inflated, shell small to large 4
 - b. Operculum concentric, whorls inflated; adult shell > 8mm 5

Valvatidae (2a)



Opercula growth patterns(3a/3b)



- a. Adult shell usually < 5 mm (up to 7 mm); whorls inflated; operculum usually smaller than outer shell opening, can be withdrawn into shell; color is usually drab and unicolored; shell has few whorls
 **Hydrobiidae**

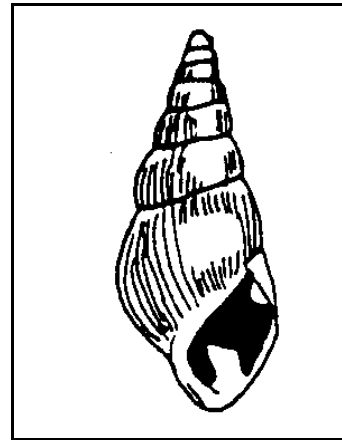
4

The Hydrobiids are represented by marine and brackish as well as freshwater types. The shell form is relatively similar among genera.
 [H/2/8/C]

- b. Adult shell usually >10 mm, whorls flattened
 **Pleuroceridae**

The shells of these animals are very solid and the opening may have a furrow in front.
 [X/2/3/C]

Pleuroceridae (4b)



- a. Adult shells 8-15 mm; operculum calcareous (bone-like), as big as outer opening, cannot be withdrawn into shell
 **Bithyniidae**

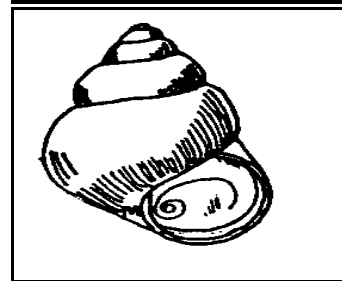
5

The genus Bithynia is the sole representative of this family in Maryland. It was until recently considered to be in the Hydrobiidae family.
 [X/1/1/R]

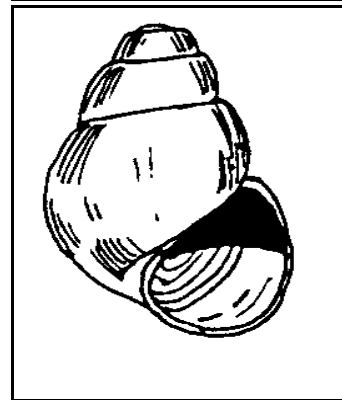
- b. Adult shells > 20 mm; operculum corneous (like horn or cartilage)
 **Viviparidae**

Viviparids are common in lakes and rivers throughout eastern North America. [M/2/2/C]

Bithyniidae (5a)



Viviparidae (5b)



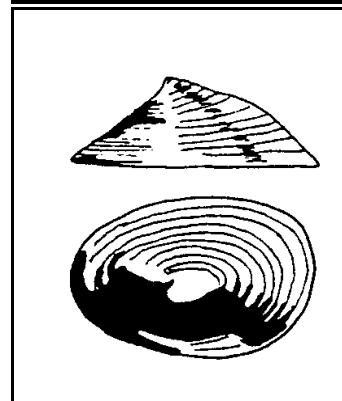
- a. Shell shaped like a wide cone and uncoiled. Limpet snails (cap shaped)
 **Ancylidae**

6

The simple shape of the shell makes this family easy to identify. [H/1/1/C]

- b. Shell coiled
 7

Ancylidae (6a)



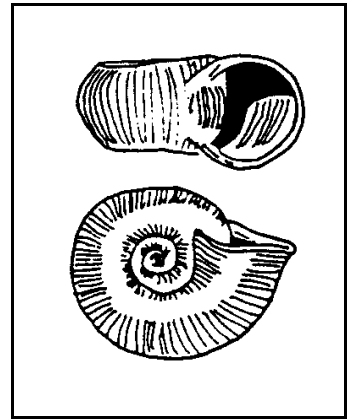
- a. Shell disk shaped and/or with a sunken spire
 **Planorbidae**

7

This family is closely related to the Ancyliidae, though they are not similar in appearance. They range in size from 1 to 30 mm and have hemoglobin as a respiratory pigment, which sometimes gives the tissue a red color.
 [H/5/7/C]

- b. Spire not sunken
 8

Planorbidae (7a)



- a. Animal and shell dextral (opening on right with spire pointing up)
 **Lymnaeidae**

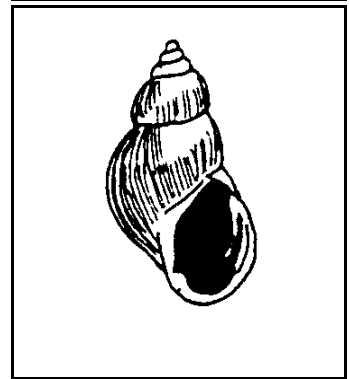
8

Lymnaeids have broad triangular tentacles and lay long tubular egg masses. [H/5/7/C]

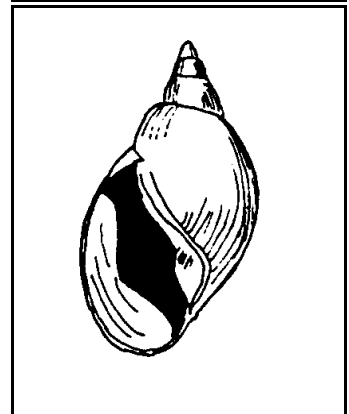
- b. Animal and shell sinistral (opening on left)
 **Physidae**

The tentacles and foot of animals in this family are slender with fingerlike extensions from the mantle (the body wall beneath the shell).

Lymnaeidae (8a)



Physidae (8b)



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Section 5

Insect and Non-Insect *Arthropoda*

Arthropods are animals with an external, hard covering and jointed legs. Most of the organisms identified in this key fall into the arthropod groups of aquatic insects and semi-aquatic Collembola.

*Use the following couplet to determine whether your next stop is **Section 6, Taxonomic Key to the Non-Insect Arthropoda** or **Section 7, Key to Insects and Collembola***

-
- a. Three pairs of legs (not including prolegs, suckers or creeping welts) or worm-like, but with distinct head parts; 1 pair of antennae
..... **Section 7; Insects and Collembola**

GO to Section 7, Taxonomic Key to the Orders of Insects and Collembola

- b. More than 3 pairs of legs **or** 3 pairs of appendages and a bivalve-like carapace (hard, shell-like covering), 2 pair of antennae or antennae absent
..... **Section 6; Non-Insect Arthropoda**

GO to Section 6, Taxonomic Key to the Non-Insect Arthropoda

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Section 6

Non-Insect *Arthropoda*

Many arthropods have common names. These names are given in the key immediately before the Latin name. Groups that are very infrequently collected in Maryland streams are only keyed to higher taxonomic levels, e.g. order or class. Some groups, such as decapods and amphipods, are keyed to family in this section.

-
- 1**
- a. Four pairs of legs (sometimes hard to see from above) and body segmentation is not readily apparent; antennae absent
..... *Water Mites*, subclass **Acari**

- b. More than 4 pairs of legs; 2 pairs of antennae
..... 2

-
- 2**
- a. With a complete carapace, shaped like an incomplete cylinder or with two halves like a bivalve
..... 3

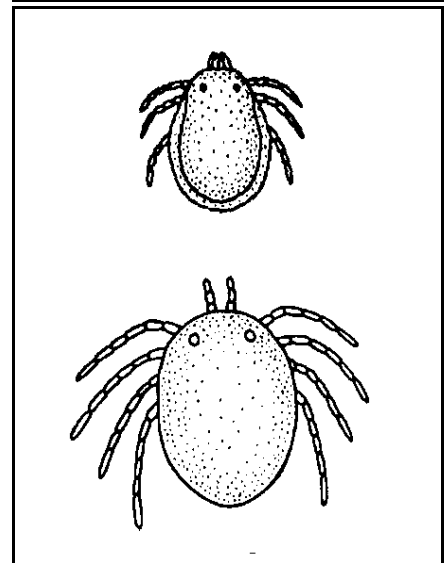
- b. No carapace or one which leaves last 2 thoracic segments exposed
..... 5

-
- 3**
- a. Carapace nearly cylindrical, covering both the dorsal and lateral surfaces of the head and thorax
..... order **Decapoda**...4

- b. Carapace bivalve-like
Water Fleas, Clam Shrimp, and Seed Shrimp
(all not included in this key).
-

Acari

(1a)



- 4 a. Abdomen flattened side to side; 2 pairs of legs with pincers
 *Shrimp*, family **Palaemonidae**
- b. Abdomen flattened top to bottom; 3 pairs of legs with pincers
 *Crayfish*, family **Cambaridae**

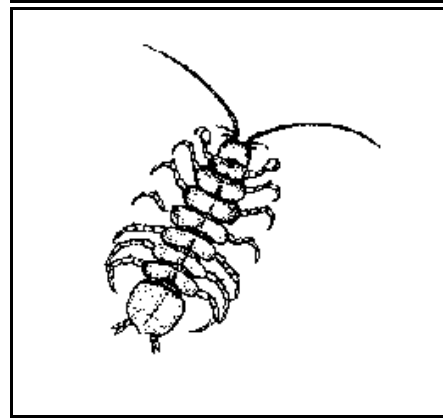
Cambaridae (4b)



- 5 a. Eyes stalked; carapace not covering last 2 thoracic segments; six pairs of legs
 *Fairy and Opposum Shrimp*
 order Mysidacea, family **Mysidae**
- b. Eyes not stalked; no carapace
 6

- 6 a. 7 thoracic segments
 7
- b. 4-6 thoracic segments
 *Water Fleas and Copepods*
(not covered in this key)

Asellidae (7a)



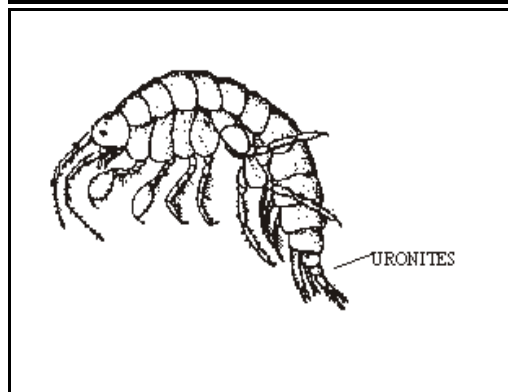
- a. Body flattened top to bottom; 6-7 pairs of legs
 *Sow Bugs*, order Isopoda,
 family **Asellidae**

Isopods include the terrestrial potato bug common in gardens and forest litter. The aquatic isopods usually are burrowers and detritus feeders on the bottom of streams and lakes.

- 7 b. Body flattened side to side (laterally); 5 pairs of legs
 *Scuds*, order **Amphipoda**...8

Amphipods can be observed swimming short distances and crawling among algae or clumps of organic debris in eddies or water edges. They feed on microbes and detritus associated with decaying organic material.

Amphipoda (7b)



- a. Antennae highest on the head (first pair of antennae) shorter than the lower pair; each upper antenna lacks a small appendage (accessory flagellum) branching from the third segment

8

..... family **Talitridae**
(also known as **Hyaellidae**)

- b. Highest pair of antennae longer than lower pair; small accessory flagellum (sub-antenna) branching from third segment of upper antenna

..... 9

Talitridae

(8a)



- a. Prominent spines pointed upward near the end of the abdomen on uronites; accessory flagellum with 2-7 segments, usually more than 2; telson (flat lobe behind spine) split from tip to base

9

..... family **Gammaridae**

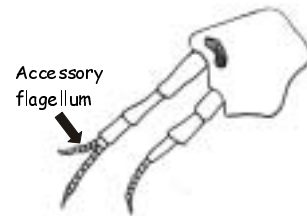
- b. No spines pointing upward near end of abdomen; accessory flagellum with 1-2 segments;; telson not split or split only from tip to 1/3 its length

..... family **Crangonyctidae**

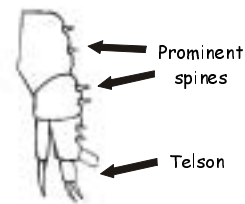
Amphipoda

(9)

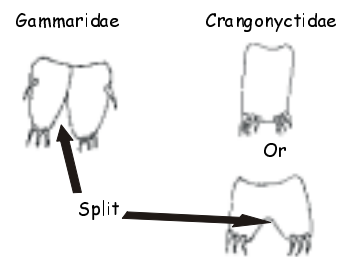
HEAD WITH ANTENNAE



URONITES ON GAMMARIDAE



TELSON



Gammaridae

(9a)



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Section 7

Insects and Collembola

Many arthropod orders of insects and Collembola have common names. These names are given in the key immediately before the Latin name. Once you have identified an organism to order-level, go to the relevant family-level key to continue the identification process.

Photographs and illustrations of many of these groups are contained within the specific family-level keys. For example, to find photos of True Flies (Diptera), look in that section of the key.

- a. Thorax without segmented legs (except pupae)
..... **True Flies, Diptera (Section 7c)**

 - 1** b. Thorax with 3 pairs of segmented legs (exception: Curculionidae larvae of the order Coleoptera have no legs but instead have three pairs of swellings with tiny hairs)
..... 2

 - a. With large, functional wings
..... 3

 - 2** b. Wingless, or with wingpads (immature wings)
..... 4
-

-
- a. Hardened wing covers meet along the centerline of the back; chewing mouthparts
..... *Beetles*, **Coleoptera** (adults)
(Section 7b)

- 3** b. Wings leathery at base, with membranous tips overlapping (exception: wings of Pleidae of the order Hemiptera meet along centerline); sucking tube-like mouthparts
..... *True Bugs*, **Hemiptera** (in part)
(Section 7e)

-
- a. Abdomen with 6 segments or less; abdominal furcula (leaping appendage or spring tail) usually present; length < 5 mm
4 *Springtails*, **Collembola**(**Section 7a**)

- b. Abdomen with more than 6 segments; no furcula; size variable
..... 5

-
- a. With 2-3 long, terminal filaments (tails)
..... 6
 - 5** b. Terminal filaments absent or not multi-segmented, leaf-like
..... 7

-
- a. Abdomen with plate-like, feather-like or leaf-like gills; usually with 3 terminal filaments, sometimes 2; claws single, except in **Metretopodidae** where there are two on the first claw
6 *Mayflies*, **Ephemeroptera**
(Section 7d)

- b. Gill absent from middle segments (4-6) of abdomen; 2 terminal filaments; claws double
.. *Stoneflies*, **Plecoptera** (**Section 7i**)
-

-
- a. Labium (lower jaw) forming an elbowed, grasping extension
 *Dragonflies and Damselflies*,
Odonata (Section 7h)
- 7**
- b. Mouthparts adapted for chewing or sucking
 8
-

- a. Sucking mouthparts, tube-like
 9
- 8**
- b. Chewing mouthparts, not tube-like
 10
-

- a. Middle legs with double claws
 *True Bugs*, **Hemiptera** (in part)
- 9**
- b. Middle legs with single claw; always associated with freshwater sponges
 *Spongilla Flies*, order Neuroptera,
Sisyridae

This is the only family of the nerve-winged insects (Neuroptera) with an aquatic association and, thus, are keyed here. The larvae are very uncommonly collected.

- a. Prolegs on abdomen with crochets (fine hooks like Velcro®)
 *Moths*, **Lepidoptera (Section 7f)**
- 10**
- b. Abdomen without prolegs or prolegs only on last segment
 11
-

- a. Antennae extremely small, with 1 segment
Caddisflies, **Trichoptera (Section 7j)**
- 11**
- b. Antennae elongate with 3 or more segments
 12
-

-
- a. Claws double; conspicuous filaments on sides of abdomen; abdomen ending in a single slender filament or in 2 prolegs, each with 2 hooks

... *Fishflies, Dobsonflies, and Alderflies,*
Megaloptera (Section 7g)

12

- b. Claws single **or** claws double and without conspicuous filaments on sides of abdomen **or** abdomen ending in 2 slender filaments or a single proleg with 4 hooks

..... *Beetles, Coleoptera* (larvae)
(Section 7b)

Section 7a

Semi-Aquatic Springtails (Collembola)

Springtails float on the surface film and feed on unicellular algae and plankton. They are not ordinarily collected and the families have no widely used common names. The Sminthuridae and Poduridae are most likely to be found.

- a. Body plump; no distinct segmenting on thorax and abdomen
..... **Sminthuridae**

1 [X/X/2/C]

- b. Body more elongate; thorax and abdomen segmented
..... 2
-

- a. Mouth directed downward; furcula (forked spring tail) present and forks come together at ends; 1st thoracic segment visible from above and with setae (hairs)
..... **Poduridae**

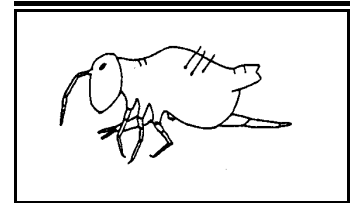
2 [X/X/1/C]

- b. Mouthparts directed forward; furcula absent or present with forks that do not distinctly converge; 1st thoracic segment hidden and without setae
..... **Isotomidae**

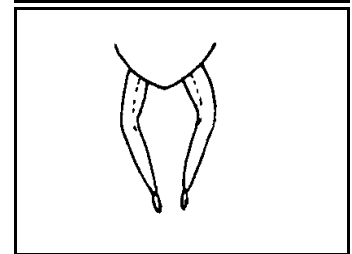
[X/X/2/C]

These are the only families containing freshwater genera with primary or secondary aquatic associations. Merritt and Cummins (1996) also include the **Onychiuridae**, which are elongate and have 3 visible thoracic segments. The furcula are absent or variable and the Onychiuridae have no eyes.

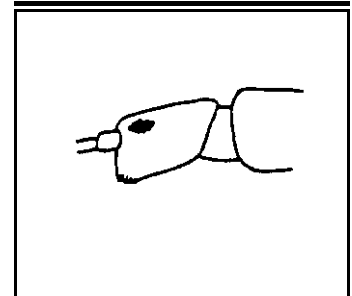
Sminthuridae (1a)



Collembola furcula (2a)



Side-view of Isotomidae head (2b)



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Section 7b

Aquatic Beetle Larvae and Adults (*Coleoptera*)

Many families of *Coleoptera* have common names. These names are given in the key immediately before the Latin name. Many beetles are aquatic as adults. The key to adult beetles immediately follows this key to the larvae.

Beetle larvae

- a. Two claws on each tarsus (foot)
..... 2
- 1**
- b. One claw on each tarsus **or** legs absent
..... 4
-

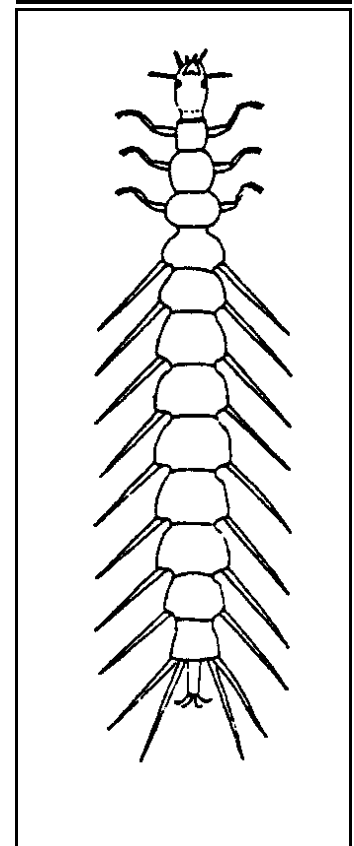
- a. Abdomen with 2 pairs of hooks on terminal segment; abdomen segments 1-9 with feathery lateral gills
..... *Whirligig Beetles, Gyrinidae*

2

Adults of this family are commonly seen swimming in circles on the water's surface. This is not normal behavior, but is an alarm mechanism sometimes triggered by the observers presence. Adults scavenge for floating food while larvae are predaceous.
[M/2/2/C]

- b. Not as above (couplet a)
..... 3
-

Gyrinidae (2a)



- a. Cerci (tail filaments) longer than the first abdominal segment and slender **or** cerci shorter or absent; legs long and adapted for swimming; mandibles sickle-shaped without enlarged molar portion

..... *Predaceous Diving Beetles,*
Dytiscidae

These beetles swim well enough to capture macroinvertebrates, tadpoles and fish.

Adults fly and can therefore be found in a variety of water types. They trap air for underwater breathing beneath the elytra.

[M/6/30/C]

3

- b. Cerci shorter than abdominal segment 1 or absent; legs short and adapted for digging; mandibles with enlarged molar portion

. *Burrowing Water Beetles, Noteridae*

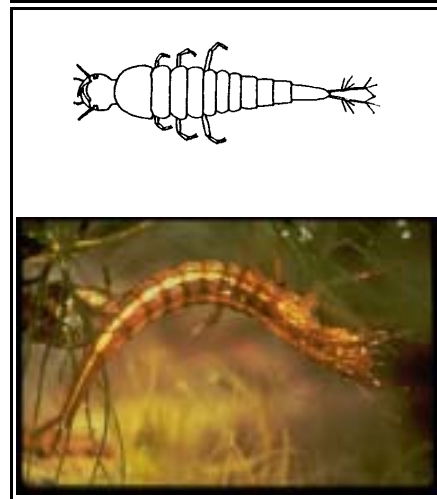
These beetles are mostly predators as adults and live in close association with vegetation.

Larvae may be more omnivorous.

[X/o/3/X]

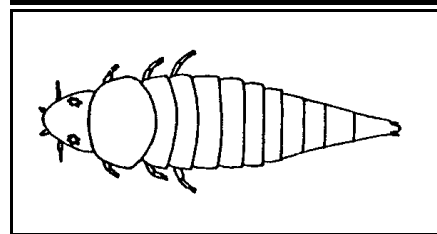
Dytiscidae

(3a)



Noteridae

(3b)



- a. Legs distinctly 5-segmented; abdomen ends in 1 or 2 long filaments; mature larvae have projections from back of thoracic and abdominal segments or 10th segment is very long

.. *Crawling Water Beetles, Haliplidae*

These beetles are often found in pond weeds or submerged vegetation in streams. They can swim, but usually crawl. They carry air in a pocket under the elytra. Adults are herbivores and larvae are predators.

[M/2/2/C]

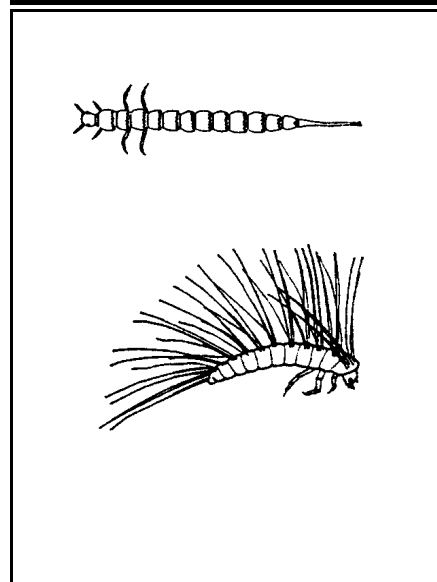
4

- b. Legs variable; not with the above combination of projections and filaments

..... 5

Haliplidae

(4a)



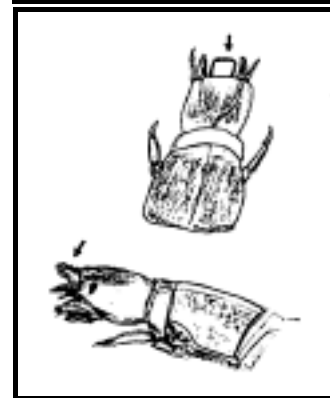
- 5 a. Labrum (upper lip) continuous with head capsule (labium [lower lip] may be visible from above) 6
- b. Labrum separated from front of head capsule by a thin, flexible groove (distinct suture) 10

Labrum continuous

(5a)



Labrum with flexible groove (5b)

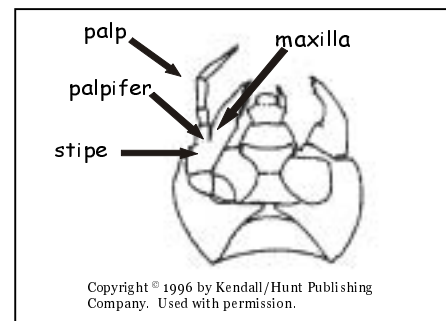


- 6 a. Maxilla with palpifer appearing as part of stipes (6a); spiracles (openings to the respiratory system on the abdomen) ring-shaped *Rove Beetles, Staphylinidae* (in part)

6 *Rove beetles are well represented by non-aquatic species (which are commonly found in carrion or fungal growths, and can be predacious) and the species likely to be collected are usually semi-aquatic.*

- b. Maxilla with palpifer appearing as a segment of palp; spiracles with 2 openings 7

Staphylinidae (6a)



(6b)

- 7 a. Abdomen with 10 segments; cerci very short; legs short with 3 segments; small larvae; rare *Minute Mud-loving Beetles, Georyssidae*

7 *These beetles live in sediments on the edge of streams.*

- b. Abdomen with 8 - 9 segments; legs long with 4-5 segments 8

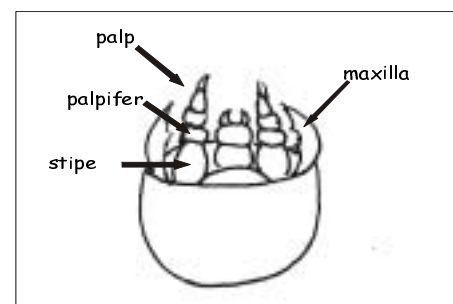


Fig. 6a, 7a, and 8a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

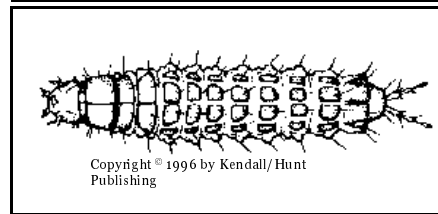
- a. Abdomen with 9 complete segments and the 10th reduced but distinct; hard skinned
 **Helophoridae**

8

Helophoridae are represented by a single aquatic genus and are closely related to the Hydrophilidae. Adults and larvae are herbivores living on margins of lakes and streams.

- b. Abdomen with 8 complete segments with the 9th and 10th reduced
 9

Helophoridae (8a)



- a. Base of antennae nearer the front and side of head than the base of mandibles; labium and maxillae in a furrow beneath head
 **Hydrochidae**

Hydrochidae are represented by the single aquatic genus Hydrochus and are closely related to the Hydrophilidae. Adults and larvae are herbivores, living on margins of lakes and streams.

9

- b. Base of antennae farther from the front and side of head than the base of the mandibles; labium and maxillae at lower front edge of head
 *Water Scavenger Beetles,*
Hydrophilidae

These beetles live in lakes or streams backwaters and usually in association with vegetation. Larvae are predaceous as are some adults, though others feed on detritus.
 [M/8/20/C]

Hydrophilidae (9b)



- a. Thorax and abdomen short and plump, without distinct sclerites (hardened plates); legs reduced or absent
 11

10

- b. Thorax and abdomen cylindrical or flattened, not obese; tops of thoracic and abdominal segments clearly defined; legs adapted for walking
 12

- a. Legs very small but complete; spiracles on top of abdominal segment 8 forming large spines
 *Leaf Beetles, Chrysomelidae*

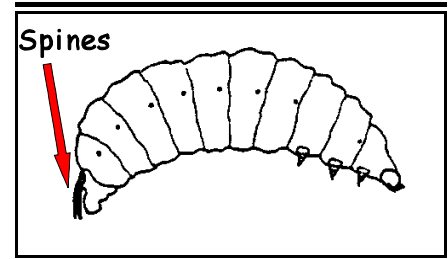
The aquatic larvae of one genus of leaf beetles (Donacia) feed on submerged vegetation and obtain oxygen by inserting their abdominal spines into plant tissues. Adults are terrestrial or semi-aquatic.
 [X/X/1/R]

11

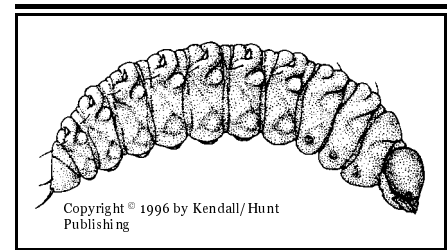
- b. Legs entirely absent; spiracles sometimes on tubular extensions, but abdominal segment 8 without spines
 *Weevils, Curculionidae*

This large terrestrial family has a few aquatic species. Most larvae are not aquatic, living in plant tissues. Aquatic adults crawl on submerged vegetation nocturnally.
 [X/1/X/X]

Chrysomelidae (11a)



Curculionidae (11b)



- a. Abdomen with 10 segments; segment 9 with jointed cerci
 13

12

- b. Abdomen with 9 segments; segment 8 or 9 sometimes with immovable appendages, but without jointed cerci
 14

- a. Mandibles with large molar lobe
 ... *Minute Moss Beetles, Hydraenidae*

The Hydraenidae are closely related to the Hydrophilidae but are generally smaller. Larvae are riparian, developing in moist soil, and adults live in shallow water of stream or lake margins. [X/X/4/X]

13

- b. Mandibles sickle-shaped, without molar lobe
 *Rove Beetles, Staphylinidae*
 (in part)

Rove beetles are well represented by non-aquatic species (which are commonly found in carrion or fungal growths, and can be predacious) and the species likely to be collected are usually semi-aquatic.

Hydraenidae mandible with large molar lobe (13a)

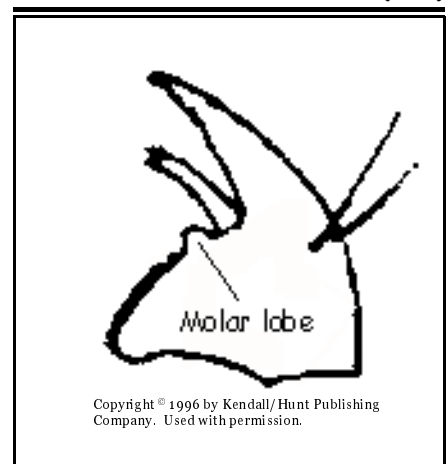


Fig. 11b and 13a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

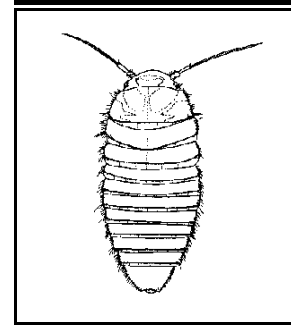
- a. Antennae longer than head and many-jointed
 *Marsh Beetles, Scirtidae*

14

The larvae of marsh beetles live in the emergent zone, feeding on vascular plants and detritus. Adults are semi-aquatic or terrestrial. [H/1/4/C]

- b. Antennae short, with 2-3 segments
 15

Scirtidae (14a)



- a. Body oval & extremely flattened, with thoracic and abdominal segments expanded to cover head and legs
 *Water Pennies, Psephenidae*

15

The water penny larvae flatten themselves against rocks and woody debris in streams, where they scrape algae. Adults are non-feeding and inhabit the splash zone. [M/2/3/C]

- b. Body cylindrical or nearly cylindrical; head and legs visible from above
 16

Psephenidae, bottom view showing gills (15a)



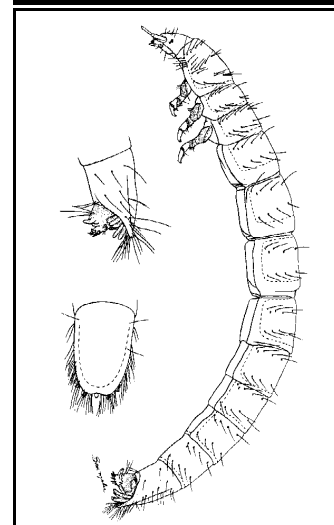
- a. Terminal segment 9 without an operculum (hinged flap); with clusters of lobe-like anal gills
 . *Toed-winged Beetle, Ptilodactylidae*

These larvae are detritivores, especially of rotting wood and leaf litter in streams, and the adults live in leaf litter in riparian areas. [M/1/1/C]

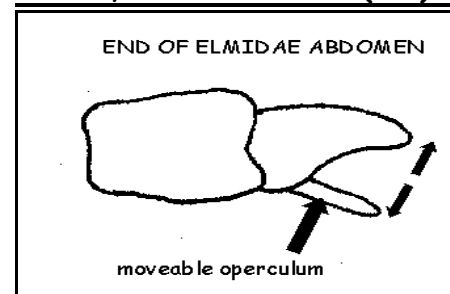
16

- b. Abdominal segment 9 with a moveable operculum covering the lower end ventrally
 17

Ptilodactylidae (16a)



Elmidae, etc. (16b)



17

- a. Terminal abdominal segment divided or notched and with lateral ridges; head capsule with 5 groups of eye-spots on the side
 *Riffle Beetles, Elmidae*

Riffle beetles live in cool, fast running and well oxygenated water. Larvae and adults are herbivores and detritivores. [M/7/8/C]

- b. Terminal abdominal segment rounded posteriorly; head capsule with groups of 6 eye-spots, 5 on the side and 1 below or eyes absent
 18

Elmidae (17a)



18

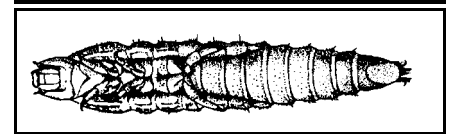
- a. Opercular chamber with 2 retractable hooks and 3 tufts of retractable gills; mandibles with prostheca (accessory feeler)
 . . . *Marsh Loving Beetles, Lutrochidae*

Lutrochidae feed on periphyton and adults live in the splash zone. [X/1/1/C]

- b. Opercular chamber without hooks or gills; mandibles without prostheca
 . . *Long-toed Water Beetles, Dryopidae*

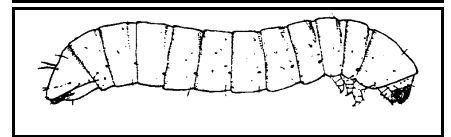
These beetles are covered with hairs that repel water and retain air for breathing under water. They crawl on the bottom of streams and are herbivores. [M/1/1/C]

Lutrochidae (18a)



Copyright © 1996 by Kendall/Hunt Publishing

Dryopidae (18b)



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Fig. 18a and 18b - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

Beetle adults

- a. Eyes divided into upper and lower parts (4 eyes) either completely separate or with a dividing ridge; antennae short and clubbed

..... Whirligig Beetles, **Gyrinidae**

1

These beetles are commonly seen swimming in circles on the water's surface. This is not normal behavior, but is an alarm mechanism sometimes triggered by the observer's presence. Adults scavenge for floating food while larvae are predaceous. [M/2/3/C]

- b. Eyes not divided (2 eyes); antennae not short and clubbed

..... 2

- a. Head extended forward like a snout

..... Weevils, **Curculionidae**

2

This large terrestrial family has a few aquatic species. Most larvae are not aquatic, living in plant tissues. Aquatic adults crawl on submerged vegetation nocturnally. [X/1/X/X]

- b. Head not extended like a snout

..... 3

- a. Elytra (hard wing covers) short, with at least 2 abdominal segments exposed

..... Rove Beetles, **Staphylinidae**

3

Rove beetles are well represented by non-aquatic species (which are commonly found in carrion) and the species likely to be collected in streams are usually only semi-aquatic.

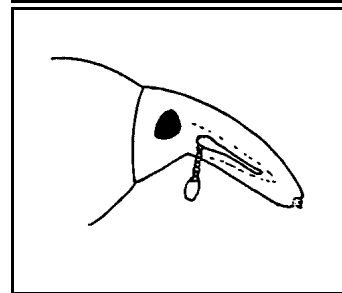
- b. Elytra covering entire abdomen with at most 1 abdominal segment exposed

..... 4

Gyrinidae adult, side view (1a)



Side view of adult Curculionidae head, extended forward into a snout (2a)



Staphylinidae adult (3a)

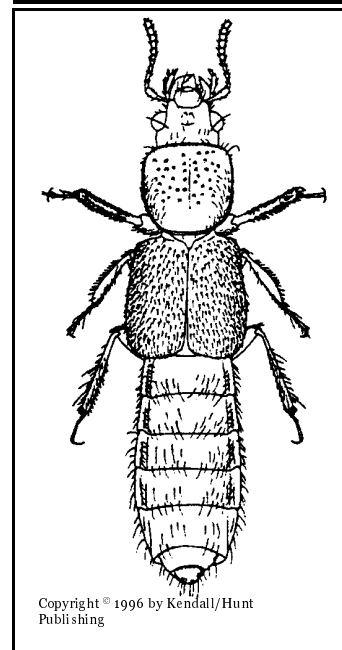


Fig. 3a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

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- a. Hind coxae (bases of legs) broad, flattened and covering front 1-3 abdominal segments and base of hind femur
 . . *Crawling Water Beetles, Haliplidae*

4

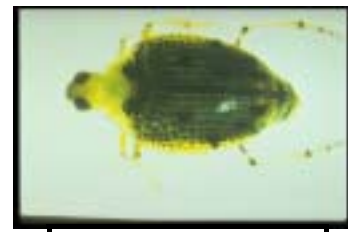
These beetles are often found in pond weeds or submerged vegetation in streams. They can swim, but usually crawl. They carry air in a pocket under the elytra. Adults are herbivores and larvae are predators.
 [M/2/2/C]

- b. Hind coxae not broadened or covering abdominal segments
 5

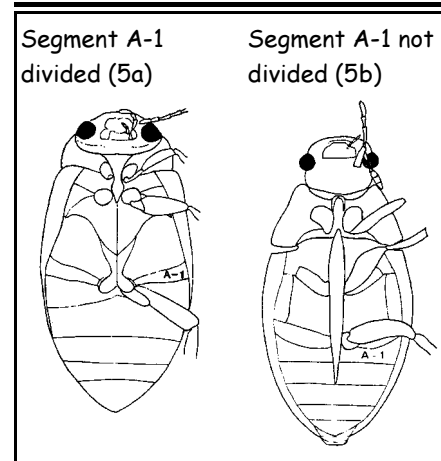
5

- a. Hind coxae dividing first abdominal segment into 2 separate plates
 6
- b. Hind coxae not dividing first abdominal segment
 7

Haliplidae adult (4a)



Hind coxae and first abdominal segments (A-1) (5a/5b)



- a. Fore and middle tarsi (feet) with 5 segments (segment 4 similar in size to segment 3) **and** hind tarsi with 2 equal, slender curved claws **and** scutellum (nob or triangular plate between elytra) concealed

..... *Burrowing Water Beetles,*
Noteridae

These beetles are mostly predators as adults and live in close association with vegetation. Larvae may be more omnivorous.
[X/o/3/X]

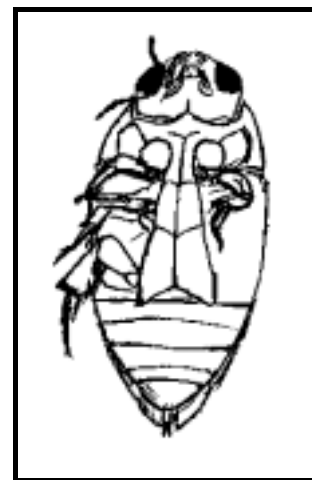
6

- b. Fore and middle tarsi with 4 segments **or** fore and middle tarsi with 5 segments with segment 4 very small and concealed between lobes of segment 3 **or** fore and middle tarsi with 5 segments and hind tarsi with a single claw **or** fore and middle tarsi with 5 segments, hind tarsi with 2 claws and scutellum large and exposed

..... *Predaceous Diving Beetles,*
Dytiscidae

These beetles swim well enough to capture macroinvertebrates, tadpoles and fish. Adults fly and can therefore be found in a variety of water types. They trap air for underwater breathing beneath the hardened hind wing covers (elytra). [M/6/30/C]

Ventral view of
Noteridae (6a)



- a. Antennae ending in a 3-5 segmented club
..... 8

7

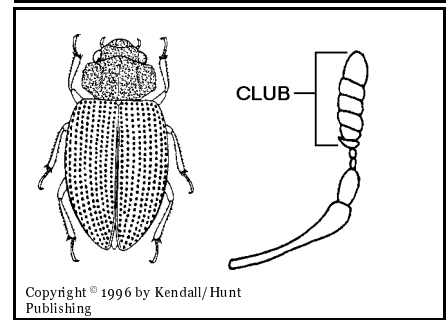
- b. Antennae long and slender (Fig. 18) **or** short and thick with basal segment enlarged (Fig 15b)
..... 12

8

- a. Abdomen with 6-7 visible segments; antennae ending in a 5 segmented club
... *Minute Moss Beetles*, **Hydraenidae**

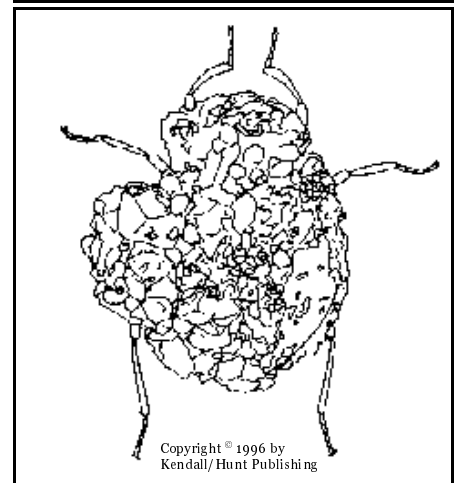
The Hydraenidae are closely related to the Hydrophilidae but are generally smaller. Larvae are riparian, developing in moist soil, and adults live in shallow water of stream or lake margins. [X/X/4/X]

Hydraenidae adult with antennae ending in 5 segmented club (8a)



- b. Abdomen with 5 visible segments; antennae ending in a 3 segmented club (not including segment 6)
..... 9

Georyssidae adult (9a)



9

- a. Fore tarsi with 4 segments; hind coxae widely separated; may be camouflaged with grains of sand glued to its back
..... *Minute Mud-loving Beetles*, **Georyssidae**

These beetles live in sediments on the edge of streams.

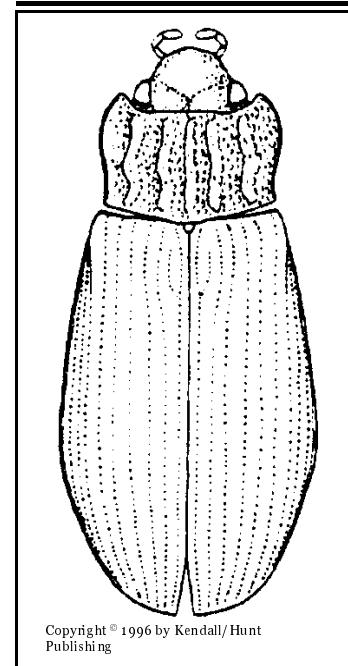
- b. Fore tarsi with 5 segments; hind coxae close together
..... 10

10

- a. Pronotum (back plate, just behind head) with 5 grooves running lengthwise
..... **Helophoridae**

Helophoridae are represented by a single aquatic genus and are closely related to the Hydrophilidae. Adults and larvae are herbivores living on margins of lakes and streams.

Helophoridae adult (10a)



- a. Pronotum without 5 grooves
..... 11

Fig. 8a, 9a, and 10a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

- a. Eyes protruding; pronotum narrower than base of adjoining elytra; scutellum small; antennae with 3 or fewer segments before cupule (base of terminal club)

..... **Hydrochidae**

Hydrochidae are represented by the single aquatic genus Hydrochus and are closely related to the Hydrophilidae. Adults and larvae are herbivores, living on margins of lakes and streams.

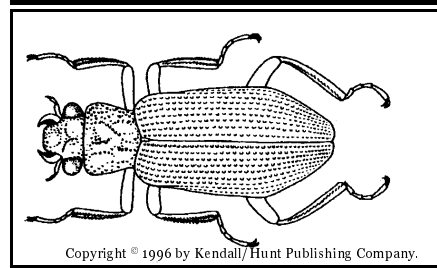
11

- b. Eyes usually not protruding; pronotum not distinctly narrower than elytra (if narrower then scutellum is large); antennae often have 5 segments before cupule

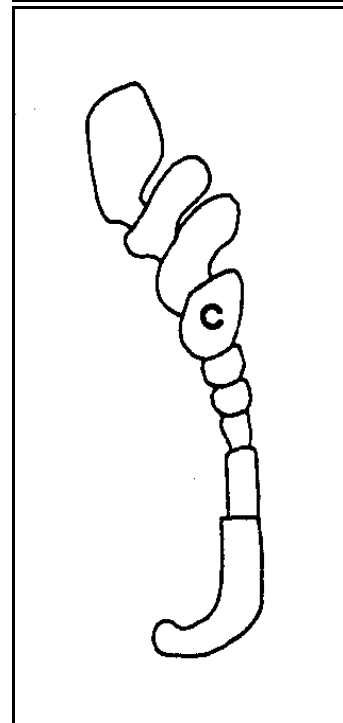
..... *Water Scavenger Beetles,*
Hydrophilidae

These beetles live in lakes or streams backwaters and usually in association with vegetation. Larvae are predaceous as are some adults, though others feed on detritus.
[M/8/20/C]

Hydrochidae adult (11a)



Hydrophilidae adult antennae with 5 segments before cupule (C) (11b)



- a. Tarsal formula (number of segments in the fore, middle and hind tarsi, respectively) 4-4-4

..... *Leaf Beetles,* **Chrysomelidae**

The aquatic larvae of one genus of leaf beetles (Donacia) feed on submerged vegetation and obtain oxygen by inserting their abdominal spines into plant tissues. Adults are terrestrial or semi-aquatic.
[X/X/1/R]

12

- b. Tarsal formula 5-5-5

..... 13

Chrysomelidae adult (12a)

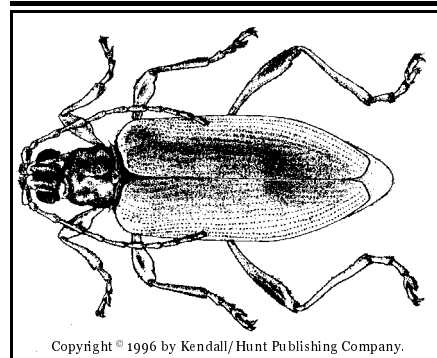


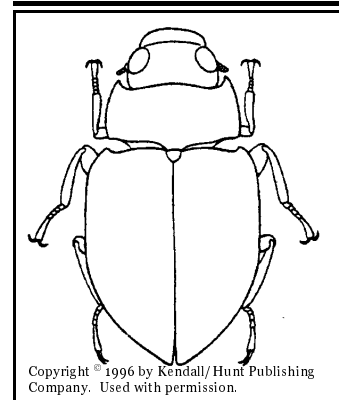
Fig. 11a and 12a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

- a. Prosternum (chest plate) expanded forward under head; head usually contracted into thorax concealing antennae and eyes
- 13** 14
- b. Prosternum not expanded forward, antennae clearly visible
- 16

- a. Antennae longer than head and slender, usually visible when viewed from above, anterior coxae round
..... *Riffle Beetles, Elmidae* (in part)
- 14**
- Riffle beetles live in cool, fast running and well oxygenated water. Larvae and adults are herbivores and detritivores. [M/7/8/C]*
- b. Antennae usually thick, with enlarged basal segment, about as long as or shorter than head
- 15

- a. Antennae with 10 segments, hind coxae contiguous, body length 2-2.5 mm (Fig. 14a)
.. *Marsh Loving Beetles, Lutrochidae*
- Lutrochidae feed on periphyton and adults live in the splash zone. [X/1/1/C]*
- 15** b. Antennae with 11 segments, hind coxae separated, body length 5.0-6.3 mm; elytra with many tiny hairs
.. *Long-toed Water Beetles, Dryopidae*
- These beetles are covered with hairs that repel water and retain air for breathing under water. They crawl on the bottom of streams and are herbivores. [M/1/1/C]*

Lutrochidae adult (14a)



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Dryopidae adult, showing antenna near eye (15b)

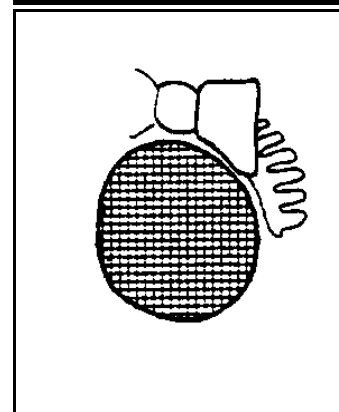


Fig. 14a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

-
- a. Tarsi with 4th segment bilobed
..... *Marsh Beetles*, **Scirtidae**

16

The larvae of marsh beetles live in the emergent zone, feeding on vascular plants and detritus. Adults are semi-aquatic or terrestrial. [H/1/4/C]

- b. 4th segment of tarsi not bilobed
..... 17

-
- a. Antennae thread-like, club-shaped or concealed by prothorax; typically hard-bodied; tarsal claws usually greatly enlarged
..... *Riffle Beetles*, **Elmidae** (in part)

17

Riffle beetles live in cool, fast running and well oxygenated water. Larvae and adults are herbivores and detritivores. [M/7/8/C]

- b. Antennae saw-toothed or comb-like, never concealed; typically soft-bodied; tarsal claws not greatly enlarged
..... 18

Elmidae adult (17a)



18

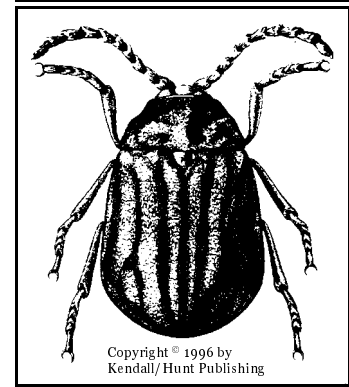
- a. Abdomen with 6-7 segments; maxillary palp with 2nd segment longer than next 2 combined **or** abdomen with 5 segments; maxillary palp with 2nd segment much shorter than next 2 combined **and** antennae bases close together between eyes, significantly constricting front of head capsule
..... *Water Pennies, Psephenidae*

The water penny larvae flatten themselves against rocks and woody debris in streams, where they scrape algae. Adults are non-feeding and inhabit the splash zone.
[M/2/3/C]

- b. Abdomen with 5 segments; maxillary palp with 2nd segment much shorter than next 2 combined; bases of antennae below eyes, only slightly constricting head capsule
. . *Toed-winged Beetle, Ptilodactylidae*

These larvae are detritivores, especially of rotting wood and leaf litter in streams, and the adults live in leaf litter in riparian areas.
[M/1/1/C]

Psephenidae adult (18a)



Head of Ptilodactylidae adult showing slight constriction of head capsule at bases of antennae (18b)

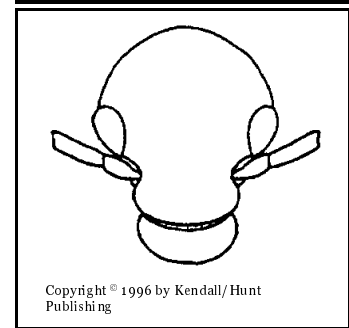


Fig. 18a and 18b - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

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Section 7c

True Fly Larvae (*Diptera*)

Many true fly families have common names. These names are given in the key immediately before the latin name.

- a. Head capsule complete and visible (exception: head capsule in Tipulidae is within thorax and small). Mandibles moving against one another side to side; (used for biting and chewing)
..... suborder **Nematocera**...2

1

- b. Head capsule partially or entirely retracted into thorax and usually small. Mandibles moving up and down and parallel to each other (used for piercing and slashing)
..... suborder **Brachycera**...12

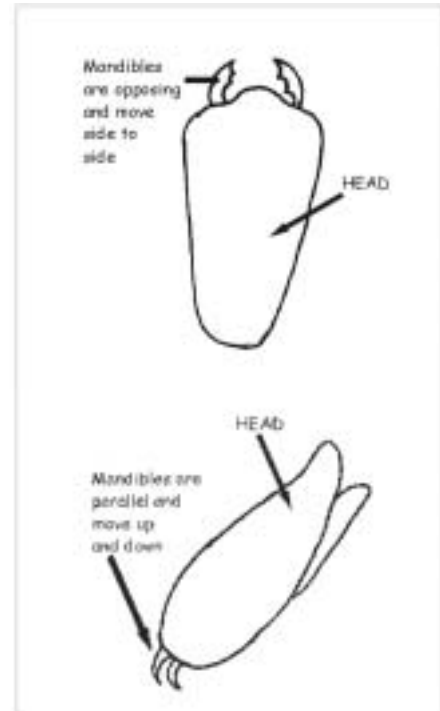
-
- a. Head capsule partially to fully retracted within thorax; anal spiracles (respiratory openings) usually bordered by 1-3 or 5-7 pairs of short lobes that are often fringed with setae (hairs)
..... *Crane Flies, Tipulidae*

2

This is the largest family of flies, though most of the genera are not aquatic. The habitat and feeding habits of aquatic larval Tipulids are diverse, but they commonly burrow in stream sediments. Adult Tipulids are very short lived and resemble large, long-legged mosquitos. [M/13/19/C]

- b. Head capsule complete and visible; anal spiracles without fringed lobes
..... 3
-

Diptera Heads (1a and 1b)



Tipulidae (2a)



- a. Head not distinctly separated from thorax; body flattened and divided into 7 segments; segments 1-6 each with a single suction disk

..... *Net-Winged Midges,*
Blephariceridae

3

The Blephariceridae cling to rocks in flowing water and feed on diatoms and other algae.
 [L/1/1/R]

- b. Head and thorax separated by a constriction; no suction disks
 4

Blephariceridae (3a)



- a. Abdomen ending in a long, slender telescopic (retractile) respiratory tube; abdominal segments 1-3 with small prolegs; body with many ridges or rows of setae

..... *Phantom Crane Flies,*
Ptychopteridae

4

The Ptychopteridae inhabit clumps of detritus in shallow water, extending the breathing tube above the surface. [M/1/3/R]

- b. Not with the above characters
 5

- a. Thoracic segments appear as a single segment, wider than abdominal segments; fan-like tufts of setae on thorax and abdomen and/or fan of setae on last abdominal segment

..... 6

5

- b. Thoracic segments distinguishable and about as wide as abdomen; setae on thoracic and abdominal segments not tufted and anal fan absent

..... 7

- a. Antennae prehensile (grasping) and with long setae; prominent mouth brushes absent
 *Phantom Midges, Chaoboridae*

The Phantom Midges are so-called because they are nearly transparent. They are usually found in lakes and use their antennae to capture prey. [L/1/3/R]

- 6** b. Antennae not prehensile and with short setae; prominent mouth brushes present on either side of labrum (upper lip)
 *Mosquitos, Culicidae*

The Mosquitos have a swollen thoracic section and swim in still water with a flip-flop motion. They obtain oxygen at the water's surface through an abdominal tube. They feed on detritus and microorganisms. [H/7/10/C]

Culicidae (6b)



- a. Pairs of prolegs with crochets (hooks) on 1st and usually 2nd abdominal segments; 2 flattened lobes behind anal spiracles with fringed margins above the hard anal segment with papillae (lobes)
 *Dixid Midges, Dixidae*

- 7** *These midges are found near the surface in still water, where they obtain air through their spiracles. They feed of detritus and microorganisms in the surface film. [M/1/2/R]*

- b. No prolegs on 1st and 2nd abdominal segments; no flattened lobes as above
 8

Dixidae (7a)



- a. First thoracic segment with 1-2 prolegs
 9

- 8** b. First thoracic segment lacking prolegs
 11

- a. Head capsule usually with a pair of folding fans at the upper sides of mouth; abdominal segments 5-8 swollen; last segment with a ring of tiny hooks
 *Black Flies, Simuliidae*

9

Black Flies attach to rocks, wood or vegetation in the bottom of streams. They filter food from the current using their mouth fans. [H/4/8/A]

- b. No folding fans near mouth; abdomen not swollen; no ring of hooks as above
 10

Simuliidae (9a)



- a. Back of all body segments with prominent tubercles (elevated fleshy projections) and/or setae
 *Biting Midges, Ceratopogonidae*
 (in part)

Biting midges, also known as No-See-Ums, typically do not have prolegs and are therefore identified through couplet 11b. Larvae are extremely small, swim like snakes, and are predators. The family is diverse and includes riparian and terrestrial forms. As adults, some will bite people for a blood meal. [M/8/15/C]

Ceratopogonidae (10a)



- 10** b. No prominent tubercle or setae on back of body
 *Midges, Chironomidae*

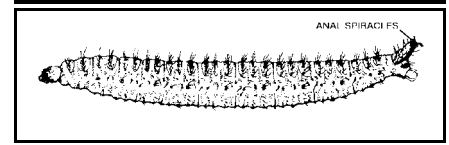
Chironomids are the largest family of aquatic insects. Most have both anterior and posterior pairs of prolegs but are quite diverse in this feature as well as in form and size. Because of the size and diversity of the family, they can be found in almost all aquatic habitats, and some species are highly tolerant of pollution and low levels of oxygen. They are mostly herbivores, detritivores and predators and are also an important food source for fish. [H/86/151/A]

Chironomidae (10b)



- a. All body segments divided into 2-3 sub-segments, some or all with hardened plates on back; dark spots where hardened plates are lacking; anal spiracles on short tube
 **Moth Flies, Psychodidae**

Psychodidae (11a)



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11

The Moth Flies, also called Drain Flies, are found among debris and vegetation in shallow areas of ponds and still margins of streams. They are commonly associated with organically polluted water and can even live in sink and floor drains. They feed on detritus and microorganisms in the surface film. [M/1/4/C]

- b. Body segments not subdivided; surface smooth and white with a few setae on last segment; no anal spiracles but sometimes an anal proleg
 **Biting Midges, Ceratopogonidae**
 (in part)

See comments in couplet 10a above. [M/8/15/C]

- a. Head capsule mostly visible; body somewhat flattened dorsoventrally, skin tough and leathery; usually with distinctive eye bumps; anal spiracles surrounded with long hairs
 **Soldier Flies, Stratiomyidae**

Stratiomyidae (12a)



12

Many Soldier Flies develop in terrestrial habitats, but a few live among vegetation in the shallow margins of lakes. As well as the above characteristics, they are often covered with calcium carbonate crystals. They live just below the water's surface and feed on algae and detritus. [M/1/7/R]

- b. Head capsule mostly internal; body usually cylindrical; no distinctive eye bumps; no long hairs at anal spiracle
 13

Fig. 11a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

- a. Retractable respiratory tube at least half as long as body
 *Flower Flies, Syrphidae*

These dipteran larvae are also called Rat-tailed Maggots. Most of the Syrphidae have prolegs and compared to other Brachycerans, are broader and blunter near the head. They live in shallow and still water, especially where decomposing organic matter is abundant, including in sewage lagoons. Larvae feed on detritus and microorganisms and adults feed on nectar from flowers. [M/1/6/C]

13

- b. No retractable respiratory tube
 14

- a. Anterior spiracles simple, each with 1 to several openings arranged around the end of a short projection; body often flattened and with several tubercles; posterior spiracles on 2 short stalks, each with 2 pairs of openings arranged one behind the other
 **Phoridae**

The Phoridae mostly feed on detritus and microorganisms and live in sediments of lakes and streams. One species is a predator of Psychodidae. They are sometimes found in trickling filter beds of sewage treatment plants. [X/o/1/R]

14

- b. Not with the above combination of characteristics
 15

- a. Body terminating in a short divided tube or in a pair of spines
 *Shore and Brine Flies, Ephydriidae*

The many genera of Ephydriidae are quite diverse in habitat preferences. Most are only semi-aquatic, but the aquatic types live among vegetation and debris in shallow water or in unusual habitats such as ponds containing oil. They feed on algae and detritus. Some have prolegs on the abdomen. [X/X/X/C]

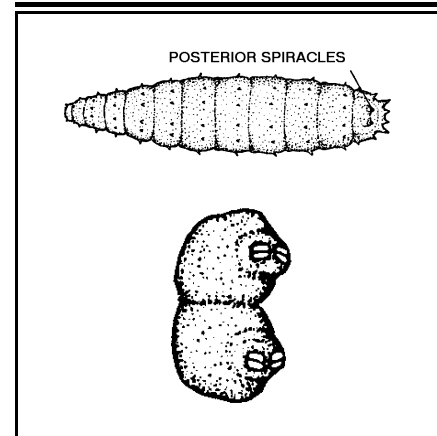
15

- b. Body not terminating in a short divided tube or in a pair of spines
 16

Syrphidae (13a)



Phoridae, showing enlargement of posterior spiracles (14a)



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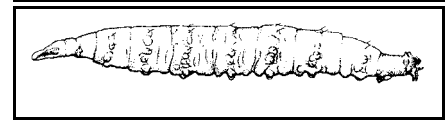
Ephydriidae (15a)



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- a. Posterior spiracular disk with branched hairs and surrounded by 8-10 lobes, some very short; body wrinkled, with segments often covered with short, fine hairs; posterior segment often somewhat tapered
 **Marsh Flies, Sciomyzidae**

Sciomyzidae (16a)



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16 *The Marsh Flies are predators or parasites of snails and clams. They live in still water near their prey. They breathe air through their spiracle at the water surface and swallow an air bubble to keep themselves and their prey floating. [X/X/12/R]*

- b. Posterior spiracular disk without hairs; if surrounded by lobes, body not wrinkled
 17

- a. Abdominal segments 1-7 girdled by 3-4 pairs of creeping welts; spine or vertical bar between posterior spiracles; no other projections from the abdomen
 **Horse and Deer Flies, Tabanidae**

Tabanidae (17a)

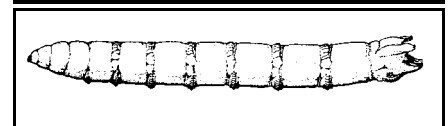


17 *The Tabanidae live in riffles, stream margins, and among vegetation in lakes. They are predators of other macroinvertebrates as larvae and are blood-suckers as adults. [M/2/8/C]*

- b. Distinct prolegs, paired creeping welts paired terminal processes present, but no girdles of creeping welts
 18

- a. Body terminating in a spiracle pit with four pointed lobes
 **Long-Legged Flies, Dolichopodidae**

Dolichopodidae (18a)



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18 *This family is represented by several terrestrial species as well as a few aquatic species. They live in a variety of stream and lake habitats and are predaceous. [M/X/X/C]*

- b. Body not terminating in a spiracle pit with four pointed lobes
 19

Fig. 16a and 18a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

- a. Body terminating in a pair of hairy divergent projections; abdomen with prolegs on 8 abdominal segments
 **Athericidae**

19

The Athericidae are represented by the single genus Atherix in Maryland. They are found in riffles and among vegetation in streams and feed on insect larvae. [L/1/1/R]

- b. Divergent projection absent or not hairy; with or without prolegs
 20

- a. Some external head structure visible, with palpi and antennae usually present; abdomen usually with prolegs and elongate, paired terminal appendages or a swollen segment
 **Dance Flies, Empididae**

20

The aquatic larvae of Dance Flies are small (< 7 mm), predaceous, and live in fast currents of streams. [M/3/7/C]

- b. No visible external head structure; abdomen often with creeping welts and usually short paired terminal appendages
 **Muscidae**

The Muscidae are predators living in streams, marshes and ponds. [M/1/X/C]

Athericidae (19a)



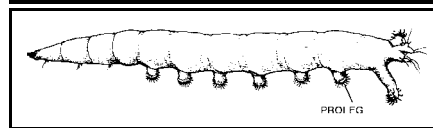
Terminal end of Athericidae (19a)



Terminal end of Empididae (20a)

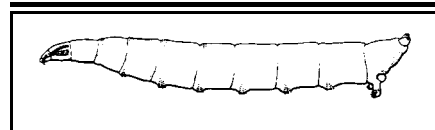


Empididae (20a)



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Muscidae (20b)



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Section 7d

Mayfly Nymphs (*Ephemeroptera*)

Mayfly families do not have widely used common names.

- a. Mandibles have large tusks projecting forward and visible in dorsal view (from the top); fringed gills are lateral and dorsal on abdominal segments 2-7
..... 2

1

- b. Mandibles without projecting tusks; fringed gills absent from segments 2-7 or present but projecting ventrolaterally (below and to the sides)
..... 4
-

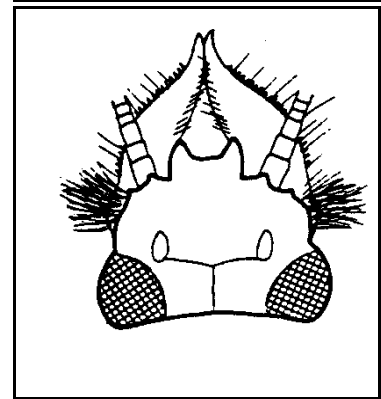
- a. Gills lateral, projecting from sides of abdomen; protibia (forearm of front leg) slender and nearly cylindrical
..... **Potamanthidae**

2

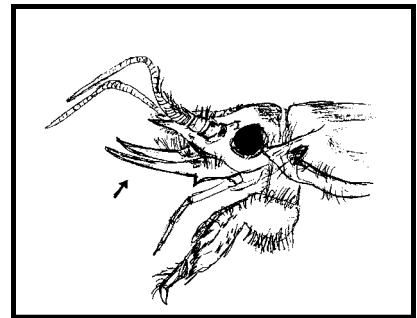
These burrowing nymphs occur in medium to large streams where they most often sprawl on gravel and sand in shallow runs.
[X/1/1/R]

- b. Gills dorsal, curving up over abdomen; protibiae adapted for burrowing
..... 3
-

Tusks projecting from mandibles, dorsal view (1a)



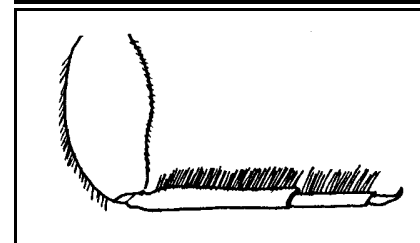
Tusks projecting from mandibles, side view (1a)



Fringed gills on abdominal segments (1a)



Potamanthidae front leg (2a)



- a. Tusks in lateral view curving downward; apex of metatibiae (hindmost forearms) rounded

..... **Polymitarcyidae**

These nymphs filter algae and detritus from the water they circulate through their burrows. They also graze on algae and detritus. They are found in silt, clay, or silt-gravel substrates of medium to large streams or lakes. [X/X/1/R]

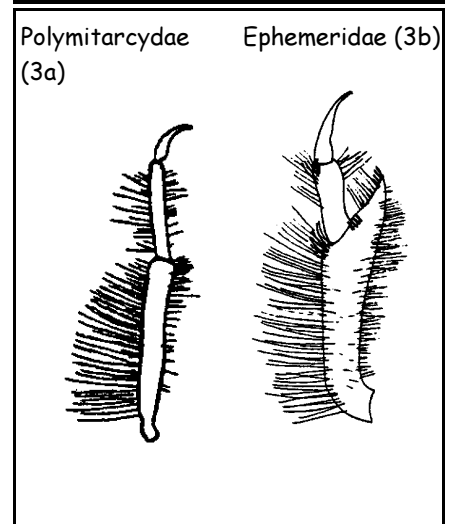
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- b. Tusks in side view curving upward; front end of metatibiae forms an acute point on the lower edge

..... **Ephemeridae**

Ephemeridae inhabit sandy or silty substrates of streams and clean lakes. They filter food from water circulated through their burrows and graze on algae and detritus. [M/2/3/C]

Metatibiae of Polymitarcyidae and Ephemeridae (3a/3b)



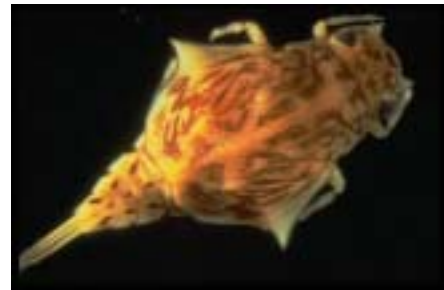
- a. Mesonotum (shield-like dorsal portion of middle thoracic segment) projecting back to cover the gills on abdominal segments 1-6

..... **Baetiscidae**

4

Baetiscidae partially burrow into silty and sandy sediments on the margins of streams and clean lakes. [M/1/1/C]

Baetiscidae (4a)



- b. Mesonotum not projecting backwards, gills exposed
- 5

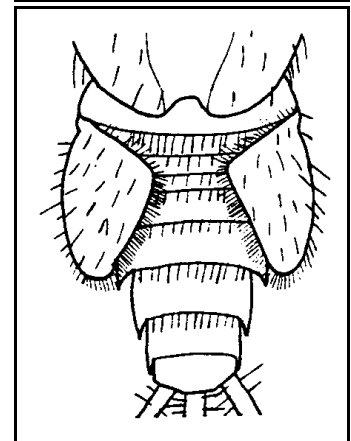
- a. Gills on abdominal segment 2 operculate (covering all or most of the following gills)

..... 6

5

- b. Gills on abdominal segment 2 similar to those on following segments or absent
- 8

Mayfly with operculate gills on 2nd abdominal segment (5a)



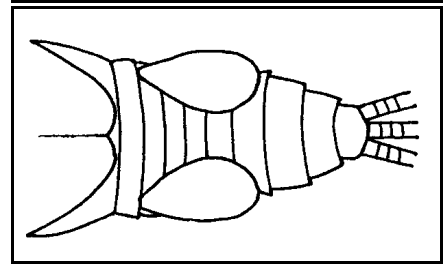
- a. Operculate gills oval or roughly triangular, separated from each other; gills on segments 3-6 without fringed margins
 **Tricorythidae**

6

Nymphs are far ranging and are found in detritus, silt and gravel in streams of all sizes. Some species are tolerant of low dissolved oxygen levels. [X/o/1/R]

- b. Operculate gills rectangular and meeting or overlapping on inside edge; gills on segments 3-6 with fringed margins
 7

Tricorythidae with oval operculate gills (6a)



- a. Operculate gills fused together along inside edge; mesonotum with distinct rounded lobe on anterolateral corners
 **Neophemeridae**

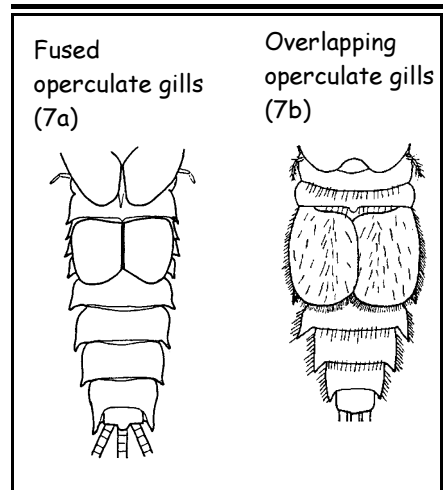
These nymphs are found clinging to vegetation, debris or the underside of rocks in slow to rapid flowing streams. They are more common in southern states. [X/o/1/R]

7

- b. Operculate gills not fused but overlapping on inside edge; mesonotum without anterolateral lobes
 **Caenidae**

In a wide variety of water types, the Caenidae inhabit sediments and are often covered in silt. They are more tolerant of low dissolved oxygen levels than other families. [H/1/2/C]

Operculate gills on Neophemeridae and Caenidae (7a/7b)



- a. Gills on abdominal segment 2 absent, gills may be absent from segments 1 and 3 also, gills on segments 3 or 4 may be operculate; paired tubercles often present on abdominal (dorsal) terga

8

..... **Ephemerellidae**

These nymphs generally inhabit leaf litter or eddies of clean streams. Some are more tolerant and some inhabit lake shores. Most are herbivores and detritivores. [M/5/6/C]

- b. Gills on abdominal segments 1 or 2 to 7
..... 9

Terga of Ephemerellidae (8a)



- a. Head and body flattened top to bottom; eyes and antennae on top of head; mandibles not visible in dorsal view

9

..... **Heptageniidae**

Heptageniidae cling to rocks and woody debris in currents of all types. [M/7/10/A]

- b. Head and body not flattened top to bottom; eyes and usually antennae on sides of head; mandibles visible in dorsal view
..... 10

Heptageniidae (9a)



- a. Claws of front legs noticeably shorter than those of middle and hind legs and bifid

10

..... **Metretopodidae**

These nymphs are found along banks and in vegetation of medium to large streams. They are excellent swimmers. [L/1/2/R]

- b. Claws of all legs similar in length
..... 11



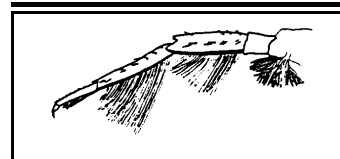
- a. Front femur (upper leg) with a dense row of setae (hairs) along the inner margin

11

..... 12

- b. No dense row of setae on femur
..... 13

Row of dense setae on femur (11a)



- a. Gills on abdominal segment 1 dorsolateral (on top-sides), similar to gills on other segments; nymphs minnow-like
 **Isonychiidae**

Isonychiidae were only recently recognized as distinct from the Oligoneuriidae. Both families filter the water for algae and diatoms with the long setae of their front legs.
 [L/1/X/C]

12

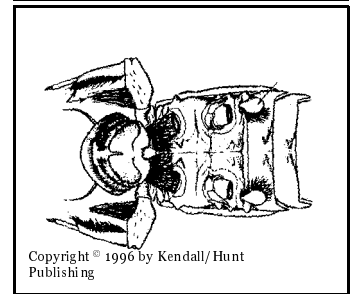
- b. Gills on abdominal segment 1 ventrolateral (on under-side)
 **Oligoneuriidae**

These are more common in southern states and may not occur at all in Maryland.

Isonychiidae (12a)



Oligoneuriidae showing ventrolateral gills (12b)



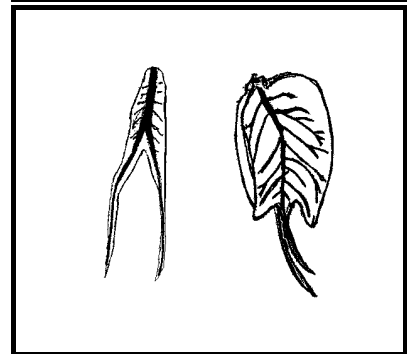
- a. Gills on abdominal segments 2-7 either forked, in tufts, with all margins fringed, or with double layers terminating in points (bilamellate); dense brush of hairs on apicolateral margin of maxillae (outside end of mouthparts behind mandibles)
 **Leptophlebiidae**

These nymphs live in a variety of streams, in slow or fast currents, and on all types of coarser substrates. [M/3/5/C]

13

- b. Gills single or double layers, oval or heart shaped; apicolateral margin of maxillae without dense brush of hairs (though Ameletidae have comb-like spines)
 14

Forked gills (left) Bilamellate gills (right) (13a)



Double layered gills (13b)

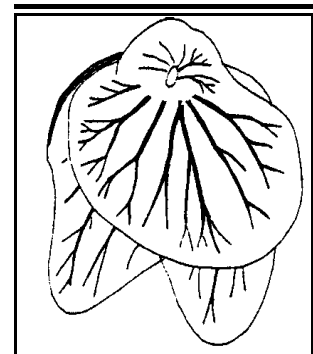


Fig. 12a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright ©1996 by Kendall/Hunt Publishing company. Used with permission.

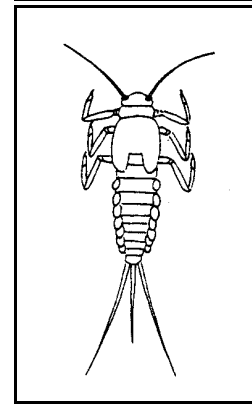
- a. Middle caudal (tail) filament reduced **or** absent **and** antennae more than twice as long as head width
 **Baetidae**

14

The baetids are active swimmers, abundant in streams and lakes. [H/8/8/A]

- b. Middle caudal filament as long as others **and** antennae less than twice width of head
 15

Baetidae (14a)



- a. Maxillae with comb-like spines; oval gills with a hardened band on the edge and usually down the middle
 **Ameletidae**

15

Until recently, the Ameletidae were part of the Siphonuridae family. They are swimmers and clingers found in all types of streams. [L/1/1/R]

- b. Maxillae without comb-like spines; gills variable
 **Siphonuridae**

This family of swimmers and clingers is quite variable in habitat preferences and feeding behavior. [H/1/2/C]

Ameletidae with comb-like spines on maxillae (15a)



Fig. 15a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright ©1996 by Kendall/Hunt Publishing company. Used with permission.

Section 7e

Bugs (*Hemiptera*)

Many families of *Hemiptera* have common names. These names are given in the key immediately before the Latin name.

- 1**
- a. Antennae shorter than head, based under eyes and not visible from above
..... 2

- b. Antennae longer than head, based in front of eyes and visible from above
..... 7

- a. Rostrum (beak) broad and triangular, not distinctly segmented, often with transverse grooves; front tarsi (feet) scoop-shaped, single segment
..... *Water Boatmen, Corixidae*

2

The water boatmen mostly feed on algae, detritus and microorganisms, in contrast to the other Hemipterans, which are predators. They resemble the Notonectidae but are more flattened. Most live in lakes, though they are at times found in the slow water of streams. [M/5/11/C]

- b. Rostrum cylindrical or cone-shaped with 3-4 segments; front tarsi not scoop-shaped
..... 3

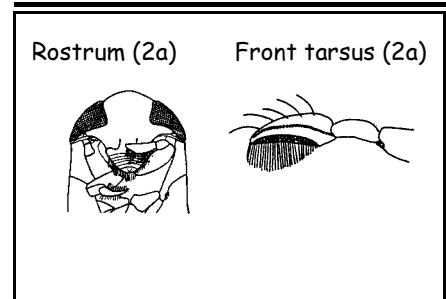
- a. Abdomen with a slender respiratory tube
..... *Water Scorpions, Nepidae*

3

Water scorpions are usually found among vegetation on lake margins. They are poor swimmers but cling to plants as they hunt for invertebrate prey. They breath through the respiratory tube when at the surface and store air beneath the wings while submerged. [M/o/2/C]

- b. Abdominal respiratory tube absent or short and flat
..... 4

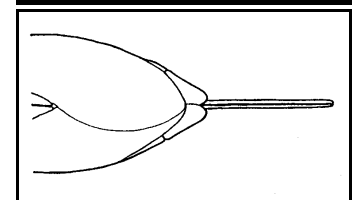
Corixidae showing rostrum and front tarsus (2a)



Corixidae (2a)



Nepidae abdomen with respiratory tube (3a)

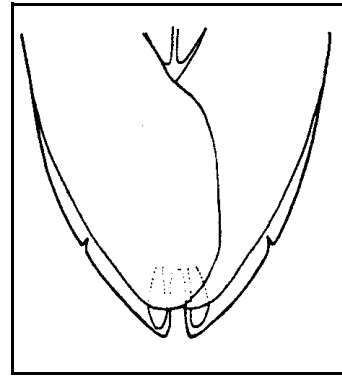


Nepidae (3a)



- a. Body flattened and oval; front upper legs broad
..... 5
- 4** b. Body elongate or hemispherical, not flattened; front upper legs similar to others
..... 6

Belostomatidae, showing respiratory flaps (5a)



- a. Length > 18 mm; short respiratory flaps at end of abdomen; eyes protruding
... *Giant Water Bugs, Belostomatidae*

The giant water bugs are among the largest invertebrate predators, capturing anything they can hold including fish and frogs. They live in lakes and marshes or in other calm and vegetated waterbodies. They sometimes fly towards lights. [H/1/2/C]

- 5** b. Length <16 mm; no respiratory flaps; eyes even with margin of head
... *Creeping Water Bugs, Naucoridae*

The creeping water bugs are more common in the southern states. They usually live in well oxygenated water of streams or small ponds and carry an air bubble under the wings. [M/0/1/C]

Belostomatidae (5a)



Naucoridae (5b)



- a. Body hemispherical; rostrum 3-segmented; length <3 mm
..... *Pigmy Backswimmers, Pleidae*

Pigmy backswimmers have shell-like wings like Beetles. They live in vegetated areas of ponds, lakes, marshes and slow streams. They swim upside-down and crawl on vegetation in search of invertebrate prey. [M/0/1/R]

- 6** b. Body elongate; rostrum 4-segmented; length > 5 mm
..... *Backswimmers, Notonectidae*

Backswimmers swim upside-down but out of the water (during occasional or migratory flight) orient themselves right-side-up. They are found in lakes, ponds and stream pools either near the surface or submerged for long periods. They are predators. [H/1/2/C]

Pleidae (6a)



Notonectidae (6b)



- a. Membrane of wing with 4 or 5 distinct similar cells; hind coxae (base of hind legs) large and broad
 *Shore Bugs, Saldidae*

7

The shore bugs are semi-aquatic, living on margins of streams, lakes and marshes. They are predators. [X/X/X/C]

- b. Membrane of wing lacking distinct similar cells **or** may be wingless; hind coxae small, cylindrical or conical
 8

8

- a. Claws of front tarsi attached along side
 9
- b. Claws of front tarsi attached at tip
 10

- a. Hind femur (upper leg or thigh) long, extending far beyond tip of abdomen
 *Water Striders, Gerridae*

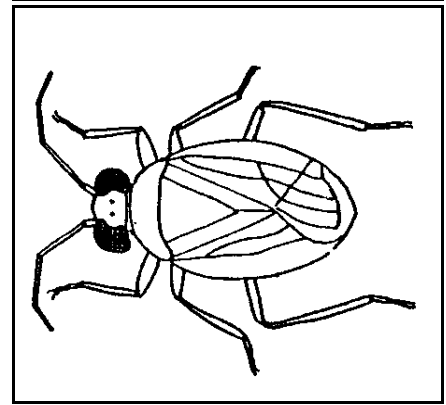
Water striders are large bugs living on any flat-water (no ripples) habitat and are often found among vegetation. They feed on terrestrial insects that are trapped in the surface film or other near-surface invertebrates. Some types lack wings. [X/2/7/C]

9

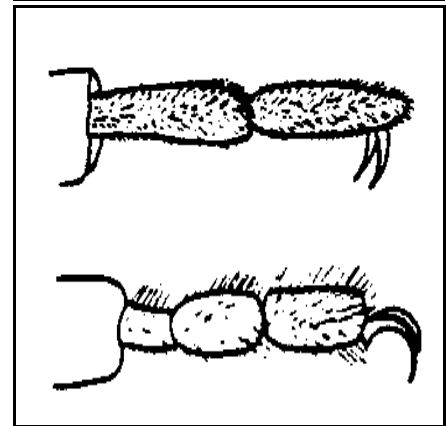
- b. Upper hind leg shorter, extending only to or slightly past tip of abdomen
 *Broad Shouldered Water Striders, Veliidae*

The Veliidae are smaller than the Gerridae and are usually wingless. They live on flat water (no ripples) and are predaceous. [M/1/3/C]

Saldidae (7a)



Front tarsal claws attached along side and at tip (8a/8b)



Veliidae (9b)



Gerridae (9a)





- a. Head as long as entire thorax and slender; eyes about midway on head
 ... *Water Measurers, Hydrometridae*

The water measurers are stick-like and close to 1 cm in length. They walk on vegetation or the water's surface where there are no waves and usually in the absence of fish. They prey on invertebrates in the surface film by spearing them. [M/o/1/C]

10

- b. Head short and stout; eyes at rear of head
 11

- a. Lower part of head grooved to receive rostrum; tarsi 2-segmented; legs without bristles; length < 2.5 mm
 *Velvet Water Bugs, Hebridae*

Velvet water bugs live on calm water or on the moist soil at water's edge. They are slower moving than Veliidae. [X/o/2/R]

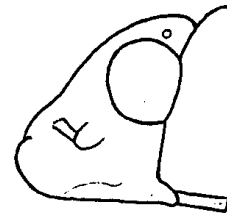
11

- b. Lower part of head not grooved; tarsi 3-segmented; black spines on legs; legs with scattered, stiff, black bristles; length 2-4 mm
 *Water Treaders, Mesoveliidae*

Water treaders live among emergent and floating vegetation on calm water. They are often wingless. They prey on small invertebrates in the surface film. Freezing kills adults and nymphs, so they overwinter as eggs. [X/o/1/R]

Heads of Hebridae and Mesoveliidae (11a/11b)

Hebridae with lower part of head receiving rostrum (11a)



Mesoveliidae with free rostrum (11b)



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Fig. 11a and 11b - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

Section 7f

Aquatic Moth Larvae (Lepidoptera)

Moth families do not have widely used common names.

- a. Thorax and abdomen with filamentous gills **or** case made of leaves or plant material; body with granular surface; crochets (hooks on prolegs) of 2 lengths and arranged in an oval **Pyralidae**

1 Some authors (e.g., Thorp and Covich) state that all truly aquatic Lepidoptera are in this family. They are herbivores; shredding, chewing or mining leaves of aquatic plants and algae. They climb and sometimes swim.

- b. Not with any of the above combinations of characteristics **2**

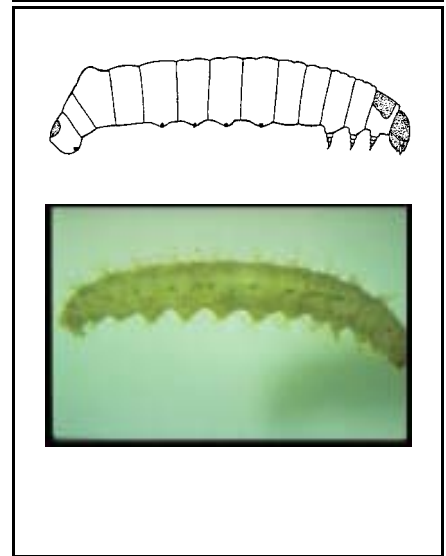
- a. Terminal segment of abdomen with anal fork or comb **or** body covered with tiny spicules (needle-like spines); primary setae short; associated with nutgrass **Tortricidae**

2 The Tortricidae are represented by the single genus *Archips*. They burrow and climb in emergent and floating vegetation of lakes, ponds, and marshes.

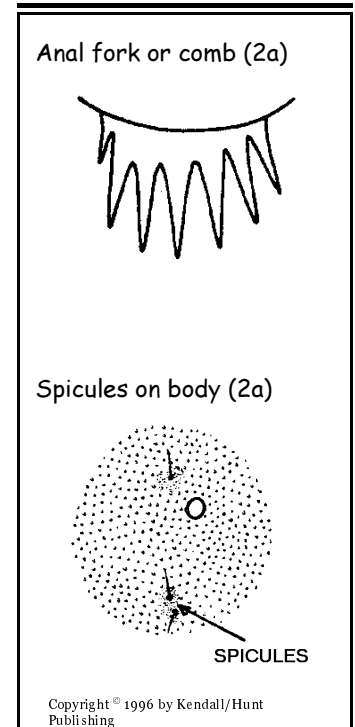
- b. Not with any of the above combinations of characteristics **3**

Fig. 2a - From *An Introduction to Aquatic Insects of North America*, Third Edition by R.W. Merritt and K.W. Cummins. Copyright © 1996 by Kendall/Hunt Publishing company. Used with permission.

Pyralidae (1a)



Characteristics of Tortricidae (2a)



-
- a. Body with prominent verrucae (elevated tufts of setae); head mottled black and white **or** large larvae (50-70 mm at maturity); crochets in a single slightly curved row or in a semi-circle; burrowers in aquatic plant stems

..... **Noctuidae**

The Noctuidae generally live among vegetated margins of lakes, ponds, and marshes.

3

- b. Not with any of the above combinations of characteristics; body smooth, without spicules; primary setae long; crochets in a single circular row; associated with sunflowers and other plants

..... **Cosmopterygidae**

Cosmopterygidae live among vegetation at stream and lake margins, where they burrow into plant parts.

Noctuidae

(3a)



Section 7g

Alderfly and Dobsonfly Larvae (Megaloptera)

Common names are given in the key immediately before the Latin name.

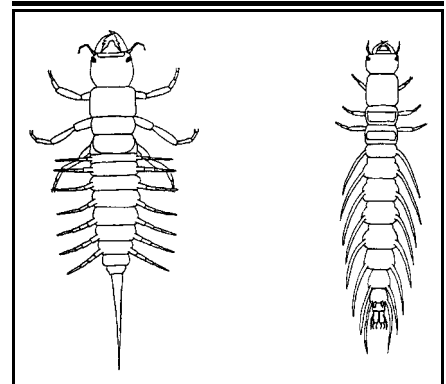
- a. Abdomen with 7 lateral filaments and a single long terminal filament
..... Alderflies, **Sialidae**

The alderflies, represented by a single genus Sialis, do not get as large as Corydalidae. They are mostly found in sediments of cold lakes and streams and are predaceous. [M/1/1/C]

- 1** b. Abdomen with 8 lateral filaments and without a terminal filament; last abdominal segment with 2 clawed prolegs
..... Dobsonflies, **Corydalidae**

In addition to dobsonfly, the Corydalidae are also called fishflies and hellgrammites. They can grow as large as 9 cm. Most live in well oxygenated water of streams and are predaceous. Some live in lakes and feed on detritus as well as living prey. [M/3/4/C]

**Sialidae (left) and
Corydalidae (right) (1a/1b)**



Sialidae (1a)



**Corydalidae larva preying on a stonefly
(Plecoptera) nymph (1b)**



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Section 7h

Dragonfly and Damselfly Nymphs (*Odonata*)

Some families of Odonata have common names. These names are given in the key immediately before the Latin name.

- a. Abdomen terminates in 3 leaf-like gills; body form is usually elongate, 4-5 times longer than wide
.. *Damselflies*, suborder **Zygoptera**...2

At rest, the adults of these insects hold their wings folded against each other behind and above the back. All are predators.

- 1** b. Abdomen terminates in sharp, stiff, pointed spine-like processes; body form is usually rounded or curved on the sides, 1 1/2 - 3 times longer than wide
. *Dragonflies*, suborder **Anisoptera**...4

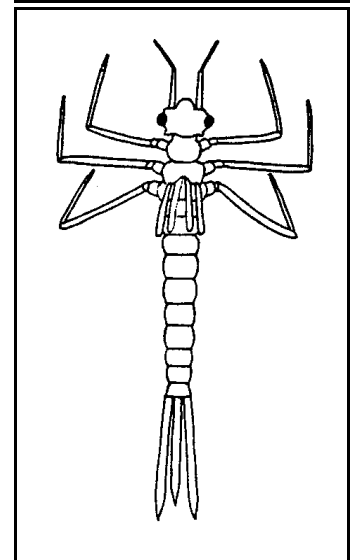
At rest, the adults of these insects hold their wings straight out to the sides of the body. All are predators.

- a. First antennal segment (closest to the head) as long or longer than all other segments combined; prementum (lower part of hinged jaw) with deep median cleft; gills triangular in cross section
..... **Calopterygidae**

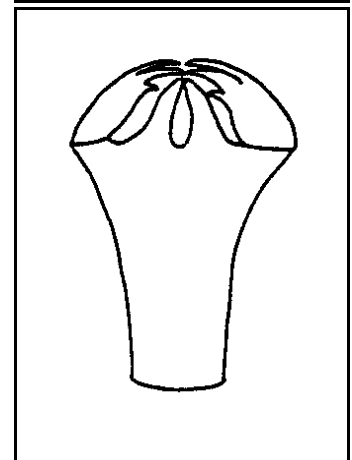
- 2** *The Calopterygidae are found in streams of all sizes, usually among vegetation and debris. [M/1/2/C]*

- b. First antennal segment shorter than other segments combined; prementum barely divided, if at all; gills flat or somewhat plump but not triangular
..... 3
-

Calopterygidae (2a)



Premetum of damselfly nymph (Calopterygidae); view from underside of head (2a)



- a. Prementum narrows abruptly to an elongate basal half; when closed, hinge of prementum is at or behind mesocoxae (base of middle legs)

..... **Lestidae**

Lestidae mostly live among vegetation of lakes and marshes, though they are sometimes found in the slow waters of large streams and rivers. [M/X/2/C]

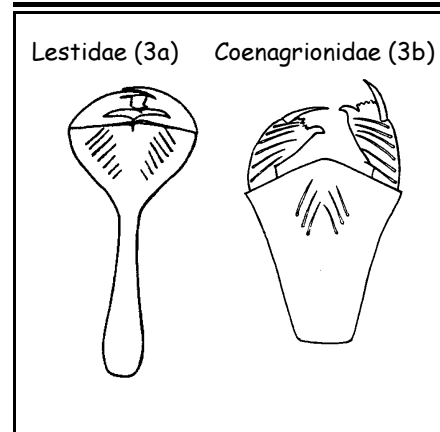
3

- b. Prementum narrows gradually from front to back; hinge of prementum reaches to procoxae (base of front legs) at most

..... **Coenagrionidae**

Coenagrionidae are usually found among vegetation in lakes, ponds, and marshes, though some species are found in streams. They stalk and ambush small invertebrate prey. [H/4/8/C]

Damselfly prementum (3a/3b)



Lestidae (3a)



- a. Prementum nearly flat with no setae (hairs) on inside surface; palpal lobes (pincers) also flat and usually without setae

..... 5

4

- b. Prementum rounded in front of face (spooned shaped) and usually with setae on inside surface; palpal lobes also rounded and always with stout setae

..... 7

Flat prementum (4a)



Spoon shaped prementum (4b)



- a. Antennae with 4 segments (the 4th can be very small); pro- and mesotarsi (front and middle feet) with 2 segments; ligula without a median cleft
 **Gomphidae**

Gomphidae are relatively shorter and broader in the abdomen than Aeshnidae or Petaluridae. They can be found in streams or lakes, where they burrow into sediments to ambush prey. [M/8/9/C]

5

- b. Antennae with 6 or 7 segments; pro- and mesotarsi with 3 segments; ligula with a median cleft
 6

- a. Antennae slender and with few if any hairs
 **Darners, Aeshnidae**

The Aeshnidae are large and elongate compared to other dragonflies. They commonly live among vegetation in lakes, ponds and marshes, though are also found in streams. [M/2/7/C]

6

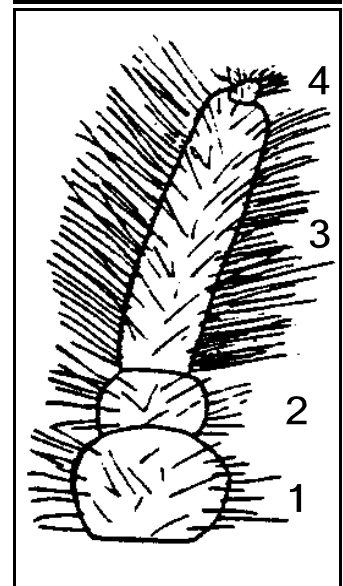
- b. Antennae stout and hairy
 **Petaluridae**

Petaluridae are relatively rare, but can be found in bogs, seeps, and among the mossy margins of cold streams.

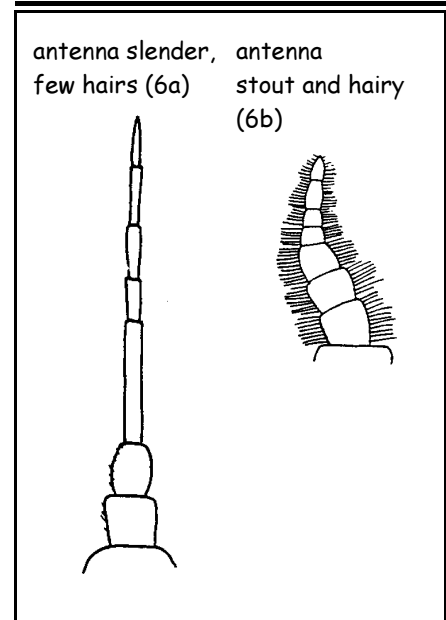
Gomphidae (5a)



Gomphidae antenna with 4 segments (5a)



Antennae of Aeshnidae and Petaluridae (6a/6b)



Aeshnidae (6a)



- a. Palpal lobes with large and irregular teeth; ligula (front and center of prementum) projecting forward and with cleft

..... *Biddies, Flying Adders,*
Cordulegastridae

7

The Cordulegastridae live in small streams where they ambush prey from concealed positions in silt at the upstream edges of pools. [L/1/3/C]

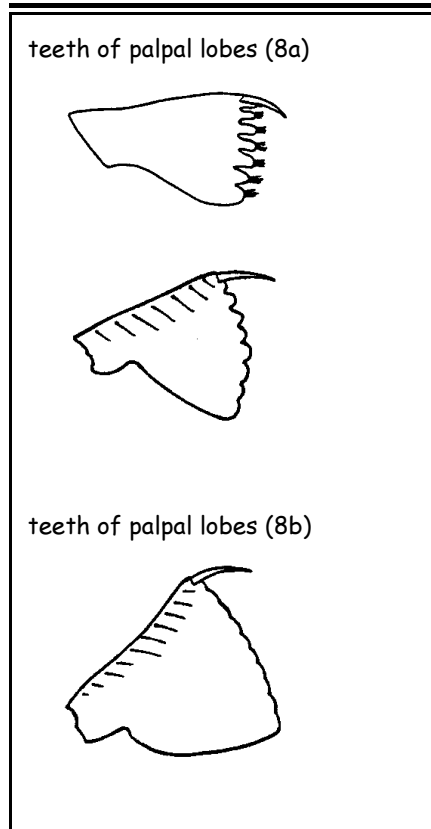
- b. Palpal lobes with small, regularly spaced teeth with setae or nearly flat; ligula not as above

..... **8**

Cordulegastridae palpal lobes with irregular teeth and cleft (7a)



Corduliidae and Libellulidae teeth of palpal lobes (8a/8b)



- a. Teeth of palpal lobes approximately $\frac{1}{4}$ to $\frac{1}{2}$ as high as they are wide (deeply toothed); lateral spines on abdominal segment 8 shorter than overall length of segment 9; dorsal hooks on abdomen often sickle like

..... **Corduliidae***

[L/2/8/C]

- b. Teeth of palpal lobes approximately $\frac{1}{10}$ to $\frac{1}{6}$ as high as they are wide (shallowly toothed); lateral spines on abdominal segment 8 longer than overall length of segment 9

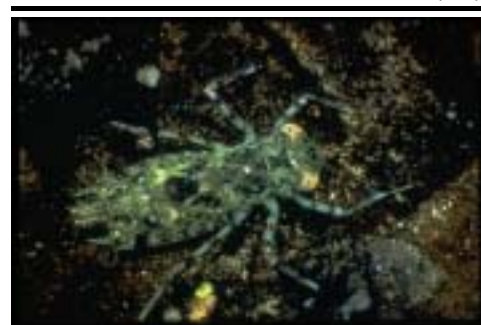
8

..... **Libellulidae***

[H/2/13/C]

** Couplet 8 is an uncertain descriptor, especially in first instar. Some taxonomists use a single family Libellulidae, with subfamilies Corduliinae and Macromiinae. Macromiinae were once considered a separate family distinguishable by long legs and a horn between the eyes. To be confident, list any animal reaching couplet 8 as "Libellulidae and Corduliidae" or identify to genus using a key such as Merritt and Cummins (1996). Within this group, the diversity of habitats and habits is extensive.*

Libellulidae (8b)



Section 7i

Stonefly Nymphs (Plecoptera)

Stonefly families do not have widely used common names.

- 1**
- a. All thoracic segments have conspicuous, branched clusters of gills on sides and venter
..... 2
 - b. Gills on thorax are either absent, unbranched, or only on the prosternum (chest plate closest to the head)
..... 3

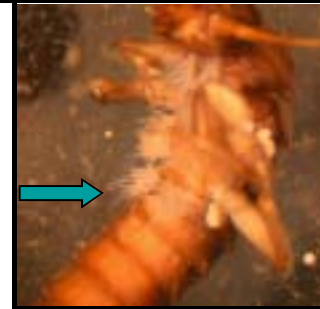
- 2**
- a. Gills on the 1st, 2nd, and sometimes 3rd segment of the abdomen
..... **Pteronarcyidae**

These large stoneflies require 1-4 years to mature, emerging in the spring or early summer. They feed mostly on coarse particulate (organic) matter and inhabit debris in small to medium sized streams. [L/1/1/R]

- b. Gills absent on the visible segments of the abdomen
..... **Perlidae**

Perlidae are relatively large predators, common in streams of all sizes and living within the debris in cool fast riffles. They require 1-3 years for development and emerge in the summer. [L/6/10/C]

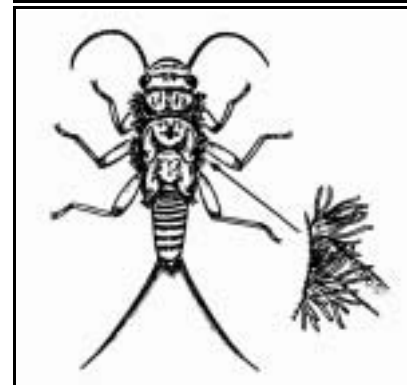
Pteronarcyidae gills on abdomen
(2a)



Pteronarcyidae (2a)



Perlidae (2b)



- a. Thoracic sterna (breastplates) extend back to overlap each following segment; gills at the base of the middle and hind legs are single, double or forked; body form is roach-like, head bent under
 **Peltoperlidae**

3

These distinctively shaped nymphs live in small mountain streams where they feed on decaying leaves, detritus and microorganisms. Most develop in 1-2 years and emerge in late spring or early summer. [L/2/2/R]

Peltoperlidae (3a)



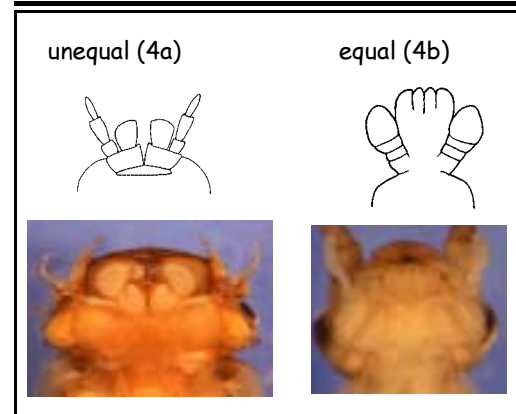
- b. Thoracic sterna are not overlapping; if gills are present at the base of the legs, they are not pointed; body form is not roach-like, head is not bent under
 4

- a. The paraglossae (outer lobes of the labium [lower lip]) extend further forward than the glossae (inner lobes); adapted for predation
 5

4

- b. The paraglossae and glossae are approximately equal in length; adapted for herbivory; scraping or collecting detritus
 6

Two different types of stonefly labium structure (4a/4b)



- a. The cerci (tail filaments) are as long or longer than the abdomen; the hind wing pads diverge from the axis of the body; the head and thorax of mature nymphs are usually patterned
 **Perlodidae**

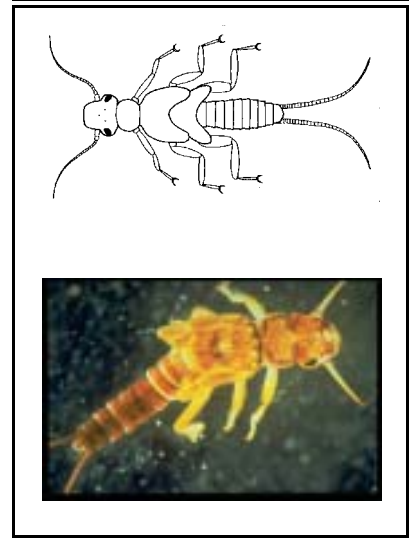
Small to medium sized, the Perlodidae live in all sizes and types of streams. Most are predators at least in later stages of their one year development. They emerge in the spring. [L/5/11/C]

5

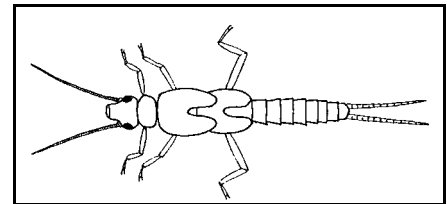
- b. The cerci are shorter than the abdomen, usually $\leq 3/4$ length of abdomen; the hind wing pads are parallel to the body axis; the head and thorax usually have no patterning
 **Chloroperlidae**

The Chloroperlidae are small and predatory in later stages of a one year development. Emerging in late spring and early summer, they inhabit gravel bottoms of cold, small to medium sized streams. [M/4/6/C]

Perlodidae (5a)



Chloroperlidae (5b)



- a. The 2nd tarsal (foot) segment is about as long as the first; gills on the inner coxae (base of the legs) are single and telescoping **or** the last abdominal segment with large ventral triangular plate
 **Taeniopterygidae**

6

Known as a “winter stoneflies”, these small to medium sized nymphs emerge in late winter or very early spring. They crawl slowly but swim efficiently, are herbivores-detritivores, and are frequently found among vegetation in streams of all sizes. [M/3/5/C]

- b. The 2nd tarsal segment is much shorter than the first (wedge shaped); gills on the inner coxae are absent **and** last abdominal segment without a large ventral triangular plate
 7

7

- a. Small, robust body; length < 12 mm; hind legs can extend to or beyond the tip of the abdomen; wing pads are divergent from the body axis; may have cervical gills (just below head on ventral side)
 **Nemouridae**

These stout, small larvae are detrital feeders that live in debris and soft sediments of small streams and spring seeps. They develop in one year, and emerge from spring to autumn depending on the species. [L/6/9/C]

- b. Elongate body; hind legs can not reach to tip of abdomen; wingpads are parallel to the body axis
 8

Taeniopterygidae (6a)



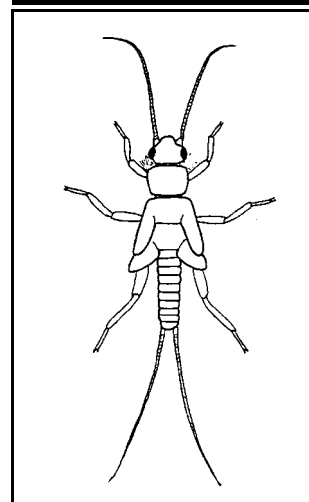
Taeniopterygidae telescoping gills (6a)



Taeniopterygidae triangular plate (6a)



Nemouridae (7a)



Nemouridae 2nd tarsal segment (7a)



Taeniopterygidae 2nd tarsal segment (6a)



- a. Abdominal segments 1-9 divided by a membranous fold at the lower sides; hind wing pads, if present, about the same distance apart as the forward wingpads (and often short and broad); abdominal segments widest at terminal end
 **Capniidae**

A "winter stonefly", the small, elongate nymphs are especially abundant in small streams and spring seeps. They feed on decaying leaves, develop in one year and emerge in the late winter or early spring.
 [L/3/5/C]

8

- b. Abdominal segments 7-9 without a membranous fold at the lower sides; hind wingpads similar in shape to the forward wingpads, but closer together; abdominal segments cylindrical
 **Leuctridae**

Found mostly among gravel in cool, small streams, the Leuctridae feed on decaying leaves. They are small and elongate, develop in one year, and emerge from spring to autumn, depending on the species.
 [L/2/3/C]

Position of membranous folds on abdominal segments of Capniidae and Leuctridae (8a/8b)



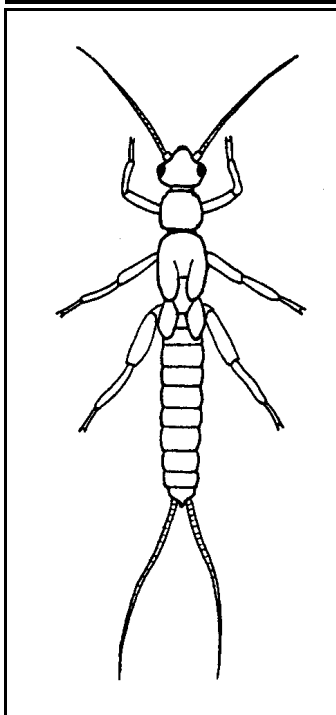
abdominal segments 1-9 divided by membranous fold (8a)



abdominal segments 7-9 without a membranous fold (8b)



Capniidae (8a)



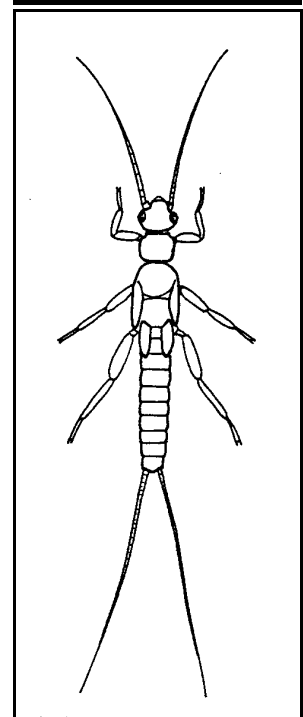
Capniidae (8a)



Leuctridae (8b)



Leuctridae (8b)



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Section 7j

Caddisfly Larvae (Trichoptera)

Caddisfly families do not have widely used common names.

- a. Case spiraled and resembling a snail shell; made up of sand grains or tiny stones
..... **Helicopsychidae**

1

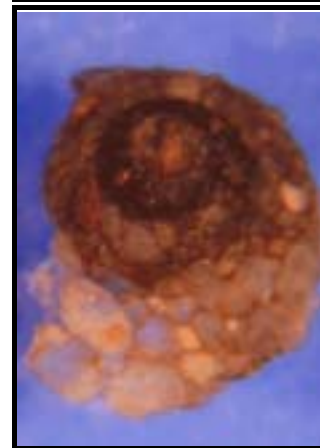
These larvae never abandon their snail-like case. They crawl over rocks, wood, and burrow in sand beds. They can tolerate warm water, develop in a year and emerge throughout the summer. [L/O/1/R]

- b. Case not resembling a snail shell; case made up of varying material (or no case)
..... 2
-

- a. Each thoracic segment covered dorsally with a hardened plate or pair of joined plates (pro, meso and metanotum)
..... 3

- 2** b. Metanotum and often mesonotum (tops of hind and middle thoracic segments) with hairs and scattered small sclerites (hardened plates), but otherwise membranous
..... 4
-

**Helicopsychidae case
(1a)**



3

- a. Branched gills along lower sides of abdomen
..... **Hydropsychidae**

This common, diverse and important family is found in streams of all sizes, currents and temperatures. They are omnivorous, feeding on whatever is caught in their nets. They develop in 1 to 2 years. Some species are quite tolerant of poor conditions. [H/5/8/A]

Hydropsychidae (3a)



- b. No branched gills on abdomen
.... **Micro-caddisflies, Hydroptilidae**

These very small larvae are free-living in their first four instars and build a purse or barrel-shaped case during their last, when their abdomen is relatively enlarged. They feed on algae and other plant material in a variety of habitats. [M/4/12/C]

Hydroptilidae (3b)



4

- a. Antennae very long and prominent (at least 6 times as long as wide) **and/or** sclerites on mesonotum (middle back) lightly pigmented except for a pair of dark curved lines; hind legs longer than others
..... **Leptoceridae**

These larvae are diverse in case construction, habitat and feeding behavior, though they are generally omnivorous. [M/5/7/C]

Leptoceridae case (4a)



- b. Antennae not more than 3 times as long as wide; no sclerotized lines
..... 5

Leptoceridae, lateral view of head showing antennae (4a)

5

- a. Mesonotum and metanotum sparsely sclerotized; sclerites covering less than half of notum, or both entirely membranous
..... 6
- b. Mesonotum mostly covered with sclerites; usually pigmented
..... 12



- 6 a. Abdominal segment 9 with a dorsal (top) sclerite 7
- b. Abdominal segment 9 with dorsum entirely membranous 9

Phryganeidae with prosternal horn (7a)

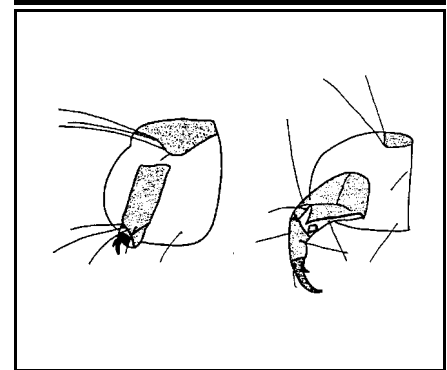


- 7 a. Prosternal (front chest) horn present, though it may be small; metanotal sa3 (3rd setal area, farthest to the sides and slightly forward on notum) with a small sclerite and a cluster of setae (hairs) **Phryganeidae**

These large caddisflies usually have a boldly striped head and distinctive cases of spiral or concentric rings of vegetation. Many are predators living among debris in a variety of waterbody types. [M/1/7/C]

- b. No prosternal horn; metanotal sa3 with a single setae and no sclerite 8

Glossosomatidae (left) and Rhyacophilidae (right), position of anal proleg (8a/8b)



- a. Anal proleg joined with last abdominal segment along about half of its length; claw is small and has at least one hook on top **Glossosomatidae**

Larvae build a turtle-like case and inhabit rocky surfaces in cold, clean streams. They feed on diatoms and algae scraped from the substrate. [L/2/4/C]

- 8 b. Anal proleg mostly free of last abdominal segment; claw not so small and without any hooks on the topside **Rhyacophilidae**

These free-living predatory larvae inhabit cool streams. [L/1/1/C]

Glossosomatidae (8a)



Rhyacophilidae (8b)



- a. Labrum (upper lip) membranous and T-shaped (narrower where it joins the head) often retracted; head without markings

..... **Philopotamidae**

9

Living in silk retreats on the bottom of rocks, these larvae capture algae and detritus in their nets. [L/3/3/C]

- b. Labrum sclerotized and rounded; widest near base

..... 10

- a. Fore trochantins (projections near shoulder of front legs) broad and hatchet shaped

..... **Psychomyiidae**

10

These larvae graze on detritus, fungi and periphyton in the vicinity of their silk retreats.. [L/2/2/C]

- b. Fore trochantins pointed; head usually patterned

..... 11

- a. Tarsi (feet) of all legs wider than tibiae (forearms), flat and hairy; tip of the labium is very long

..... **Dipseudopsidae**

These larvae build tubes in the sand and silt along margins of lakes and streams. They eat detritus caught in the net within the tube. [M/1/1/C]

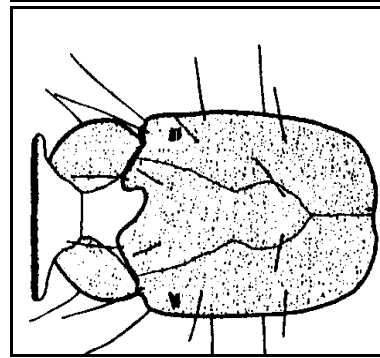
11

- b. Tarsi not as above, not flattened; head usually with muscle scars (darker spots on back and side of head)

..... **Polycentropodidae**

Most species are predators and have tubular retreats. The retreats also aid in respiration, as the larvae undulate their bodies to move water through the tube and past their gills. [M/3/5/C]

Philopotamidae head (9a)



Psychomyiidae foretrochantin (10a)



Dipseudopsidae leg (11a)



Polycentropodidae (11b)



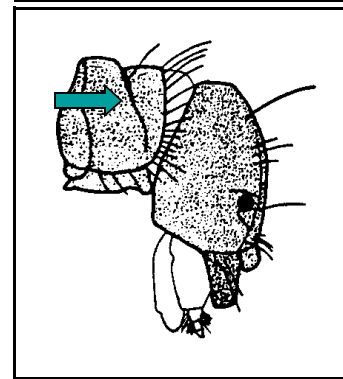
- a. First abdominal segment with no lateral or dorsal humps; prothorax divided by distinct furrow
 **Brachycentridae**

12

Often attaching their cases to moss or vegetation in cold spring-fed streams, these caddisflies graze on periphyton or gather food from the current with their long legs.
 [L/2/3/C]

- b. First abdominal segment with lateral humps on each side, although not always prominent and often a dorsal hump
 13

Brachycentridae, with furrowed thorax (12a)



- a. Claws of hind legs very small compared to those of other legs **or** modified into slender filaments about the same length as tarsus
 **Molannidae**

13

These larvae live in sand and silty sediments in slow currents, feeding on algae, vascular plants and invertebrates. [M/1/1/R]

- b. Claws of hind legs similar in size to other claws
 14

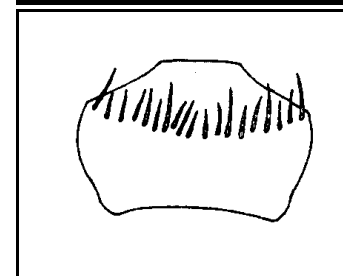
- a. Labrum with a row of 16-18 long setae across central part
 **Calamoceratidae**

14

Cases are made of leaf pieces or hollowed twigs. These larvae are found in pools of cool streams. They can take two years to develop and grow quite large. [L/1/1/R]

- b. Labrum with 6 or less setae across central part
 15

Calamoceratidae labrum with row of 16-18 long setae (14a)



- a. Anal proleg with a lateral sclerite extending posteriorly and bearing a long seta (hair) at the end; inside base of anal claw with a membranous surface and brush of setae
..... **Beraeidae**

15 *Larvae of this family are rare, live in muck margins of spring seeps, and build curved tapered cases of sand. [L/X/1/R]*

- b. Anal proleg not as above; setae may be present on dorsum of proleg but not as a brush on inside base of claw
..... 16

- a. Antennae (small) close to front of head capsule; prosternal horn lacking
..... 17

16 b. Antennae closer to eye or midway between eye and front of head capsule; prosternal horn present, though it may be small 18

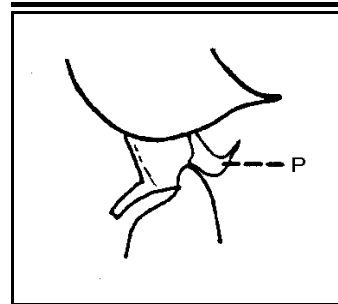
- a. Anal prolegs with about 30 long setae each; protrochantins large and hook-shaped
..... **Sericostomatidae**

These larvae live in horn-shaped cases in the sandy substrates of lakes, streams and spring seeps. They feed primarily on detritus. [L/1/1/R]

17 b. Anal prolegs with about 5 long setae each; protrochantins small and not hook-shaped
..... **Odontoceridae**

Cases of these larvae are horn-shaped and tough. They are found in cold streams and spring seeps, and are omnivorous. [L/1/2/C]

Sericostomatidae
protrochantin (P) (17a)



- a. Antennae very close to eyes; median dorsal hump on 1st abdominal segment lacking
 **Lepidostomatidae**

18

Most members of this family live in cold streams, though some are found in lakes. Larvae are detritivores and are found among detritus over various stream bottom types.
 [L/1/2/C]

- b. Antennae midway between eye and front of head capsule; dorsal hump usually present on 1st abdominal segment
 19

- a. Mesonotum extended forward on both sides, either long and pointed or rounded and spiny
 **Goeridae**

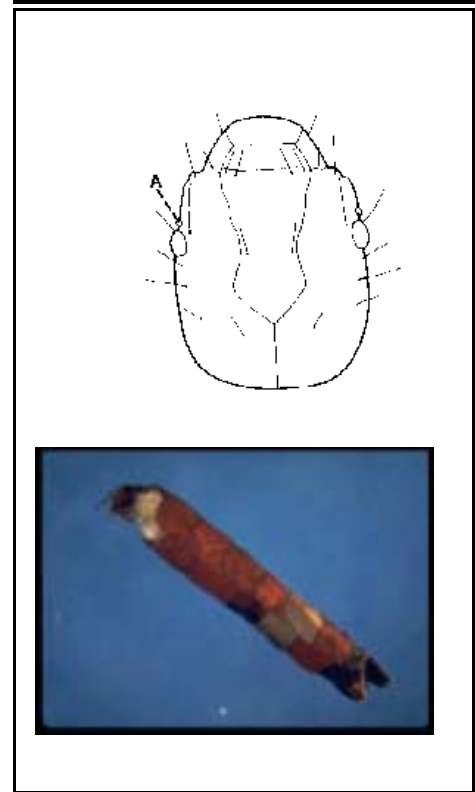
19

Larvae inhabit either cobbles or muck in tube- or horn-shaped cases. They feed on periphyton, vascular plants, and detritus.
 [X/X/2/R]

- b. Mesonotum without extensions as above
 20

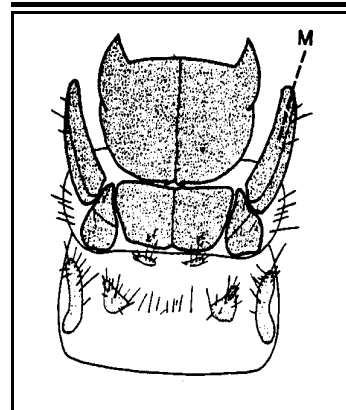
Lepidostomatidae, head showing antenna (A) and animal in case

(18a)



Goeridae thorax with mesonotum (M) extended on both sides

(19a)



- a. Anterior edge of mesonotum is notched at centerline; metanotal sa1 (front and center pair of setal areas on the hind thoracic segment) unsclerotized and with only one or two setae

..... **Uenoidae**

20

These larvae occur in streams and springs, where they feed on detritus, diatoms and algae. Their case is either long or short and horn-shaped. [L/1/1/C]

- b. Anterior edge of mesonotum straight or continuously curved; metanotal sa1 with a sclerotized plate **and/or** more than 2 setae

..... 21

- a. Mesonotum with setal areas on 2 or 3 pairs of sclerites **or** basal seta of each tarsal claw extending far short of tip of claw and mandibles each with two or more teeth

..... **Limnephilidae**

This is a large and diverse family, difficult to characterize as to habitat or case construction. They feed primarily on large particulate organic matter. [L/6/24/C]

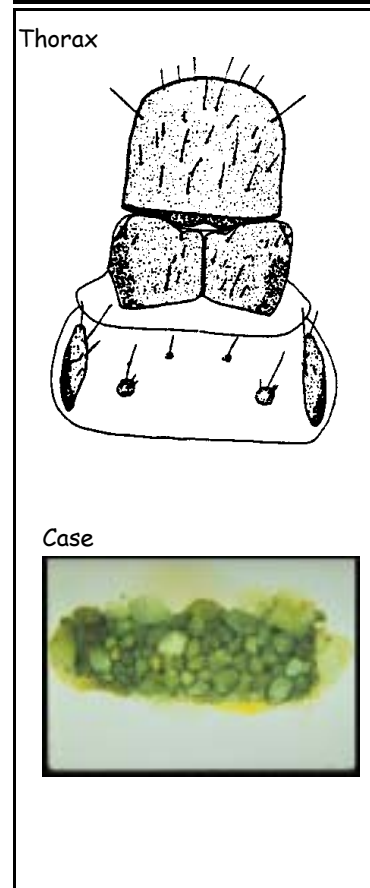
21

- b. Mesonotum with 1 pair of sclerites joining or close along center line; basal seta of each tarsal claw extending to, or close to, tip of claw; mandibles with scraper blades, not teeth

..... **Apataniidae**

These larvae are found in cold mountain streams, spring seeps and cold clean lakes. Their case is tapered and strongly curved. They feed on periphyton and detritus.

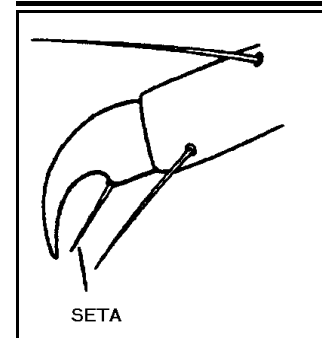
Uenoidae thorax and case (20a)



Limnephilidae with and without case (21a)



Apataniidae basal seta of tarsal claw (21b)



Section 8

Aquatic Worms, Group Descriptions Without Keys

Segmented Worms (Annelida)

Oligochaeta

These rounded and segmented worms are best described by the loose translation of their name; with few (oligo) spines (chaetae).

The body segments behind the first have bundles of chaetae, the number and shape of which are important in identification of the families and genera. Other distinguishing characteristics are quite variable in presence and form among the species. Such characteristics include reproductive organs, body texture, eyespots, gills, and proboscis (or nose).

Oligochaetes are widely distributed and occupy most habitats. Most are quite tolerant of organic enrichment, and one family, the Tubificidae, are commonly referred to as sludge worms. Oligochaetes burrow in sediments or live in constructed tubes. They are detritivores. They are easily distinguished from the insect order Diptera by their lack of a head capsule or hardened head parts.

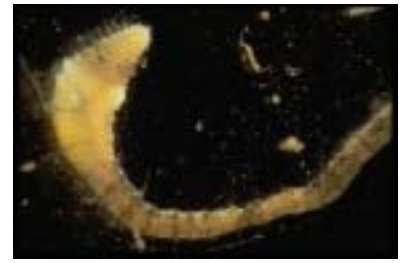
Leeches (Hirudinea)

The leeches are typically known as blood-suckers, though many are predators of macroinvertebrates. All are fluid feeders, and those that ingest macroinvertebrates evacuate the hard parts after extracting the fluids.

The leeches are segmented, lack chaetae, have an oral sucker and usually an anal sucker, and have male and female genital openings one in front of the other central on the underside. Variation in eyespots, body and sucker form, coloration, sub-segmentation, and position of genitalia are used for identification to family and genus.

Leeches are diverse in habitat preference, dependent on host or prey preferences. Predatory leeches are usually nocturnal and opportunistic.

Oligochaeta



Leeches



Roundworms

Nematoda

Nematodes are common in all water types and on many substrates. They are parasitic in invertebrates and plants, burrow, or attach to substrate using a sticky mucous, in which microorganisms are captured as food. The largest nematodes, of the family Mermithidae, are usually collected as adults following development within an invertebrate host. All have a complete intestinal tract except the Mermithidae, in which the intestine becomes detached from the remainder of the alimentary tract.

Nematodes are generally less than 1 cm long. They have a pointed tail section behind the anal pore. The body surface may have lengthwise grooves, hairs, or pocks, but are not segmented like the Annelids. The larger Mermithidae can be distinguished from Nematomorpha by their lack of pigment and fragile body wall.

Horsehair worms (Nematomorpha)

The nematomorphs, or horsehairworms, were once thought to arise from horsehairs that had fallen into water. This was scientifically disproven by Leidy in 1870 when after several months, his horsehairs in water never vivified. They are parasitic on invertebrates until the final adult stage, when they are free living. At this stage, these unsegmented worms are dark, long, thin and are generally rounded at the ends. They are usually several centimeters long.

Flatworms

Turbellarians

The turbellarian flatworms are of the phylum Platyhelminthes. They are classic laboratory specimens (e.g. *Planaria*) and are the subject of regenerative experiments, as any part dismembered will regrow into a whole animal. The most commonly recognized order, the Tricladida, are flat elongate animals with two eyespots on the arrow- or diamond-shaped head.

The flatworms are quite variable and not all are flat. Most have a single opening to the digestive tract (*Phagorata* has more than one opening to the digestive tract), with no distinct anus. Most are less than 1 mm, though the Tricladida are larger. Pigmentation varies.

The group is diverse in habitat preferences and may be found interstitially in gravel, in sand or silt beds, among coarse organic material or on vegetation. Flatworms feed on bacteria, algae, protozoans and invertebrates. Tricladida are mostly predaceous.

Ribbonworms (Nemertea)

Nemerteans are unsegmented worms with a sticky muscular proboscis, or long probe, which is coiled within a cavity connected to the mouth. Through rapid extension and recoiling, this proboscis is used in both predation and locomotion. Unlike turbellarians, nemerteans have an anus. Adults only crawl, while juveniles can also swim.

Little is known of habitat selection by nemerteans, but they have been found in lakes and streams, in muddy and gravelly substrates and in filamentous algae. In the MBSS samples, the genus *Prostoma* of the group Hoplonemertea has been identified.

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Section 9

Glossary

abdomen:	the third main division of the body; behind the head and <i>thorax</i>
accessory flagellum:	a small fingerlike projection or sub-antenna of the antenna, especially of amphipods
anterior:	in front; before
apical:	near or pertaining to the end of any structure, part of the structure that is farthest from the body; distal
apicolateral:	located <i>apically</i> and to the side
basal:	pertaining to the end of any structure that is nearest to the body; proximal
bilobed:	divided into two rounded parts (lobes)
calcareous:	resembling chalk or bone in texture; containing calcium
carapace:	the hardened part of some arthropods that spreads like a shield over several segments of the head and <i>thorax</i>
carinae :	elevated ridges or keels, often on a shell or exoskeleton
caudal filament:	threadlike projection at the end of the abdomen; like a tail
cercus (pl. cerci):	a paired appendage of the last abdominal segment
cleft:	split, partly divided longitudinally
concentric:	a growth pattern on the opercula of some gastropods, marked by a series of circles that lie entirely within each other; compare multi-spiral and pauci-spiral

corneus:	resembling horn in texture, slightly hardened but still pliable
coxa:	the basal segment of an arthropod leg
creeping welt:	a slightly raised, often darkened structure on dipteran larvae
crochet:	a small hook-like organ
cupule:	a cup shaped organ, as on the antennae of some beetles (Coleoptera)
detritus:	disintegrated or broken up mineral or organic material
dextral:	the curvature of a gastropod shell where the opening is visible on the right when the spire is pointed up
distal:	near or toward the free end of any appendage; that part farthest from the body; apical
dorsal:	pertaining to, or situated on the back or top, especially of the thorax and abdomen
dorsolateral:	toward the top and side
elytra:	hardened shell-like mesothoracic wings of adult beetles (Coleoptera)
femur:	the leg section between the tibia and coxa of Arthropoda, comparable to an upper arm or thigh
flagellum:	a small fingerlike or whiplike projection
furcula:	the forked springtail of Collembola
gill:	any structure especially adapted for the exchange of dissolved gases between animal and a surrounding liquid
glossae:	a lobe or lobes front and center on the labium; in Plecoptera, the lobes are between the paraglossae

hemelytra:	the leathery mesothoracic wings of some Hemiptera
labium:	a lower mouthpart of an arthropod like a jaw or lip
labrum:	an upper mouthpart of an arthropod consisting of a single usually hinged plate above the mandibles
lateral:	feature or marking located on the side of a body or other structure
lateral teeth:	ridges on the inside edge of a bivalve shell, near the hinge and to the sides of the beak
ligula:	forming the ventral wall of an arthropod's oral cavity; the "lower lip"
lobe:	a rounded projection or protuberance
mandibles:	the first pair of jaws in insects
maxillae:	the second pair of jaws in insects
mesocoxae:	the basal segments of the middle legs
mesonotum:	the dorsal surface of the <i>mesothorax</i>
mesotarsi:	the <i>tarsus</i> of the middle legs
mesothorax:	the second or middle-section of the thorax bearing the middle legs
metathorax:	the third or hind section of the thorax bearing the hind legs
metatibiae:	hind <i>tibia</i>
molar lobe:	the ridged or roughened grinding surface of the <i>mandible</i>

multi spiral:	a growth pattern on the opercula of some gastropods marked by several turns from the center to the edge; compare pauci-spiral and concentric
notum:	the dorsal surface of any thoracic segment
operculate:	having a lid or cover
operculum:	a lid or covering structure, like a door to an opening
palpal lobes:	the grasping pinchers at the end of the odonate lower jaw
palpus (pl. palpi):	tactile, usually segmented structure on the <i>maxillae</i> and <i>labium</i>
papillae:	fleshy protuberances
paraglossa (pl. paraglossae) :	lateral lobe of the <i>labium</i>
pauci-spiral:	a growth pattern on the opercula of some gastropods marked by few turns from the center to the edge; compare multi-spiral and concentric
periphyton:	algae and associated organisms that live attached to underwater surfaces
procoxae:	the basal segments of the front legs
posterior:	behind; opposite of anterior
prementum:	distal portion of the lower jaw of an odonate
proleg:	any projection appendage that serves for support locomotion or attachment
pronotum:	the upper or top part of the <i>prothorax</i>
protarsus (pl. protarsi):	front foot; occurring on legs arising from first thoracic segment

prostheca:	a <i>mandibular sclerite</i> set with hair
prothorax:	the first <i>thoracic</i> segment closest to the head
protibia (pl. protibiae):	tibia of the foreleg
protrochantin :	on the front leg, a small, forward projecting sclerite on the trochanter (the segment between the coxa and femur)
rostrum:	a beak or beak-like mouthpart
Sa1, sa2, sa3:	the three dorsal areas where setae are located on each side of the two <i>thoracic</i> segments of trichopterans
sclerite:	a hardened area of an insect body wall, usually surrounded by softer membranes
scutellum:	in adult coleopterans and hemipterans, the triangular sclerite between the bases of the <i>elytra</i> or <i>hemelytra</i>
serrated:	sawlike; with notched edges
seta (pl. setae):	hairlike projection
sinistral:	the curvature of a gastropod shell where the opening is seen on the left when the spire is pointed up
spiracle:	an opening to the internal respiratory system usually at the sides or end of the abdomen of insects
sternum (pl. sterna):	the entire <i>ventral</i> portion of a thoracic or abdominal segment
tarsus (pl. tarsi) :	the leg segment or segments at the apex of the <i>tibia</i> usually bearing a claw
telson:	the most <i>posterior</i> segment of a crustacean
tergum:	the dorsal portion of a thoracic or abdominal segment

thoracic:	of or pertaining to the <i>thorax</i>
thorax:	middle portion of the body between the head and abdomen, consisting of three segments (prothorax, mesothorax, and metathorax), each of which bear a pair of articulated legs
tibia:	the segment of an arthropod leg, between the femur and tarsus, comparable to a shin or forearm of human anatomy
tubercles:	small bumps or pimple like structures
venter:	sternum or ventral portion of thorax or abdomen
ventral:	toward the lower surface when the body is in normal walking position; opposite of <i>dorsal</i>
verrucae:	wartlike elevations bearing several to many <i>setae</i> pointing in different directions
ventrolateral:	on the lower surface and to one side of the midline
wingpads:	the developing wing of an immature insect

Section 10

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