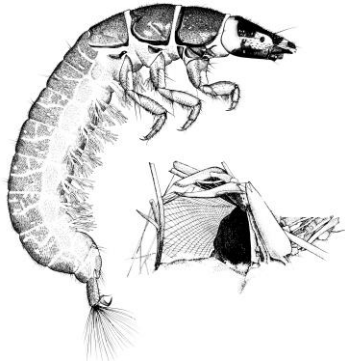
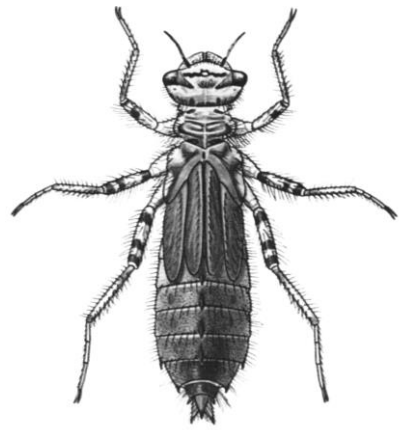
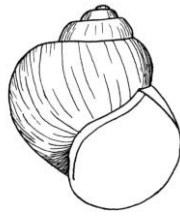
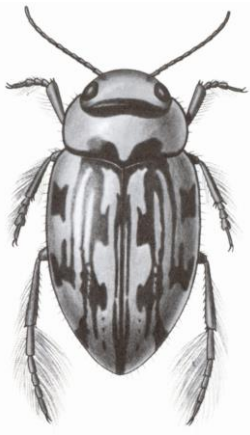
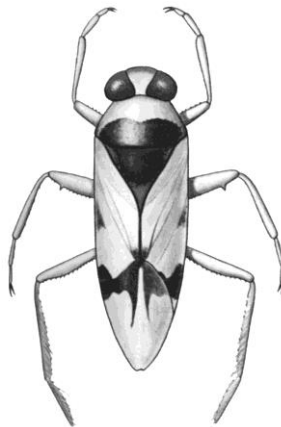
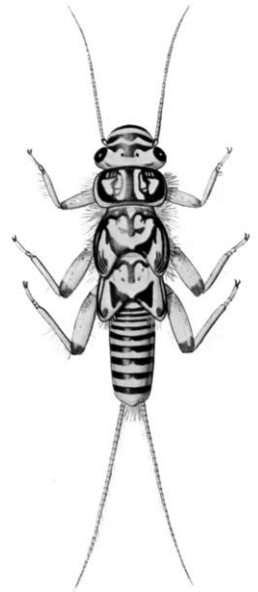
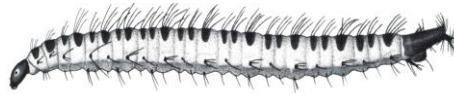
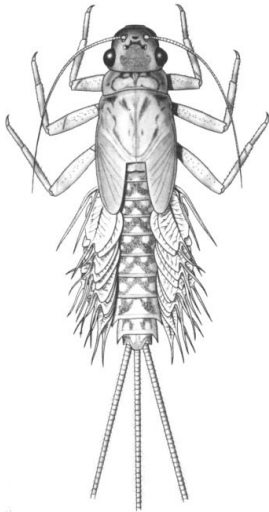


Illustrated Guide to Boreal Shield Invertebrate Benthos



**Cooperative Freshwater Ecology Unit
Vale Living with Lakes Centre, Laurentian University
2014**

Illustrated Guide to Boreal Shield Invertebrate Benthos

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Cooperative Freshwater Ecology Unit

2014

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Pennak, R.W. 1989. Freshwater Invertebrates of the United States, 3rd edition. John Wiley and Sons, Inc., New York. 628 pp.

Figure of caddisfly larva from:

Wiggins, G.B. 1996. Larvae of the North American Caddisfly Genera (Trichoptera), 2nd edition. University of Toronto Press, Toronto, Ontario. 457 pp.

Figure of springtail from:

Merritt, R.W. and K.W. Cummins (eds.) 1996. An Introduction to the Aquatic Insects of North America, 3rd edition. Kendall/Hunt Publ. Co., Dubuque, Iowa. 862 pp.

Figures of adult beetle, dragonfly nymph, fly larva, mayfly nymph, stonefly nymph, and true water bug from:

McCafferty, W.P. 1998. Aquatic Entomology: The Fishermen's and Ecologists' Illustrated Guide to Insects and their Relatives. Jones and Bartlett Publishers, Sudbury, Massachusetts. 448 pp.

Acknowledgements

We would like to thank Kim Fram for providing invaluable input into key taxonomic features. Thanks also go to Karen Oman for her instruction in the use of her scanner and for making her work station available to us on numerous occasions. Chris Jones of the Dorset Environmental Science Centre provided detailed input on the draft copy for which we are very appreciative.

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Section 1. Introduction

The field of freshwater benthic taxonomy is vast and complex. The purpose of this Guide is therefore restricted to outlining key identification features for all benthic invertebrate families collected during the sampling effort for the Freshwater Invertebrate Research Network of Northern Ontario (FIRNNO; see details below). Figures accompany the descriptions in order to facilitate the task for novices to the field. However, it should be noted that benthic families tend to be comprised of numerous species having different body forms. Therefore, not all figures will be applicable to the organisms being identified although the key features will relate to most members within each family.

Identification keys should always form the basis for any identification efforts (see Section 3 for a list of excellent texts). This Guide serves as a companion to these and is specific to benthos found on the Boreal Shield. The reader should be aware that other families, not included in this paper, may be found in their samples. Another important point is that most keys relate to mature larvae/nymphs/adults. If an immature organism or one in the midst of metamorphosis is encountered, the identification keys and this Guide will probably be of little use. Lastly, identification may not be possible if specimens are missing key taxonomic features. For example, mayfly gills are fragile in some groups and are easily lost.

Also note that other invertebrates are commonly found in these types of samples but are not classified as “benthos” or they otherwise don’t meet the FIRNNO criteria for inclusion in the counts. Some of these can be seen in the Appendix to this paper. Included are terrestrial organisms (e.g. aphids) and others not targeted by the sampling method described below (Reynoldson et al., 1999).

The scope of this Guide is specific to those benthos encountered by the Cooperative Freshwater Ecology Unit (CFEU) throughout the Boreal Shield during the FIRNNO project. Sampling was done during the fall months since 2003. See the map on the following page for the locations of all sampling sites. The families within the CFEU benthos reference collection were all verified by Craig Logan, Aquatic Invertebrate Taxonomist for the National Water Research Institute of Environment Canada (Burlington, Ontario).

As per Reynoldson et al. (2005), benthic invertebrates were collected using a travelling kick-and-sweep technique. The substrate was kicked to disturb and dislodge the surface sediment which was swept up with a standard kick net with 500 µm mesh. Stream invertebrate sampling was conducted according to Environment Canada’s CABIN protocols (Reynoldson et al., 1999). The collector zigzagged from bank to bank for 3 minutes. Lake sampling methods were similar to procedures outlined in David et al. (1998) with a few modifications. Benthic invertebrates were collected for approximately 10 minutes at each site along a varying number of transects (0-1 m depth) aligned perpendicular to shore and located 2 m apart.

Most of the major benthic invertebrate groups have been included in this Guide, with two notable exceptions. The aquatic worms and aquatic mites were intentionally omitted. In order to identify these organisms to the family level, high powered magnifications are required to which novices may not have access. Also, the worm taxonomy is quite involved and not easily mastered without detailed keys and the guidance of an experienced taxonomist. If the identification of these groups is required, the reader is referred to texts by Kathman and Brinkhurst (1998) for the worms and Peckarsky et al. (1990) for the mites.



Section 2. Benthos classification

This general taxonomic scheme only makes mention of those orders containing families found during the FIRNNO sampling done between 2003 and 2013 by the CFEU. It is largely based upon the classification outlined in the Integrated Taxonomic Information System (ITIS), found online at: <https://www.itis.gov/>. The first part of this classification scheme is complete down to the Order level. Between Order and Family levels there are other levels of classification which exist in several cases (i.e. Suborder, Infraorder, and Superfamily) but are not specified here. The groups which are in bold have their own separate sections within this paper.

Kingdom Animalia

A. Phylum Arthropoda

a) Subphylum Hexapoda

1. Class Insecta

1) Subclass Pterygota

(1) Infraclass Neoptera

- **Order Coleoptera**

- **Order Diptera**

* - **Order Heteroptera**

- **Order Lepidoptera**

- **Order Plecoptera**

- **Order Trichoptera**

i. Superorder Neuropterida

- **Order Megaloptera**

- **Order Neuroptera**

2. Class Entognatha

- **Order Collembola**

b) Subphylum Crustacea

1. Class Malacostraca

1) Subclass Eumalacostraca

(1) Superorder Peracarida

- **Order Amphipoda**

- **Order Isopoda**

(2) Superorder Eucarida

- **Order Decapoda**

B. Phylum Mollusca

a) Class Bivalvia

1. Subclass Heterodonta

- Order Veneroida

2. Subclass Palaeoheterodonta

- Order Unionoida

b) Class Gastropoda

- Order Basommatophora

- Order Heterostropha

- Order Neotaenioglossa

C. Phylum Annelida

a) Class Clitellata

1. Subclass Hirudinea

1) Infraclass Euhirudinea

- Order Arhynchobdellida

- Order Rhynchobdellida

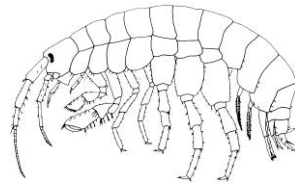
1. Order Amphipoda (scuds) → 3 local families

[figure from Peckarsky et al. (1990)]

Family Crangonyctidae

Family Gammaridae

*Family Hyallellidae (=Talitridae)



2. Order Coleoptera (aquatic beetles) → 10 local families

[figures from McCafferty (1998)]

Family Chrysomelidae

Family Curculionidae

Family Dryopidae

Family Dytiscidae

Family Elmidae

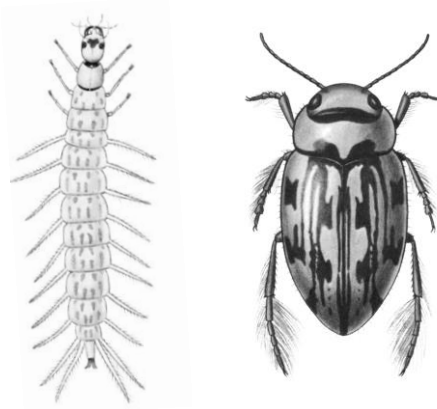
Family Gyrinidae

Family Haliplidae

Family Hydraenidae

Family Hydrophilidae

Family Psephenidae



3. Order Collembola (springtails) → 6 local families

[figure from McCafferty (1998)]

Family Entomobryidae

Family Hypogastruridae

Family Isotomidae

Family Onychiuridae

Family Poduridae

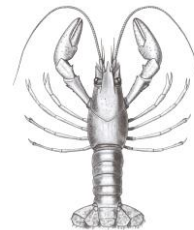
Family Sminthuridae



4. Order Decapoda (crayfish) → 1 local family

[figure from McCafferty (1998)]

Family Cambaridae



5. Order Diptera (fly larvae) → 16 local families

[figures from Merritt and Cummins (1996)]

Family Athericidae

Family Ceratopogonidae

Family Chironomidae

Family Culicidae

Family Dixidae

Family Dolichopodidae

Family Empididae

Family Ephydriidae

Family Muscidae

Family Phoridae

Family Psychodidae

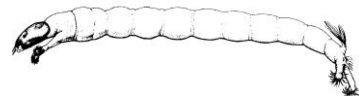
Family Sciomyzidae

Family Simuliidae

Family Stratiomyidae

Family Tabanidae

Family Tipulidae



6. Order Ephemeroptera (mayfly nymphs) → 11 local families

[figures from McCafferty (1998)]

Family Baetidae

Family Baetiscidae

Family Caenidae

Family Ephemerellidae

Family Ephemeridae

Family Heptageniidae

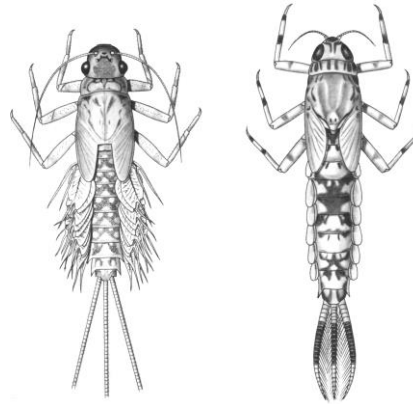
*Family Isonychiidae (=Oligoneuriidae)

*Family Leptohyphidae (=Tricorythidae)

Family Leptophlebiidae

Family Metretopodidae

Family Siphonuridae



7. *Order Heteroptera (=Hemiptera) (true water bugs) → 5 local families

[figure from McCafferty (1998)]

Family Belostomatidae

Family Corixidae

Family Gerridae

Family Nepidae

Family Notonectidae



8. Subclass Hirudinea (leeches) → 2 local families

[figure from Peckarsky et al. (1990)]

A. Order Arhynchobdellida

Family Erpobdellidae

B. Order Rhynchobdellida

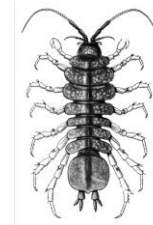
Family Glossiphoniidae



9. Order Isopoda (sowbugs) → 1 local family

[figure from McCafferty (1998)]

Family Asellidae



10. Order Lepidoptera (aquatic caterpillars) → 1 local family

[figure from McCafferty (1998)]

Family Pyralidae



11. Order Megaloptera (alderfly and dobsonfly larvae) → 2 local families

[figure from McCafferty (1998)]

Family Corydalidae

Family Sialidae



12. Phylum Mollusca (snails and clams) → 8 local families

[figures from Pennak (1989)]

A. Class Bivalvia (clams)

1) Order Veneroida

**Family Sphaeriidae (=Pisidiidae)*

2) Order Unionida

Family Unionidae

B. Class Gastropoda (snails)

1) Order Basommatophora

Family Ancyliidae

Family Lymnaeidae

Family Physidae

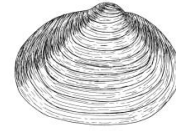
Family Planorbidae

2) Order Heterostropha

Family Valvatidae

3) Order Neotaenioglossa

Family Hydrobiidae



13. Order Neuroptera (spongilla fly larvae) → 1 local family

[figure from McCafferty (1998)]

Family Sisyridae

14. Order Odonata (dragonfly and damselfly nymphs) → 8 local families

[figures from McCafferty (1998)]

A. Dragonfly nymphs (Suborder Anisoptera)

Family Aeshnidae

Family Cordulegastridae

Family Corduliidae

Family Gomphidae

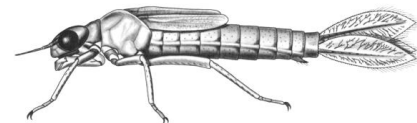
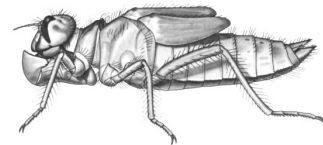
Family Libellulidae

**Family Macromiidae*

B. Damselfly nymphs (Suborder Zygoptera)

Family Calopterygidae

Family Coenagrionidae



15. Order Plecoptera (stonefly nymphs) → 8 local families

[figure from McCafferty (1998)]

Family Capniidae

Family Chloroperlidae

Family Leuctridae

Family Nemouridae

Family Perlidae

Family Perlodidae

Family Pteronarcyidae

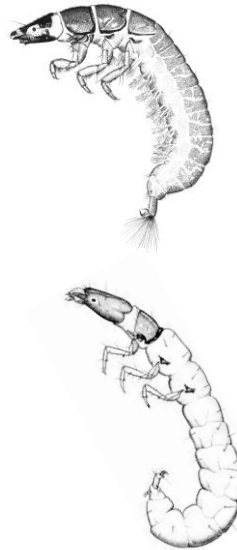
Family Taeniopterygidae



16. Order Trichoptera (caddisfly larvae) → 15 local families

[figures from Wiggins (1996)]

Family Brachycentridae
Family Glossosomatidae
Family Helicopsychidae
Family Hydropsychidae
Family Hydroptilidae
Family Lepidostomatidae
Family Leptoceridae
Family Limnephilidae
Family Molannidae
Family Odontoceridae
Family Philopotamidae
Family Phryganeidae
Family Polycentropodidae
Family Psychomiidae
Family Rhyacophilidae



**Note: Those groups which are italicized in the preceding classification scheme were modified to reflect recent taxonomic changes, as per Reynoldson et al. (1999)*

Section 3. References commonly used to identify invertebrate benthos

General:

- McCafferty, W.P. 1998. Aquatic Entomology: The Fishermen's and Ecologists' Illustrated Guide to Insects and their Relatives. Jones and Bartlett Publishers, Sudbury, Massachusetts. 448 pp.
- Merritt, R.W. and K.W. Cummins (eds.) 1996. An Introduction to the Aquatic Insects of North America, 3rd edition. Kendall/Hunt Publ. Co., Dubuque, Iowa. 862 pp.
- Peckarsky, B.L., Fraissinet, P.R., Penton, M.A. and D.J. Conklin, Jr. 1990. Freshwater Macroinvertebrates of Northeastern North America. Cornell University Press, Ithaca, New York. 442 pp.
- Pennak, R.W. 1978. Freshwater Invertebrates of the United States, 2nd edition. John Wiley and Sons, Inc., New York. 803 pp.
- Thorp, J.H. and A.P. Covich. 2001. Ecology and Classification of North American Freshwater Invertebrates, 2nd edition. Academic Press, Inc., San Diego, California. 911 pp.

Specialized books for more detailed identification of individual families:

- Clarke, A.H. 1981. The Freshwater Molluscs of Canada. National Museum of Natural Sciences, Ottawa, Ontario. 446 pp.
- Cook, D.R. 1974. Water mite genera and subgenera. Mem. Amer. Entomol. Inst. 21: 1-860.
- Edmunds, G.F., Jr., Jensen, S.L. and L. Berner. 1976. The mayflies of North and Central America. Univ. Minn. Press, Minneapolis. 330 pp.
- Kathman, R.D. and R.O. Brinkhurst. 1998. Guide to the Freshwater Oligochaetes of North America. Aquatic Resources Center, College Grove, Tennessee. 264 pp.
- McAlpine, J.F., Peterson, B.V., Shewell, G.E, Teskey, H.J., Vockeroth, J.R. and D.M. Wood. 1981. Manual of Nearctic Diptera, Volume 1. Biosystematics Research Centre, Ottawa, Ontario. 674 pp.
- McAlpine, J.F., Peterson, B.V., Shewell, G.E, Teskey, H.J., Vockeroth, J.R. and D.M. Wood. 1987. Manual of Nearctic Diptera, Volume 2. Biosystematics Research Centre, Ottawa, Ontario. 1332 pp.
- Needham, J.G., Westfall, M.J. and M.L. May. 2000. Dragonflies of North America. Scientific Publishers, Inc., Gainesville, Florida. 940 pp.
- Stewart, K.W., Stark, B.P. and J.A. Stanger (Illustrator). 2002. Nymphs of North American Stonefly Genera (Plecoptera), 2nd edition. The Caddis Press, Columbus, Ohio. 510 pp.
- Westfall, M.J., Jr. and M.J. May. 1996. Damselflies of North America. Scientific Publishers, Inc., Gainesville, Florida. 650 pp.
- Wiggins, G.B. 1996. Larvae of the North American Caddisfly Genera (Trichoptera), 2nd edition. University of Toronto Press, Toronto, Ontario. 457 pp.

Section 4. Order Amphipoda (scuds) → 3 local families

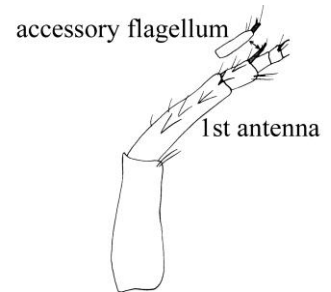
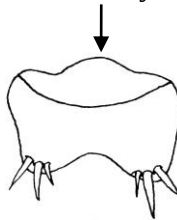
[unless otherwise specified, details and figures from Pennak (1989)]

Key features:

- laterally compressed bodies
- thorax possesses 7 pairs of legs
- first 2 pairs of legs are modified for grasping

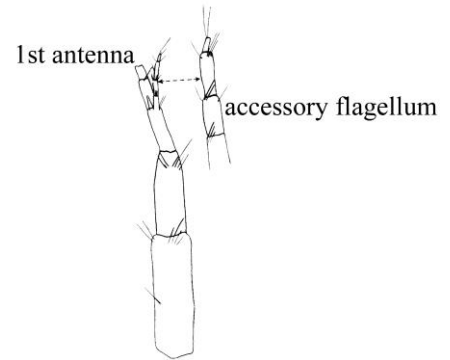
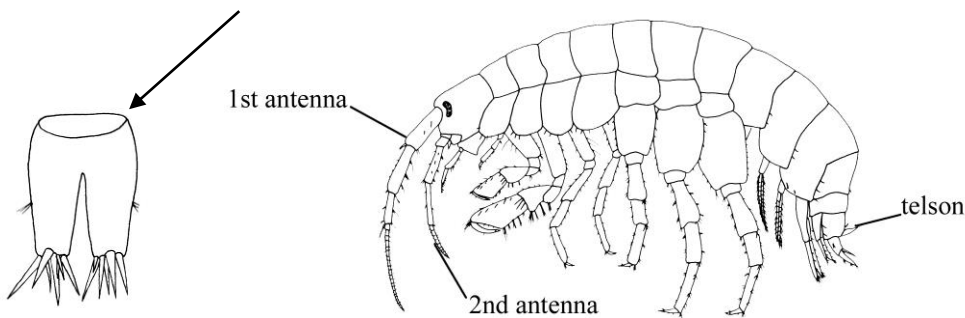
Family Crangonyctidae:

- medium to large body size (up to 22 mm long)
- 1st antennae longer than 2nd antennae (see body figure of Gammaridae)
- 1st antennae with accessory flagellum
- accessory flagellum of 1st antennae never with more than 2 segments
- telson cleft or not; if cleft then no more than $\frac{3}{4}$ way to base [detail from Peckarsky et al. (1990)]



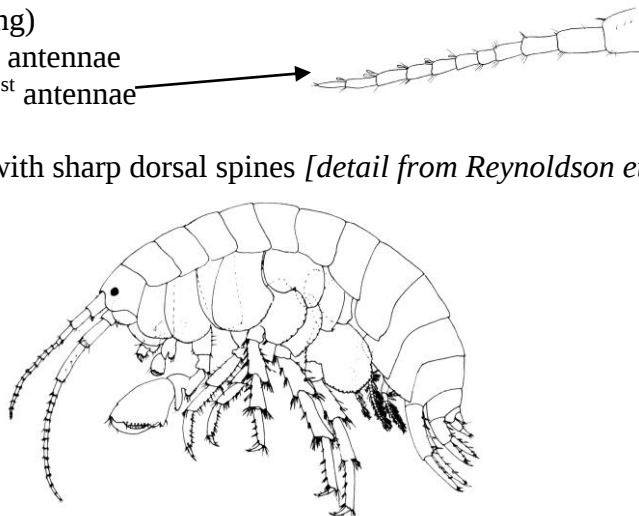
Family Gammaridae [figure of body from Peckarsky et al. (1990)]:

- large body size (up to 25 mm long)
- 1st antennae longer than 2nd antenna
- 1st antennae with accessory flagellum
- accessory flagellum of 1st antennae with 3-7 segments
- telson cleft, nearly to base [detail from Peckarsky et al. (1990)]



Family Hyallellidae (=Talitridae):

- small body size (4-8 mm long)
- 1st antennae shorter than 2nd antennae
- no accessory flagellum on 1st antennae
- telson is entire (not cleft)
- some abdominal segments with sharp dorsal spines [detail from Reynoldson et al. (1999)]

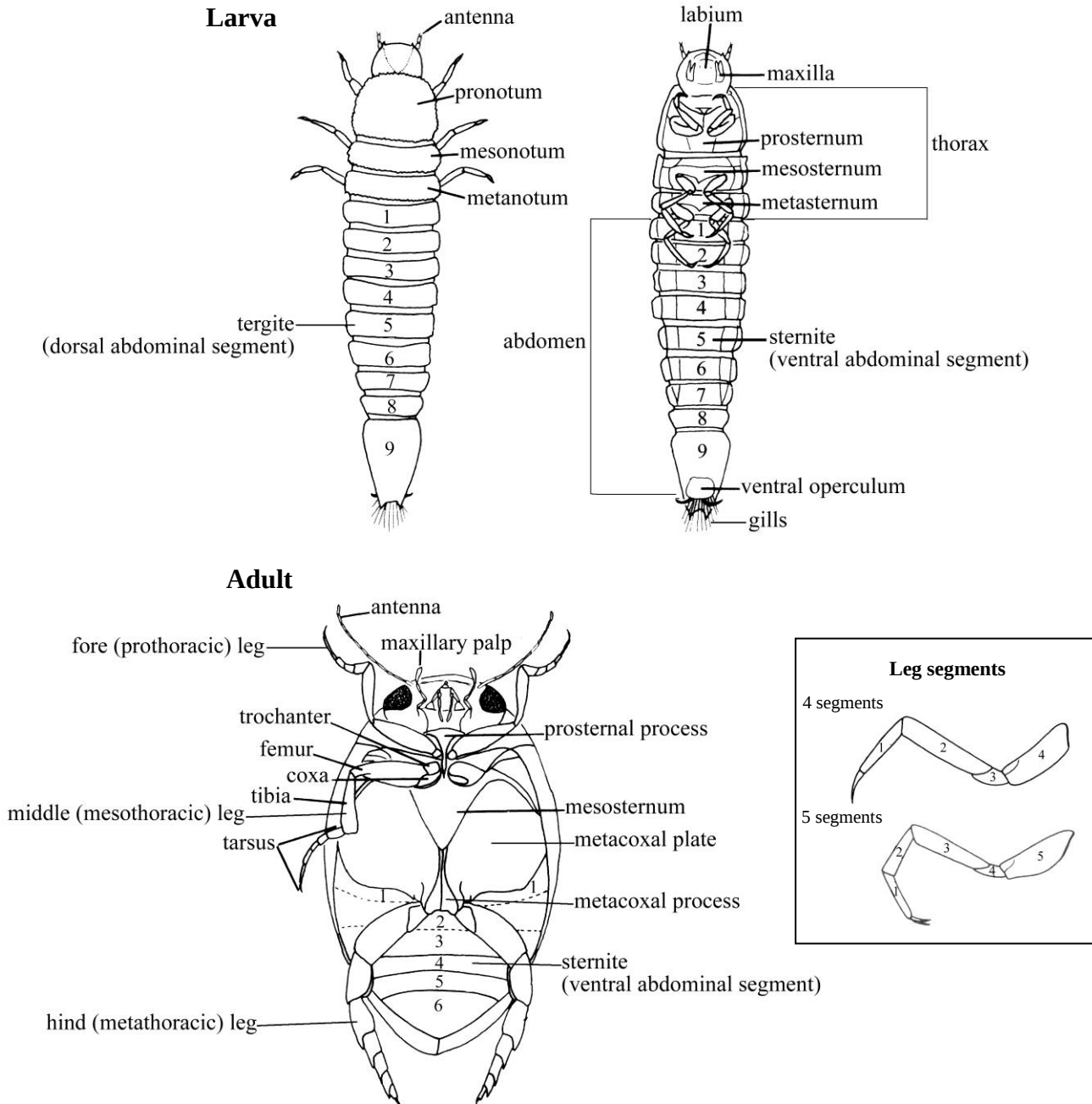


Section 5. Order Coleoptera (aquatic beetles) → 10 local families

[general figures seen below from Peckarsky et al. (1990);
unless otherwise specified, details and other figures from McCafferty (1998)]

Key features:

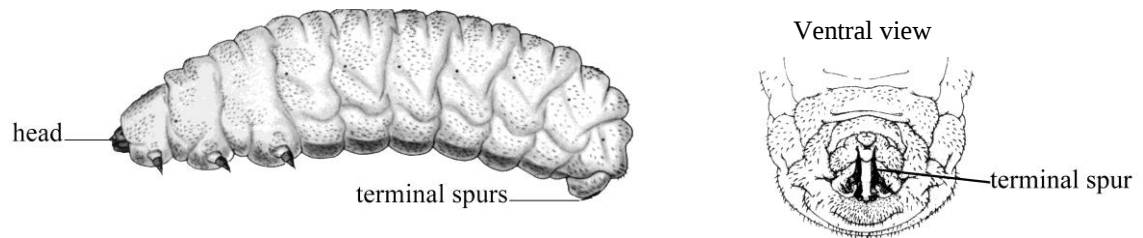
- 3 pairs of thoracic legs
- large shell-like wings (“elytra”) present on adults (hardened and meet at the midline, not membranous as in some species of true water bugs)



Note: Each form (larva or adult) has its own set of identification characteristics and typically the larva of a species rarely resembles its adult form. In some families only larval forms are aquatic, in other families the adults are **also** aquatic, and in the last group of beetles only the adults are aquatic. This is specified in the following section.

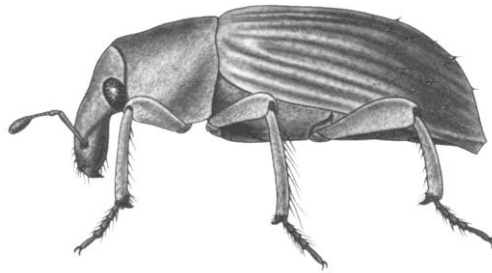
Family Chrysomelidae (aquatic leaf beetles):

- larva only:
- grub-like body with a pair of sharp spurs (“hooks”) at the end of the abdomen [figure showing spurs from Merritt and Cummins (1996)]
 - small head and legs on an enlarged body
 - each tarsus with 1 claw



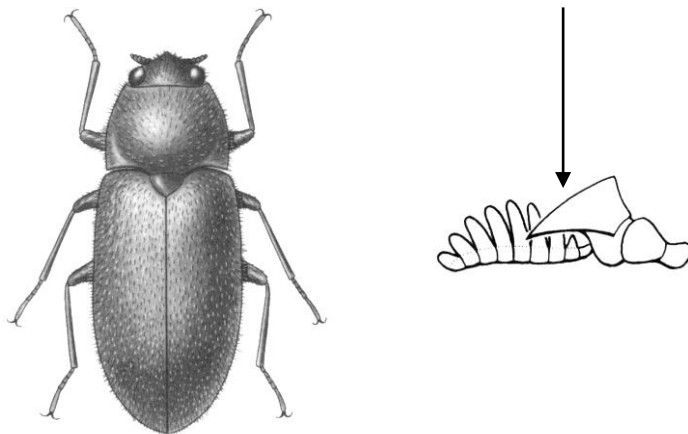
Family Curculionidae (water weevils):

- adult only:
- head elongated into a distinct snout



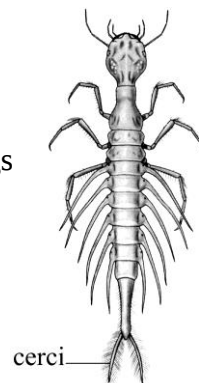
Family Dryopidae (long-toed water beetles):

- adult only:
- body not streamlined with no swimming hairs on hind legs
 - head is mostly withdrawn into the thorax [detail from Voshell (2002)]
 - long legs with long claws
 - all tarsi distinctly 5-segmented
 - antennae short and thick
 - segments 4-11 of the antennae are laterally expanded into a “pectinate club”

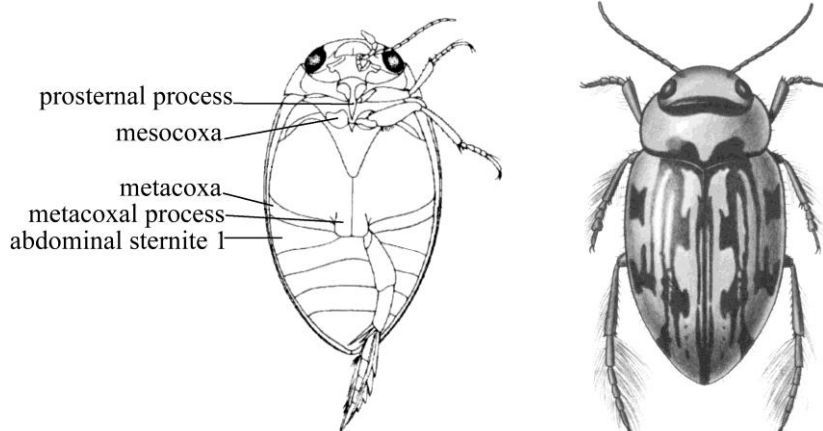


Family Dytiscidae (predaceous diving beetles):

- larva:
- elongate bodies with 8-segmented abdomen and slender legs
 - sickle-shaped mandibles clearly visible
 - often with various forms of abdominal filaments
 - abdomen usually strongly tapered at the end
 - each leg 5-segmented, with 2 claws

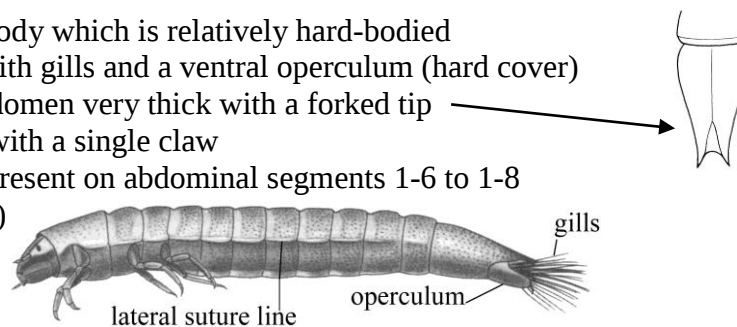


- adult:
- body oval and streamlined; in side view the body curves outward (convex) at the top and bottom [detail from Voshell (2002)]
 - hind legs with long swimming hairs
 - posterior margin of first abdominal sternite is divided completely by the metacoxal process
 - prosternum with a prosternal process that extends posteriorly to the mesocoxae [detail from Thorp and Covich (2001), ventral figure from Merritt and Cummins (1996)]

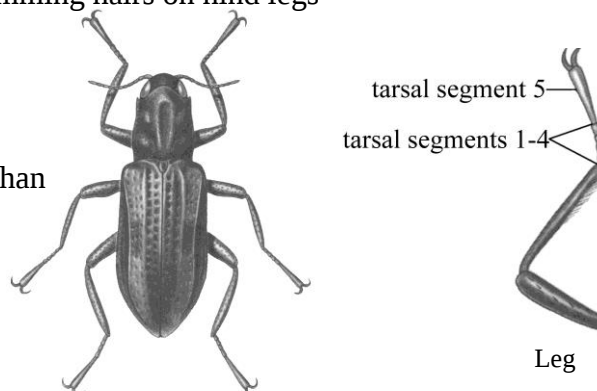


Family Elmidae (riffle beetles):

- larva:
- elongated, cylindrical body which is relatively hard-bodied
 - abdominal segment 9 with gills and a ventral operculum (hard cover)
 - terminal segment of abdomen very thick with a forked tip
 - each leg 4-segmented, with a single claw
 - lateral suture lines are present on abdominal segments 1-6 to 1-8 (may be difficult to see)

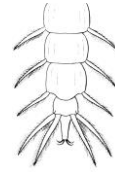
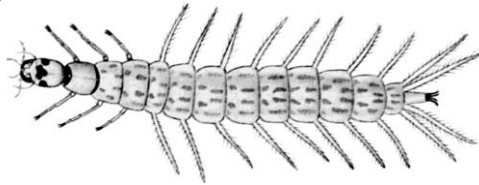


- adult:
- body small, not streamlined with no swimming hairs on hind legs
 - long legs with long claws
 - all tarsi distinctly 5-segmented
 - tarsal segment 5 is at least as long as the basal four tarsal segments combined
 - antennae very slender and much longer than the head which distinguishes Elmidae adults from Dryopidae adults (which have pectinate clubs)

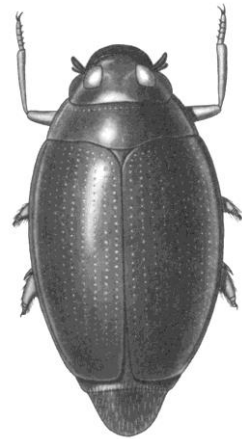
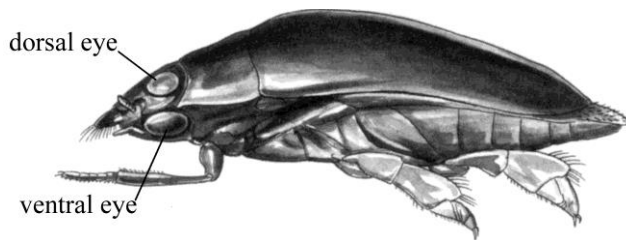


Family Gyrinidae (whirligig beetles):

- larva:
- elongate body with 9-10 abdominal segments
 - abdomen possesses more than 8 pairs of long lateral filaments and terminates in 4 small hooks
 - each leg 5-segmented, with 2 claws



- adult:
- body is oval and flattened [*figure of side view from Voshell (2002)*]
 - dorsal and ventral pairs of eyes
 - fore legs are relatively long, and middle and hind legs are short and usually flattened

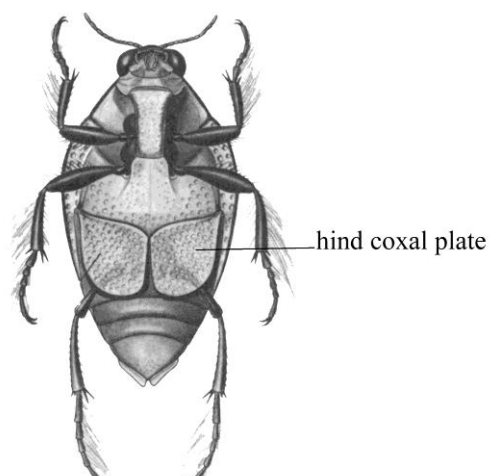
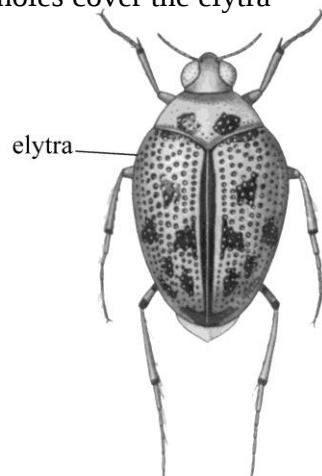


Family Haliplidae (crawling water beetles):

- larva:
- elongate body
 - abdomen 9-10 segmented and the terminal segment is often elongate
 - each leg 5-segmented, with 1 claw
 - body very similar to Elmidae larvae. The main differentiating feature is the terminal segment of the abdomen which has an operculum in Elmidae but it very long and lacking an operculum in Haliplidae.

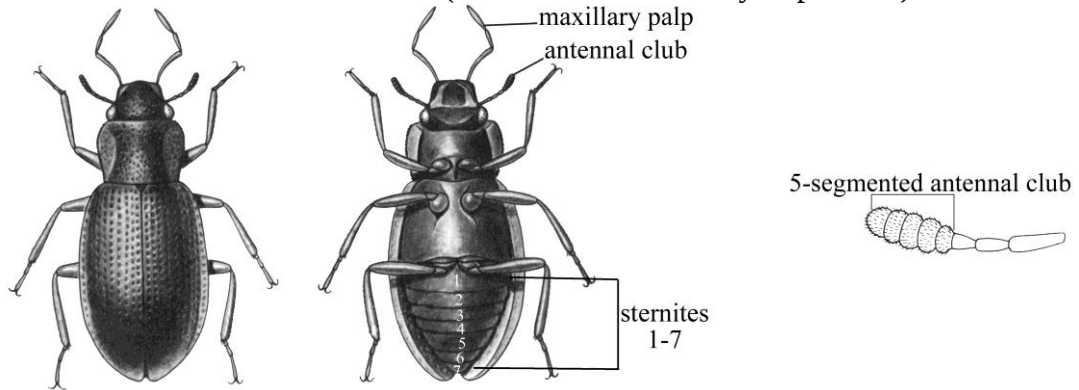


- adult:
- body oval, usually yellowish with large dark spots on the elytra (hardened fore wings)
 - large ventral coxal plates cover the bases of the hind legs and much of the abdomen
 - rows of tiny holes cover the elytra



Family Hydraenidae (minute moss beetles):

- adult only:
- tiny body, not streamlined with no swimming hairs on hind legs
 - body not over 2.5 mm long which distinguishes this family from Hydrophilidae
 - antennae terminates in a 5-segmented club and usually has a cup-like segment at the base (versus a 3-segmented antennal club in Hydrophilidae)
 - abdomen has 6-7 visible sternites (versus 5 sternites in Hydrophilidae)

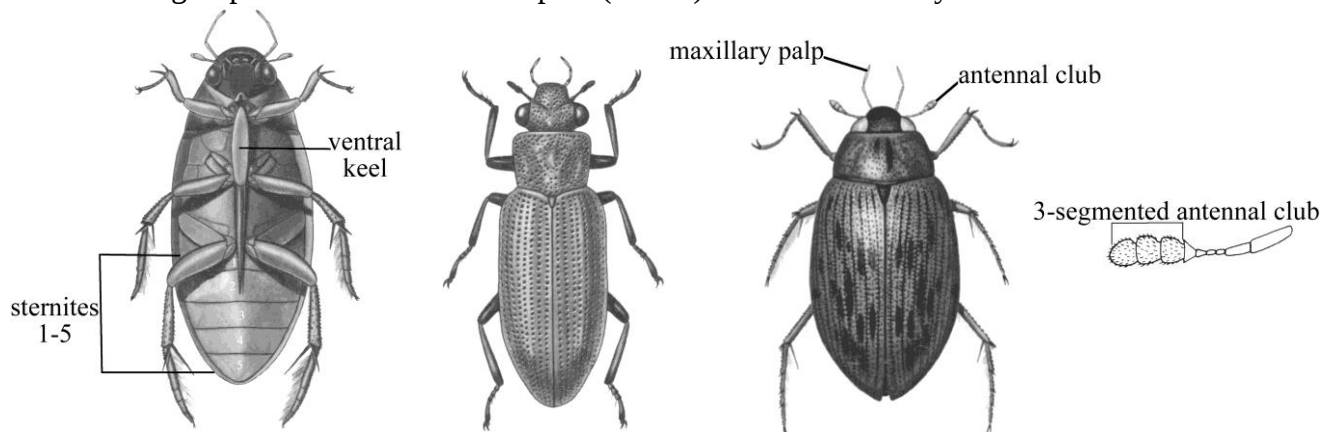


Family Hydrophilidae (water scavenger beetles):

- larva:
- head with well-developed mandibles that protrude forward
 - abdomen 8-segmented, often has a wrinkled appearance, and may possess filaments
 - each leg 4-segmented, with 1 claw

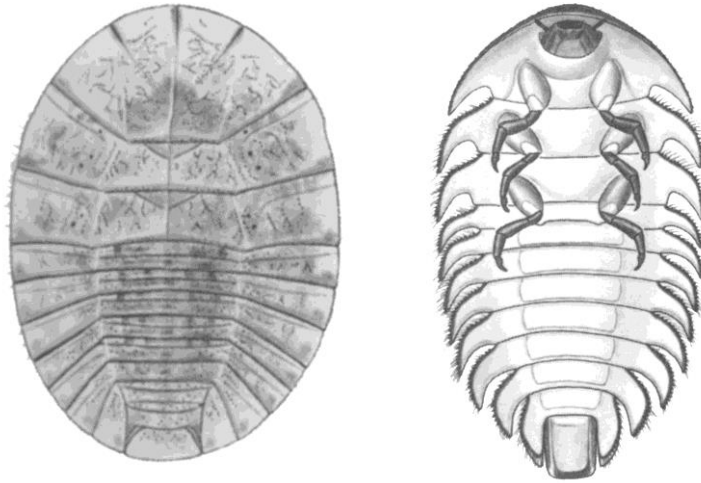


- adult:
- body oval or elongate, depending upon the species {3 types are shown below}
 - body over 2.5 mm long
 - in side view, the body curves outward (convex) on the top but is flat or curves in (concave) at the bottom (versus also being convex ventrally in Dytiscidae adults) [detail from Voshell (2002)]
 - posterior margin of first abdominal sternite undivided by the metacoxal process (as it is in Dytiscidae adults)
 - antennae with a 3-segmented terminal club and usually with a cup-like segment at the base (Note: antennae are sometimes hidden beneath the head and could be mistaken for the very long maxillary palps)
 - abdomen has 5 visible sternites
 - one group has a distinct ventral spine (“keel”) extended ventrally between the hind coxae



Family Psephenidae (water pennies):

- larva only: - body is a flattened disc with dorsal plates covering the head and legs
- each tarsus 4-segmented, with 1 claw



Section 6. Order Collembola (springtails) → 6 local families

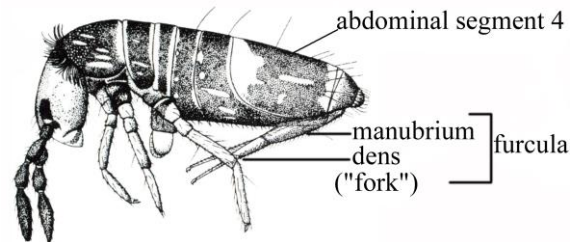
[unless otherwise specified, details from Lehmkuhl (1979)
and figures from Merritt and Cummins (1996)]

Key features:

- 3 pairs of segmented thoracic legs
- no wingpads
- most species possess a spring-like jumping organ (“furcula”) located on the underside of the abdomen

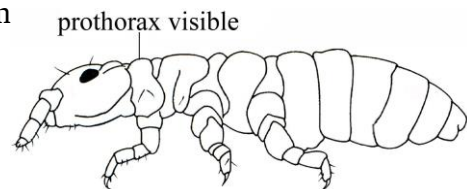
Family Entomobryidae:

- body elongate and distinctly segmented, often with large scales
- prothorax (i.e. 1st segment of thorax) reduced and without hairs or setae, often covered and hidden in dorsal view by the mesothorax (i.e. 2nd segment of thorax) thus creating a “neck”
- similar to Isotomidae but in dorsal view abdominal segment 4 is much longer than segment 3
- abdominal segment 4 is often saddle-shaped
- in some species, the mesothorax has a hump



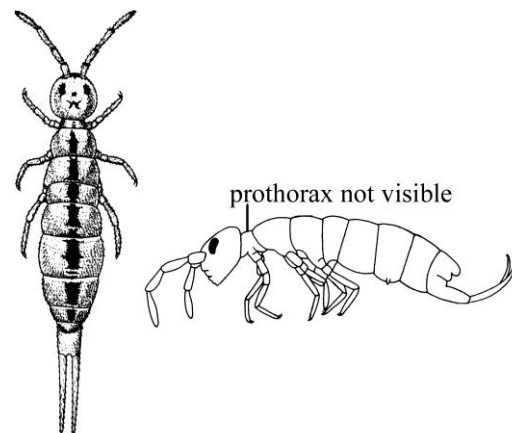
Family Hypogastruridae:

- body elongate and distinctly segmented, relatively bare
- prothorax about equal in length to other thoracic segments and not hidden dorsally
- usually dark-pigmented
- dentes (see figure under Entomobryidae) absent or less than 2.5 times as long as manubrium [detail from Merritt and Cummins (1996)]



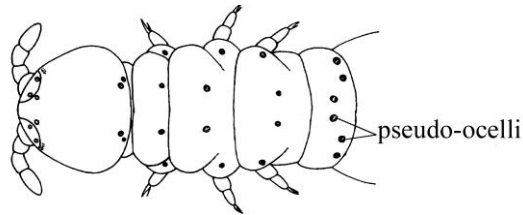
Family Isotomidae:

- body elongate and distinctly segmented, without scales
- prothorax reduced and without hairs or setae, often covered and hidden in dorsal view by the mesothorax thus creating a “neck”
- similar to Entomobryidae but in dorsal view segment 4 of the abdomen is never more than 1.5 times as long as segment 3
- some species have a distinctive dark band running down the middle of the dorsum



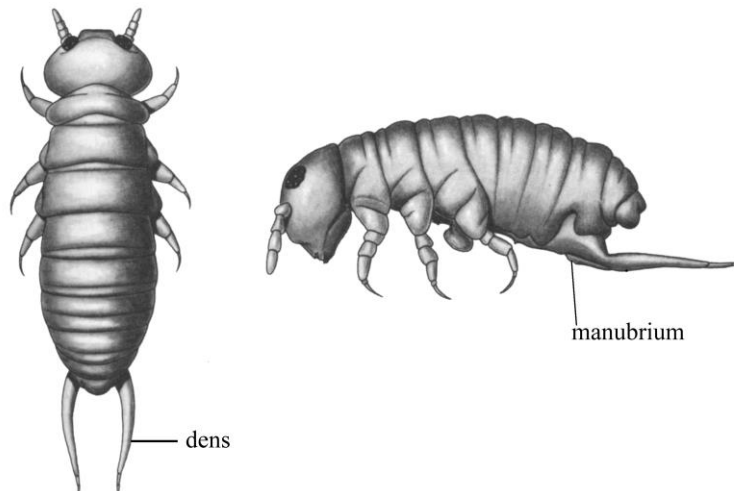
Family Onychiuridae:

- body small and elongate, distinctly segmented
- prothorax about equal in length to other thoracic segments and not hidden dorsally
- no eyes and no furcula
- body covered with pseudo-ocelli (pores) and typically white in color



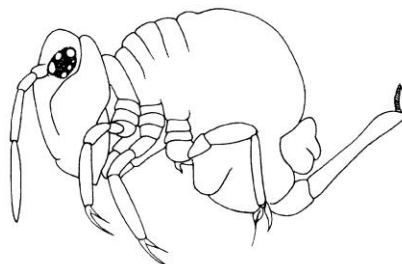
Family Poduridae [figure from McCafferty (1998)]:

- body elongate and distinctly segmented
- prothorax about equal in length to other thoracic segments and not hidden dorsally
- usually dark-pigmented
- furcula long so that when folded forward it would reach the hind pair of legs
- dentes more than 3 times as long as the manubrium [detail from Merritt and Cummins (1996)]



Family Sminthuridae:

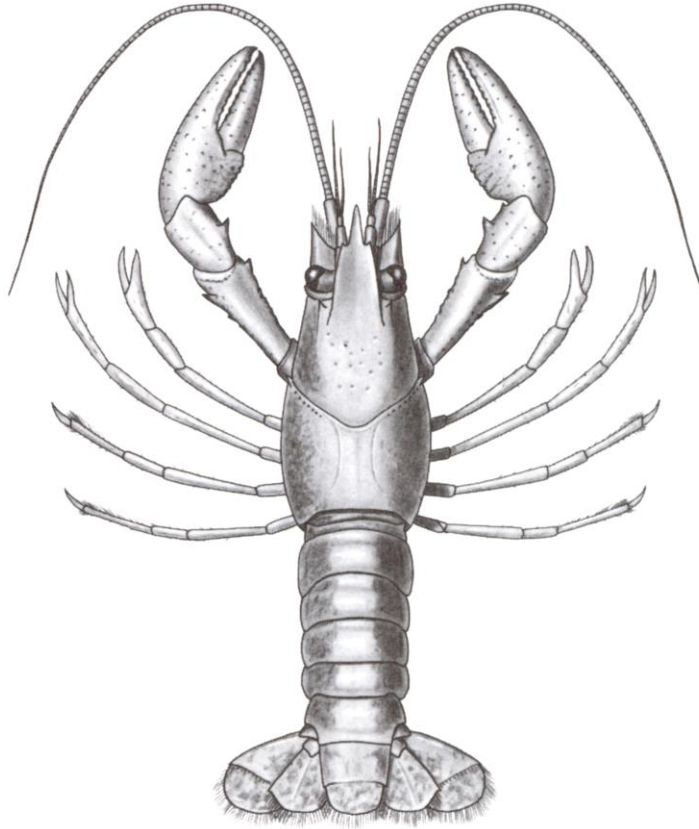
- body globular in shape
- without distinct segmentation dividing thorax from abdomen



Section 7. Order Decapoda (crayfish) → 1 local family
[details and figure from McCafferty (1998)]

Family Cambaridae:

- head and entire thorax form a large cephalothorax
- cephalothorax possesses five pairs of legs
- first two or three pairs of legs are pincer-like at their ends and the first pair is often very robust



Section 8. Order Diptera (fly larvae) → 16 local families

[unless otherwise specified, details from McCafferty (1998)
and figures from Merritt and Cummins (1996)]

Key features:

- larvae usually elongate, maggot-like forms
- no developed legs
- no wingpads
- abdomen is 8-10 segmented
- head may be fully developed or reduced to metacephalic rods only

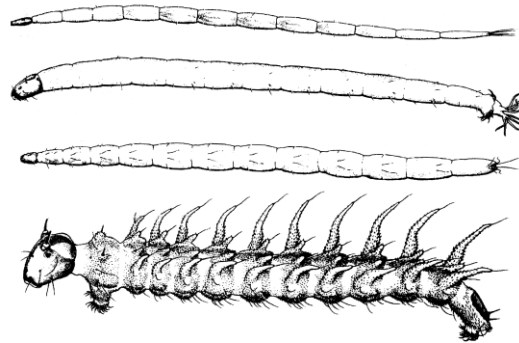
Family Athericidae (water snipe flies):

- measure 12-18 mm at maturity
- abdomen has a series of well-developed pairs of ventral prolegs and short dorsal and lateral filaments on each segment
- terminal segment has a pair of fringed divergent processes that are longer than the terminal prolegs



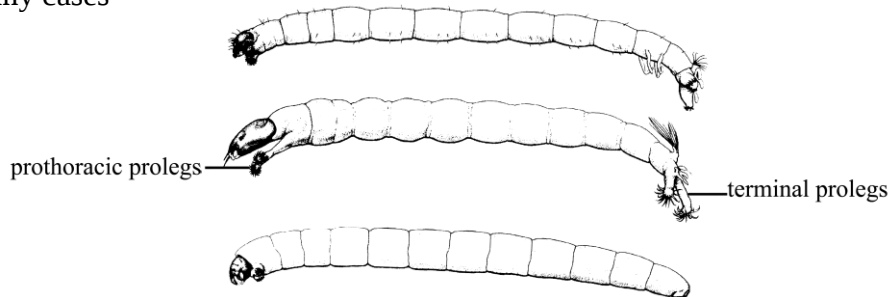
Family Ceratopogonidae (biting midges) {4 types are shown below}:

- measure 2-15 mm at maturity
- in most common species the body is very slender and cylindrical with a distinctly visible head
- prothoracic and terminal prolegs may or may not be present (when both are present the body possesses well-developed bristles or spines)



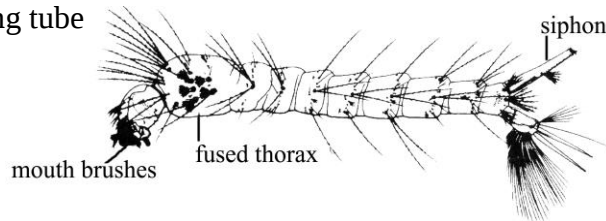
Family Chironomidae (midges) {3 types are shown below}:

- usually measure 2-20 mm at maturity but are occasionally larger
- slender body which is commonly cylindrical and slightly curved with a distinctly visible head
- a pair of prothoracic prolegs and a pair of terminal prolegs present
- terminal segment usually has a short dorsal pair of tubercles, each with tufts of hairs
- some have tiny cases



Family Culicidae (mosquitoes):

- small or medium sized
- head distinctly visible and has mouth brushes
- thoracic segments are fused and are much thicker than the abdomen
- prolegs absent
- dorsal terminal breathing tube (siphon) present



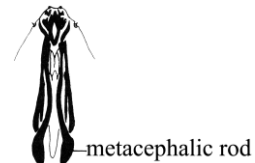
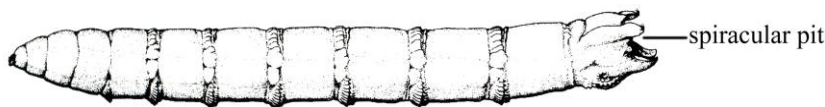
Family Dixidae (dixid midges):

- measure 3-7 mm at maturity
- elongate and slender body
- head distinctly visible and has mouth brushes
- abdomen possesses a small pair of ventral prolegs on segment 1 and usually another pair on segment 2
- abdomen terminates in a median breathing tube and has lateral paddle-like structures



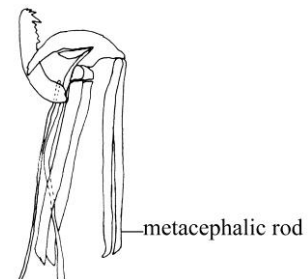
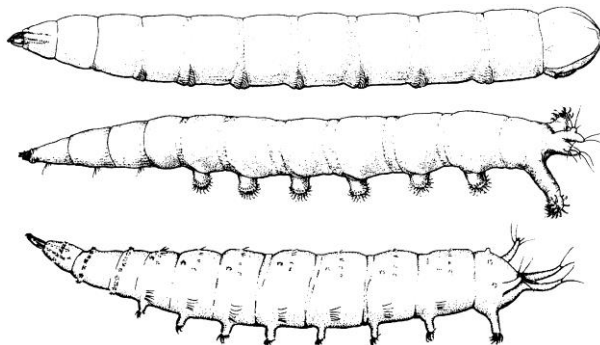
Family Dolichopodidae (aquatic long-legged flies):

- measure 3-10 mm at maturity
- has metacephalic rods versus a fully formed head; these are expanded posteriorly [*detail and figure of rods from Peckarsky et al. (1990)*]
- abdomen may or may not have ventral prolegs (if present, in the form of small welts only)
- abdomen is concave at the end, forming a spiracular pit surrounded by short posteriorly projecting lobes



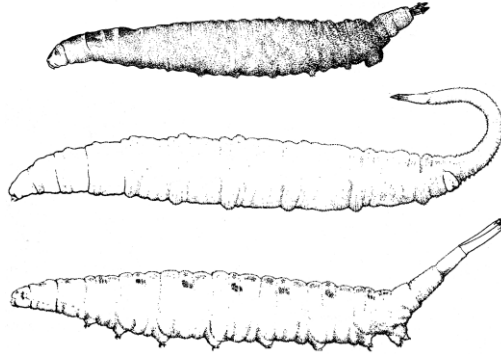
Family Empididae (aquatic dance flies) {3 types are shown below}:

- measure 2-7 mm at maturity
- has metacephalic rods versus a fully formed head; these are slender posteriorly [*detail and figure of rods from Peckarsky et al. (1990)*]
- ventral prolegs are fully developed or reduced to welts only
- terminal processes are variable in number and shape but are rarely longer than the terminal prolegs and are not fringed, as in Athericidae



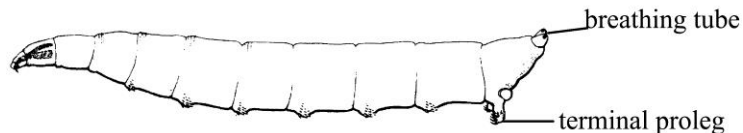
Family Ephydriidae (shore flies) {3 types are shown below}:

- small size, measuring 1.2-12 mm or more at maturity
- may be wrinkled and extensible
- may or may not possess ventral abdominal prolegs
- body terminating in a short tube that is divided apically or with a pair of spines that frequently have a black sclerotized tip [detail from Thorp and Covich (2001)]



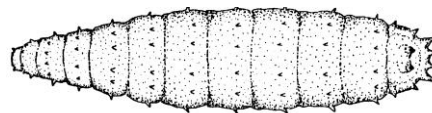
Family Muscidae (aquatic muscids):

- generally elongate, measuring 6-14 mm at maturity
- abdominal prolegs, when present, are usually in the form of welts having short, scattered, well-developed spines
- terminal prolegs are usually as long or longer than the pair of short terminal breathing tubes



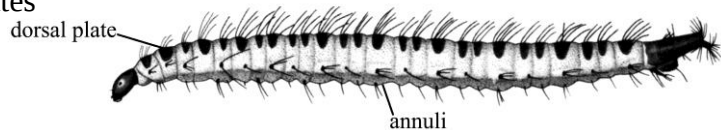
Family Phoridae (hump-backed flies) [details from Merritt and Cummins (1996)]:

- body often dorsoventrally flattened and bearing a series of tubercles
- posterior spiracles with openings arranged in 2 pairs placed behind the other



Family Psychodidae (moth flies) [figure from McCafferty (1998)]:

- measure less than 5 mm at maturity
- small cylindrical body which is dark grey and hairy, with a distinctly visible head
- body segments are usually divided into subdivisions, termed “annuli”; at least some of these annuli possess small and dark dorsal plates



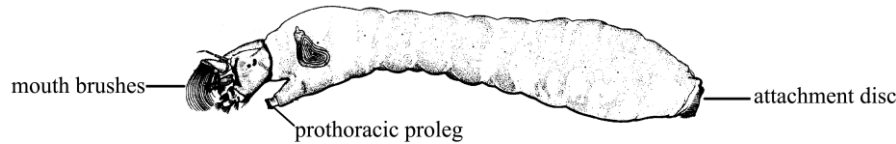
Family Sciomyzidae (marsh flies):

- wrinkled, cylindrical body which measures 4-14 mm at maturity
- tapers at both ends (anterior end is slightly curved ventrally)
- scattered round tubercles usually encircle each body segment
- abdomen may possess a short, tapered breathing tube
- some short lobes or processes usually surround the terminal spiracular disc



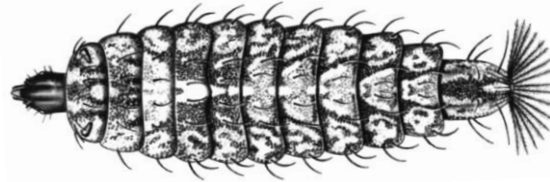
Family Simuliidae (black flies):

- measure 3-8 mm at maturity, rarely up to 12 mm or more
- cylindrical body with a fully formed head
- head often possesses distinct fan-like mouth brushes
- prothorax has a single median ventral proleg
- abdomen swollen posteriorly and terminates in an attachment disc



Family Stratiomyidae (aquatic soldier flies) [figure from McCafferty (1998)]:

- measure 7-30 mm at maturity
- somewhat flattened and broad body
- body surface is somewhat hardened and thickened with deposits of calcium carbonate
- head is distinctly set off from the thorax
- prolegs are lacking, but bristles or filaments are often present
- abdomen is terminally fringed with hairs



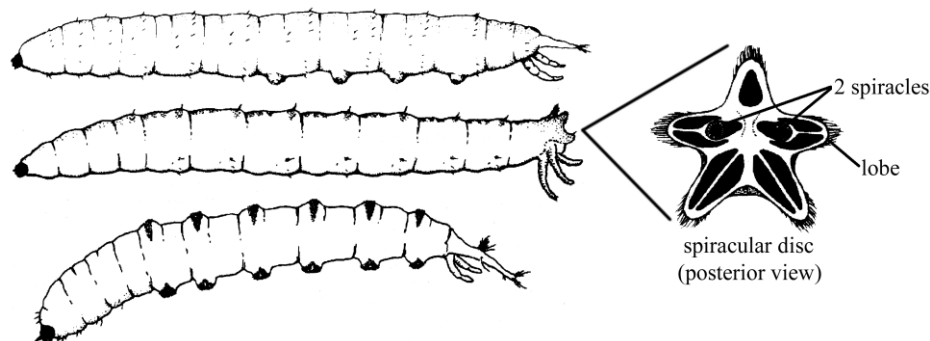
Family Tabanidae (horse flies and deer flies):

- measure 11-55 mm at maturity
- elongate and cylindrical, spindle-shaped body
- body tapers at both ends and possesses a series of fleshy encircling rings
- abdomen lacks terminal prolegs but terminates in a small respiratory siphon



Family Tipulidae (crane flies) {3 types are shown below}:

- measure 10-25 mm at maturity
- body often cylindrical and peg-like, somewhat rounded anteriorly and blunt but expanded posteriorly
- head capsule is incomplete and is usually retracted to some extent into the thorax
- abdomen commonly possesses small lobes or creeping welts
- end of abdomen is usually a spiracular disc consisting of variously developed lobes and processes surrounding posterior spiracles
- in a few species, the abdomen terminates in a pair of elongate processes

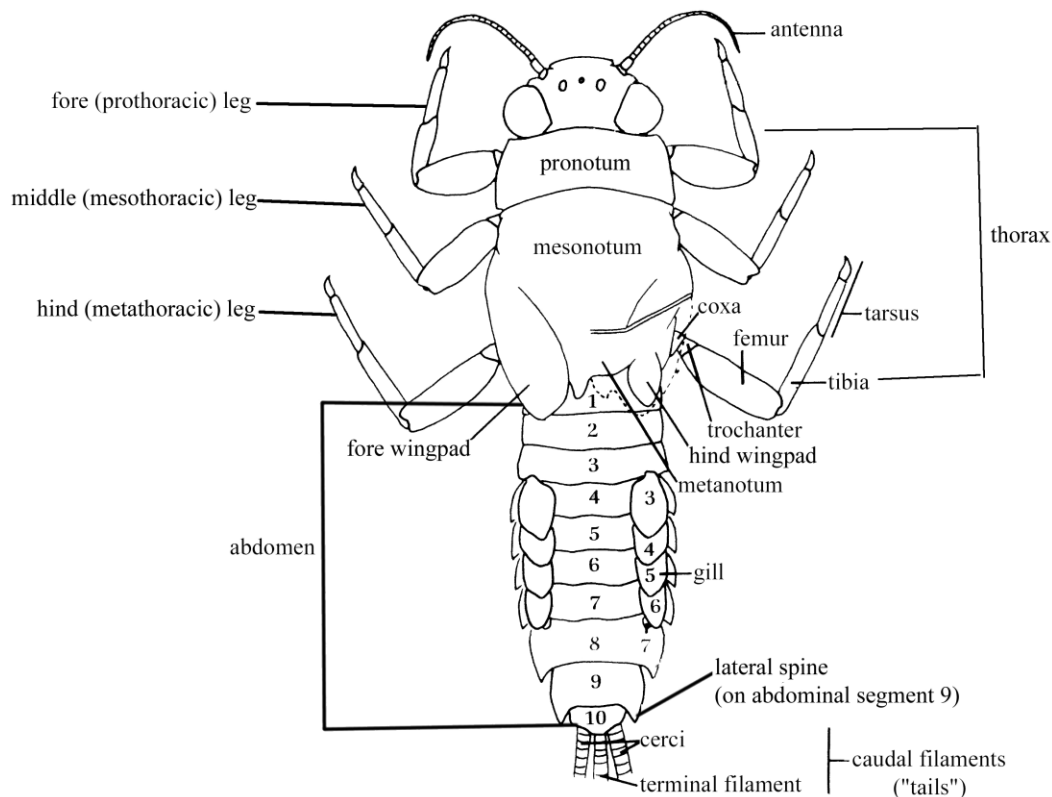


Section 9. Order Ephemeroptera (mayfly nymphs) → 11 local families

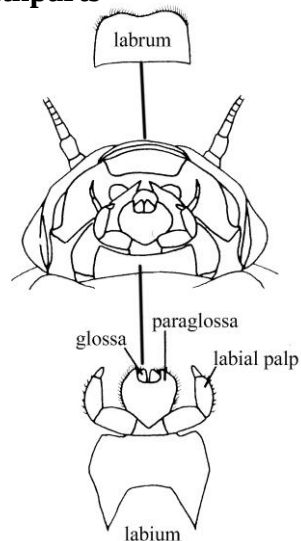
[general figures seen below from Peckarsky et al. (1990);
unless otherwise specified, details and other figures from McCafferty (1998)]

Key features:

- 3 pairs of segmented thoracic legs
- 2 pairs of developing wingpads
- abdomen terminates in 3 long filamentous tails (“cerci”), except for one group of Baetidae which has only 2 tails
- most abdominal segments possess prominent lateral gills
- legs possess a single claw (versus 2 in stoneflies)

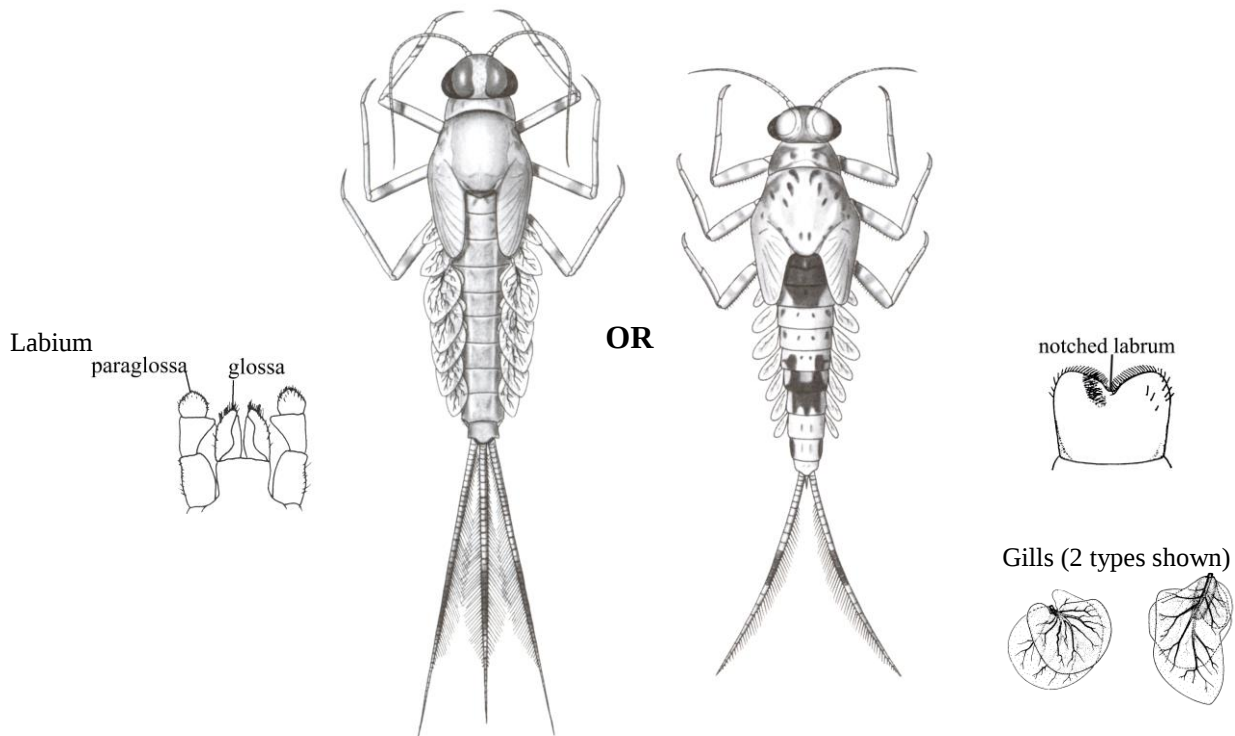


Ventral view of head showing mouthparts



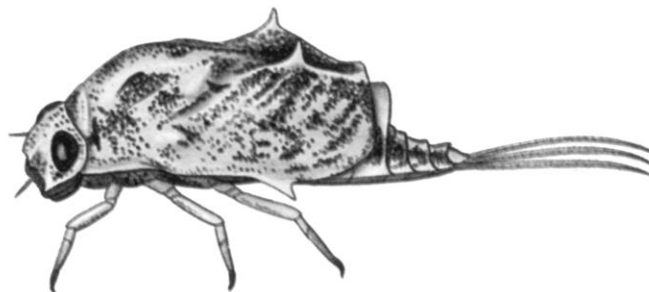
Family Baetidae (small minnow mayflies):

- body elongate with a vertical head
- very long antennae (2-3 times the head width) if 3 tails are present
- may have only 2 tails present, in which case the antennae are much shorter
- similar to Siphonuridae but has no or poorly developed lateral spines on the corners of abdominal segment 9
- plate-like gills are present on abdominal segments 1-7, 1-5, or 2-7 [*figures of gills from Merritt and Cummins (1996)*]
- also distinguished by its notched labrum (versus being straight in Siphonuridae) [*detail and figure of labrum from Merritt and Cummins (1996)*]
- glossae and paraglossae of labium are long and narrow (versus being short and broad as in Siphonuridae) [*detail and figure of labium from Peckarsky et al. (1990)*]



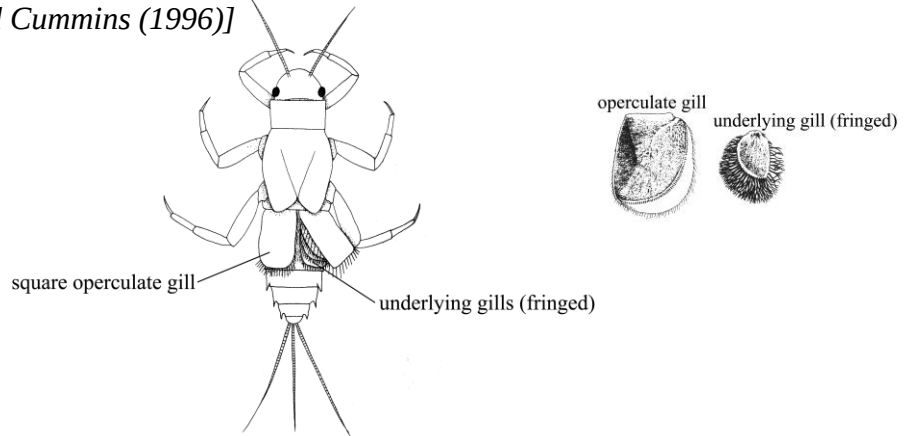
Family Baetiscidae (armored mayflies):

- body very stout
- thorax is developed into a large carapace-like shield that extends over abdominal segment 5



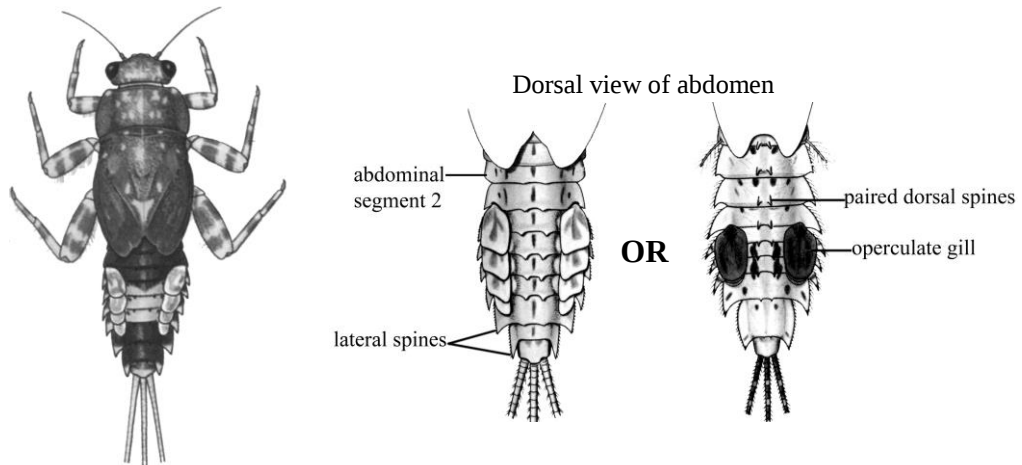
Family Caenidae (small square-gills) [figure of body from Pennak (1978)]:

- generally small (2-8 mm)
- gills on abdominal segment 2 are operculate and square, overlapping but not fused
[Note: operculate = “covering succeeding pairs of gills” as defined by Merritt and Cummins (1996)]
- gills beneath the operculate gills have a fringe on their edges [detail from Voshell (2002), figure of gills from Merritt and Cummins (1996)]



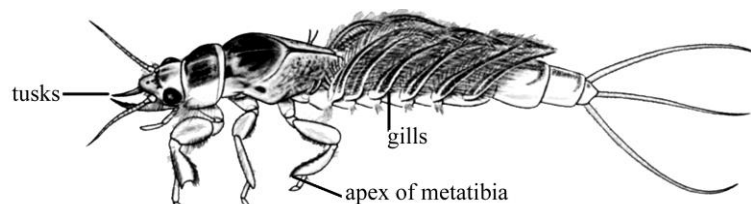
Family Ephemerellidae (spiny crawlers):

- long axis of head tends to be vertically oriented
- blunt to sharp spines are often present dorsally on the head, thorax, and/or abdomen
- abdominal segments usually have prominent lateral spines
- gills are never present on abdominal segment 2
- plate-like gills on abdominal segments 3-7 or 4-7 lie tightly upon the abdomen
- gills on segments 3 or 4 may be operculate [detail from Peckarsky et al. (1990)]



Family Ephemeridae (common burrowers) [details from Peckarsky et al. (1990)]:

- head with large, anteriorly projecting tusks that curve upwards
- abdominal gills 2-7 are double and elongate with prominent fringed margins
- gills dorsal, curving up over the abdomen
- apex of metatibiae projected into an acute point ventrally



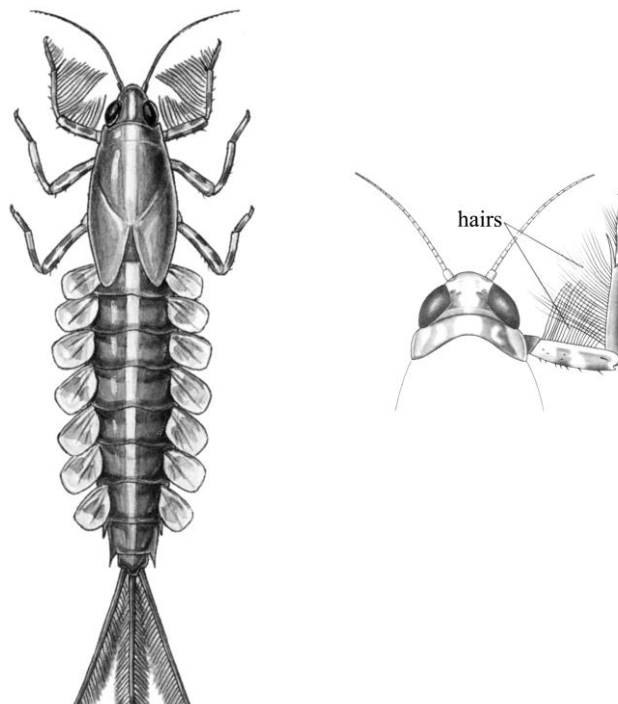
Family Heptageniidae (flat-headed mayflies):

- flattened body with sprawling legs [*figure of side view from Voshell (2002)*]
- large flattened head which is horizontally oriented
- gills are present on abdominal segments 1-7 or rarely 1-6 and are single lamellae (plate-like) [*figures of gills from Merritt and Cummins (1996)*]
- all or most of the gills have tufts at their base [*figure of tufts from Peckarsky et al. (1990)*]



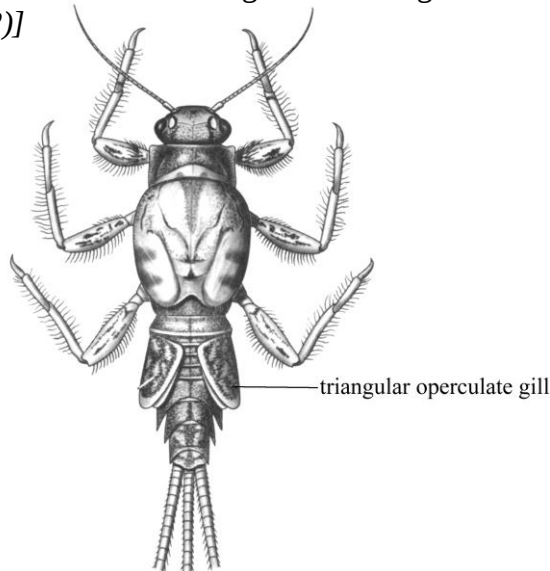
Family Isonychiidae (= Oligoneuriidae) (brush-legged mayflies) [*figure of body from Voshell (2002)*]:

- body elongate with a vertical head
- two rows of conspicuous long hairs are present along the inner surface of the fore legs
- gills are present on abdominal segments 1-7 or 2-7 [*detail from Peckarsky et al. (1990)*]
- gills on segments 2-5 are usually plate-like
- gill tufts are present at the base of the maxillary mouthparts (no figure shown for this feature)



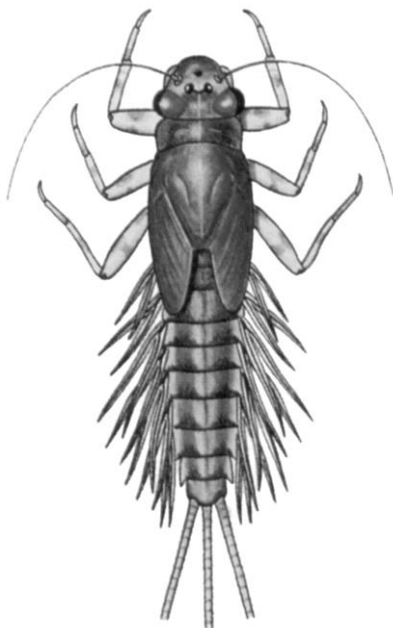
Family Leptohyphidae (=Tricorythidae) (little stout crawlers):

- thorax appears stout in relation to the abdomen
- gills are present on abdominal segments 2-6
- gills on abdominal segment 2 are operculate (i.e. covering succeeding gills), triangular, and well separated from each other
- gills beneath the operculate gills do not have a fringe on their edges and resemble the operculate gills [detail from Voshell (2002)]

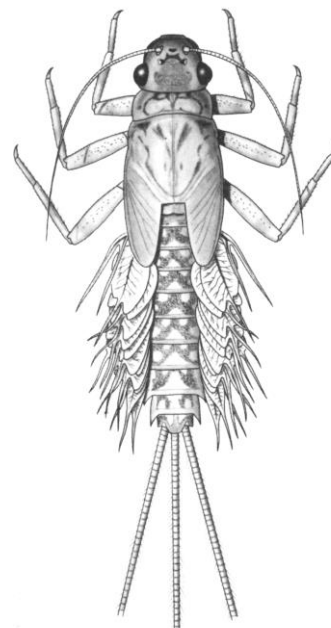


Family Leptophlebiidae (prong-gills) {2 types are shown below}:

- somewhat cylindrical to flattened forms
- long axis of head ranges from vertical to horizontal
- gills are present on abdominal segments 1-6 or 1-7, and on segments 2-6 are forked or double and elongate, or with finger-like projections or in clusters of filaments and are never placed ventrally [figures of gills from Merritt and Cummins (1996)]

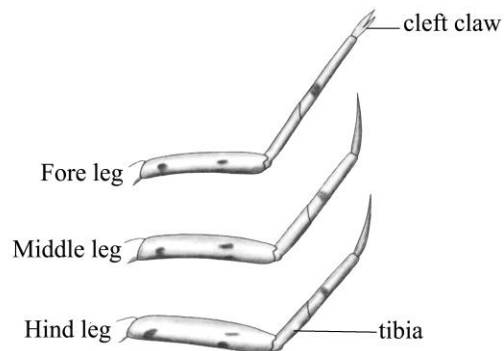


Gills (7 types shown)



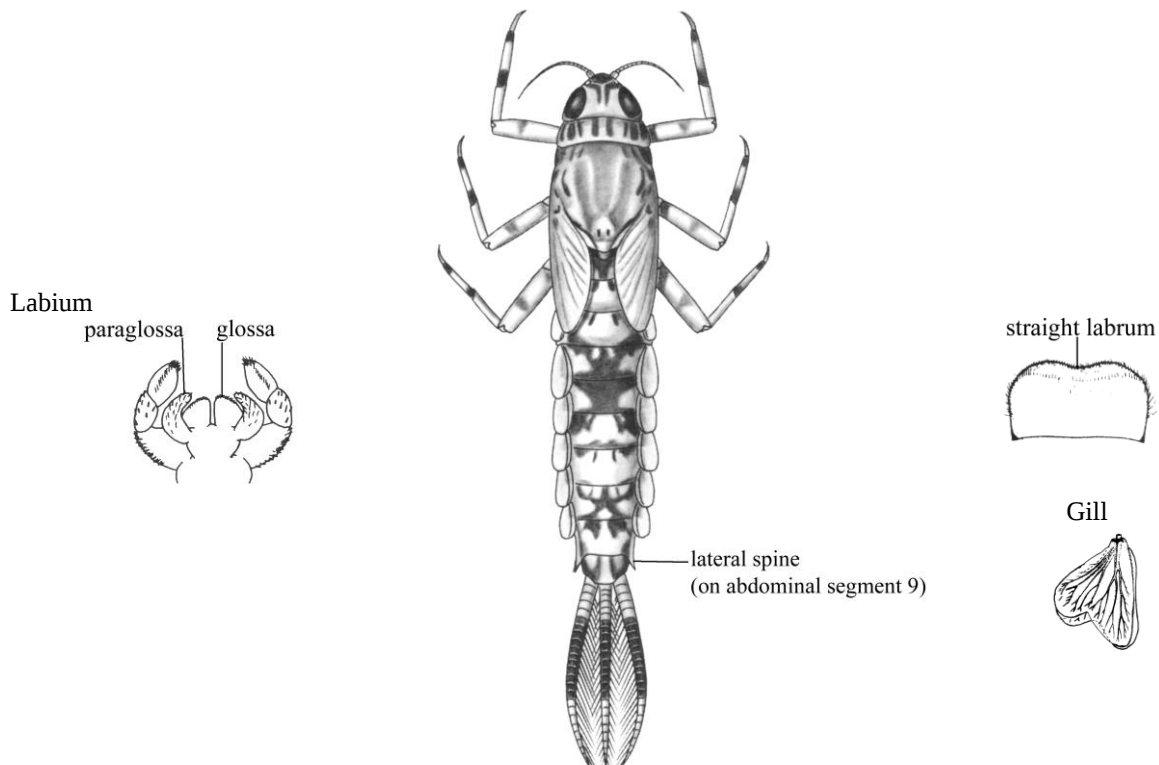
Family Metretopodidae (cleft-foot minnow mayflies):

- body elongate with a vertical head
- body very similar to Siphonuridae (see body figure below) except that the claws of the fore legs are cleft and the claws of the middle and hind legs are not cleft but are longer than the tibiae on those legs



Family Siphonuridae (primitive minnow mayflies):

- body elongate with a vertical head
- similar to Baetidae but always has 3 tails and the antennae are shorter than 2 times the head width
- posterior abdominal segments have sharp lateral spines
- claws on all legs are similar (versus the differences noted for Metretopodidae)
- plate-like gills are oriented dorsally on abdominal segments 1-7 [*figure of gills from Merritt and Cummins (1996)*]
- labrum straight [*detail and figure of labrum from Merritt and Cummins (1996)*]
- glossae and paraglossae of labium are short and broad [*detail and figure of labium from Peckarsky et al. (1990)*]



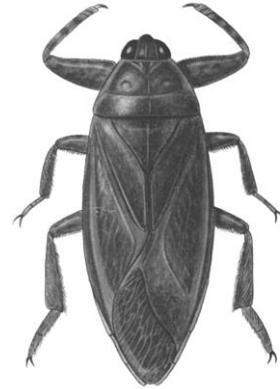
Section 10. Order Heteroptera (= Hemiptera) (true water bugs) → 5 local families
[unless otherwise specified, details and figures from McCafferty (1998)]

Key features:

- 3 pairs of segmented thoracic legs
- large wings may be present (membranous and overlap, not hardened as in some species of aquatic beetle adults)
- no gills and no tails
- mouth is modified into sucking mouthparts, formed into a tube (also termed “beak” or “rostrum”)

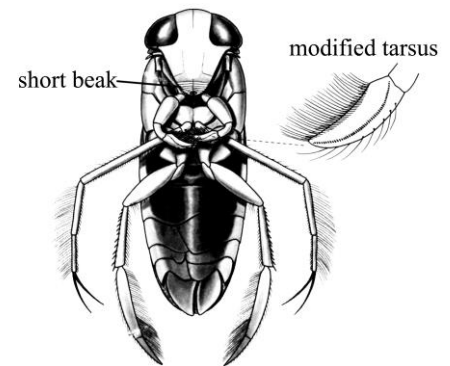
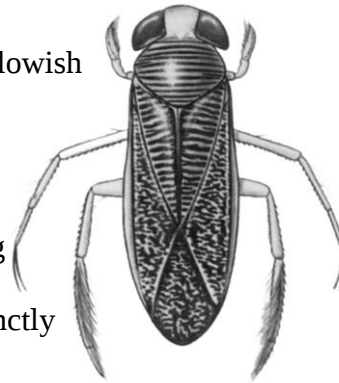
Family Belostomatidae (giant water bugs):

- flattened and oval, typically very large body (20-65 mm)
- raptorial fore legs
- abdomen ends in a pair of short plate-like structures
- beak is elongate (see example under Notonectidae)
- antennae are shorter than the head



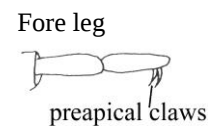
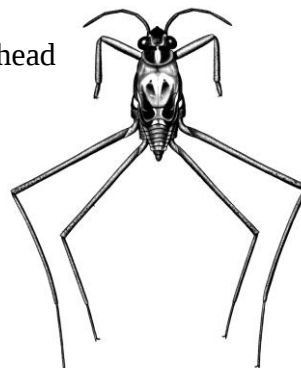
Family Corixidae (water boatmen):

- somewhat flattened and parallel-sided body
- usually dark brown with fine, wavy, and yellowish lines across the top of the body [detail from Voshell (2002)]
- fore legs are short; tarsus is modified into a scoop-shaped structure
- hind legs are oar-like and possess swimming hairs
- beak is short, blunt, triangular, and not distinctly segmented (sometimes striated)
- antennae are shorter than the head



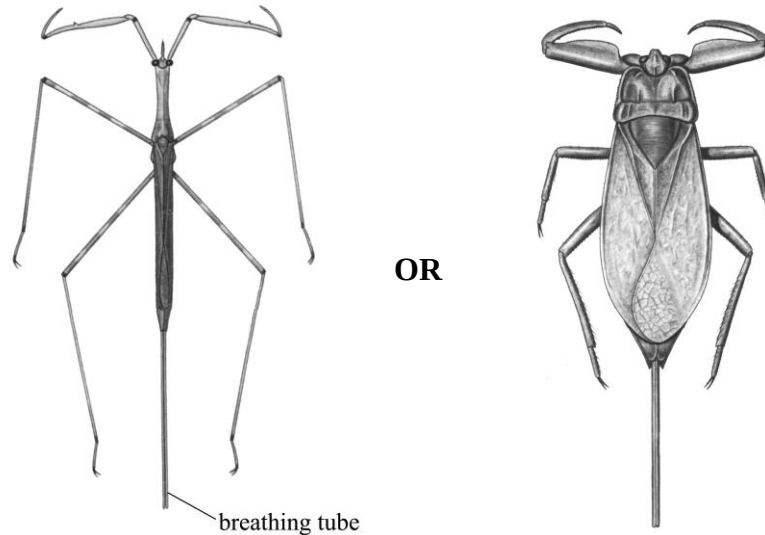
Family Gerridae (water striders):

- slender to robust body
- long-legged (hind femora reach well beyond the tip of the abdomen)
- preapical claws present (i.e. arise just before the end of the legs) [figure showing claws from Peckarsky et al. (1990)]
- antennae are as long or longer than the head



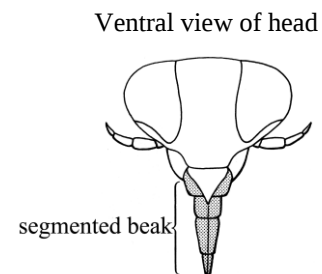
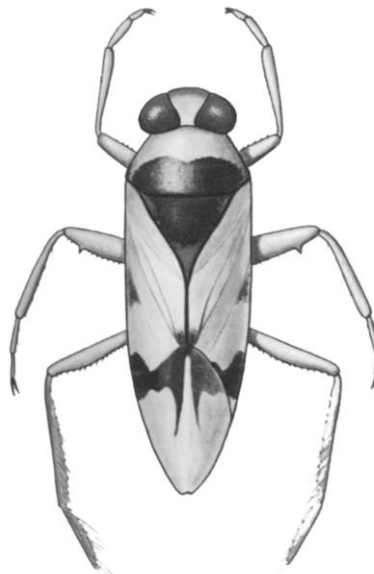
Family Nepidae (water scorpions):

- generally large, either narrow and elongate OR broad and oval {both types are shown below}
- fore legs are raptorial
- abdomen terminates in a well-developed, elongate breathing tube
- beak is elongate (see example under Notonectidae)
- antennae are shorter than the head



Family Notonectidae (back-swimmers):

- elongate, somewhat slender and deep-bodied
- their shading is reversed from the norm, being dark on the bottom and light on top, because they swim upside down [*detail from Voshell (2002)*]
- the hind legs are oar-like and possess swimming hairs
- viewed ventrally, the beak is elongate and segmented
- antennae are shorter than the head



Section 11. Subclass Hirudinea (leeches) → 2 local families
[unless otherwise specified, details and figures from Peckarsky et al. (1990)]

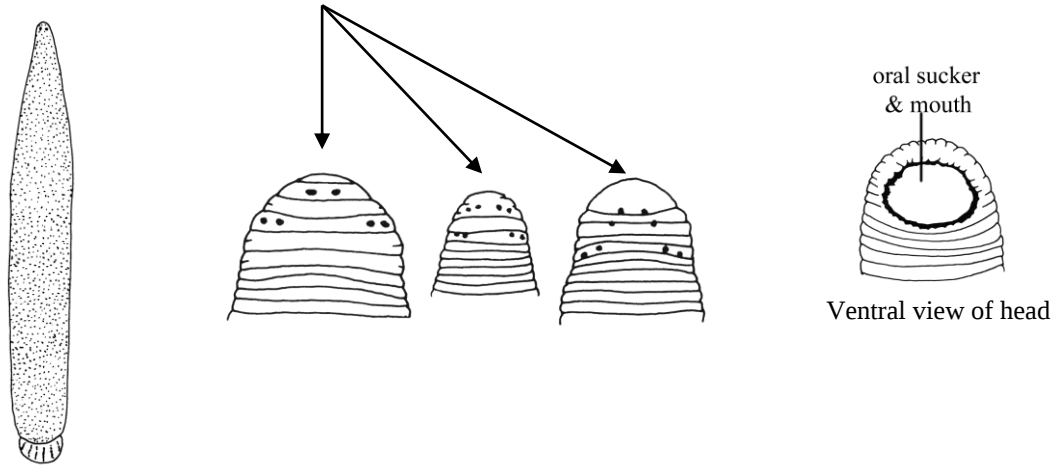
Key features:

- dorsoventrally flattened
- body comprised of 34 segments which are externally divided into a number of annuli (“subdivisions”)
- have suckers at both ends of the body
- the mouth is surrounded by an oral sucker that may be large or small, fused at the anterior end, and lip-like [detail from Pennak (1989)]

A. Order Arhynchobdellida

Family Erpobdellidae:

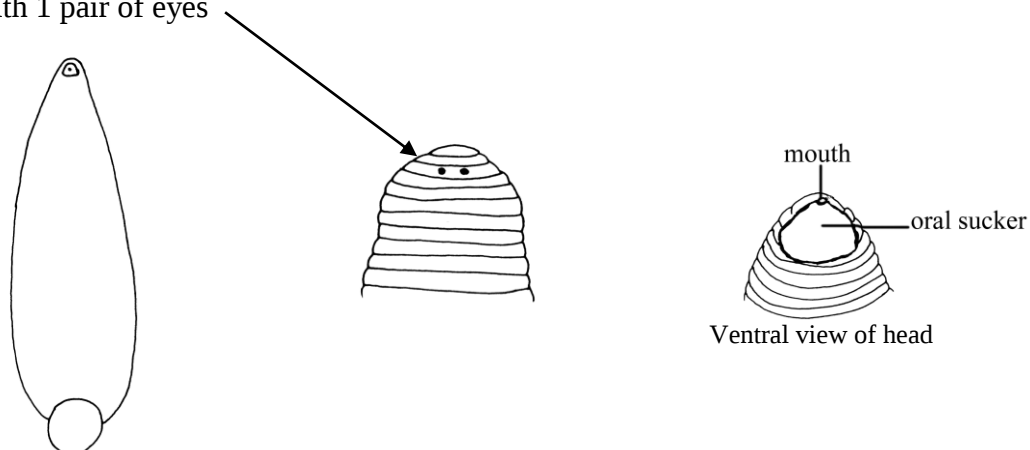
- narrow body
- mouth medium to large in size, occupying the entire oral sucker, without a proboscis
- 3 or 4 pairs of eyes, never arranged in a regular arch



B. Order Rhynchobdellida

Family Glossiphoniidae:

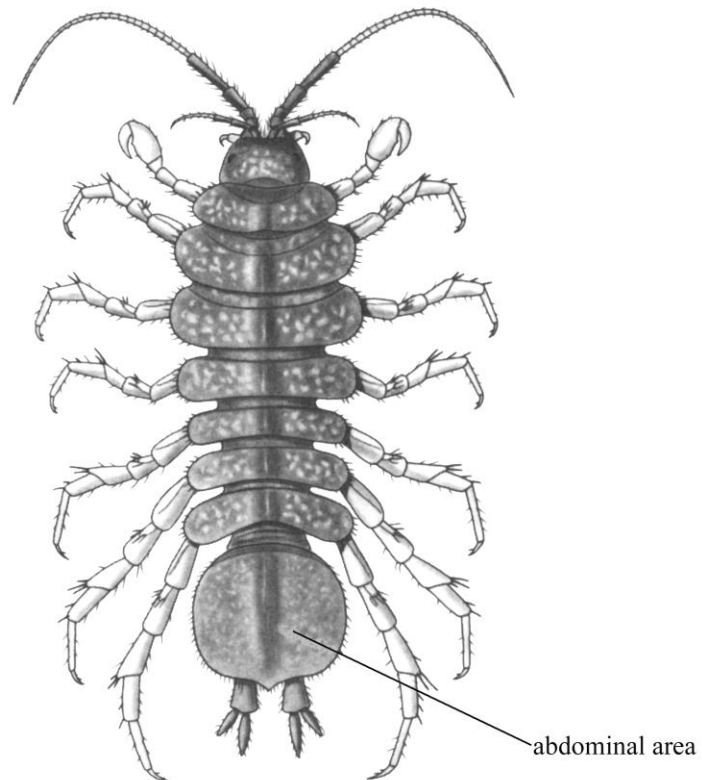
- body flat and much wider than the head region
- well defined segmentation (personal observation)
- mouth a small pore in the oral sucker which is ventrally placed, through which a muscular proboscis can be protruded
- generally with 1 pair of eyes



Section 12. Order Isopoda (sowbugs) → 1 local family
[details and figure from McCafferty (1998)]

Family Asellidae (aquatic sowbugs):

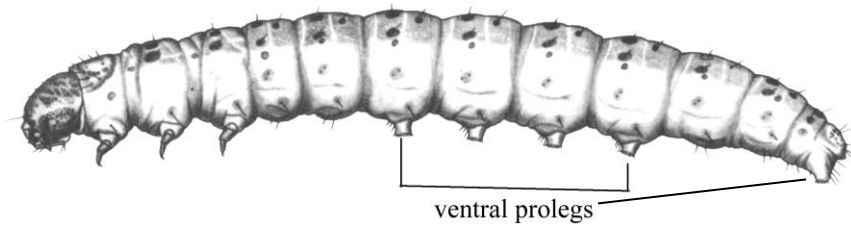
- small body (5-20 mm)
- body strongly dorsoventrally flattened
- head and first thoracic segment form a cephalothorax
- remainder of thorax possesses seven pairs of well-developed legs, the first pair being modified for grasping
- abdominal segments are fused into a relatively short region



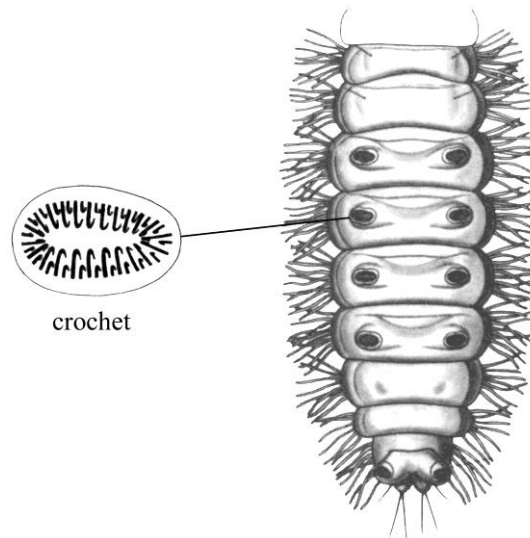
Section 13. Order Lepidoptera (aquatic caterpillars) → 1 local family
[details and figures from McCafferty (1998)]

Family Pyralidae (aquatic pyralid moths):

- generally large (3-35 mm at maturity)
- 3 pairs of segmented thoracic legs
- prolegs are present on abdominal segments 3-6 and 10
- each proleg usually has a crochet (series of minute curved hooks terminally)
- crochet is in the form of a circle (incomplete in some species) or two curved rows and is composed of hooks of at least two distinct sizes



Ventral view of abdomen



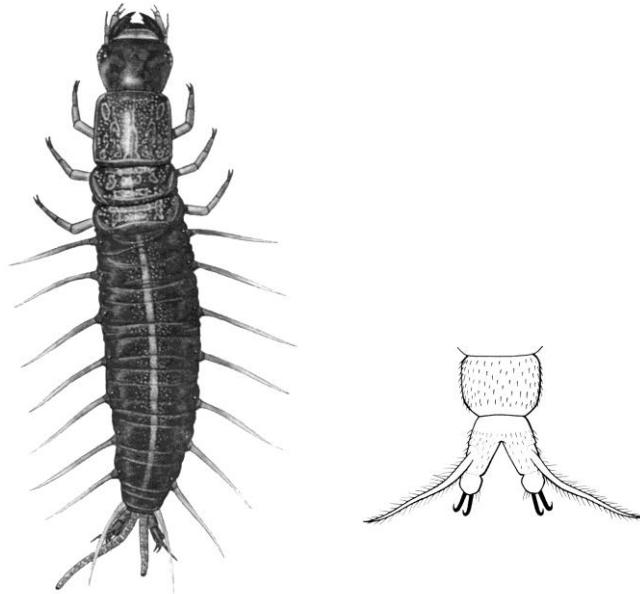
Section 14. Order Megaloptera (alderfly and dobsonfly larvae) → 2 local families
[details and figures from McCafferty (1998)]

Key features:

- larvae are elongate and slightly flattened with stout bodies
- 3 pairs of segmented thoracic legs
- no wingpads
- 7-8 pairs of prominent lateral filaments on abdominal segments
- abdomen ends in either prolegs with hooks or a long terminal filament

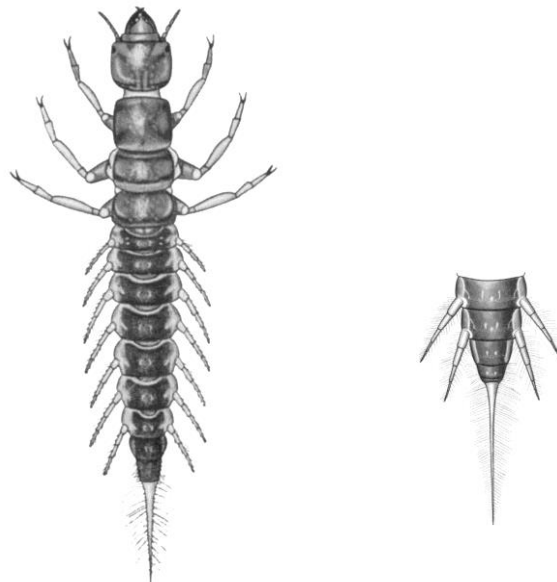
Family Corydalidae (dobsonflies):

- abdomen possesses 8 pairs of 2 segmented lateral filaments
- abdomen terminates in two anal prolegs, each of which has two terminal hooks



Family Sialidae (alderflies):

- abdomen possesses 7 pairs of 4-5 segmented lateral filaments
- abdomen terminates in a single unbranched filament



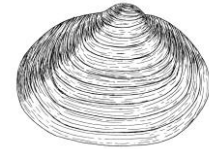
Section 15. Phylum Mollusca (clams and snails) → 8 local families
[unless otherwise specified, details from Voshell (2002) and figures from Pennak (1989)]

A. Class Bivalvia (clams):

1) Order Veneroida

Family Sphaeriidae (=Pisidiidae) (fingernail clams):

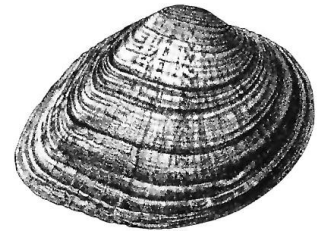
- shell 2-10 mm long, rarely up to 20 mm
- shell usually thin and fragile
- growth rings are very close together and hardly raised creating a smooth texture
- color of shell ranges from whitish or cream to light tan or light gray



2) Order Unionida

Family Unionidae (unionid mussels):

- shell 30-250 mm long
- in side view, different kinds have various shapes including elongate, oval, triangular, trapezoidal, and rectangular
- shell usually thick and strong
- some kinds have bumps, wrinkles, or ridges on their shells
- color of shell can be light yellow-green, dark green, brown, or blackish



B. Class Gastropoda (snails):

1) Order Basommatophora

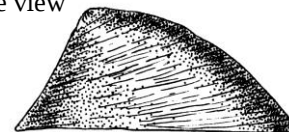
Family Ancyliidae (limpets):

- shell 3-7 mm long
- no operculum
- instead of being coiled, shell is shaped like a low, flat cone

Top view



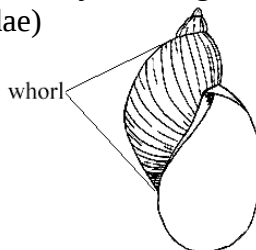
Side view



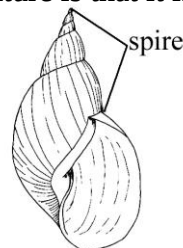
Family Lymnaeidae {2 types are shown below}:

- shell 5-50 mm high
- no operculum
- shell coiled with opening on right side (“dextral”)
- looks very similar to Physidae; major distinguishing feature is that it is right opening (versus being left opening in Physidae)

whorl

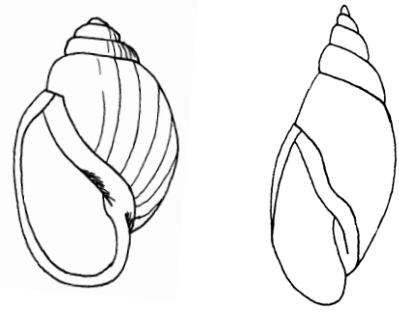


spire



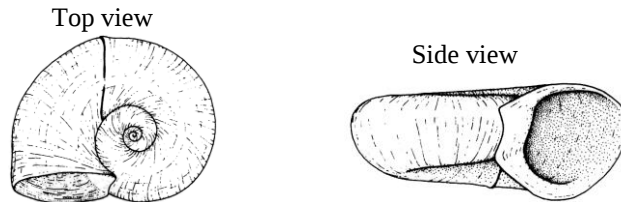
Family Physidae {2 types are shown below}:

- shell 5-20 mm high
- no operculum
- shell coiled with opening on left side (“sinistral”); it is the only family with this feature



Family Planorbidae:

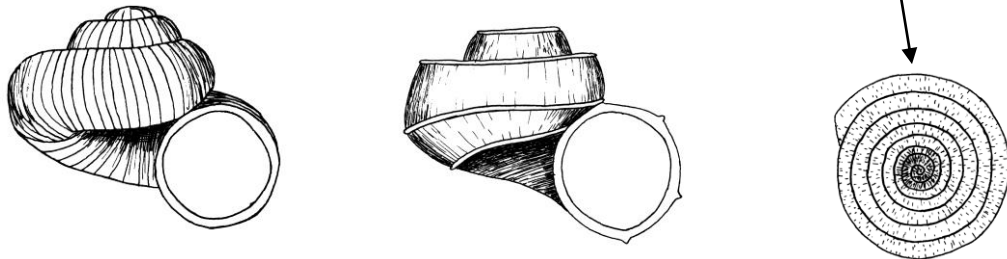
- shell 3-30 mm across coil
- no operculum
- shell is coiled flat instead of being extended into a spire



2) Order Heterostrophia

Family Valvatidae {2 types are shown below} [unless otherwise specified, details from Pennak (1989)]:

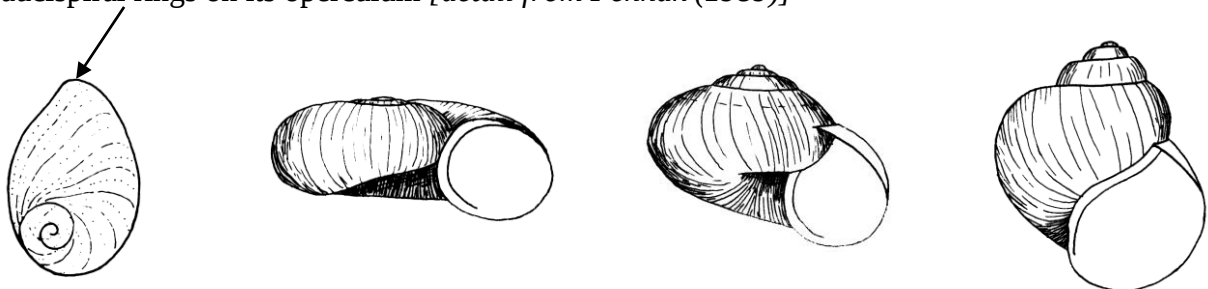
- with an operculum
- spire somewhat depressed
- shell as wide or wider than high and smaller in size (≤ 5 mm high) than Hydrobiidae [detail from Peckarsky et al. (1990)]
- difficult to distinguish from Hydrobiidae. Valvatidae has circular and multispiral rings on its operculum whereas Hydrobiidae has paucispiral rings on its operculum (see below).



3) Order Neotaenioglossa

Family Hydrobiidae {3 types are shown below}:

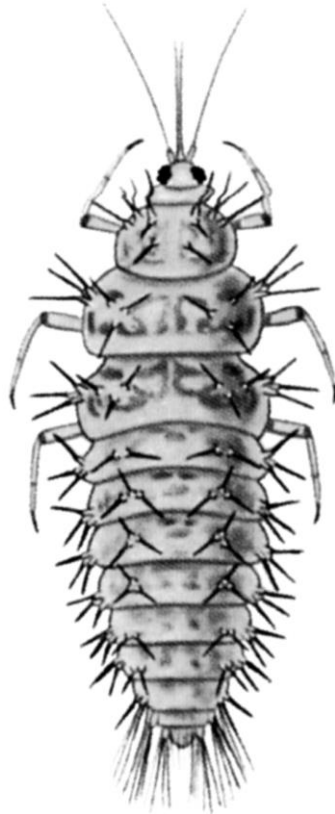
- shell 3-7 mm high
- with an operculum
- whorls of the shell bulge out distinctly at the sides (i.e. are inflated) [detail from Peckarsky et al. (1990)]
- shell higher than wide and larger in size (≤ 9 mm high) than Valvatidae [detail from Peckarsky et al. (1990)]
- has paucispiral rings on its operculum [detail from Pennak (1989)]



Section 16. Order Neuroptera (spongilla fly larvae) → 1 local family
[details and figure from McCafferty (1998)]

Family Sisyridae (spongilla flies):

- body small with long bristles, usually measuring 3-8 mm
- 3 pairs of segmented thoracic legs
- no wingpads and no tails
- very long antennae
- mouthparts are highly modified into a long needle-like sucking apparatus that projects forward



Section 17. Order Odonata (dragonfly and damselfly nymphs) → 8 local families
 [unless otherwise specified, details and figures from McCafferty (1998)]

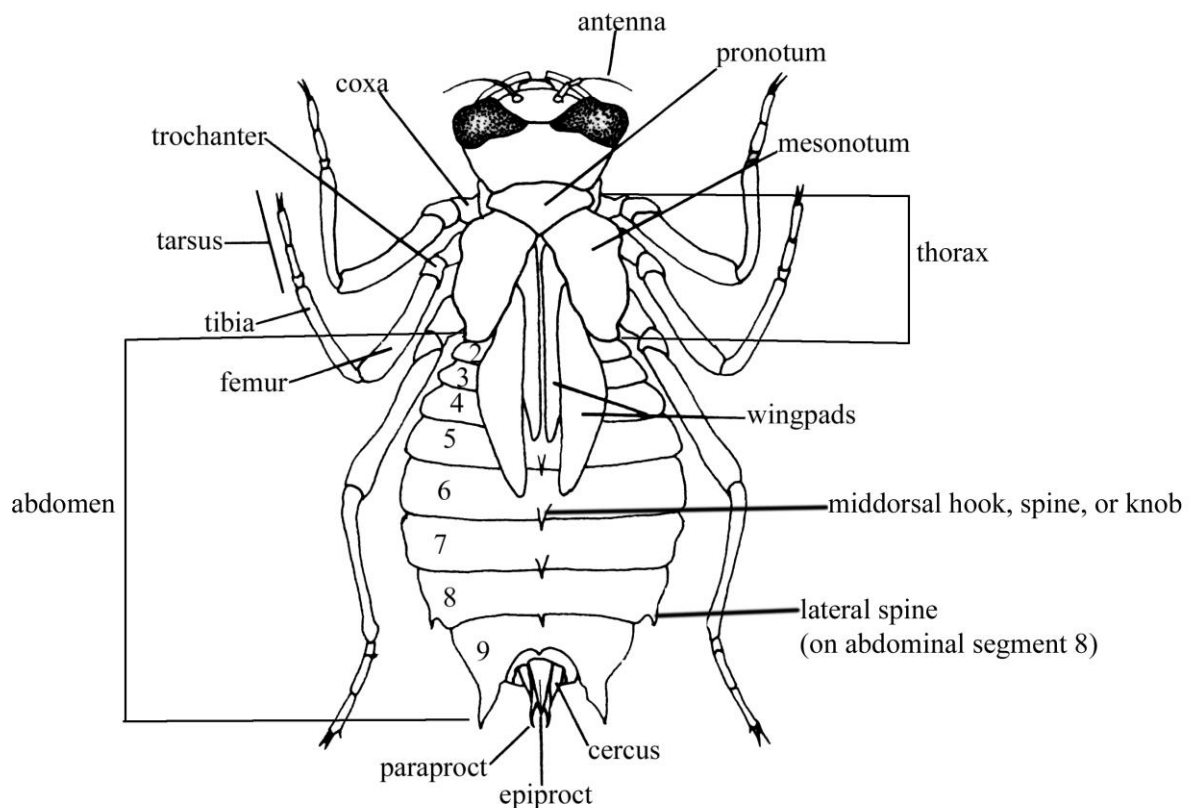
Key features:

- 3 pairs of segmented thoracic legs
- 2 pairs of developing wingpads
- no gills and no tails (however, leaf-like caudal lamellae are present in damselflies)
- labium is highly modified as an extensible prehensile organ

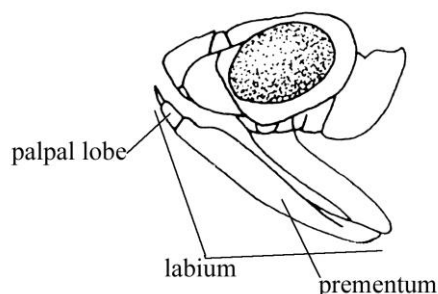
A. Dragonfly nymphs (Suborder Anisoptera):

[general figure seen below from Peckarsky et al. (1990)]

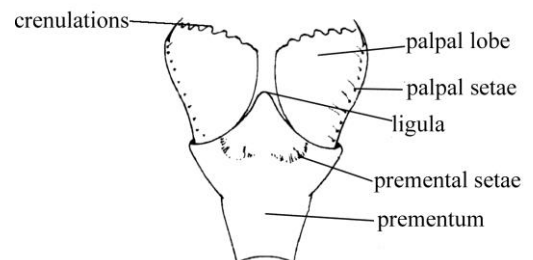
- stout body with an abdomen ending in 5 short, stiff and pointed appendages (2 cerci, 2 paraprocts, 1 epiproct) [detail from Merritt and Cummins (1996)]



Side view of head showing labium
 [figure from Peckarsky et al. (1990)]

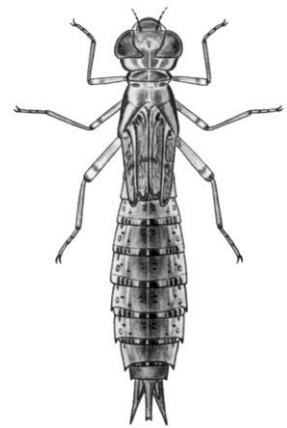
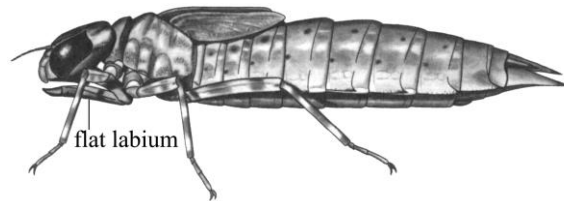


Premmentum of labium
 [figure from Merritt and Cummins (1996)]



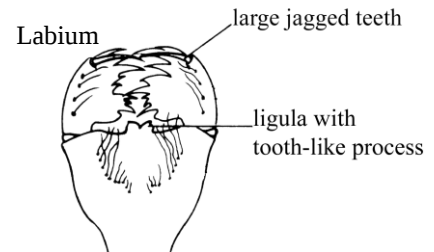
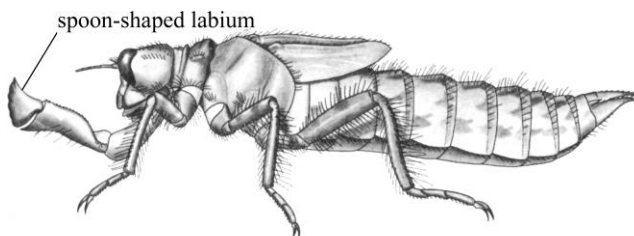
Family Aeshnidae (darners):

- somewhat elongated, usually patterned body which is tapered at the end
- labium is flat (only other local family with this feature is Gomphidae)
- slender antennae with 6-7 segments



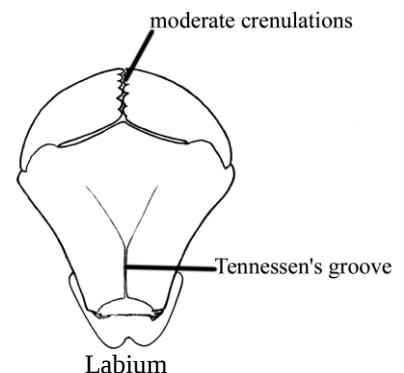
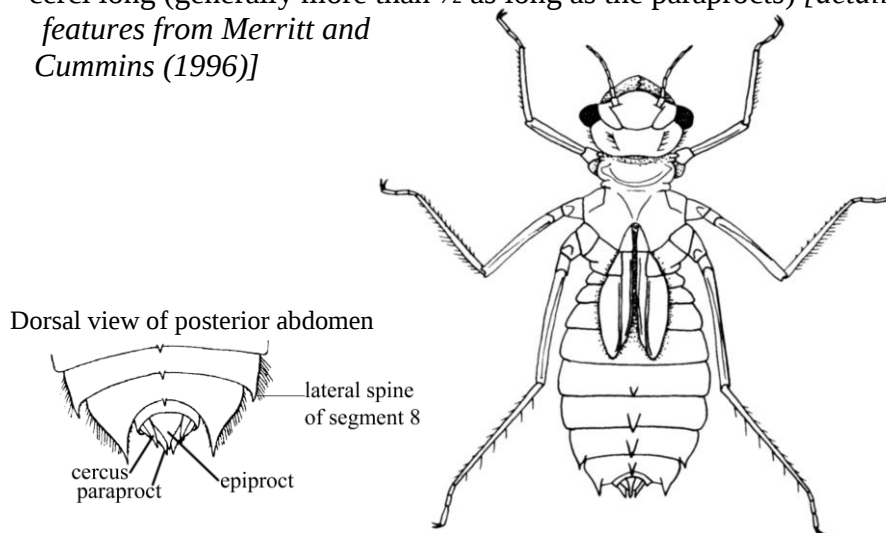
Family Cordulegastridae (biddies):

- very hairy body
- end of abdomen curls upwards (personal observation)
- labium is spoon-shaped
- lateral edges of palpal lobes possess large jagged teeth
- ligula represented by a tooth-like process cleft in the middle [*detail and figure of labium from Merritt and Cummins (1996)*]



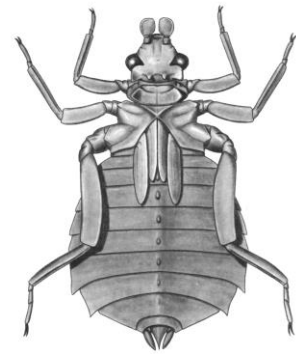
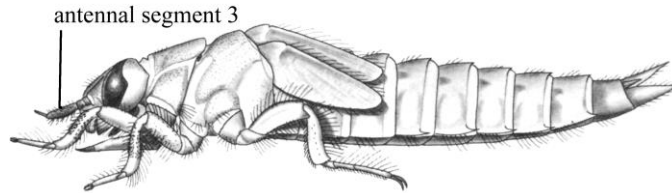
Family Corduliidae (green-eyed skimmers) [*figure of body from Pennak (1978)*]:

- relatively small to medium sized, usually hairy with a somewhat broadened abdomen
- labium is spoon-shaped
- lateral lobes of labium have a series of distinct, moderately sized crenulations
- lateral spines of abdominal segment 8 are either absent or shorter than the midlength of abdominal segment 9
- Tennesen's groove present on ventral side of the prementum (absent in Libellulidae which this family is easily confused with) [*detail and figure of labium provided personally by Dr. Ken Tennesen, Medical Entomologist for the Tennessee Valley Authority (2006)*]
- cerci long (generally more than 1/2 as long as the paraprocts) [*detail and figure of posterior features from Merritt and Cummins (1996)*]



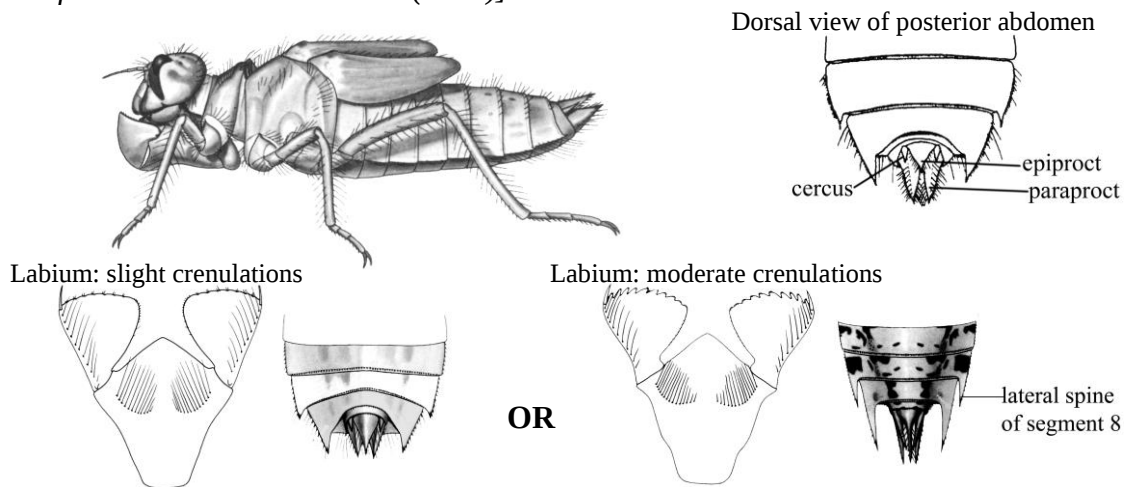
Family Gomphidae (club-tails) {2 types are shown below}:

- labium is flat
- antennae are four-segmented; segment 3 is large and robust and segment 4 is relatively small and sometimes inconspicuous



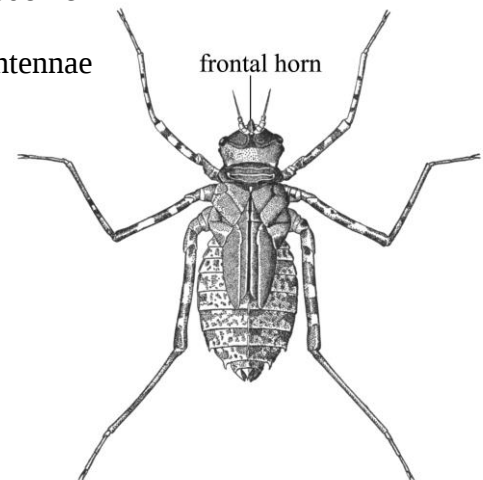
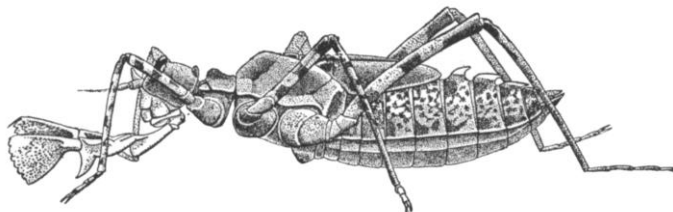
Family Libellulidae (common skimmers):

- similar in size to Corduliidae
- labium is spoon-shaped
- lateral lobes of labium usually possess only slight crenulations; if moderately pronounced then the lateral spines on abdominal segment 8 are as long or longer than the midlength of abdominal segment 9
- no Tennesen's groove on ventral side of the prementum (which is present in Corduliidae) *[detail provided personally by Dr. Ken Tennesen (2006)]*
- cerci short (generally not more than ½ as long as the paraprocts) *[detail and figure of posterior features from Merritt and Cummins (1996)]*



Family Macromiidae (belted and river skimmers) [figures from Pennak (1978)]:

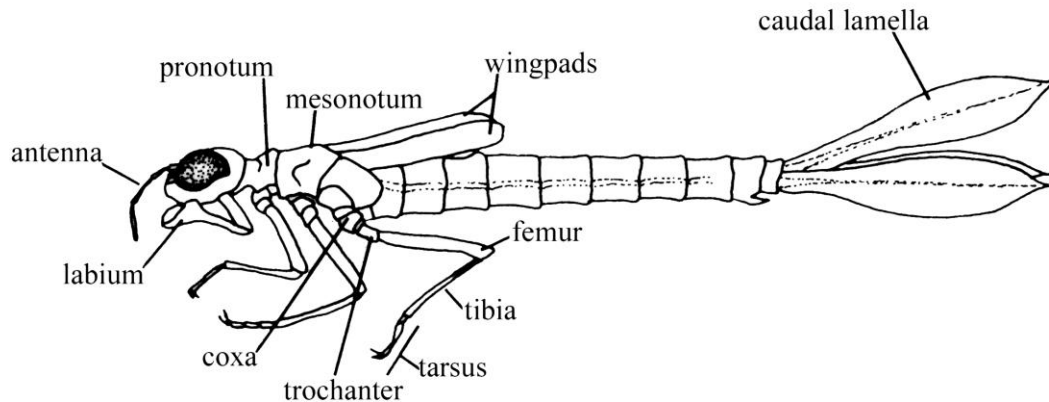
- robust body with very long and slender legs and a broad flat abdomen
- labium is spoon-shaped
- head possesses a distinctive frontal horn arising between the antennae



B. Damselfly nymphs (Suborder Zygoptera):

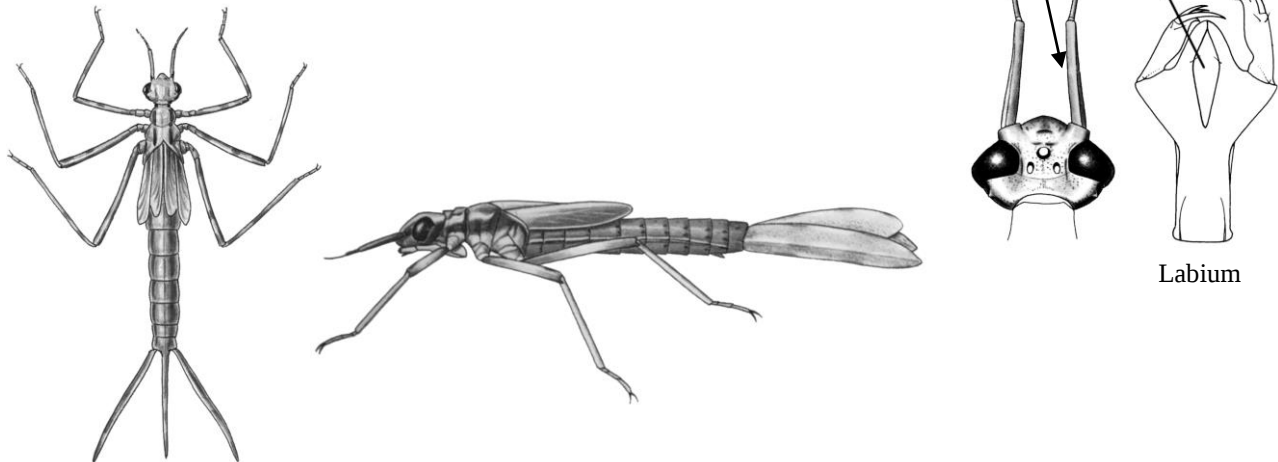
[general figure seen below from Peckarsky et al. (1990)]

- slender body which terminates in three well-developed caudal lamellae



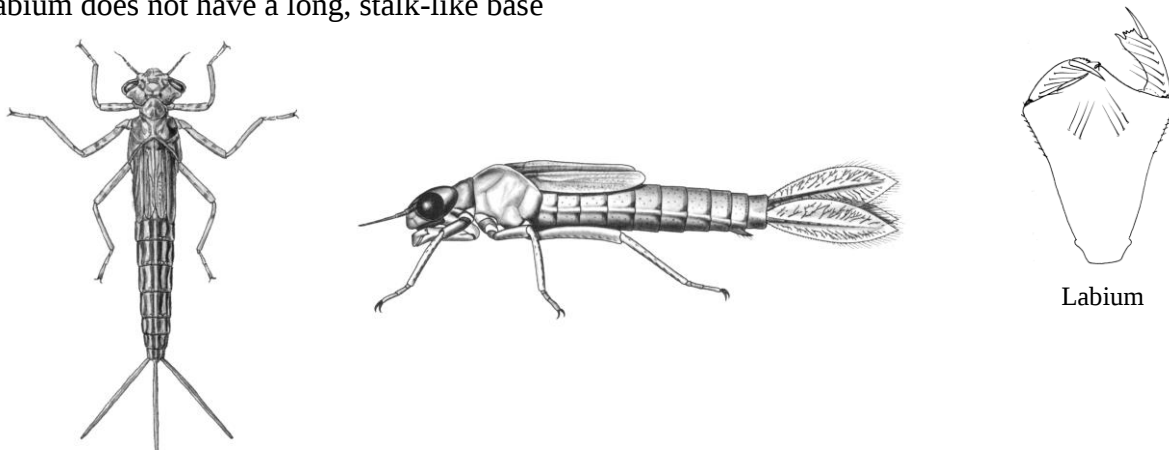
Family Calopterygidae (broad-winged damselflies) [top view of body from Voshell (2002)]:

- long and slender body with generally stilt-like legs
- 1st segment of antennae conspicuously long (longer than all other segments combined)
- median lobe of labium is deeply cleft
- lateral caudal lamellae are more slender and elongate than the middle lamella



Family Coenagrionidae (narrow-winged damselflies) [top view of body from Voshell (2002)]:

- shorter body length than Calopterygidae
- segments of antennae all of approximately equal length
- median lobe of labium is never cleft
- labium does not have a long, stalk-like base

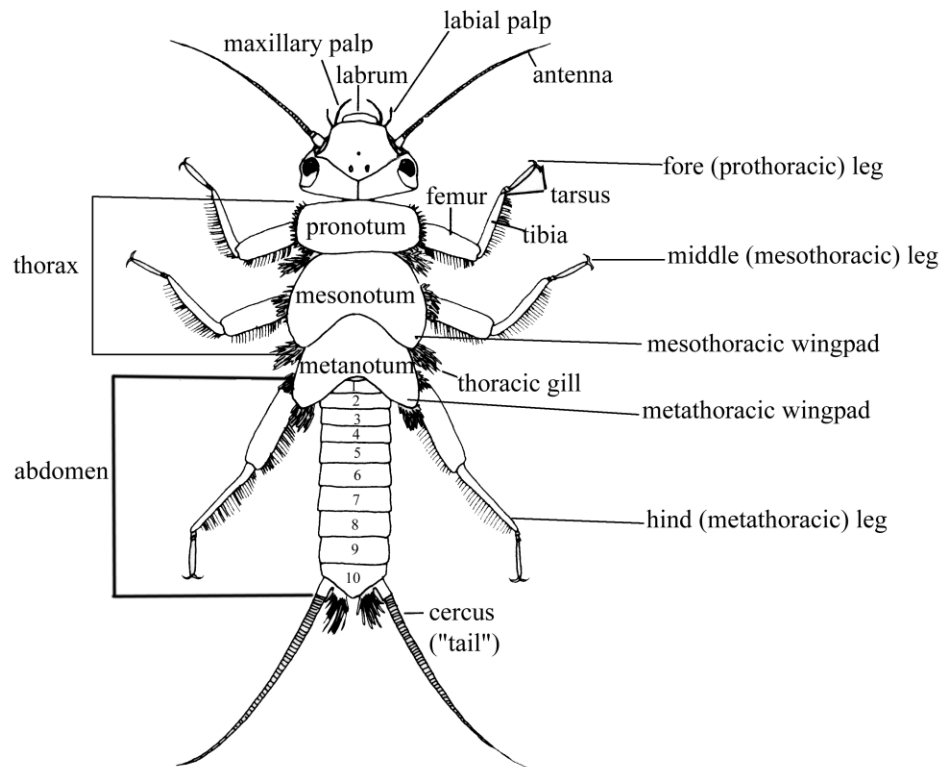


Section 18. Order Plecoptera (stonefly nymphs) → 8 local families

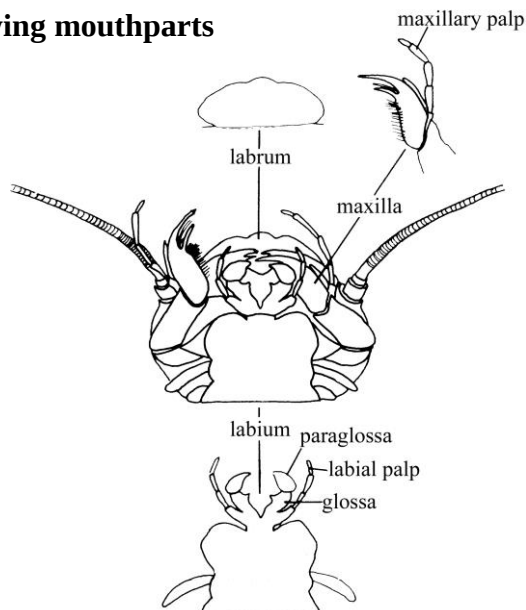
[general figures seen below from Peckarsky et al. (1990);
unless otherwise specified, details and other figures from McCafferty (1998)]

Key features:

- 3 pairs of segmented thoracic legs
- 2 pairs of developing wingpads
- abdomen terminates in 2 long filamentous tails (“cerci”)
- no gills or, if present, are on the head, thorax, and/or basal segments of the abdomen (never on middle abdominal segments as seen in mayflies)
- legs possess 2 claws (versus single claws in mayflies)

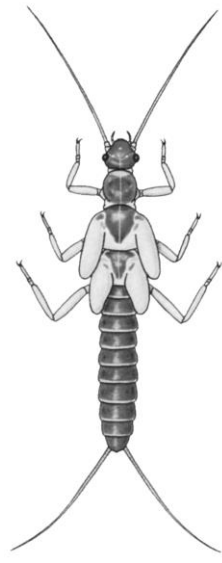


Ventral view of head showing mouthparts



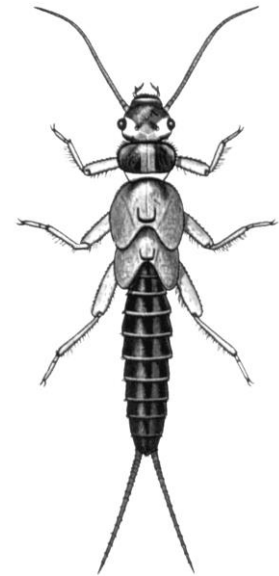
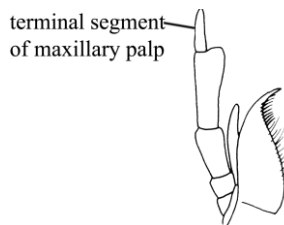
Family Capniidae (slender winter stoneflies):

- small and slender body
- body usually highly pigmented brown [detail from Peckarsky et al. (1990)]
- labium even (see figure under Leuctridae); glossae and paraglossae are about the same length
- lateral margins of abdomen, as viewed from above, appear zigzagged
- abdomen with segments 5-7 distinctly wider than other segments (i.e. bulges slightly at the middle) [detail from Peckarsky et al. (1990)]
- parallel wingpads
- lateral longitudinal fold of abdomen extends through segment 8 (this feature is difficult to see) [figure of fold from Peckarsky et al. (1990)]



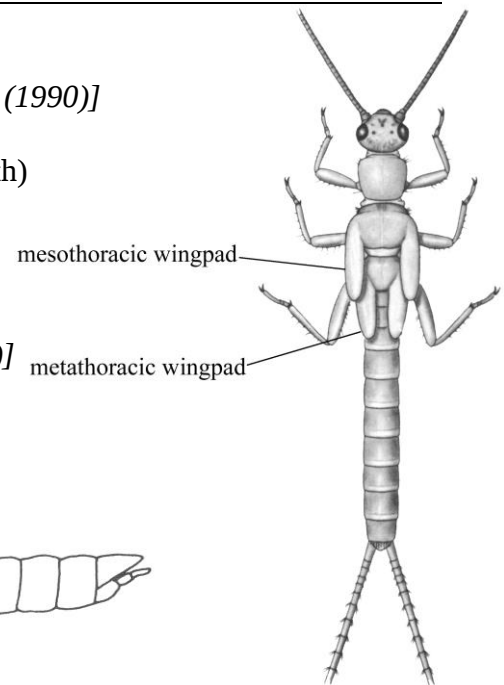
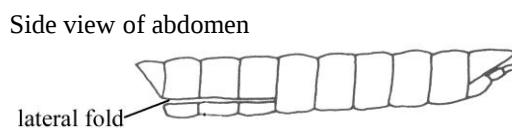
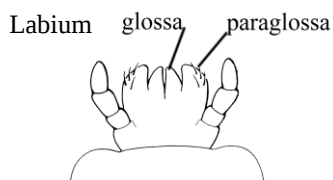
Family Chloroperlidae (green stoneflies):

- often patternless, somewhat cylindrical body
- tails usually shorter than the abdomen (versus being longer in Perlodidae)
- labium deeply divided (see figure under Perlodidae); tips of glossae situated far behind tips of the paraglossae
- parallel wingpads
- terminal segment of maxillary palp very thin (versus being of equal size to other segments, as in Perlodidae) [detail and figure of palp from Peckarsky et al. (1990)]



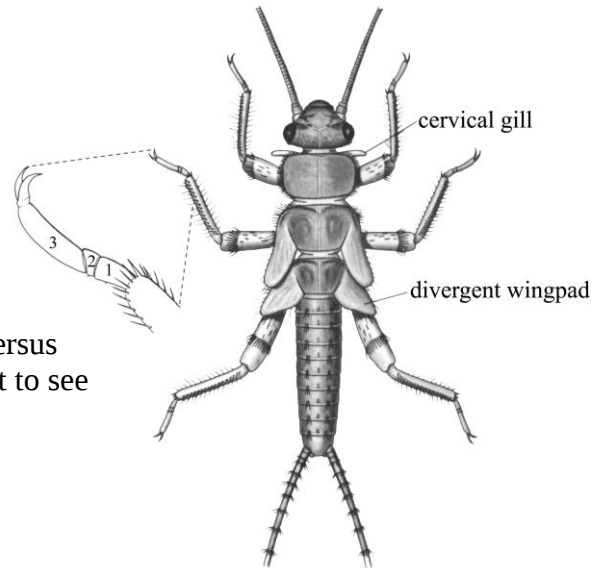
Family Leuctridae (rolled-winged stoneflies):

- small and slender body
- usually lightly pigmented yellow [detail from Peckarsky et al. (1990)]
- antennae and tails are typically very long (but easily broken)
- labium even (glossae and paraglossae are about the same length)
- lateral margins of abdomen, as viewed from above, are relatively smooth and straight
- parallel wingpads
- metathoracic wingpads are distinctly closer together than the mesothoracic wingpads [detail from Thorp and Covich (2001)]
- lateral longitudinal fold of abdomen does not extend beyond segment 7 (this feature is difficult to see) [figure of fold from Peckarsky et al. (1990)]



Family Nemouridae (nemourid broad-backs):

- relatively short and robust body with many hairs
- cervical (“neck”) gills may be present
- hind legs usually can be extended beyond the tip of the abdomen [detail from Peckarsky et al. (1990)]
- labium even (see figure under Leuctridae); glossae and paraglossae are about the same length
- strongly divergent wingpads
- tarsal segment 2 is much shorter than tarsal segment 1 (versus being longer in Taeniopterygidae); this feature is difficult to see

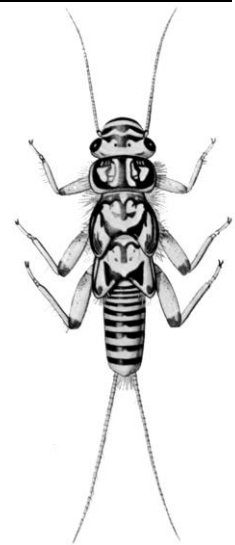
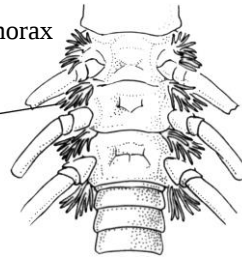


Family Perlidae (common stoneflies):

- typically with brown and yellow markings
- finely branched gills are present on the sides and underside of all thoracic segments but are absent from abdominal segments [detail from Peckarsky et al. (1990), figure showing gills from Voshell (2002)]
- hind legs can be extended beyond the tip of the abdomen
- labium deeply divided (see figure under Perlodidae); tips of glossae situated far behind tips of the paraglossae

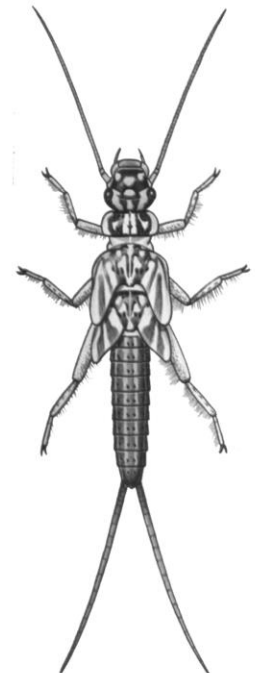
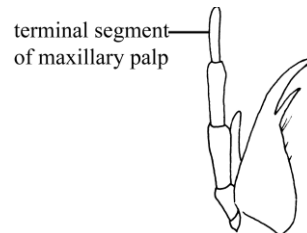
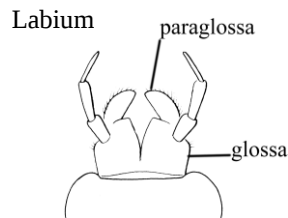
Ventral view of thorax

branched gills



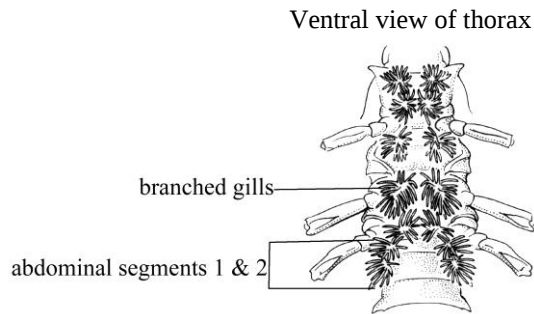
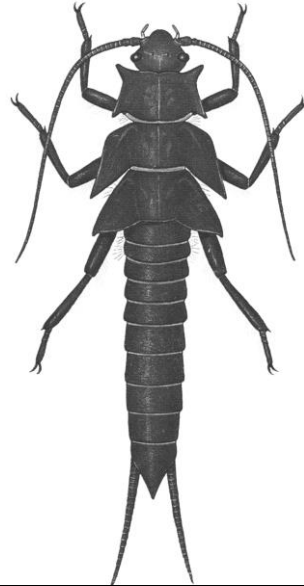
Family Perlodidae (perlodid stoneflies):

- often with a highly patterned body
- tails usually as long or longer than the abdomen
- labium deeply divided (tips of the glossae situated far behind tips of the paraglossae)
- divergent wingpads
- terminal segment of maxillary palp approximately the same size as the other segments [detail and figure of palp from Peckarsky et al. (1990)]



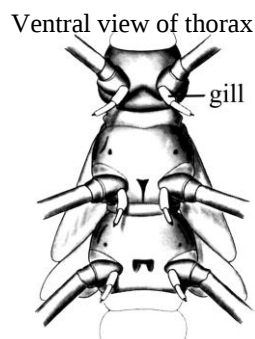
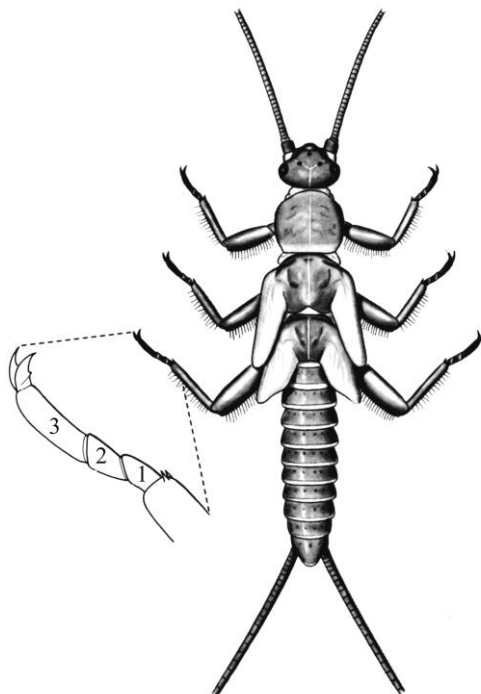
Family Pteronarcyidae (giant stoneflies):

- very large body (one locally found species is black with a rectangular pronotum, as seen below)
- finely branched gills are present on the sides and underside of all thoracic segments and are present on abdominal segments 1-2 or 1-3 [detail from Peckarsky et al. (1990), figure showing gills from Voshell (2002)]
- hind legs usually cannot be extended beyond the tip of the relatively long abdomen
- labium even (see figure under Leuctridae); glossae and paraglossae are about the same length



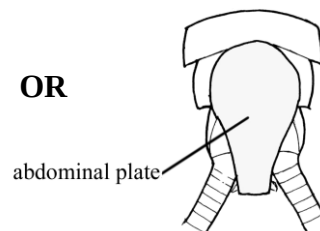
Family Taeniopterygidae (taeniopterygid broad-backs):

- has slender finger-like gills at the base of each leg OR has a large triangular plate on the ventral side of the terminal segment of the abdomen [detail from Peckarsky et al. (1990), figure of plate from Thorp and Covich (2001)]
- labium even (see figure under Leuctridae); glossae and paraglossae are about the same length
- divergent wingpads
- tarsal segments 1 and 2 are approximately the same size (this feature is difficult to see)



Ventral view of posterior abdomen

OR



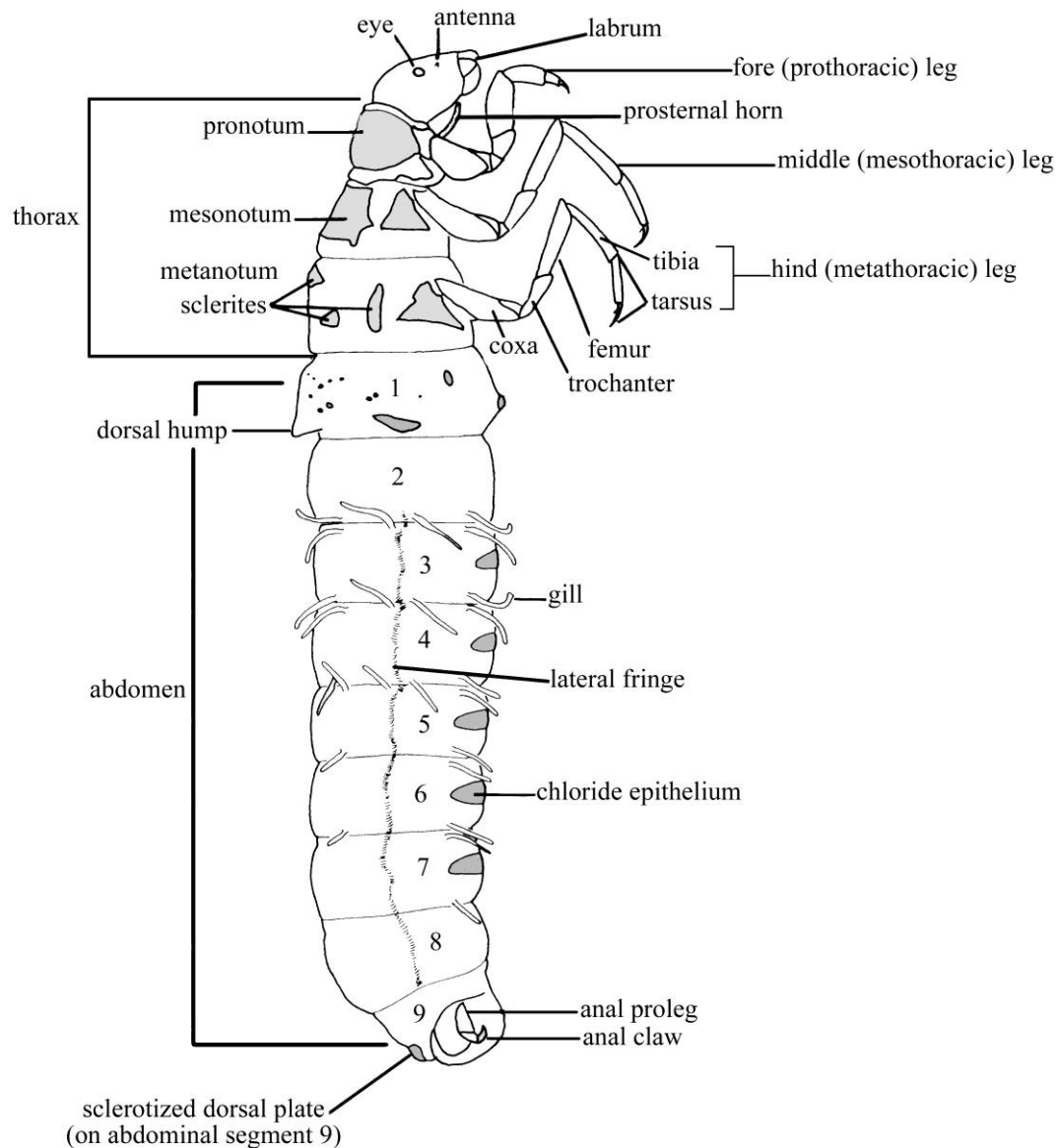
Section 19. Order Trichoptera (caddisfly larvae) → 15 local families

[general figure seen below from Peckarsky et al. (1990);

unless otherwise specified, details from McCafferty (1998) and figures from Wiggins (1996)]

Key features:

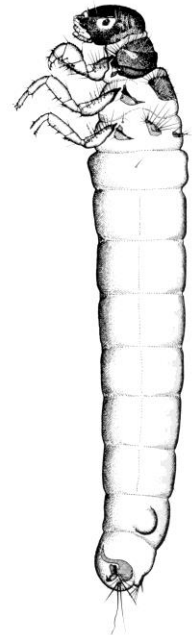
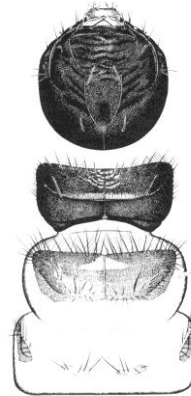
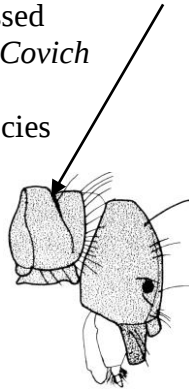
- elongated bodies which terminate in a pair of anal prolegs, each with a single claw that is usually hook-shaped
- 3 pairs of segmented thoracic legs
- no wingpads and no tails
- may have simple filamentous gills
- most construct either cases or nets which are of taxonomic significance



Family Brachycentridae (hump-less case makers):

Case: - variable (only one type is shown below)

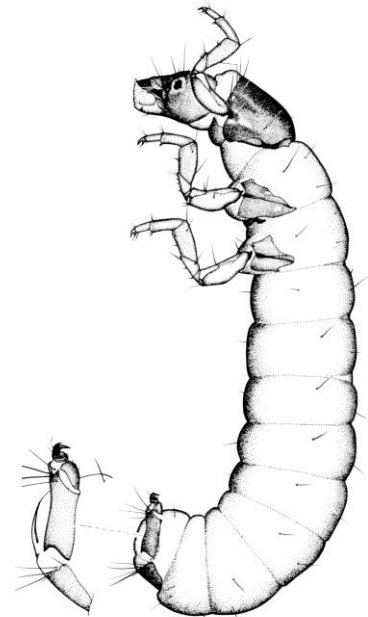
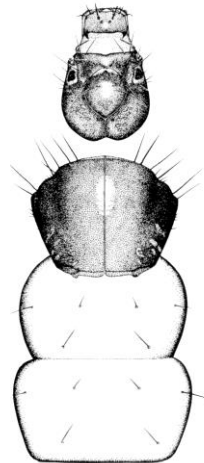
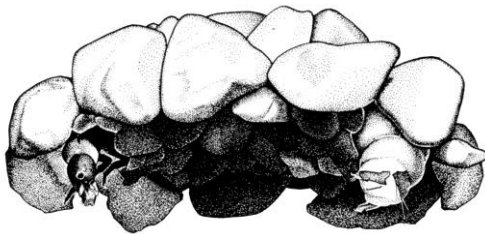
- pronotum and mesonotum have hardened plates covering most of their surface
- no dorsal or lateral abdominal humps
- pronotum divided by a sharp transverse furrow across the middle, the area in front of the furrow being depressed
[detail and figure of head from Thorp and Covich (2001)]
- short prosternal horn is present in some species
[detail from Merritt and Cummins (1996)]



Family Glossosomatidae (saddle-case makers):

Case: - made entirely of rocks in a “tortoiseshell” saddle-case form

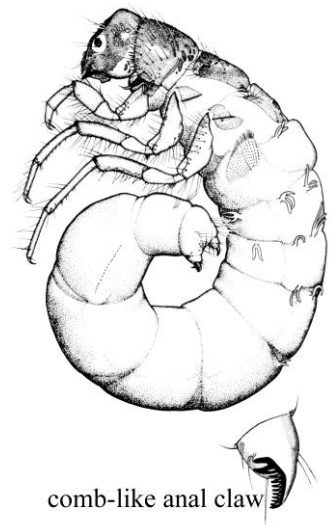
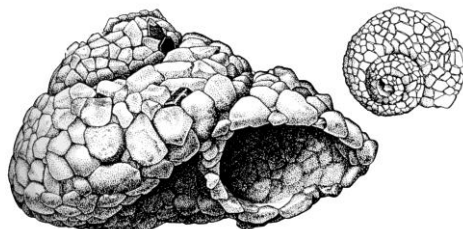
- only the pronotum has a hardened plate
- anal prolegs fused for roughly half their length and dark in color
- abdominal segment 9 has a dorsal plate



Family Helicopsychidae (snail-case makers):

Case: - made entirely of rocks and resemble tightly coiled snail shells

- pronotum and mesonotum have hardened plates covering most of their surface
- body strongly curved
- claw of anal prolegs distinctly comb-like (i.e. with a row of secondary teeth)
- rarely collected without their cases [detail from Voshell (2002)]

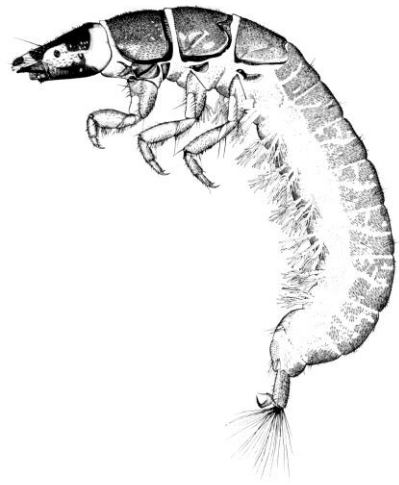
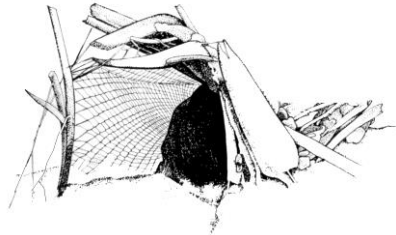


comb-like anal claw

Family Hydropsychidae (common netspinners):

Case: - does not construct a portable case but rather silken capture nets

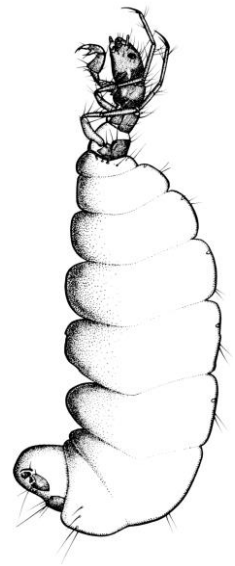
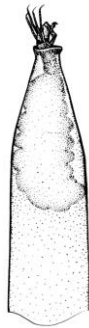
- all 3 thoracic segments have hardened plates
- curved body
- abdomen possesses branched ventral gills
- anal prolegs usually have a tuft of long hairs



Family Hydroptilidae (micro caddisflies):

Case: - variable but commonly purse-like and laterally flattened

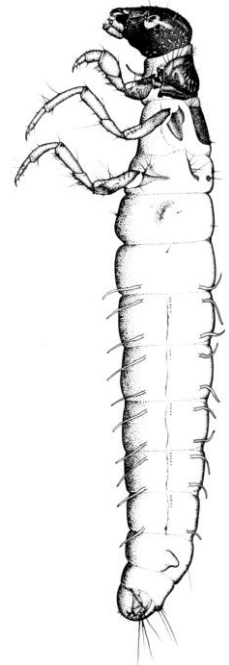
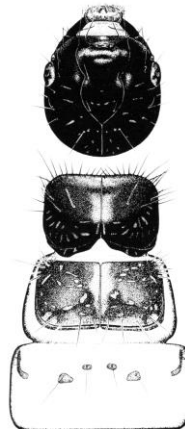
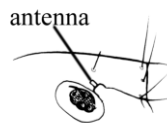
- all 3 thoracic segments have hardened plates
- extremely small body (1-4 mm)
- in some species the middle segments of the abdomen are gradually or abruptly expanded



Family Lepidostomatidae (lepidostomatid case makers):

Case: - variable (only one type is shown below)

- pronotum and mesonotum have hardened plates
 - prosternal horn present
 - small lateral humps only
 - no dorsal hump (versus being prominent in Limnephilidae)
 - tiny antennae are positioned very close to the eyes (versus being closer to the anterior margin of the head in Limnephilidae)
 - bristles are not well-developed on abdominal segment 1 (versus being prominent in Limnephilidae)
 - no chloride epithelia (which are usually present in Limnephilidae)
- [detail from Peckarsky et al. (1990)]



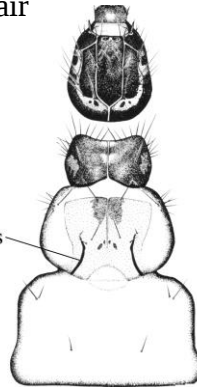
Family Leptoceridae (long-horned case makers):

Case: - variable (only one type is shown below)

- pronotum and mesonotum have hardened plates (second one is only lightly sclerotized)
- dorsal and lateral humps present
- antennae very long and prominent, at least 6 times as long as wide OR sclerites on mesonotum lightly pigmented, except for a pair of dark curved lines on the posterior half [detail from Merritt and Cummins (1996)]
- the hind legs are much longer than the other legs and are often held over the thorax and head [detail from Voshell (2002)]

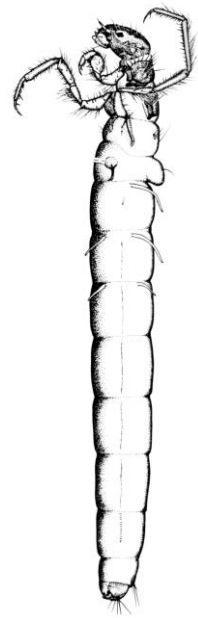
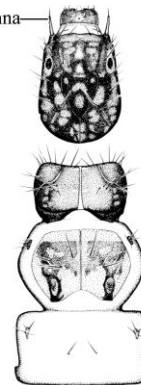


curved lines



long antenna

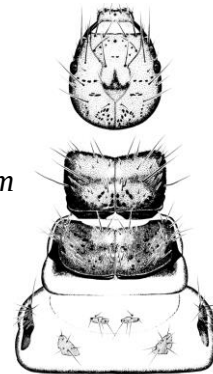
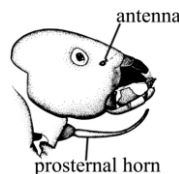
OR



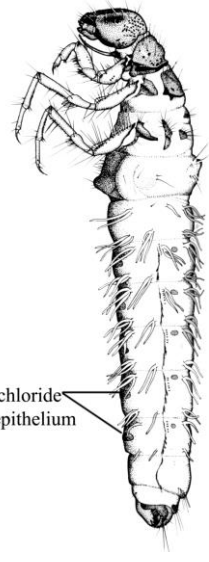
Family Limnephilidae (northern case makers):

Case: - variable (only one type is shown below)

- pronotum and mesonotum have hardened plates but some species also have small medial plates ("sclerites") on thoracic segment 3
- prosternal horn present
- prominent lateral and dorsal humps present
- antennae situated halfway between the eye and the anterior margin of the head
- abdominal segment 1 almost always has pronounced bristles
- gills are simple, branched, or absent
- chloride epithelia usually present on the abdomen [detail from Peckarsky et al. (1990)]



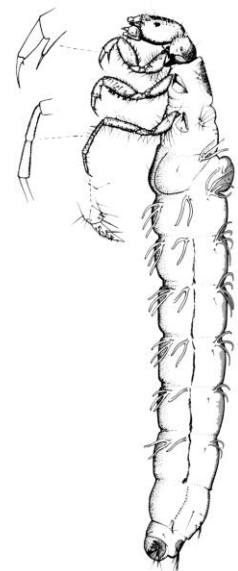
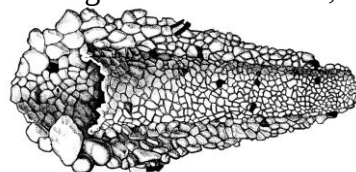
chloride epithelium



Family Molannidae (hood-case makers):

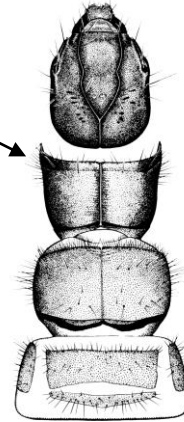
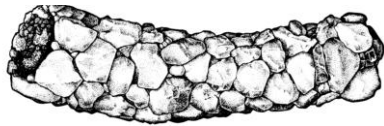
Case: - made of rocks in the shape of a flanged and flattened hood-case

- pronotum and mesonotum have hardened plates (second one is only lightly sclerotized)
- head has a darkened Y marking on the dorsal side in the only locally found genera, *Molanna* sp. [detail from Wiggins (1996)]
- lateral fringe is well-developed [detail from Wiggins (1996)]
- humps on abdominal segment 1 are prominent [detail from Wiggins (1996)]
- claws of hind legs are either short and covered with tiny stout bristles (*Molanna* sp.) OR long and filament-like; only *Molanna* sp. is shown here



Family Odontoceridae (strong-case makers):

- Case: - made of rocks, cylindrical, gradually tapering and/or curved
- very strongly cemented together
- pronotum and mesonotum have hardened plates
 - gills consist of clusters of many small filaments
 - in some species the anterolateral margins of the pronotum are produced into long, sharp, forward-projecting points [detail from Peckarsky et al.(1990)]

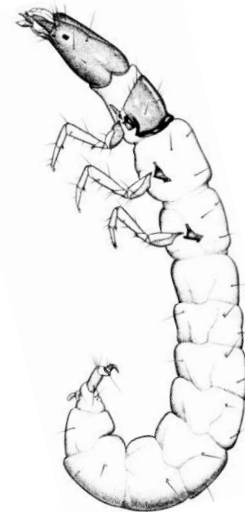
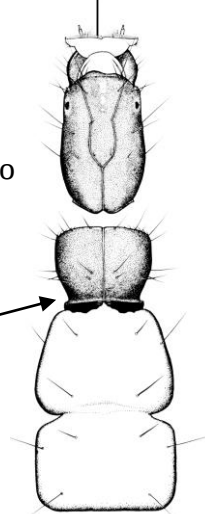


Family Philopotamidae (finger-net caddisflies):

- Case: - does not construct a portable case but rather saddle-like nets
- only pronotum has a hardened plate
 - most of the anal prolegs are free and well-developed
 - labrum is membranous and T-shaped (sometimes retracted so not always obvious)
 - no dorsal or lateral humps
 - abdomen tends to have a strong ventral curve and is whitish in color
 - pronotum is bordered posteriorly by a black line

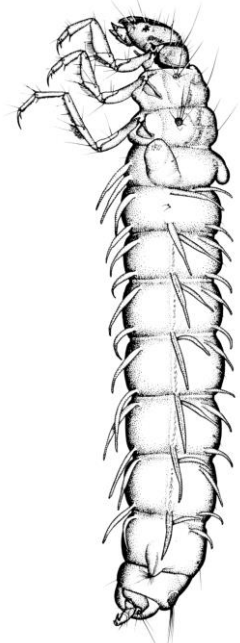
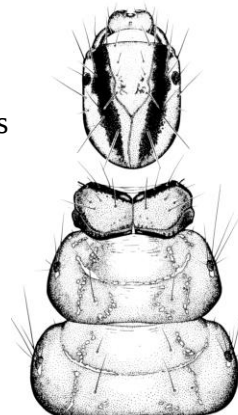


T-shaped labrum



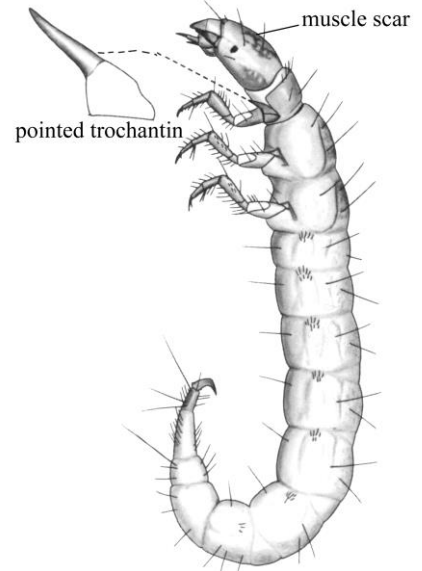
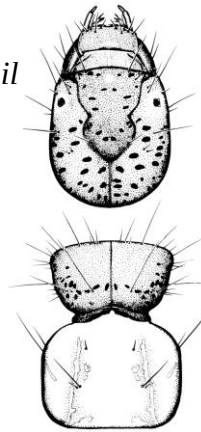
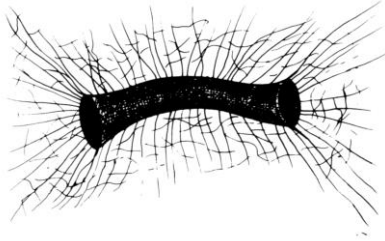
Family Phryganeidae (giant case makers):

- Case: - variable, usually made of plant materials (only one type is shown below)
- large, elongated bodies
 - some species only have a hardened plate on the pronotum (outlined in dark bands in most species); others also have a hardened plate on the mesonotum
 - head and pronotum are conspicuously marked with dark stripes on a yellow background [detail from Voshell (2002)]
 - prosternal horn present
 - dorsal hump very obvious
 - abdominal segment 1 has ventral gills, and other segments may or may not have gills
 - abdominal segment 9 has a dorsal plate



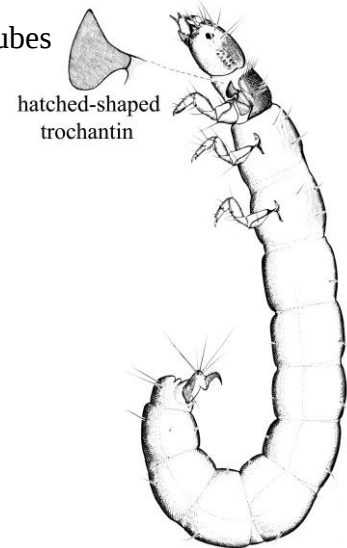
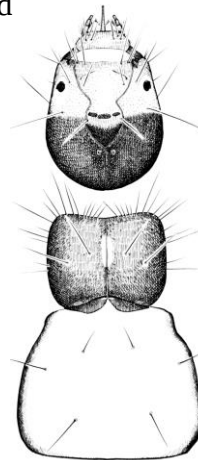
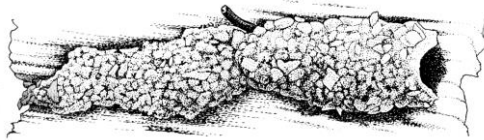
Family Polycentropodidae (tube-making caddisflies) [figure of body from McCafferty (1998)]:

- Case: - does not construct a portable case but rather nets or tubes
 - only pronotum has a hardened plate
 - most of the anal prolegs are free and well-developed
 - no dorsal or lateral humps
 - fore trochantin pointed at apex
 - head usually with muscle scars ("spotted") [detail from Peckarsky et al. (1990)]



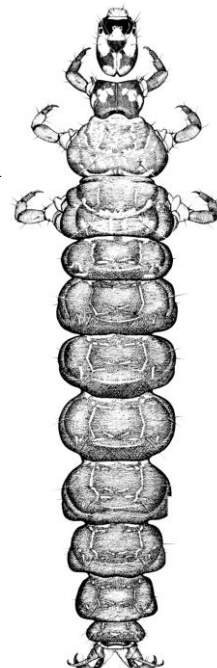
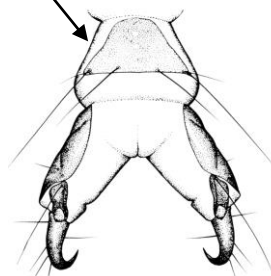
Family Psychomyiidae (net-tube caddisflies):

- Case: - does not construct a portable case but rather particle covered tubes
 - only pronotum has a hardened plate
 - most of the anal prolegs are free and well-developed
 - no dorsal or lateral humps
 - fore trochantin broad at apex ("hatchet-shaped")



Family Rhyacophilidae (freeliving caddisflies):

- Case: - only caddisfly that does not build any form of case or net
 - only pronotum has a hardened plate
 - anal prolegs are well-developed and free for most of their length
 - abdomen usually has deep constrictions between the segments, as seen from above
 - no dorsal or lateral humps
 - claws on the prolegs are long, stout, curved, and sharply pointed
 - abdominal segment 9 possesses a dorsal plate



Literature Cited

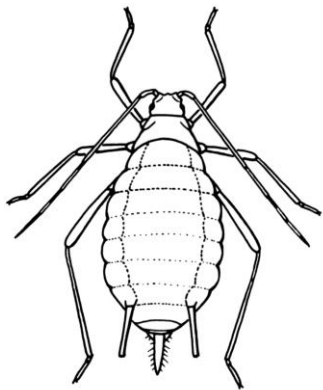
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Online reference for CABIN: <https://www.canada.ca/en/environment-climate-change/services/canadian-aquatic-biomonitoring-network.html>

Online reference for the ITIS: <https://www.itis.gov/>

Appendix 1. Other aquatic invertebrates not included in FIRNNO counts

[Note: These are commonly found in local benthic samples but are not included in counts, following the RCA protocol – see page 1 for details]



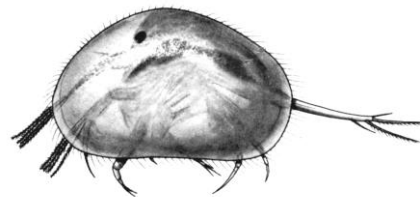
Aphid



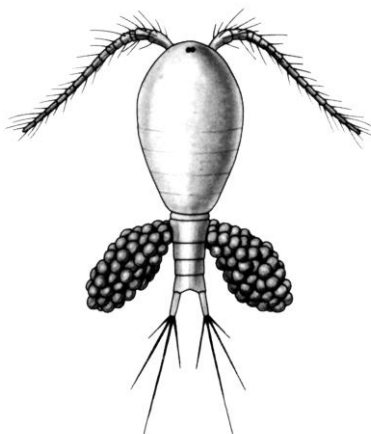
Nematode



Planarian (flat worm)



Ostracod (seed shrimp)



Zooplankton (Copepod)



Zooplankton (Cladocera)