

John Mercer

# Macrobenthos of the Saint John River Headponds



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Report No. 15e

**The Saint John River Basin Board**

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2. Hydrology of the Saint John River Basin
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- S 2 The Water Resources of the Saint John River Basin
- S 3 Floods in the Saint John River Basin
- S 4 Water Quality in the Saint John River Basin
- S 5 Water Use for Agriculture in the Saint John River Basin
- S 6 Water Use in the Forest Industries in the Saint John River Basin
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- S 8 Water Use for Wildlife in the Saint John River Basin
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- S12 Water Use for Manufacturing in the Saint John River Basin
- S13 Water Use by Municipalities in the Saint John River Basin
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- S16 Water Use and Toxic Pollutants in the Saint John River Basin

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## FOREWORD

This study is one of a series commissioned by the Saint John River Basin Board as part of its program for preparing a water management plan for the Basin. A draft has been reviewed by members of the Board, its Advisory and Liaison Committee and Planning Office. The reviewers are satisfied that the work was conducted conscientiously by highly qualified people and that they have fulfilled their terms of reference. Although the report has been checked carefully for errors, inconsistencies and omissions, a few almost certainly remain. The Planning Office would appreciate hearing of them.

This is a report made to the Board, and the recommendations put forward in it are the author's own. Each recommendation will be carefully considered during the process of developing the comprehensive plan for the river basin. However, some recommendations made with the aim of improving conditions for one water use may not be compatible with needs of other uses. As the objective of the plan is to seek an optimum balance among all uses of the water resource, it is quite possible that the Board will not include in its final plan all the recommendations contained in this report. They are presented here, nevertheless, for public information and debate.

The Saint John River Basin Board,  
Fredericton, New Brunswick,  
November, 1973.

MACROBENTHOS OF THE  
SAINT JOHN RIVER HEADPONDS

A report prepared  
for the  
Saint John River Basin Board

by

F.C. Duerden, A. McMinn and P. Keachie

Resource Development Branch  
Fisheries and Marine Service  
Canada Department of the Environment  
Halifax, Nova Scotia

July 1973

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## INTRODUCTION

An understanding of the viability of any body of water must take into consideration the productive capacity of the organisms contained within it. A knowledge of the variety of organisms present is therefore important in any thorough investigation of aquatic ecosystems. The initial stages in the ecological study of the headponds of the Saint John River Basin included the cataloguing of the phytoplankton (Watt, 1971) and the zooplankton populations (Duerden, McMinn and Harding, 1973). The present report catalogues the benthic community of the headponds.

In addition to their significance as producers in aquatic food chains, information on the benthos is becoming increasingly important in studies involving the pollution of both marine and freshwaters. The use of some members of the benthic community as pollution indicators appears promising, and indeed has already been applied to the Saint John River Basin headponds (Watt et al, 1973).

## TECHNIQUES

Sampling was conducted in Glazier Lake and in the Tobique, Grand Falls, Beechwood, Woodstock, Woolastook and Nackawic headponds, using an Ekman Grab covering an area of 0.023m<sup>2</sup>. Approximately 7 grab samples were taken at each station and placed in plastic sand buckets.

In the laboratory, the samples were washed clean of fine mud and debris using a Ponar Wash Frame (screen mesh size = 0.52 mm.). After washing, the organisms were placed in 475 ml jars and formalin was added. Sub-samples were then obtained using a Folsom Plankton splitter. Each sub-sample was then washed through a series of standard mesh screens (mesh sizes 10, 20 and 40). The organisms were removed from the screens and placed in one of two 10 ml vials. One vial received only members of the Oligochaeta while the remaining animals were placed in the other.

It was possible to identify and enumerate most animals using a stereomicroscope only. In some instances, however, slide preparations were necessary. When this was the case, Amman's lactophenol was used as a mounting medium and a Wild phase contrast high power microscope was employed for identification and enumeration. A collection of permanent slides for use as references was prepared in the following manner. Hoyer's Insect Mounting Medium and Turtox CMC-S were used as permanent mountants. When dry, the slides were ringed with enamel to preserve them. Animals mounted in CMC-S were stained with acid fuschin present in the mountant. The organisms which were not placed on slides were preserved in 10% formalin in 10 ml vials.

Classification

Occurrence

Planariidae

Cura foremanii

Nematoda

Oligochaeta

Aulodrilus americanus

Limnodrilus angustipenis

Limnodrilus claparedeianus

Limnodrilus hoffmeisteri

Limnodrilus profundicola

Limnodrilus udekemianus

Lumbriculus variegatus

Peloscolex superiorenensis

Stylodrilus heringianus

Tubifex kessleri americanus

Tubifex tubifex

Glossiphoniidae

Hirudidae

Classification	Occurrence						
	Glazier Lake	Tobique	Grand Falls	Beechwood	Woodstock	Nackawic	Woolastook
<u>Planariidae</u>							
<u>Cura foremanii</u>					+		
<u>Nematoda</u>	+	+	+	+	+		
<u>Oligochaeta</u>							
<u>Aulodrilus americanus</u>	+						
<u>Limnodrilus angustipenis</u>							
<u>Limnodrilus claparedeianus</u>		+	+	+			
<u>Limnodrilus hoffmeisteri</u>	+	+	+	+	+	+	+
<u>Limnodrilus profundicola</u>		+					
<u>Limnodrilus udekemianus</u>	+						
<u>Lumbriculus variegatus</u>	+						
<u>Peloscolex superiorenensis</u>	+	+					
<u>Stylodrilus heringianus</u>	+						
<u>Tubifex kessleri americanus</u>	+						
<u>Tubifex tubifex</u>	+	+	+	+	+	+	+
<u>Glossiphoniidae</u>	+	+	+	+	+	+	+
<u>Hirudidae</u>			+	+	+		

Classification	Occurrence						
	Glazier Lake	Tobique	Grand Falls	Beechwood	Woodstock	Nackawic	Woolastook
<u>Crustacea</u>							
<u>Amphipoda</u>							
<u>Hyalella azteca</u>	+	+		+	+		
<u>Isopoda</u>							
Asellus			+	+	+		
<u>Decapoda (Astacidae)</u>							
Cambarus	+						
<u>Ephemoptera</u>							
Ecdyonurus	+						
Ephemera	+						
Hexagenia	+						
<u>Odonata</u>							
Ischnura				+			
Lestes		+					
<u>Plecoptera</u>							
Leuctra	+						
<u>Neuroptera</u>							
Chauliodes	+						
Sialis		+					

Classification	Occurrence						
	Glazier Lake	Tobique	Grand Falls	Beechwood	Woodstock	Nackawic	Woolastook
<u>Coleoptera</u>							
Dryops		+					
Dubiraphia		+			+		
Gyrinus			+				
<u>Trichoptera</u>							
Oecetis		+		+			
Phylocentropus	+						
Polycentropus	+	+					
Triaenodes		+					
<u>Lepidoptera</u>							
Bellura					+		
Nymphula	+						
<u>Diptera larvae</u>							
( <u>Ceratopogonidae</u> )							
Helinae (sub-family)	+						
Stilobezzia	+			+			
( <u>Chaoborinae</u> )							
Chaoborus	+				+		+

Classification

	Glazier Lake	Tobique	Grand Falls	Beechwood	Woodstock	Nackawic	Woolastook
<u>Diptera larvae</u>							
<u>(Chironomidae)</u>							
Calopsectra	+	+		+	+		
Chironomus	+	+	+	+	+	+	+
Clinotanypus	+						
Corynoneura		+					
Cryptochironomus	+	+	+	+	+	+	+
Diamesinae/Hydrobaeninae	+	+	+				
Endochironomus	+	+	+	+	+		
Glyptotendipes	+	+	+	+	+	+	+
Limnochironomus	+						
Microtendipes	+						
Pentaneura	+	+		+	+		
Phaenopsectra	+	+	+	+	+		+
Polypedilum	+						
Procladius	+	+	+	+	+	+	+
Pseudochironomus	+	+					
<u>Empididae</u> Clinocera	+						
<u>Tabanidae</u> Tabanus	+	+	+				
<u>Tipulidae</u> Pedicia		+	+				
<u>Parasitengona</u>	+	+					

Classification	Occurrence						
	Glazier Lake	Tobique	Grand Falls	Beechwood	Woodstock	Nackawic	Woolastook
Mollusca							
<u>Gastropoda</u>							
( <u>Ancylidae</u> )							
Ferrissia	+						+
( <u>Bulimidae</u> )							
Amnicola	+	+	+	+	+		
( <u>Planorbidae</u> )							
Gyraulus			+	+	+		
Helisoma	+	+	+	+			
( <u>Valvatidae</u> )							
Valvata	+	+	+	+	+		
<u>Pelecypoda</u>							
<u>Anodonta catarecta</u>	+			+	+		
<u>Ligumia nastuta</u>					+		
Musculium				+	+		
Pisidium	+	+	+	+	+		
Sphaerium				+	+		

## GLOSSARY OF BIOLOGICAL TERMS

- Atria:** In the Oligochaeta, storage or intromittent organs for sperm, before copulation; usually paired, sometimes single.
- Carapace:** A secreted chitinous or bony covering over the back of an animal.
- Carina:** A keel-like ridge found along the bottom of the sternum of an insect.
- Cercus** A jointed appendage at the end of the abdomen in many arthropods.
- Clitellum:** A thickened region, glandular in nature and which produces the cocoon at oviposition. In the Oligochaeta, it is one cell thick, more or less opaque, papillate and occupying from 2-6 segments.
- Coelomocytes:** Free granular, spherical to ovoid cells found in the coelom or body cavity of some species of Oligochaetes.
- Dextral:** Univalve mollusks are dextral if the aperture is on the right when the shell is held with the apex uppermost and with the aperture facing the observer.
- Elytrum:** The anterior wing of certain insects; hard and case-like.
- Eruciform:** Caterpillar-like.
- Frons:** Anterior region of insect head.
- Glossa:** Literally a tongue; inner of the two terminal lobes of an insect labium.
- Hydrofuge pubescence:** In adult aquatic beetles, fine sclerotized granules holding a thin film of O<sub>2</sub> to various portions of the body.

- Imago: The last or adult stage in insect metamorphosis.
- Instar: Any one of the several stages through which a metamorphosing arthropod passes before reaching an adult or imago.
- Labial plate: In the chironomidae, a plate forming the 'lower lip' or floor of mouth; usually with row of chitinous teeth on anterior edge.
- Lamella: The gill of a pelecypod mollusc; small plate or plate-like structure.
- Lentic: Pertaining to standing water; living in brook or river.
- Mandibles: The most anterior of three pairs of mouthparts in many arthropods.
- Maxilla: Mouth appendages which are just posterior to the mandibles of many arthropods and modified according to the species' needs.
- Mental Setae: Bristles found on the distal segment of the labrum or 'upper lip' in insects.
- Meson: The medial or sagittal plane of an animal.
- Mesonotum: Dorsal part of insect mesothorax.
- Mesothorax: Middle segment of thoracic region.
- Microphagous: Feeding on minute organisms or particles.
- Operculum: Lid-like structure or epiphragm closing mouth of shell in some gastropods.
- Pallial line: In pelecypods, this muscular device keeps the mantle (glandular tissue) securely fastened, preventing foreign particles from getting between mantle and shell.

palpal lobes:	Labial feelers of insects.
Paralabial plates:	In the Chironomidae, two flat structures, rounded to rectangular and found on the ventral side of the head, posterior to the mouth.
Paucispiral:	With few coils or whorls.
Pereiopods:	Locomotory thoracic limbs of Malacostraca; trunk legs.
Phytophagous:	Herbivorous, living on plants.
Prementum:	Structure on ventral side of insect head; the united stipites bearing ligule and labial palps.
Pronotum:	The dorsal part of prothorax of insects.
Prothorax:	Anterior thoracic segment of Arthropoda.
Protopodite:	Basal segment of an arthropod limb.
Raptorial setae:	Bristles found on the second thoracic leg or thoracopod of Malacostraca.
Radula:	A short and broad strip of membrane with longitudinal rows of chitinous teeth in the mouth of most gastropods.
sa 1, sa 2, sa 3:	In the Trichoptera, the thoracic area has clusters of setae or sclerotized areas bearing setae. The primary setae or setal areas have been identified by the designations sa 1, sa 2, sa 3.
Sclerites:	Calcareous or chitinous plate or spicule; part of exoskeleton.
Sinistral:	Univalve molluscs are sinistral if the aperture is on the left when the shell is held with the apex uppermost and with the aperture facing the observer.

Spermathecae:

Ectodermal pouches which store sperm after copulation in hermaphroditic animals such as the tubificidae.

Spiracular Disc:

Flattened rounded area which bears a pair of functional breathing apertures or spiracles. Located at the extreme posterior end of larvae of crane flies and marsh flies.

Sternum:

Ventral plate of typical arthropod segment; all the ventral sclerites of a thoracic segment in insects.

Stipes:

Distal part of protopodites of first maxilla of insects.

---

Phylum: Platyhelminthes

Class: Turbellaria (flatworms)

Order: Tricladida

More or less elongated. 5-30 mm. long; various shades of gray, brown or black, often dorsal stripes, spots or mottlings. Ventral surface usually lighter in colour.

Gastrovascular cavity consisting of 3 main branches, one anterior and two posterior and lateral.

Family: Planariidae

Head triangular, up to 20-30 mm. long, without an adhesive organ in the center of the anterior margin; nearly always with eyes; coloured or white. Two main eyes, accessory eyes sometimes present as abnormalities; low auricles, testes few, prepharyngeal.

Genus: Cura

Species: C. foremanii, Girard

Short, broad, plump, to 15 mm. long. Uniformly seal-brown or dark grey to black; auricles with a slanting white dash, capsules spherical, stalked. Penis normal with bulb and papilla.

Distribution: New England and Canada, west into Michigan, south into Tennessee and North Carolina; in cool creeks and rivers.

Phylum: Nematoda (roundworms)

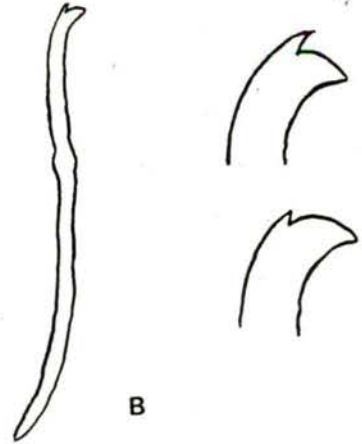
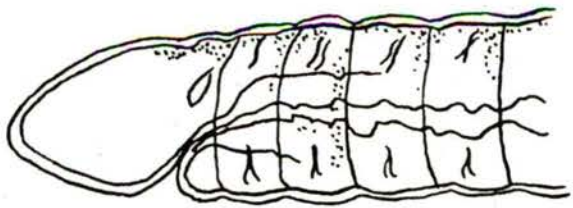
Nematodes occur in practically any collection of sand, mud, debris or vegetation from the bottom or margin of ponds, lakes, brooks or rivers, yet as a group, the freshwater species are poorly known. Nematodes are bilaterally symmetric, cylindroid, unsegmented, bisexual triploblastic organisms, whose identification requires very detailed study of many minute anatomical features. Nematodes occurred in only a very few of the samples obtained from the headponds in this survey, and their presence was so scarce that no attempt was made to classify them beyond the phyletic level.



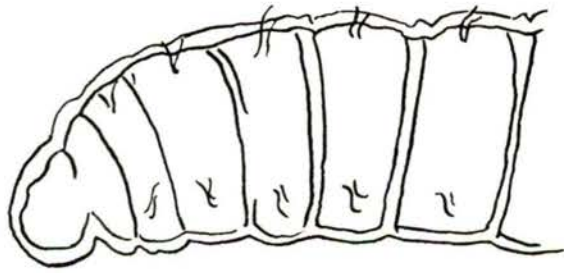
## DESCRIPTION OF OLIGOCHAETE ILLUSTRATIONS (Cont'd)

E III.

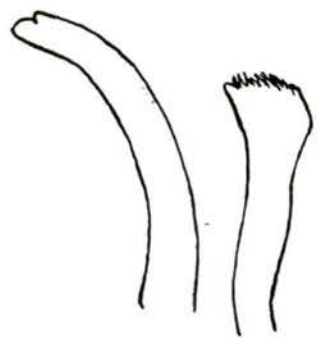
- W --- Limnodrilus angustipenis, penis sheath  
X --- Seta of L. angustipenis  
Y --- Limnodrilus profundicola, penis sheath  
Z --- Limnodrilus hoffmeisteri, seta  
a --- L. hoffmeisteri, penis sheath (typical)  
b --- L. hoffmeisteri, (straight-headed variant)  
c --- L. hoffmeisteri, spiral muscles around penis sac  
(acc. to Eisen.)



B



D



1 2



F



G



H

C

E



I



J



K



L



M



N



O



P



Q



R



S



T



U



V



W



X



Y



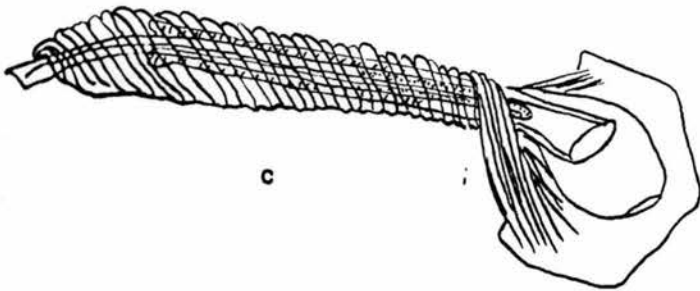
Z



a



b



c

Class: Oligochaeta

Order: Limicolae

Aquatic oligochaetes have the same general structure as the common terrestrial earthworms. The body is clearly divided into segments separated externally by distinct grooves. The prostomium is a half segment at the extreme anterior end of the body and is variously modified in different species. True aquatic oligochaetes range from 1-30 mm., the body wall is thin and the internal organs can easily be seen in living animals. The mouth is in segment one, the peristomium. Posterior to the mouth, segments are numbered consecutively. Setae for locomotion are easily seen, and their shape and arrangement are of taxonomic importance. Two types are: hair setae, which are slender and flexible, and needle setae, which are heavier and less flexible. Some aquatic oligochaetes possess gills either at the posterior end or along the sides of the segments. The number and arrangements of the gills are of taxonomic importance. The oligochaetes feed on filamentous algae, diatoms, or miscellaneous plant and animal detritus. Distribution: Common in mud, debris, substrate of stagnant pools and ponds and in streams and lakes everywhere.

Family: Lumbriculidae

Reproduction mostly sexual, clitellum ordinarily posterior to segment 8. Usually large in size. Ordinarily not more than 2 well developed setae per bundle; male pores ordinarily on some other segment than 11 or 12. Ovaries, 1-3 pairs in the region of segments 9-13; male pores on the segment that contains the most posterior pair of testes.

Genus: Lumbriculus

Species: L. variegatus

Setae bifid with upper tooth reduced in all segments. Prostomium never produced into a proboscis; prostomium conical. Anterior segments without annuli. Non-retractable penes absent. Lateral caecae of posterior vascular system well developed. Distribution: Probably cosmopolitan; found in Alaska, Yukon Territory, North West Territory, Michigan, New Brunswick.

Genus: Stylodrilus

Medium sized worms; prostomium rounded; setae single pointed, or bifid, or both. One pair male pores on 10th segment, one pair spermathecal pores on 9th. Posterior lateral blood vessels often present. Two pair testes in 9-10. Two pairs male funnels and vasa deferentia present. Vasa deferentia join atria proximally to apically, one pair relatively small. Spherical to tubular atria present in 10. One pair ovaries in segment 11. One pair spermathecae in 9.

Species: *S. heringianus*

Setae all or mostly bifid; one pair long, non-retractable penes present on segment ten, 0.3 mm. long, reflexed over ventral surface of body.

Family: Tubificidae

With well developed setae on most segments. Reproduction mostly sexual, never by budding; clitellum ordinarily posterior to segment 8; usually larger in size. Ordinarily with more than 2 well developed setae per bundle in some segments. Male pores ordinarily on segment 11 or 12. The ventral setae is ordinarily cleft; spermathecae, if present, usually open on segment 10; usually reddish in appearance, commonly more than 25 mm. in length, many live in tubes.

Subfamily: Aulodrinae

Prostate glands more or less solid but attached to the atria by broad bases. Sperm in bundles in spermathecae, not as spermatophores. Coelomocytes absent.

Genus: Aulodrilus

Species of *Aulodrilus* reproduce asexually, commonly found to have the reproductive organs located more anteriorly than usual. Degenerate testes often appear in maturing worms in the segment in front of the fully developing testes, but no extra male ducts have been described. Posterior end of body usually thin, without setae, more or less unsegmented. May be a region of regeneration but has usually been described as functioning as a respiratory organ. Hair setae, when present, are short and bent.

Species: A. americanus

Setae of at least mid and hind region broad with many teeth.

Genus: Limnodrilus

The genus is one of the most clearly defined, but the species are not always easy to separate owing to the simplicity of the setae.

Segments of body without gills; dorsal bundles without hair setae. Paired spermathecal pores in segment 10, sperm ducts with one definite prostate gland. Setae distinctly cleft.

Species: L. angustipenis

Penis sheaths with thin-walled hood, basal section narrowing abruptly into shaft, hood reflected over shaft.

Distribution: Eastern North America.

Species: L. claparedeianus

Body less than 140 segments, penis sheath about 20-30 X as long as broad; proximal prongs with setae only slightly reduced. Hood small, pear-shaped, shaft enters hood centrally.

Distribution: Entire North American continent.

Species: L. hoffmeisteri

Body with more than 140 segments, penis sheaths up to 14 X longer than broad, hood with opening at right angles to shaft, or hood is a plate with scalloped edges. Spiral muscles around penis sheath are an unusual characteristic.

Distribution: Entire North American continent, cosmopolitan.

Species: L. profundicola

Penis sheaths up to 7 X longer than broad, more or less straight, hood reflected back over shaft unless forced forward.

Distribution: Cosmopolitan or widely distributed.

Species: L. udekemianus

Body 140 segments, penis sheath 4-6 X longer than broad, proximal prongs of setae much reduced. Upper tooth of anterior setae thicker than lower; penis sheaths with narrow, flange-like hood.

Distribution: Cosmopolitan or widely distributed.

Genus: Peloscolex

Male efferent ducts with vasa deferentia long to fairly long, atria broad tubes, mostly curved horse-shoe shaped over connection with large prostate glands situated  $\frac{1}{3}$  to  $\frac{1}{2}$  way down atria from union with vasa deferentia.

narrowing to short ejaculatory ducts which enter true penes with or without penis sheaths. Penis sheaths commonly cylindrical, about 3 X longer than broad. Spermathecal setae modified or unmodified, penial setae rarely modified. Spermathecae with spermatophores. No coelomocytes. Body wall variously covered with secretion with included foreign particles forming either papillae or a sheath covering all or some of the body, or as little as a thin granular tube; may be shed periodically or apparently absent. Sensory papillae present or absent, usually associated with dense sheath or papillate covering. Prostomium and first segment commonly retractable within other segments.

Distribution: Eurasia, N. and S. America.

Species: P. superiorenensis

Hair setae present, together with bifid or pectinate setae in anterior dorsal bundles, sometimes simple, pointed setae with hairs posteriorly. No modified genital setae. Body wall naked, or with a sheath composed of foreign matter embedded in a secretion. Sheath less completely enveloping body or absent. Pectinate setae with short teeth, penis sheath cylindrical with a basal flange.

Distribution: Found in freshwater, Great Lakes, eastern North America.

Subfamily: Tubificinae

Genus: Tubifex

Segments of body without gills, two lateral teeth of dorsal pectinate setae widely divergent; length of atrium and penis combined much shorter than the remainder of the sperm duct.

Species: Tubifex kessleri americanus

Dorsal bundles with 3-4 hair setae; 3-4 pectinate setae with several intermediate teeth, upper tooth longer than the lower which frequently bears a small spine. Vasa deferentia about 3 X the length of the atria, enter atria apically; atria spindle-shaped with large prostate. Penis sheaths broad proximally, narrow distally with lateral openings.

Distribution: Lake Superior, U. S. A., eastern Canada.

Species: Tubifex tubifex

Ventral setae simple, pointed, bifid, or with a small intermediate tooth on the lower lateral tooth. Few hair setae in a restricted number of bundles; penis sheaths thin, tub-shaped. (T. tubifex "bergi" form).

Pectinate setae present, with lateral teeth distinct from intermediate teeth; penis sheath thin, short tub-shaped. Vasa deferentia long; atria comma-shaped; pectinate setae with several irregular intermediate teeth. (T. tubifex "tubifex" form).

Distribution: Cosmopolitan or widely distributed.

### FLOW CHART FOR THE OLIGOCHAETA

This flow chart was compiled as an aid in identifying the Oligochaete species found in the St. John River. Since taxonomical keys for Oligochaetes are based on variations in sexual characteristics, only sexually mature worms were considered in drafting the chart.

Flow Chart for the Oligochaeta (sexually mature)

Class Oligochaeta

Two setae present/bundle  
4 bundles/segment  
(Family Lumbriculidae)

Several setae/bundle  
(Family Tubificidae)

anterior end rounded.  
tractable penes  
on segment X

Lumbricus americanus  
(Plate I, C, D)

anterior end conical  
tractable penes

Lumbricus variegatus  
(Plate I, A, B)

Hair setae absent  
(see next page)

Hair setae present

Setae bifid or simple-  
pointed, not broad with  
many teeth.

Broad setae with many teeth  
in at least mid and hind region

Aulodrilus americanus  
(Plate I, E, 1.2.)

Pectination in dorsal  
and ventral bundles

Pectination in dorsal  
bundles only. Penis sheath  
thin, short, tub-shaped.

Tubifex tubifex  
(Plate I, F, G, H)

anterior end papillate.  
Penis sheath thin,  
cylindrical when present.

Tubifex superiorenensis  
(Plate I, I, J, K, L, M)

Body wall non-papillate.  
Penis sheath cylindrical  
with a basal flange.

Tubifex kessleri americanus  
(Plate II, N, O, P, Q)

Hair setae >1 in  
most bundles.

T. tubifex ("tubifex"  
form)

Few hair setae  
present in a  
restricted number  
of bundles.

T. tubifex  
("bergi" form)

Flow Chart for Oligochaeta (continued)

Hair Setae Absent

Penis sheath up to 14 X longer than broad.

Penis sheath >14 X longer than broad.

Limnodrilus claparedeianus

(Plate II, R, S, T)

Upper tooth of anterior setae at little longer than lower.

Upper tooth of anterior setae much longer than lower.

Limnodrilus udekemianus

(Plate II, U, V)

Penis sheath narrowing gradually to apex, cylindrical.

Penis sheath with thin walled basal section narrowing abruptly into shaft, hood reflected over shaft.

Limnodrilus angustipenis

(Plate III, W, X)

Penis sheath up to 7 X longer than broad, hood reflected  
Penis sheath up unless forced forward.

Penis sheath up to 14 X longer than broad, hood either characteristic with openings at right angles to shaft, or hood a plate with scalloped edges.

Limnodrilus profundicola

(Plate III, Y)

Limnodrilus hoffmeisteri

(Plate III, Z, a,b,c)

Phylum: Annelida  
Class: Hirudinea (leeches)  
Order: Arhynchobdellida

Mouth medium to large, without a proboscis, jaws present or absent; usually 5 annuli per segment in middle of body, blood red.

Family: Hirudidae

Five pairs of eyes forming a regular arch; jaws typically present and toothed, but may be toothless or absent; with one to several pairs of large, gastric caeca; medium to very large size.

Order: Rhyncobdellida

Rhyncobdellida members have a small, pore-like mouth in an oral sucker through which a muscular proboscis may be protruded. Jaws are absent, the blood is colourless. Primarily fresh water group, many forms are predators and scavengers, only a few species take blood. Often brightly coloured and patterned, colouration of some species is highly variable. Length of mature leeches ranges from 5-46 mm. (Haemopsis).

Family: Glossiphoniidae

Dorsoventrally flattened, caudal sucker usually ventral, much larger, discoid, powerful, expanded over a central attachment pedestal. Anus dorsal, in front of sucker. Body surface may be smooth, wrinkled, tuberculate or papillated. All leeches composed of only 34 true segments. In the mid-portion of the body of most leeches a segment typically has 3, 5 or 6 annuli. No distinct clitellum, usually 3 annuli per segment in middle of body. One to 4 pairs of eyes; eggs in membranous sacs on ventral side of adult; young clinging to ventral side of adult, poor swimmers.

Distribution: The leeches are one of the few freshwater groups in which transport from one drainage system to another is known to occur. They actively and readily spread from place to place within individual drainage systems. They occur in suitable habitats throughout North America as well as in other continental areas.

Class: Crustacea

Subclass: Malacostraca

The malacostracan crustaceans differ from other crustacean subclasses in having a definite and fixed number of body segments or somites.

Order: Amphipoda (scuds)

Compressed laterally, respiratory organs attached to the pereopods. Adult female brood pouch similar to Isopoda. Males have sex organs near the base of the last pereopods. Three anterior pairs of abdominal appendages with multi-articulate rami; rami of last 3 pairs with 1 or 2 joints.

Family: Talitridae

First antenna has no accessory flagellum. Mandible without palp. First maxilla with small, 1-jointed palp. Only one genus and species in North America - Hyaella azteca.

Genus: Hyaella

Species: azteca

Order: Isopoda (aquatic sowbugs)

The Isopoda lack a carapace, are somewhat flattened dorsoventrally and have the pleopods modified as respiratory organs. A brood pouch is developed in adult females between the bases of the pereopods. In males, the inner ramus of the 2nd pleopod bears a slender copulatory stylet.

Family: Asellidae

Uropods attached to last abdominal somite in terminal or subterminal position.

Genus: Asellus

Free-living, morphologically unmodified, uropods terminal, without a carina on the anterior margin of cephalothorax, suture between exopod segments of third pleopod running from the median margin less obliquely toward the lateral margin. Up to 20 mm. long, eyes present or absent, 7 pairs of walking legs, the first thoracic limb modified as a mouthpart. Abdominal limbs two-branched, flat and leaf-like.

Distribution: About 25 species reported mostly from springs, streams or cave systems.

Order: Decapoda (shrimps or prawns)

Relatively thin, rather translucent shell, laterally compressed rostrum, pincers on the first 2 pairs of pereopods only. Males have 2 slender stylets on the inner margin of the inner branch of the 2nd pair of pleopods, whereas there is only 1 stylet in this position in the females. Carapace covers most or all of thoracic somites, eyes stalked.

Family: Astacidae (section Nephropsidea)

Body subcylindrical anteriorly; rostrum and abdomen dorsally depressed. First 3 pairs of pereopods chelate.

Subfamily: Cambarinae (cray fish)

Distal portion of first pleopod of male terminating in 2 or more distinct parts. Second, third or fourth pereopods of male with hooks on ischia. Gills absent on last thoracic somite. Females with an annulus ventralis.

Genus: Cambarus

Teeth present on opposable margins of ischia of third maxillipeds. Albinistic or pigmented. First pleopod terminating in 2 parts. Terminal elements of 1st pleopod short and bent caudad at right angles to main shaft of appendage, except in Cambarus obeyensis.

Class: Insecta  
Subclass: Pterygota  
Section: Palaeoptera  
Superorder: Ephemeropteroidea  
Order: Ephemeroptera (may flies)  
Family: Ephemeridae

Family: Ecdyonuridae  
Genus: Ecdyonurus

Gills consisting of 1 plate, 2 plates, 1 plate and a tuft of filaments, or up to 12 filaments. Body flat with very broad head and femora. Gills consisting of a flat plate and a tuft of filaments. Rather large or moderate sized nymph.

Distribution: Found clinging closely to stones in all types of fresh waters.

Genus: Ephemera

Eggs are laid in water by female, which enters the water for the purpose. Nymphs have an elongated body, large head, well developed mandibulate mouth parts. Mandibular tusks with smooth margins and fossorial legs for burrowing. Large paired tracheal gills on the lateral or dorsal surface of most of the abdominal segments serve to distinguish mayfly nymphs from all other aquatic insects. Length 3-28 mm.

Distribution: World wide distribution, found in the top 5 cm. of mud but may go to 15 cm. in fresh water.

Genus: Hexagenia

Mandibles have a smooth, external projecting tusk visible dorsally. The gills are dorsal and curve up over abdomen. The first tibiae are somewhat flattened and fossorial. The head has a conspicuous round, truncate or conical frontal process.

Distribution: Mayfly nymphs occur in all types of fresh waters, wherever there is an abundance of oxygen.

Order: Odonata (dragonflies, damselflies)

The order Odonata is subdivided into the Anisoptera (true dragonflies) and the Zygoptera (damselflies). With the exception of the mosquitoes, the Odonata are perhaps the best known insects having aquatic larvae. The larvae are distinguished from those of all other insects by the form of the labium or underlip, which has developed into a protractile organ in order to grasp living prey. The nymphs or naiads, are grotesque in shape, and may be smooth or rough bodied, robust or elongated, and gray, greenish or somber colored.

Suborder: Zygoptera (damselflies)

Damselfly nymphs can be distinguished from dragonfly nymphs by their three leaf-like tracheal gills at the tip of the abdomen. They are also much more slender than dragonflies.

Family: Agrionidae

First segment of antenna longer than the remaining segments combined. Prementum flat, not greatly narrowed in proximal half, its base reaching to or beyond the level of the prothoracic coxae; ligula without a median cleft. No raptorial setae on the movable hook of palpal lobe; each caudal gill with well branched small tracheae, diverging from the main axis at much less than right angles.

Distribution: Nymphs belonging to this family are found in a great variety of aquatic habitats. Water may be quite hot or very cold, still or flowing, and slightly acid or alkaline. No nymphs are known to survive long in highly polluted water but those of a few species can survive in brackish water.

Genus: Ischnura

The gills taper to a fine point; length without gills 10-15 mm., 3-5 mental setae, 5 or 6 lateral labial setae, antennae 7-segmented.

Family: Lestidae

First antennal segment much shorter than the others combined, prementum with the distal edge of the ligula entire or with a closed short median cleft. Prementum spoon-shaped, greatly narrowed in proximal half. In repose, its base reaches to the level of the mesothoracic coxae or beyond; ligula with a closed median cleft; 2 or 3 raptorial setae on the moveable hook of each palpal lobe; each caudal gill with numerous small tracheae, branched near the margins, but otherwise subparallel and almost perpendicular to the main axis.

Genus: Lestes

Distal margin of each palpal lobe divided into 4 processes - 3 sharply pointed hooks and a short, serrated, truncate protuberance between the smaller outer 2 hooks, with the tip of the outermost hook reaching almost as far distad as the tip of the moveable hook, gills never with 2 distinct and complete dark cross bands.

Distribution: Well represented in Mexico, United States (including Alaska) and Canada.

Order: Plecoptera (stoneflies)

Stonefly nymphs are all strictly aquatic, and are remarkably homogeneous in structure as a group. They resemble the adults but may be distinguished from them by the structure of the mouth parts, lack of genitalia, and often by the presence of filamentous tracheal gills and wing pads instead of wings. The most obvious features of gross anatomy are the usual division of the body into head, 3 thoracic segments and 10 abdominal segments, the long antennae, and the many-segmented cerci at the end of the body. The length of mature nymphs ranges from 6-50 mm. excluding the cerci and antennae; color ranges from yellow to black.

Distribution: Stoneflies are distributed world wide, and the nymphs occur in debris, masses of leaves and algae, and under stones in every kind of lotic environment.

Suborder: Holognatha

Tips of the glossae produced nearly as far forward as the tips of the paraglossae, or farther; tip of the lacinia with blunt teeth; middle portion of the 10th abdominal sternite  $1/3$  as long as the 9th or less, usually unsclerotized and covered by the 9th.

Family: Nemouridae

No abdominal gills in segments 1-3; thoracic sterna not produced; ocelli 3.

Subfamily: Leuctrinae

The second tarsal segment shorter than the first. Nymphs are small and slender, hairs few, fine, or lacking; hind wing pads approximately longitudinal, no cervical gills. Lateral margins of abdominal segments almost straight; abdomen appearing more cylindrical; wing pads always present; only the first 7 abdominal segments, or fewer, divided by a membranous lateral fold.

Genus: Leuctra

Less than 7 abdominal segments divided ventrolaterally by membranous fold.

Order: Neuroptera

Suborder: Sialodea (Megaloptera) (alderflies, dobsonflies, fishflies)

The aquatic larvae are campodeiform, have six well developed legs, chewing mouth parts and no cocoons. Mature Sialodea larvae are easily distinguished by the presence of a pair of lateral, cylindrical, simple or segmented gill filaments on the first 7 or 8 abdominal segments. The body is stout, elongated, from 25-90 mm in length, dull yellowish, brown or mottled. The head bears 4-segmented antennae, small compound eyes, and strong mouth parts. The legs are well developed.

Family: Corydalidae

Genus: Chauliodes

The abdomen without tracheal gill tufts. Each spiracle of 8th abdominal segment at the end of a long contractile dorsal respiratory tubule extending to or beyond hooks of anal prolegs. Distribution: Eastern and Central U. S., Canada.

Family: Sialidae (alderflies)

Sole genus: Sialis

The abdomen has a long terminal median process tapering to a fine point. Paired segmented lateral appendages occur on abdominal segments 1-7. There are no anal prolegs or abdominal tufts of gills. The body length is up to about 20 mm.

Distribution: Cosmopolitan.

Section: Oligoneoptera

Superorder: Coleopteroidea

Order: Coleoptera (beetles)

Family: Dryopidae

Small family of aquatic beetles, range from 2-6 mm in length, and the body is covered with a hydrofuge pubescence. Little is known about the larval stages. Superficially they are similar to Elmidae larvae, being cylindrical to onisciform. The larvae have legs which are apparently 4-segmented, each tarsus united with its single claw. The urogomphi are either absent, or if present, are solidly united at the base. The body is usually slender and round or triangular in cross-section, the head being exposed from a dorsal view. The 9th abdominal segment has a ventral movable operculum closing a caudal chamber. The first 5 or 8 abdominal sternites each have a median fold.

Genus: Dryops

Spiracles without adjacent swollen areas; tergites not transversely grooved; eighth and ninth tergites without tubercles or swellings; operculum evenly rounded at apex. All dorsal tergites smooth at anterior margins.

Family: Elmidae

Most Elmids are aquatic and rarely exceed 3 mm.

The larvae are slender and have retractile filamentous gills in a ventral operculate chamber, in the last abdominal segment. The legs are apparently four-segmented, each tarsus united with its single claw. Urogomphi solidly united at base or absent. Body usually slender or angular in cross-section, the head exposed from a dorsal view. Abdominal sternites flattened or evenly convex; cloacal chamber with 3 tufts of retractile gills. Operculum with a pair of internally attached hooks. Apex of last abdominal segment shallowly to deeply emarginate; each mesothoracic and metathoracic segment with pleuron of one short part or subdivided into 2 or 3 parts; antenna generally slender.

Genus: Dubiraphia

Posterior sternum absent. Body more cylindrical or triangular in cross-section, tergites without long finger-like projections. Postpleurite of 1 part, the prepleurite present. Eight abdominal segments with pleura; the last segment about 4 times longer than wide; operculum with apex acute. Found on aquatic vegetation in lakes and ponds and at margins of slow-moving streams.

Distribution: Eastern North America.

Family: Gyrinidae

Legs apparently 5-segmented, tarsi with 2 movable claws. 10th abdominal segment armed with 4 hooks; lateral gills present on all abdominal segments.

Genus: Gyrinus

Nasale with 2 to 4 teeth in a transverse row.

Order: Trichoptera (caddisflies)

Larval head and thorax may be heavily sclerotized and darkly pigmented. Abdomen soft and lightly coloured. Head has a pair of antennae, chewing mouth parts, and 2 clumps of jet black ocelli. The three thoracic segments are distinct, never fused. Prothoracic legs are generally the stoutest and shortest, and used for holding prey and case building. Larvae live in both stagnant and running waters - build cases of various materials in which they live. Case builders are usually phytophagous, sluggish and eruciform.

Family: Leptoceridae

The larvae construct a wide variety of cases and have a wide range of habitats. Each genus occurs in both lakes and streams.

Genus: Oecetis

The middle legs have a slender claw, slightly curved. The tarsus is straight, and the case is seldom transparent. The maxillary palpi are nearly as long as the stipes, the mandibles are long and sharp at the apex. The teeth are considerably below the apex. The cases are of several types. There are 15 species.

Distribution: Common and widespread.

Genus: Triaenodes

Antennae at least 7 X as long as wide and arising at base of mandibles; second tarsi straight, case not translucent, maxillary palpi about half the length of stipes, hind tibiae with a fracture near the middle which appears to divide tibiae into 2 parts and with a regular fringe of long hairs. Abdomen with at least a few gills. Case usually of short bits of twigs or grass built into a spiral pattern.

Family: Limnephilidae

The larvae make a large variety of cases and occupy numerous diverse habitats.

Genus: Pycnopsyche

Abdomen has gills and is not much wider or deeper than the thorax. Usually more than 5 mm. long. Mesonotal plates little or not incised; metanotum with sa 3 bean-shaped,

narrow. Each gill is single. The principal setae of the head are long and slender, mesonotum has only 1 pair of plates, at least 2nd abdominal segment not hairy. The anterior margin of the mesonotum is evenly rounded and not emarginate. The pronotum and frons have no longitudinal ridges, and are often smooth and shining. The head has no carina marking off an anterior flat area. The metanotum has only a few setae or definite plates bearing most of setae. The apex of eighth abdominal tergite with some strong setae or only 1 or 2 weak ones. The metanotum with sa 1 ovate, the two further apart. The dorsum of the abdomen has at least 10 pairs of gills, not counting those on the fringe line. The metathorax with sa 3 bearing 1 or 2 dark areas; the abdomen has no fringe gills on segment 6 and at most 1 on segment 5. The first segment of the abdomen has a band of scattered setae across most of tergite and sternite. The abdominal gills are long, stout and overlapping considerably on the meson, especially on segments 2 and 3. There are 18 species.

Distribution: Eastern North America.

Family: Psychomyiidae

Larvae build retreats (tunnels) on aquatic plants or burrow into sandy stream beds. Most species live in rapid water but some live in lakes.

Genus: Polycentropus

Abdomen not much wider and (or) deeper than thorax, usually more than 5 mm long; cases when present, not much larger than larvae. Either meso or metanotum or both without sclerites or with sclerotized shield subdivided into separate plates. Anal legs projecting beyond and free from, membranous lobes of 10th abdominal segment. No tubercles on 1st abdominal segment; case, if present, usually not moveable. Last abdominal segment without a sclerotized shield. Labrum entirely sclerotized, not expanded laterally; silken nets or galleries fastened to substrate and more or less covered with algae and silt, or buried in the substrate. Tenth abdominal segment long and tubular, mandibles long with a thin brush on the left mandible, tenth segment with numerous long hairs.

Genus: Phylocentropus

Similar to Polycentropus except the mandibles are short and triangular, and each has a large, thick brush.

Superorder: Mecopteroidea

Order: Lepidoptera (aquatic caterpillars)

Larvae are true aquatic caterpillars and have the characteristic body shape, thoracic legs, and ventral abdominal prolegs of terrestrial species.

Genus: Bellura

Filamentous lateral gills absent, dorsal half of last abdominal segment greatly depressed; next to last abdominal segment with 2 large spiracles on dorsal posterior margin. Larva in long, water-filled burrow in petiole of Nuphar, sometimes in Pontederia or Typha; head light brown; prothoracic shield dark brown, body color deep gray to dark brown.

Length is 45-55 mm.

Distribution: Widely distributed over eastern half of U. S. and N. E. Canada.

Genus: Nymphula

About a dozen species are known, and there are generally 2 groups. In one, there are no gills, and respiration is through spiracles. The other group has paired filamentous lateral gills. The gills range up to about 400 gill filaments. The body of the larva is slightly flattened. The larval case is sharp edged, oval to oblong, and is cut from a leaf of the food plant. The length is about 15-20 mm.

Distribution: Generally distributed in North America in ponds which are overgrown with water lilies, potamogetons and other vegetation.

Figure A: *Tabanus* sp.

AP ----- Abdominal prolegs  
AS ----- Anal siphon

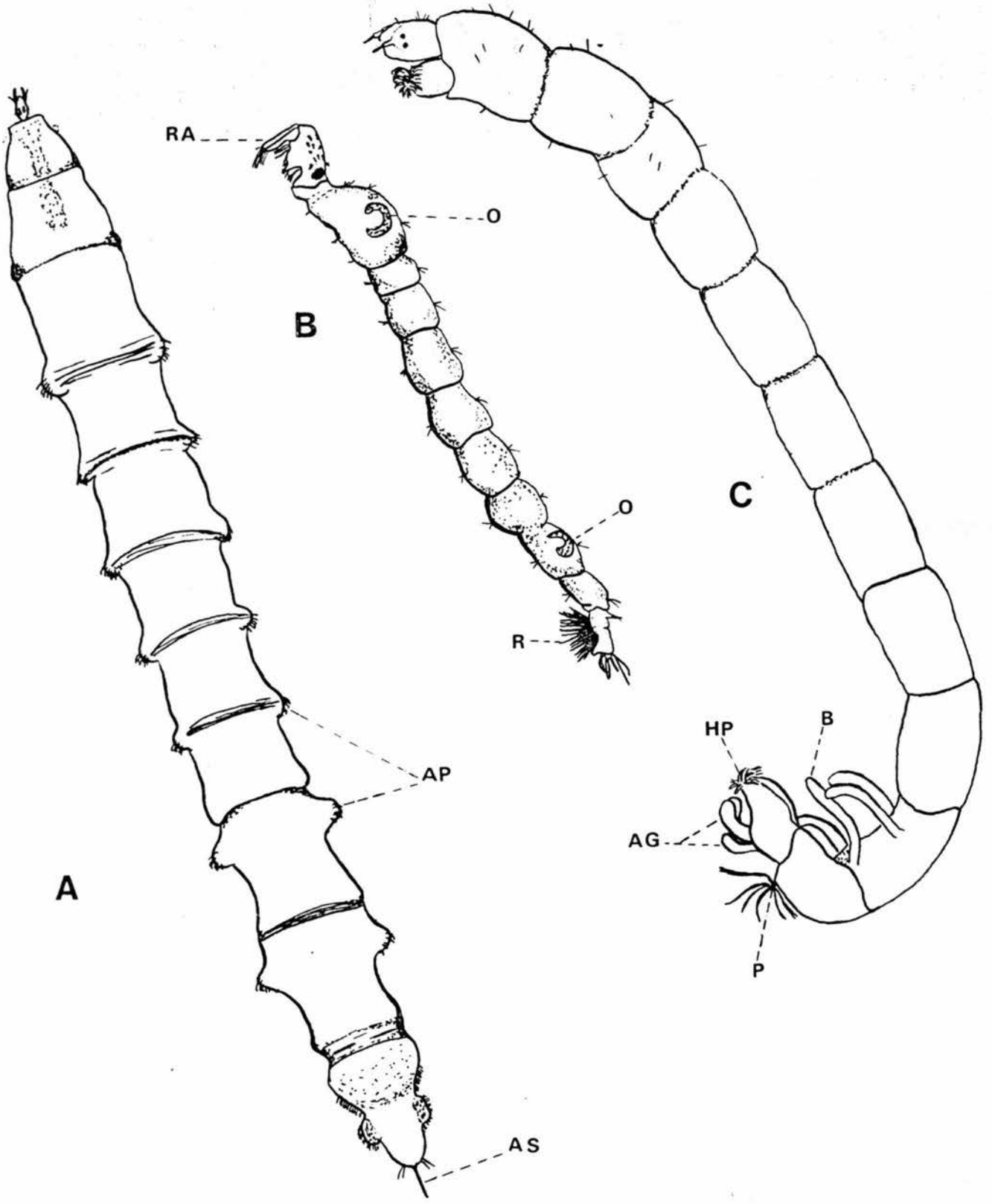
Figure B: *Chaoborus* sp.

O ----- Hydrostatic organs  
R ----- Rudder  
RA ----- Raptorial antennae

Figure C: *Chironomus* sp.

AG ----- Anal gills  
B ----- Ventral Bloodgills  
HP ----- Hind prolegs  
P ----- Preanal papillae

Diptera Larvae (-10x)



Order: Diptera (flies, mosquitoes, midges)

One of the largest insect orders, containing many members that in the larval stages are adapted to fresh water or are semiaquatic. Since so much variation occurs in the order, it is difficult to specify a "typical" dipterous larva.

Suborder: Brachycera

Mouthparts in aquatic forms are well developed; body behind head composed of fewer than 13 segments, no breast bone present. Mandibles replaced by mouth hooks which lie either parallel to each other, are never opposed, move in a vertical plane, or fused into a single structure. Pupa either remaining in the last larval skin or free; if free, the prothoracic respiratory organs are rudimentary or lacking and the antennal sacs are short, directed caudad and laterad, and not over the eyes. Head capsule well developed, usually sclerotized dorsally though often retractile; maxillae usually well developed, palpi usually distinct; antennae well developed, situated on the sclerotized dorsal plate. Pupa either free or remaining in its last larval skin. If the latter, it is unchanged in shape, the larval head being distinct.

Family: Empididae

Genus: Clinocera

Free part of head retractile; body not shagreened, pupa free. Body variable, but never with more than 1 pair of pseudopods on each abdominal segment; posterior spiracles not in a vertical cleft. Apex of abdomen without caudal process; or with such processes shorter than the pseudopods, or the latter wanting; caudal end sometimes bears 2 pairs of caudal processes.

Family: Tabanidae (horseflies)

Larvae are elongated cylindrical, tapered at both ends, white, yellowish, greenish or brownish in colour. Body divided into minute head, 3 thoracic segments, 8 abdominal segments, short posterior siphon. 1st-7th abdominal segments bear a pair of dorsal prolegs (often fused and small) as well as a pair of ventral prolegs. Eighth abdominal segment has a broad base, tapers distally. At the tip of the siphon the 2 tracheal trunks either open as a single vertical slit or end in a sharp compressed spine.

Genus: Tabanus

Mature larvae usually longer than 20 mm. Tracheal trunks usually swollen; ventral and dorsal areas smooth, especially on thorax; terminal segment of antenna shortest; almost never a protrusile spine at tip of abdomen.

Anal segment tapering; siphon elongated when extended; dark marking, when present, usually on other abdominal segments also, or confined to prothoracic collar only.

Distribution: A few species occur in swift water, but most are found in the muddy shallows of ponds and swamps.

Suborder: Nematocera

Mouthparts in aquatic forms well-developed; no breast-bone present; mandibles and other sclerotized mouthparts opposed, moving in a horizontal plane. Pupa free; prothoracic spiracles usually located at the ends of a pair of processes; antennal sacs elongated, extending over the compound eyes, thence to or beyond the bases of the wing sheaths.

Family: Ceratopogonidae (biting midges, "no-see-ums")

There are over 100 species in the family, but it is impossible to say how many are aquatic. Some genera and some species live in dung, moss, exudations from wounds in trees and other damp places.

Genus: Stilobezzia

Prolegs lacking on prothorax, head well developed, head capsule well sclerotized. Head short and thick, length not exceeding  $1\frac{1}{2}$  X width; body segments each slightly longer than head. Body curved, larva clambering, last segment without terminal hooks but with short setae; mouth parts directed anteriorly.

Distribution: Found crawling through algae on muddy bottoms in eastern North America.

Family: Culicidae

Culicidae larvae are easily distinguished from other Diptera because the fused thoracic segments are thicker than the rest of the body. There are always 4 instars, the 4th persisting for the longest time. Mature larvae usually range from 3-15 mm. in length. They are called phantom larvae because they are transparent. They are predatory and catch small Crustacea and insect larvae with their prehensile antennae.

Subfamily: Chaoborinae

Antenna developed into a prehensile organ with long strong apical spines. Pupa either with the swimming paddles fused basally, or the respiratory horn closed or almost so at the tip.

Family: Tipulidae (craneflies)

Subfamily: Tipulinae

Aquatic crane fly larvae are easily identified by the spiracular disc at the extreme posterior end. The disc bears a pair of functional spiracles and may be thrust up to the water surface for air. It is normally lobed, fringed with hairs with a quantity of delicate gills associated with it. Colour varies from brown to whitish, and the integument may be transparent. The length ranges from 10-50 mm.

Genus: Pedicia

The spiracular disc is surrounded by less than 6 lobes and has two long ventral lobes. The spiracles are large and there is no silken case.

Distribution: In cold springs and under moss at the edges of streams.

Family: Chironomidae (midges)

Larvae are elongated, cylindrical, slender, range from about 2-30 mm. in length. The first thoracic and last abdominal segments both bear a pair of prolegs, no spiracles but anal gills sometimes occur on the lateral ventral surface of the penultimate abdominal segment. Colour varies from white to deep red. The deep red colouration is responsible for the name "bloodworms" and applies to many species of midges.

Distribution: The larvae occur everywhere in aquatic vegetation and on the bottoms of all types of bodies of fresh water.

Subfamily: Diamesinae

The subfamily Diamesinae constitutes a primitive group whose members are readily recognizable in the adult stage. Diamesinae are not readily distinguishable from Orthoclaudiinae in either the larval or pupal form except that the former tends to be larger. The larvae of Diamesinae differ from those of Orthoclaudiinae in that the third antennal segment is annulate; the pupae have on the posterior margin of the abdominal segments

a fringe of short erect points. The larvae differ from the Tanypodinae in that the antennae are shorter and are non-retractile and from the Chironomidae in that the paralabial plates are wholly lacking or, if present, they are non-striated. Larvae and pupae are found in swiftly flowing water except for Prodiamesia which is found in quiet, well-aerated water.

Subfamily: Hydrobaeninae (Orthoclaudiinae)

In structural features, the larvae closely resemble the larvae of the Diamesinae and the Chironominae. The antennae are not retractile, usually short; third antennal segment not annulated; paralabial plates are absent.

Genus: Corynoneura

Corynoneura is roughly differentiated from other Hydrobaeninae by the fact that it is usually 2 or 3 mm. long. The antennae are at least 1/2 as long as the head. The second segment is slightly bent.

Subfamily: Tanypodinae (Pelopiinae)

The larvae of the subfamily Pelopiinae do not build cases but are sometimes found in the cases of other tendipedids. Predaceous, with other insect larvae forming a large part of the diet. Larvae are elongated, cylindrical, slender, range from 2-30 mm. Have a pair of prolegs on both the 1st thoracic and

last abdominal segments. Spiracles absent, sometimes anal gills on the lateroventral surface of the penultimate abdominal segment.

Distribution: Found in ponds, lakes, streams and rivers.

Genus: Clinotanypus

Similar to Pentaneura, except the ventral pair of anal gills are close to the anal opening, located on the anal pseudopods. The body has a fringe of hair on each side. The antenna is about 3/4 head length; mandible hook-like.

Distribution: North eastern United States into Canada.

Genus: Pentaneura

The antennae are retractile, usually elongated. Prolegs are long and stilt-like, the anterior pair having a common base. Segments of the body with a few scattered bristles. The body is slender, with both hairs of anal gills close to the anal opening. Most species whitish or yellowish and mottled with brown.

Distribution: Occur everywhere in aquatic vegetation and on the bottom of all types of freshwater bodies.

Genus: Procladius

Antennae retractile, usually elongated, prolegs long and stilt-like, anterior pair with a common base. Segments of body with a longitudinal hair fringe on each side; head rather broad; ventral pair of anal gills attached to base of prolegs

remote from anus. Head never more than 1/3 longer than broad; antennae 1/4 or 1/3 as long as head. Four anal gills, lingua of hypopharynx with 5 teeth, larva whitish, yellowish or reddish, somewhat mottled with brownish spots.

Subfamily: Tendipedinae (Chironominae)

The larvae are characterized as follows: the antennae are non-retractile; the mandible in most cases has a preapical comb; the paralabial plates are striated; the brain and the anlagen of the compound eyes are located in the thorax; the thoracic and caudal prolegs are well developed.

The pupae have closed thoracic respiratory organs, which may be simple as in *Tanytarsus* or composed of a tuft of filaments as in *Chironomus*, or with few branches as in *Pentapedilum*; the anal lobes are each fringed with a number of filaments.

Genus: Calopsectra

With *Tendipes*, *Calopsectra* is by far the most abundant of all *Tendipedidae*. Certain stream species have a case with several radial and upright projections at the upstream end. Salivary sheets strung between these arms catch food particles from the current. The morphology is identical to *Tendipes* except the antennae are mounted on prominent tubercles or long prominences. They are more or less elongated, somewhat curved and 5-segmented. Most abdominal segments have postero-lateral bifid plumose bristles.

Genus: Tendipes (Chironomus)

Tendipes, along with the genus Calopsectra, are the most abundant of the Tendipedidae. Some species of Tendipes that inhabit lakes where there is an O<sub>2</sub> deficiency have 1 or 2 pairs of finger-like gills on the penultimate abdominal segment. Many species are blood red. They are herbivorous and microphagous; build flimsy tubes of organic detritus, algae or small sand grains and silt lined with silky substance from salivary secretion; usually attached, but in a very few species they are moveable. Antennae not retractile, usually short, third antennal segment not annulated; paralabial plates present, radially striated, labial plate toothed in center, antennal blade at distal end of basal segment, antennae not mounted on tubercles or prominences, shorter, usually straight, and 5-segmented. Paralabial plates broadly separated, preanal papillae shorter, labial plate with an odd number of teeth. Ventral gills on 11th segment. Distribution: Occur in sluggish streams, ponds and lakes, sometimes at great depths.

Genus: Cryptochironomus

Antennae not retractile, usually short. The third antennal segment not annulated. The paralabial plates are present. The labial plate has a broad, toothless middle section flanked on either side by an obliquely placed row of darker, lateral teeth. The antennal blade is attached to the second segment.

Genus: Endochironomus

Antennae are 5-segmented; the ring organ is at or proximal of the basal fifth of the first segment. The labial plate in most cases has an even number of teeth, the 1st laterals prominent. The respiratory organ is composed of a tuft of numerous fine, white filaments. The combs on the 8th abdominal segment have 6-15 teeth. The larvae are blood red with black, distinctly separated eye-spots.

Distribution: Several species occur in eastern North America.

Genus: Glyptotendipes

Similar to *Tendipes* except: 1st and 2nd lateral teeth of labial plate not fused at base.

Distribution: The larvae of at least some members of this genus mine in the leaves and stems of aquatic plants.

Genus: Limnochironomus

Labial plate with odd number of teeth; simple middle tooth; first and second laterals of labial plate more or less fused at base; outermost labial plate distinct; par-labials not recurved laterally. Ventral gills not present on eleventh body segment.

Genus: Microtendipes

Antennae not retractile, usually short, third antennal segment not annulated; paralabial plates present, radially striated. Labial plate toothed in center, antennal blade at distal end of basal segment. Antennae not mounted on tubercles or prominences, shorter, usually straight, and 6-segmented. Two middle teeth of the labial plate are pale, the others are dark. The larvae are blood red, with a brown head and black contiguous eye-spots.

Genus: Phaenopsectra, Polypedilum

Similar to *Pseudochironomus* except paralabial plates broadly separated; preanal papillae are shorter, labial plate with an even number of teeth.

Genus: Pseudochironomus

Paralabial plates present, labial plate toothed in center; antennal blade at distal end of basal segment. Antennae not mounted on tubercles or prominences, shorter, usually straight and 5-segmented. The paralabial plates nearly touching on median line; preanal papillae nearly 3 X as long as broad.

Group: Parasitengona ("water mites")

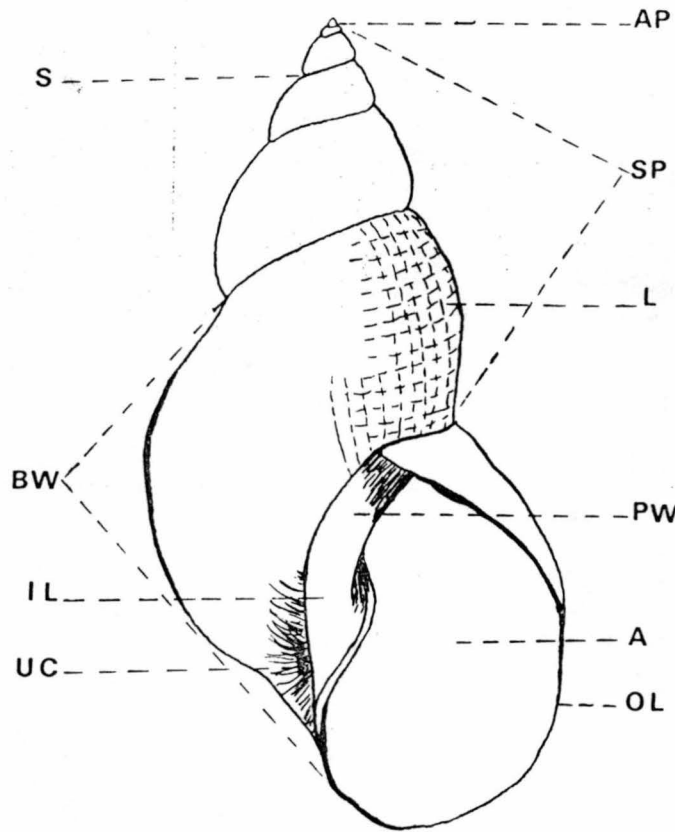
Water mites occupy a vast range of habitats from hot springs to frozen tundra. The ecological distribution of individual species is usually limited to one or a few types per habitat making the mite fauna markedly different in different ecological conditions. The larvae of water mites are six-legged and often brightly coloured. The particular water mite found in the St. John River was bright red. They are parasitic on insects, with host preference moderately developed. The nymphs have eight legs and are predaceous. Nymphs are distinguished from adults on the basis of stage of development of external genitalia.

Figure A. Anatomical features of a gastropod X 2.5  
(redrawn and modified from Baker, 1928)

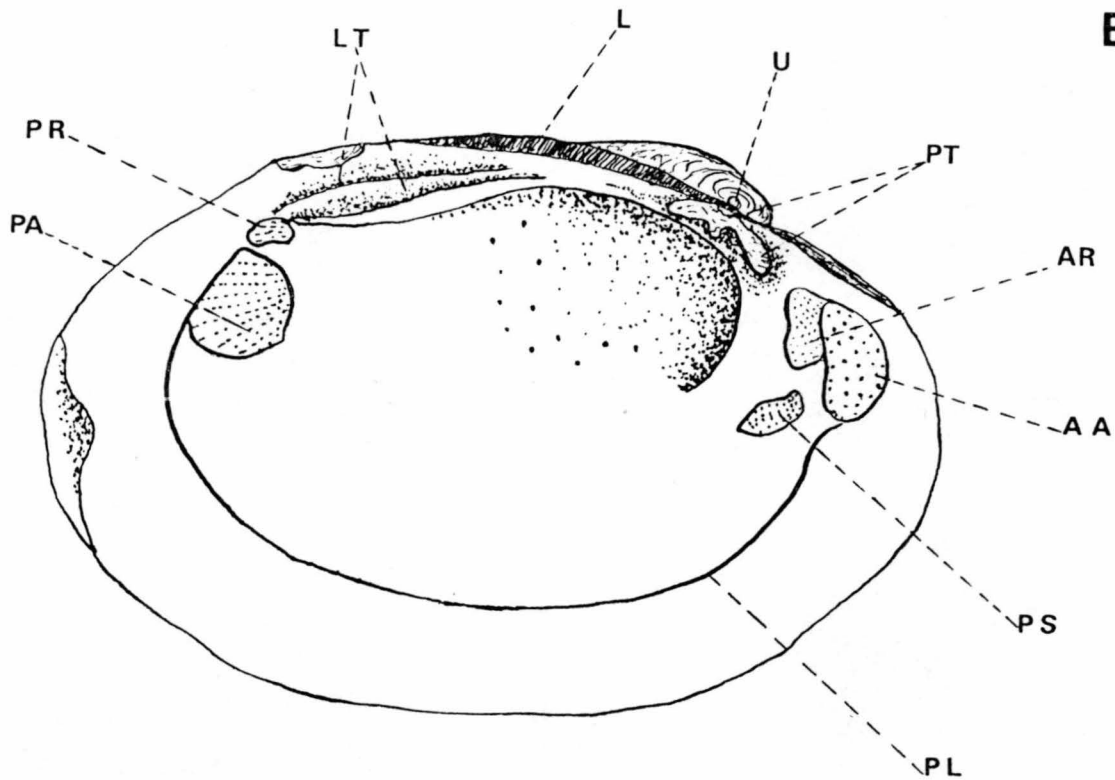
A	-----	Aperture
AP	-----	Apex
BW	-----	Body whorl
IL	-----	Inner lip reflected over columella
L	-----	Spiral and growth lines
OL	-----	Outer lip
PW	-----	Parietal wall
S	-----	Suture
SP	-----	Spire
UC	-----	Umbilical chink

Figure B. Diagrammatic views of inner surface of left  
valve of *Elliptio*, XI. (redrawn from Pennak, 1953)

AA	-----	Anterior adductor muscle scar
AR	-----	Anterior retractor muscle scar
L	-----	Ligament
LT	-----	Lateral teeth
PA	-----	Posterior adductor muscle scar
PL	-----	Pallial line
PR	-----	Posterior retractor muscle scar
PS	-----	Scar of protractor muscle of foot
PT	-----	Pseudocardinal teeth
U	-----	Umbo



**A**



**B**

Phylum: Mollusca

Class: Gastropoda (snails, limpets)

The majority of Gastropods have a one-piece spiral or discoidal coiled shell. They range in their maximum dimensions from 2-70 mm. The muscular portion projecting from the shell is called the foot. The head is at the anterior end of the foot and bears two tentacles which range in shape from short or blunt to long and filiform. The eyes are on or near the base of the tentacles. The shell is usually drab coloured. The freshwater gastropods include many species, and are widely distributed.

Family: Ancylidae (limpets)

Small, cone-shaped shell, occasionally dextrally spiral. Some species have a small ledge or septum within. Foot is large and oval; tentacles are short, blunt, cylindrical with eyes located at their inner bases. The radula has teeth arranged in nearly horizontal rows. The central tooth is small and usually unicuspid, laterals bicuspid, marginal teeth are comb-like.

Distribution: This family is found throughout North America.

Genus: Ferrissia

Univalve, shell patelliform, limpet-like, no operculum, no helical winding or coiling, shell and apex unicoloured, shell small, apex only slightly posterior without horizontal septum, apex to the right of midline.

Distribution: Numerous species in many types of habitats, widely distributed but usually localized.

Family: Bulimidae

Shell small, spiral, conical, imperforate or umbilicate, usually multicoloured. The aperture is entire with a simple and thin lip. Operculum generally paucispiral. Two jaws, and the radula has multicuspid central, lateral and marginal teeth. The central tooth has one or more basal denticles.

Genus: Amnicola

Shell univalve, with operculum, shell small, width under 6.5 mm., length under 7.5 mm., variable in form. Shell globose or elongated; spire short, shell smooth, outer lip of aperture thin. Operculum concentric.

Distribution: Introduced from Europe, in rivers and lakes of the Great Lakes region.

Family: Planorbidae (orb snails)

Shells small to medium, usually discoidal. Animal sinistral in a dextral shell. Surface of shell smooth to finely costate; whorls rounded to strongly keeled. Tentacles cylindrical; jaw in 3 segments. Radula has many horizontal rows of teeth. The central tooth is small and bicuspid, the marginals are tricuspid and the lateral teeth are multicuspid.

Genus: Gyraulus

Similar to *Helisoma* except shell small, greatest diameter < 9 mm.; lip sharp; dextral, base of body whorl convex; shell not costate, shell rounded, or with carinate or subcarinate periphery.

Distribution: Many species in a great variety of habitats.

Genus: Helisoma

Snail; single shell helically wound without an operculum; shell discoidal and orblike, coiled almost in one plane, much broader than tall; interior of aperture without lamellae or teeth; shell large, greatest diameter more than 12 mm. Lip usually thickened, shell ultradextral or ultrasinistral.

Distribution: Many species in all types of habitats; most common in quiet waters, widely distributed.

Family: Valvatidae

Small, turbinate to subdiscoidal, widely umbilicate shell. Simple, holostomatous aperture. Operculum circular and multispiral. Respiration using gills. Radula without basal denticles on the central tooth.

Genus: Valvata

Characters for the family apply as well to the genus.  
Distribution: Widely distributed in North America, especially in Canada and northern United States.

Class: Pelecypoda (clams, mussels)

Shells are bivalve, united by an elastic tissue called the ligament. No head, tentacles, eyes, jaws or radula, most pelecypods are filter feeders. Mouth is an orifice at the anterior end of the body. Foot is axe or hatchet-shaped and is found at the anteroventral margin. The inhalent and exhalent siphons are at the posterior margin. Range from about 2-250 mm. in length.

Family: Sphaeriidae

Shell thin and fragile, length ranging from approximately 2-20 mm., but rarely more than 10 mm. Concentric growth rings not prominent. Pallial line simple, widely distributed and common; fingernail clams, seed shells.

Genus: Pisidium

Shell inequiptite, anterior end longer, beaks subterminal, anal siphon only, usually 2-6 mm. long, a few species as long as 11 mm.

Distribution: Generally distributed in many types of habitats; very many species.

Genus: Musculium

Shell nearly equipartite, beaks subcentral, both anal and branchial siphons. Nepionic valves inflated, usually separated from subsequent position of shell by a distinct sulcus. Cardinal teeth minute or obsolete, shell very thin and polished, usually 5-12 mm. long.

Distribution: Distributed in many types of habitats.

Genus: Sphaerium

Shell nearly equipartite, beaks subcentral, with both anal and branchial siphons. Nepionic valves not distinctly separated from subsequent portion of shell. Usually 7-15 mm., but a few species attain 25 mm. Shell oval, relatively thick, 2 small cardinal teeth in the left valve, one in the right.

Distribution: Generally distributed in many types of habitats.

Family: Unionidae

Subfamily: Unioninae

Ligament external, shell subcircular, oval, subtriangular, or elongated with well developed pseudocardinal teeth, occasionally vestigial or absent. Gills with distinct interlamellar septa, parallel to gill filaments; lotic and lentic, pearly mussels or naiads.

Genus: Anodonta

Water tubes in gravid female divided into 3 longitudinal tubes of which only the center one is used as an ovisac; hinge rarely complete, length 25-200 mm. Beak sculpture double-looped, hinge wholly edentulous, shell thin and highly variable. Distribution: Common in lotic and lentic environments from Atlantic to Pacific coasts, paper shells, about 10 species.

Subfamily: Lampsilinae

Marsupium nearly always confined to the posterior part of the outer gills, edge of gravid marsupium distended and bulging, male and female shells usually different, 30-150 mm. long. Water tubes simple in gravid female; hinge complete.

Genus: Ligumia

Inner edge of mantle in front of branchial opening in female with a row of small, regular papillae and sometimes with a ribbon like flap; shell oval to oblong. Usually more than 50 mm. long, caruncle absent. Shell smooth. Marsupial extension of female shell of same texture as the rest of the shell.

Shell without a distinct posterior ridge, or, if distinct, then the dorsal slope radiately sculptured. Pseudo-cardinals complete and well developed. Dorsal margin not winged. Female shell more or less expanded on postbasal region; male and female shells different.

Distribution: Widely distributed throughout North America.

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