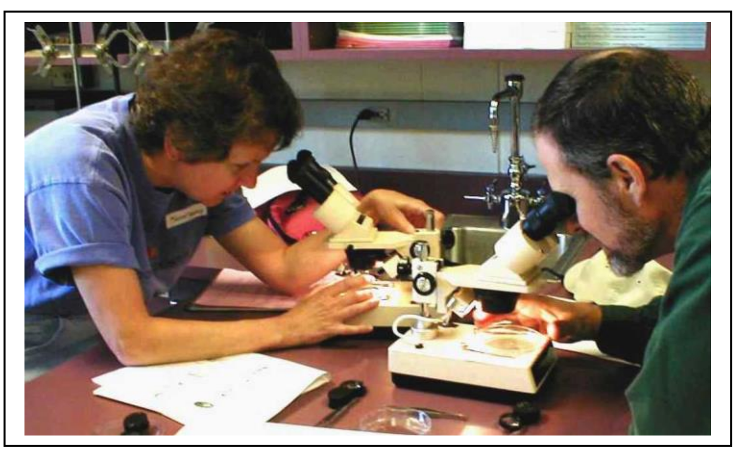
A Citizen's Guide to Biological Assessment of Wetlands

The Macroinvertebrate Index of Biological Integrity (IBI)

Field and Laboratory Protocols, Pictorial Keys to Wetland Invertebrates



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A Citizen's Guide to Biological Assessment of Wetlands

The Macroinvertebrate Index of Biological Integrity (IBI)

By Dr. Judy Helgen

2002

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Environmental Outcomes and Analysis Division
Biological Monitoring Unit
520 Lafayette Road North
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(651) 296-6300 or (800) 657-3864
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Minnesota Pollution Control Agency

This guide is dedicated to all those who care enough about the fragility, diversity and beauty of healthy wetlands to give their time, energy and spirit to understanding their condition and to trying to protect them for the future benefits of all of life.

A Citizen's Guide to Biological Assessment of Wetlands: The Macroinvertebrate Index of Biological Integrity (IBI)

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A Citizen's Guide to Biological Assessment of Wetlands:

The Macroinvertebrate Index of Biological Integrity (IBI)

Dr. Judy Helgen
Minnesota Pollution Control Agency (MPCA)
520 Lafayette Rd. St. Paul, MN 55155
Contact: Mark Gernes, MPCA

Summary
This Guide provides the framework and protocols for citizens to do biological monitoring and assessment of wetlands. It is the basis for the training sessions held in June before citizens go with team leaders to sample wetlands in their local area. The Guide provides details for the field and laboratory protocols including data sheets and metric scoring sheets for scoring the IBI. Six metrics are rated for the IBI total score: the Leech Taxa Metric, the Corixidae Proportion Metric, the Dragonfly-Damselfly Taxa Metric, the ETSD Taxa Metric, the Snail Taxa Metric and the Total Taxa Metric. Background for the identifications of typical wetland invertebrates is given, including tips for identifications, an illustrated glossary, a list of taxonomic names, and eighteen pages with pictorial keys to the wetland invertebrates.

Acknowledgements
This Guide has been produced with funding assistance from US EPA to the Minnesota Pollution Control Agency. The Guide has evolved over many years of experience with training citizens and team leaders in Dakota County, Minnesota, and more recently Hennepin County. The input and commitment of Mary Kay Lynch and Margot Monson were very important for the final revision of this Guide. Joel Chirhart and Mark Gernes of MPCA were very helpful in the development of the citizen monitoring protocols. Dan Huff and Charlotte Shover of Dakota County, and Tim Reese of Hennepin County provided the organizational skills and passion to draw in many interested citizens and team leaders. Lastly I want to thank the many citizens and team leaders who have given so much of their time, energy and commitment to learn about and assess the quality of wetlands. Their feedback and suggestions on ways to make the protocols, the training and the materials in the Guide more understandable have been critically important in shaping this Guide.

The figures in the Guide are redrawn from figures from several publications. The publishers who have graciously given permission for use of specific figures are the Canadian Museum of Nature, Ottawa, Ontario Canada; the Lyons Press, Guilford CT; Roy Sawyer and the University of Illinois Press; John Wiley and Sons, Inc., NY; Jones and Bartlett Publishers, Sudbury, MA; the Royal Ontario Museum of Canada, Toronto, Canada; and Matthew Burne, Massachusetts Division of Fisheries and Wildlife. Details about the publications and the figures used are given in the Appendix 1 at the end of the Guide.

A Citizen's Guide to Biological Assessment of Wetlands:
The Macroinvertebrate Index of Biological Integrity (IBI)

INTRODUCTION

The purpose of this Guide is to provide the background information for citizens to do biological assessments of depressional wetlands by sampling the invertebrates, identifying them, scoring the metrics for the Index of Biological Integrity (IBI), and making an assessment of the condition of the wetland. This Guide includes protocols and data sheets for field sampling, protocols and data sheets for processing samples in the laboratory, metric scoring sheets for scoring the IBI, and a pictorial guide to the common invertebrates in wetlands. This Guide is used during an all day training session on the protocols, identifications and data handling for scoring the IBIs. The training is held in early June. Following the training each team of volunteers with their team leader proceed to sample a few wetlands in their local area. The teams are brought together after the field season to share experiences and data for their wetlands. Often, teams take the information about the wetlands they sampled to their local governments.

A technical invertebrate IBI for wetlands has been developed by MPCA and other states. The IBI scores show strong responses to measures of human disturbance, or pollution, in wetlands. In Figure 1, the IBI scores for 44 large depressional wetlands are plotted against the gradient of human disturbance as measured from water and sediment chemistry and degree of physical alteration in and around the wetland. The technical IBI uses 10 different measures, called metrics, of the invertebrate community. The citizen IBI uses six metrics and is derived from the more technical IBI. Further information on the technical IBI is available in reports by MPCA (Gernes and Helgen 2002, Helgen and Gernes 2001) and on the web (US EPA 2002). Information and reports about the efforts of citizens using the citizen IBI are available on the web at the following address: www.mnwhep.org.

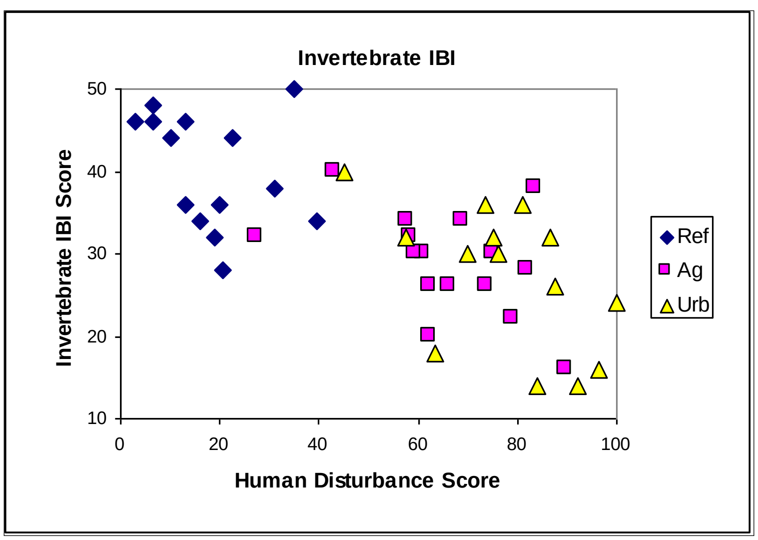


Figure 1. Invertebrate technical IBI scores totaled from ten invertebrate metrics from 44 large depressional wetlands in Minnesota. Human Disturbance Score is the sum score of factors of human disturbances in the landscape, buffer, hydrology, and water and sediment chemistry.

Macroinvertebrates are useful indicators of the health or condition of wetlands and other water bodies. They respond to many kinds of pollution, including chemical pollution and physical disturbance to the landscape around the site, wetland structure, and hydrology. There are several advantages of using macroinvertebrates:

- Invertebrates are commonly and widely distributed in many types of wetlands
- Invertebrates respond with a range of sensitivities to many kinds of pollution, for this reason they are commonly used in toxicity testing to develop water quality standards
- Many aquatic invertebrates complete their life cycles in wetlands, so they are exposed directly to the physical, chemical and biological conditions within the wetland
- Aquatic invertebrates are important in wetland food webs for wildlife

Having the life cycle of reproduction, development and maturation occur within the wetland exposes the invertebrates to all the conditions of the wetland. Usually, having more kinds (or taxa) of invertebrates is a good sign of health in a wetland. An important metric is the total taxa richness, the total number of kinds found in the sample.

Invertebrates with longer life cycles, such as dragonflies, may signal that conditions remained healthy for the duration of their development. In addition, predatory invertebrates such as leeches, beetles, dragonflies, damselflies and most true bugs require the presence of other invertebrates as their food (or prey). Having a rich array of predators means there are many prey available. Prey species of invertebrates include mosquitoes, midges, crustaceans and worms. The greater the number of taxa present, the more complex the community structure is.

Some invertebrates are more sensitive to pollution. Most kinds of mayflies and caddisflies tend to drop out of polluted wetlands; they can't tolerate polluted conditions. Likewise, most of the dragonfly and damselflies are sensitive to pollution. The midges (chironomids) are sometimes called indicators of pollution, but this is not true for wetlands. There are many kinds of midges that are lost in polluted situations, and other kinds that are pollution tolerant. The midges that are "pollution indicators" are the midges that can tolerate low oxygen conditions in streams. But many wetlands naturally have low oxygen conditions, and most of the invertebrates inhabiting them are adapted to low oxygen in the water by trapping air bubbles (some beetles and bugs), developing red blood (some midges make hemoglobin to store oxygen), or breathing air at the water's surface (mosquitoes).

Some kinds of invertebrates are tolerant and do tend to increase in relative numbers of individuals in more disturbed wetlands. The proportion of the corixid bugs (family Corixidae) increases relative to the count of all beetles and bugs in bottletrap samples. Many Corixidae bugs feed on algae and detritus that tend to increase in polluted wetlands. They increase greatly in waste stabilization ponds. In the technical IBI, the proportion of the dominant three taxa is greatest in the most disturbed wetlands. The proportion of certain taxa designated as tolerant taxa also tends to increase with disturbance.

For the citizen IBI, six invertebrate metrics are used. Five of these are based on counting the number of different kinds, or taxa, of invertebrates in the samples. The word taxon (plural is taxa) refers to uniquely different kinds of organisms. A taxon could be at the order, family, genus or species level. The approach used in the training and in the Guide is to try to identify how many members of a group such as snails, for example, appear to be different kinds or taxa. The volunteers may not be able to ascribe a precise name to each kind, but they may be able to determine there are distinctly different kinds of snails present in the sample. This can be judged by grouping all the kinds of snails from one wetland together and looking for distinctly different features, e.g., the direction of the coils and differences in shapes.

Note that for the taxa metrics, we are counting the taxon as one, we are not using the total count of individuals within that taxon.

The six metrics for the citizen invertebrate IBI are:

- *The Leech Taxa Metric.* The number of kinds of leeches found in dipnet and bottletrap samples is greater in healthier wetlands. There is one kind of leech that tends to increase in relative numbers in more polluted wetlands, but overall, more leech taxa indicates less disturbance. Leeches feed on a variety of different kinds of prey, both invertebrate and vertebrate. Very few kinds of leeches suck blood from mammals.

- *The Corixidae Proportion Metric.* All aquatic beetles and most true bugs are predators, mostly feeding on other invertebrates. Many of the corixid bugs feed on algae and detritus that tends to increase in polluted wetlands. The corixid bugs tend to increase in proportion to the total count of individuals of beetles and bugs found in the bottletrap samples. This is the only metric that relies only on data from bottletrap samples, and the only one that counts the number of individuals.

- *The Dragonfly-Damselfly Taxa (Odonata) Metric.* The number of kinds of dragonfly and damselfly larvae found in dipnet and bottletrap samples tends to be higher in healthier wetlands. These insects are predators at all stages, and have somewhat longer life cycles than other invertebrates. Dragonflies pump water in and out of their posterior end, which could expose them to pollutants. Some odonates lay their eggs on stems of aquatic plants, so if the plants are lost, they lose their egg-laying sites.

- *The ETSD Taxa Metric.* This metric adds the total number of taxa of mayfly larvae (Ephemeroptera) and caddisfly larvae (Trichoptera) and to this is added a one for the presence of dragonfly larvae (D) and a one for the presence of fingernail clams (S, for Sphaeriidae) from bottletrap and dipnet samples. Mayflies, caddisflies and fingernail clams are sensitive to pollution. Mayflies and caddisflies are gill breathers, allowing them to take in pollutants directly from the water. Fingernail clams filter small particles from the water, allowing direct intake of pollutants, but also making them more vulnerable to siltation in the water.

- *The Snail Taxa Metric.* Most snails in wetlands are lunged (pulmonate), meaning they are air breathers. Sometimes you will see snails hanging upside down under the surface film. They are breathing and may be feeding on the film. Snails are herbivores and feed on plants and the algae coating surfaces of plants, sticks and substrates. The number of taxa of snails is greater in higher quality wetlands than in disturbed wetlands. Algae and plants can accumulate contaminants, so snails could be exposed to pollutants through their feeding. Also if the vegetation is lost, there will be less food for snails.

- *The Total Taxa Metric.* The total number of invertebrate taxa is usually one of the strongest indicators of the health of wetlands. The total taxa metric sums the total number of leech taxa, dragonfly and damselfly taxa, mayfly and caddisfly taxa, snail taxa, and presence of fingernail clams. In addition, the number of macrocrustacean taxa is added to the total taxa. These are crustaceans that are visible to the eye. Smaller crustaceans like water fleas (Daphnia), ostracods and other zooplankters (copepods) are not counted. The Dipteran or true fly taxa are also included in the total taxa metric. Mosquito larvae, Chaoborus (the phantom midge), the midges (Chironomidae), the biting midges (Ceratopogonidae) and soldier flies are some examples of some of the Dipteran taxa that might occur in wetlands.

Each metric is given a score of five, three or one points. The scores for all six metrics are summed to give the IBI score. The best possible IBI score is 30 (6 metrics x 5 points), the lowest possible score is 6 (6 metrics x 1 point). Then the condition of the wetland is assessed using the suggested criteria given: 23 – 30 is excellent condition, 15 – 22 is moderate condition, 6 – 14 is poor condition. These criteria are based on dividing the possible range of IBI scores (6 to 30, a range of 24 points) by three.

Citations and web sites

Minnesota Wetland Health Evaluation Project. www.mnwhep.org

Gernes, Mark C. and Judy C. Helgen. 2002. Indexes of Biological Integrity (IBI) for Large Depressional Wetlands in Minnesota. Minnesota Pollution Control Agency, St. Paul, MN. Final Report to US EPA. May, 2002. http://www.pca.state.mn.us/index.php/view-document.html?gid=6100

Helgen, Judy C. and Mark C. Gernes. 2001. Monitoring the Condition of Wetlands: Indexes of Biological Integrity Using Invertebrates and Vegetation. In Rader, R.B., D.P. Batzer and S.A. Wissinger (eds), Bioassessment and Management of North American Freshwater Wetlands. John Wiley and Sons, Inc. New York.

US EPA. 2002. Judy C. Helgen, Principal Contributor. Methods for Evaluating Wetland Condition #9. Developing an Invertebrate Index of Biological Integrity for Wetlands. US EPA Office of Water. EPA-822-R-02-019. March 2002. Available on web: http://water.epa.gov/type/wetlands/upload/2008_12_23_criteria_wetlands_9Invertebrate.pdf

FIELD SAMPLING FLOW CHART: WETLAND INVERTEBRATES

You will have training in the field methods, and then training in the invertebrate identifications. See protocol sheet on sampling and see the diagram on where to sample.

↓

STEP 1: Select wetlands and plan sampling dates; Assemble equipment

→ Dipnet, trays with ½" screen, sieve, sample jars, squirt bottles for tap water and alcohol, alcohol, waders, bottletraps with dowels, etc.

↓

STEP 2: Go to your wetlands to sample invertebrates in the month of June. Do Steps 3 and 4 in the same week.

STEP 3: Set out 6 **bottletrap samplers (BT)** for two overnights

↓

STEP 3: After **bottletraps** are out for 2 nights, pour the contents of all the bottletraps into your sieve, backflush with alcohol into sample jar, add more alcohol to sample jar, place label (pencil on index card) inside jar. Tighten lid.

STEP 4: Do **two dipnetting (DN)** efforts (each 3-5 sweeps) for **one DN sample** within the emergent vegetation and near shore zone, in same area as bottletraps.

↓

STEP 4: Place contents of a **dipnet effort** onto ½" hardware cloth screen over trays of water. Encourage invertebrates to go into the water for 10'. Then remove the vegetation and do the **second dipnet effort** the same way. Then pour tray contents through your sieve, backflush with alcohol into a sample jar. Add label and more alcohol to sample jar. Final % alcohol should be 80%. **This is one dipnet sample.**

NOTE FOR BT AND DN SAMPLES: if sample occupies more than ¼ of the jar volume, put the sample into more than one jar (otherwise it might rot!). Label each jar "jar 1 of 2, jar 2 of 2".

↓

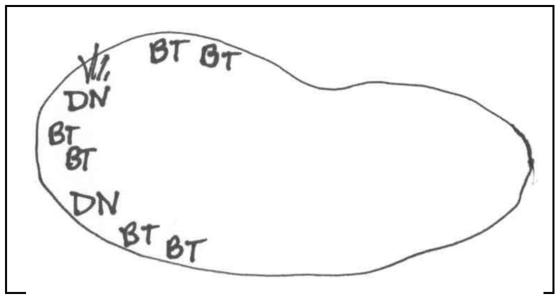
STEP 5. Check your samples to be sure the lids are tight. Change the alcohol if sample is rich in organic material, or it seems to be decomposing. Keep samples in a cool place away from heat sources or sparks.

Analyze your samples in a laboratory with microscopes. Record your data on the data sheets as guided by the training provided by MPCA. See laboratory protocols in this guide.

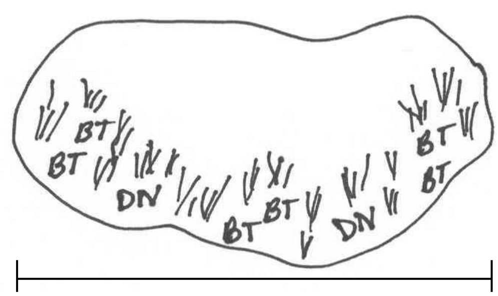
Sampling diagram for wetland invertebrate sampling

Below are three schematic diagrams of emergent vegetation in a wetland. Place your 6 bottletraps in the emergent/submerged vegetation zone, spread evenly along 45-60 feet of shoreline. Place in water less than three feet deep, but vary the depth at which the bottle traps are placed, i.e., don't place them all at 3 ft, place some at one feet, some at two feet, some at three feet. For the one dipnet sample, you will make two sampling efforts, each consisting of 3-5 sweeps of the net. Do the two dipnet efforts in areas near where you place your bottletraps. Cover about 45 – 60 ft of shoreline.

1. If there is very little vegetation, place the traps close to shore and any vegetation that might be present.

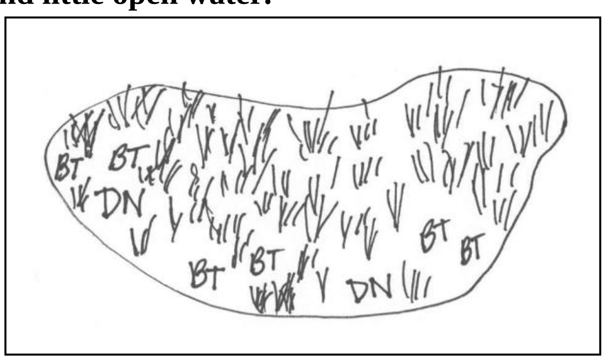


2. If there is a vegetated border around the wetland, place the traps and do the dipnetting in water from near the shore to up to one meter deep. Sweep net right into the vegetation.



Spread samples along about 60 ft of shoreline

3. If the wetland has very dense vegetation throughout, try to find open pockets in which to do the dipnetting and place the bottletraps. Dipnet with a choppy motion if there is dense submersed vegetation and little open water.



Field Sampling Protocol: Samp s Invertebrates

Goal: to collect **one complete dipnet (DN)** sample and **one complete set of bottletrap (BT)** sample from each wetland site. We do the dipnetting to get the widest number of species and the bottletrapping to get the actively swimming predators.

1. When to sample

Sample for the invertebrates in June, or at the latest, early July.

2. Where to sample

Sample for the invertebrates in the shallow, near-shore area not deeper than 3 feet (1 meter). Use the same general area where the bottletraps were set. Be sure to sample very close to the shore or in the vegetation fringe at shore.

If there is a cattail fringe (or other emergent vegetation), sample in the area between the cattails and the shore. If there is no water between the emergent vegetation and the shore, then sample within the cattails and to the outer edge of the cattails towards the open water. If there is no emergent vegetation, sample very near shore in water up to 3 feet deep.

3. Bottletrap samples --setting them out

a. Use 6 bottletraps per site.
   Spread the six bottle traps along the shore, covering 45-60 feet of shoreline.
   You will combine the data from all 6 traps for metrics.
b. Put at least two of the traps in very shallow water near shore, the others in shallow water not deeper than about 2 –3 ft.
c. Set out the bottletraps 2 nights before collecting them.
d. Fill traps with water with no air bubbles (tip trap under water so bubbles escape).
e. Press funnel into trap opening so it snaps in tightly. Again, remove air bubbles.
f. Lower bottle on dowel, orient bottle horizontally in water.
g. Put bottletraps about one hand length under the water.

4. Bottletrap samples -- collecting them

a. **Collect all of the bottletraps each into a single jar if possible**.
   If the sample occupies more than ¼ of the volume of the jar, use a second or third jar as necessary. Be sure to label the jars appropriately
b. Raise trap up the dowel, remove the funnel, pour the trap contents through your sieve.
c. Dislodge any critters stuck to the inside walls of the bottle. What's on the outside of the bottle **is not** part of the sample.
d. Collect the remaining bottle traps, and pour contents into sieve.
e. Backflush the contents of the sieve into your sample jar with 95% alcohol.
f. **NOTE:** if you have a lot of leeches or other organisms in your traps, you may need to use more jars to preserve the sample.
g. **NOTE:** if you have fish, tadpoles or salamanders you should note these on your field data sheet and leave them at the site. Note approximate numbers.

h. **Label properly**. Put pencil or India ink label inside the jars. Label outside for convenience. See # 6 below on labeling samples.

5. Dipnet (DN) samples

You collect **one dipnet sample** per site. Each DN sample **consists of two dipnetting efforts.** Dipnet in the near-shore shallow areas in water up to one meter deep. "Sample close to edge and into veg." Use a 12 x 16" wood framed ½" hardware cloth screen over a tray (or two Coleman cooler trays) of water. The tray(s) of water should sit within a larger kitty litter pan or dishpan. This can float on the wetland.

FIRST DIPNETTING EFFORT.

a. Put water in your collecting pans that sit underneath your hardware cloth screen.
b. Place the framed ½" hardware cloth screen over the water so its edges don't hang over the edge of the pans. This way the critters go down into the water in the pans.
c. Sample in the shallow emergent vegetation zone in water not deeper than 3 feet.
d. **Hold the long-handled dip net vertically**, one hand near net, one hand up handle.
e. Using strong strokes, sweep the net through the water towards you about 3-5 times.
f. BE SURE TO SAMPLE RIGHT INTO THE VEGETATION NEAR SHORE.
g. Evert all of the net contents onto the hardware cloth screen. Get everything out of the net.
h. Spread the vegetation, loosen it. Do this periodically for up to 10 minutes. This allows the critters to get down into the water in the pans.
i. After 10 minutes, remove the vegetation and do the second dipnetting effort.

SECOND DIPNETTING EFFORT

a. Move to a different shallow area.
b. Repeat the process described in a. - g. above.
c. After spreading out the vegetation for 10 minutes, remove it, and pour the water from the collecting pans through your sieve. Be sure to dislodge the leeches and snails which might attach to the pan.
d. Backflush the sieve contents into your sample jar with 95% alcohol. Be sure to get any critters which attach to the sieve walls. Use two jars if critters and debris occupy more than ¼ of the jar volume.
e. **Label properly.**
f. If your sample from the two efforts will occupy more than ¼ the sample jar divide the sample into two jars and label accordingly.

6. Sample labeling

a. **Record sample code on field data sheet**, especially if different from site name.
b. Use **pencil** or truly permanent India ink on 100% cotton cardstock or index card.
c. Indicate Site Name, Sample Code, Date, County, Collector's name, if DN or BT sample. Indicate if there is more than one jar -- jar #1 of 2, jar #2 of 2.
d. Place label **INSIDE** jar. This is the only label you trust.
e. For convenience, label also on the outside of the jar.
f. Remember alcohol is flammable. Keep lids tight. Store away from flame or heat.

Field Data Sheet Wetland Invertebrate Sampling. Site data and site sketch.

Site Name **Town** **County**

Sample name (if coded differently from site name)

Location description: DO SKETCH OF SITE ON BACK OF PAGE, show roads, compass directions. Write out road names/#'s, directions, name of park, private owner name, whatever is necessary to tell a stranger how to get to your wetland.

Date dipnet samples were collected: **Water temperature:**

Samples collected by: Collector's name/Phone #
Team Name:

Near shore area: describe vegetation (or lack of it) where you sampled (e.g. little or no veg, choked with cattails, lots of submerged vegetation, lots of duckweed).

Slope into wetland in the water near edge: gentle or steep?

Describe bottom of wetland: (e.g. solid or very mucky?)

BOTTLETRAPS (BT). You will collect 6 total bottletraps (see protocol sheet).

1 Sample codes if different from site name:
2 Date/Time BTs were set out:
3 Number of BTs deployed:
4 BTs set out by (name, phone #)
5 Locations where BTs set out (indicate on site sketch on back)
6 Date/Time BTs were collected
7 Number of BTs collected successfully
8 Number of jars which contain the BT samples:
9 Indicate if the following were present in bottletraps:

	Tadpoles	Salamander adults	Fish
	Frog adults	Salamander larvae	Other

DIPNETTING (DN). One sample consists of **two dipnetting efforts** (see protocol sheet).

1 Sample code if different from site name:
2 Date/Time DN sample was taken:
3 Locations where the 2 DN efforts were done (indicate on site sketch on back)
4 Were 2 dipnetting efforts done? (see protocol)
5 Describe approximate water depths where you sampled:

NOTES:

LAB PROCESSING OF BOTTLETRAP and DIPNET

You need to compare and count the taxa within each group from **both your BT and DN samples**. If you have the same taxon in both DN and BT samples, you count it as one taxon.

FROM BT SAMPLES ONLY

↓

Pick out to a petri dish from the BT samples all adult beetles, beetle larvae, and all bugs, including corixid bugs

↓

Count the number of corixid bugs, non-corixid bugs, beetle larvae and beetle adults and record on the **Invertebrate Lab Data Sheet Page 1** under Corixid Proportion Metric. It is OK to pool your BT samples and then do the counts for the ratio if you prefer.

↓

Transfer the data for the corixid metric to the **Metric Scoring Sheet Page 2** and score the corixid metric.

FROM BOTH BT AND DN SAMPLES

↓

Pick out the invertebrates from BT and from DN samples into separate **petri dishes labeled by group name and BT or DN** for the groups listed below. You will have 14 petri dishes, one set for the 7 groups listed from BT samples and one set for the 7 groups listed for the DN samples.

↓

1. **All leeches**
2. **All dragonfly and damselfly** larvae
3. **All caddisfly and mayfly** larvae (some may be tiny!)
4. **All snails** (unless one type is very abundant)
5. **All macro-crustaceans** (see Invertebrate Lab Data Sheet)
6. **Dipterans** (see Dipteran sheet in Guide).
7. **Fingernail clams** (don't need to pick them all, presence only)

↓

- **Look at one category of organisms, e.g., dragonflies, from both the DIPNET and the BOTTLETRAP** samples from your wetland. Get all the kinds in front of you. Then determine if they are the same kind, or are different kinds. If you have immature and more mature stages of one taxon, it counts only as one taxon.
- Use the **Identifications Sheets** provided to assist you in deciding how many kinds you have in each group of invertebrates.
- Record the number of kinds on the **Invertebrate Lab Data Sheet pages 1 - 3**. There is a page of instructions for the lab data sheets.

←

Transfer the data for the number of taxa for categories # 1 –7 to the appropriate **Metric Scoring Sheet** and score the metric for Leech Taxa, Snail Taxa, ETSD, Dragonfly and Damselfly taxa, and Total Taxa.

↓

- **On the Metric Scoring Sheet Page 5, add up the scores for the six invertebrate metrics to get the IBI total score** for your wetland: Corixid Proportion, Dragonfly-Damselfly (Odonata) Taxa, ETSD, Leech Taxa, Snail Taxa, Total Taxa.
- **Rate the wetland as having excellent, moderate or poor condition** using the suggested guidelines on the Metric Scoring Sheets Page 5. Transfer the metric scores and the IBI total score to the **IBI Scoring Table,** the table to show all the wetlands you have studied.

INSTRUCTIONS FOR THE INVERTEBRATE LAB DATA SHEETS PAGES 1 - 3.

1. **IMPORTANT NOTE:** for recording the number of taxa or kinds of invertebrates put a "1" under the DN or BT column in the Invertebrate Lab Data Sheet (**not the count of the number of individuals** of that taxon).

2. **IMPORTANT NOTE:** for recording a taxon is present **in the total sample**, **put a "1" in the Taxon Presence** column even if you saw it only in one BT sample and not in the DN sample. If you saw the same taxon in all 3 BT samples and in the DN sample, you still put a "1" in the Taxon Presence column.

3. **The lab processing protocol** has you pick your BT samples separately from your DN samples into the 7 major groups of invertebrates. You then look within one major group, e.g., snails and see how many unique taxa you have within your BT and DN samples combined. On the Invertebrate Lab Data Sheets Pages 1 – 3, you record which samples had the particular taxon, say the leech Helobdella. **It is important that you look at all the members of one group (picked from BT and DN) together to see how many unique taxa you have**.

4. **If you prefer,** you can record the unique taxa under the "Taxon Presence" column in the Invertebrate Lab Data Sheets and not under BT and DN. **THE GOAL IS TO DETERMINE HOW MANY DIFFERENT TAXA YOU HAVE FROM YOUR TOTAL SAMPLING EFFORT.**

5. **Note that for all the taxa metrics, you will be picking the major group from both BT and DN samples.**

6. **ONLY THE CORIXIDAE PROPORTION METRIC REQUIRES COUNTING THE NUMBER OF INDIVIDUALS.**

7. **For example, for the Leech taxa metric** you need to know how many taxa (or kinds) of leeches you had in your BT and DN samples combined. On the Invertebrate Lab Data Sheet Page 1, describe briefly which different kinds of leeches you have in your DN and BT samples, or give their names as best you can determine using the Guide. The goal is to record how many different kinds you have. If you have the same kind (e.g., Erpobdella) in both dipnet and bottletrap samples, you record it as one kind for the purposes of the metric (you put "1" under Taxon Presence for Erpobdella, list Erpobdella on the left under Other kinds of leeches).

   When you determine the total number of kinds of leeches, **BE SURE YOU RECORD EACH KIND OF LEECH ONLY ONCE** in the Taxon Presence column, even if it was found in both DN and BT samples.

8. **Corixid Proportion Metric.** If you put 3 pairs of bottletraps into 3 jars, then record your data as BT1, BT2 and BT3 (for 6 bottletraps). If you had very little material and pooled all 6 of your bottletraps into one jar, then note that you are analyzing a composite sample from 6 traps. In the end, the data is effectively pooled from all your bottletrap samples for making the Corixidae Proportion ratio.

   Be sure to record at the top of the data sheet how many bottletraps you used and collected. If you collected 6 traps, put 6 traps as 3 samples, or 6 traps into one sample.

For this metric, you need to count the number of individuals within the categories of corixid bugs, the bugs that are not corixids, and beetle larvae and beetle adults. THIS IS THE ONLY METRIC FOR WHICH YOU HAVE TO COUNT THE NUMBER OF INDIVIDUALS.

9. **Dragonfly-Damselfly Taxa (Odonata) Met** at the dragonfly larvae that you have from both DN and BT samples together. Look at their mouthparts under the microscope. It is important to note whether you have **more than one kind WITHIN a family.** You might have two kinds of dragonflies in the family Libellulidae, for instance. If so, record them as two different kinds (you could record "Libellulid type 1" and "Libellulid type 2").

   The same holds true for the damselflies. Look for definite physical differences in mouth parts and body structures.

10. **ETSD Metric.** For this metric you need to **record the number of Mayfly and Caddisfly Taxa** on the Invertebrate Lab Data Sheet Page 2. The **caddisflies** may have come out of their cases. If you have an empty case, and it is different from other kinds of cases in your sample, you can count it as one kind. But then don't count as a separate taxon a caddisfly that has no case. Look at the patterns on the heads of the larvae, these are different among the different species of caddisflies. Also look at the gills on the sides.

    The mayflies may be very tiny. See your identification sheet for the mayflies for the sizes of Caenis and Trichorythodes. These can easily be missed. Spread your sample out, use good light and lenses to look very closely. **Look at the veins and shapes of the gills**. Sometimes the gills are damaged and lost.

    NOTE FOR ETSD METRIC: BE SURE TO RECORD THE PRESENCE OF FINGERNAIL CLAMS ON PAGE 3 of the Invertebrate Lab Data Sheet. Then transfer a "1" to the Metric Scoring Sheet for ETSD. Also transfer a "1" for the presence of dragonfly larvae to the Metric Scoring Sheet for ETSD.

11. **The snail metric** is the number of kinds or taxa of snails, and there might be two species of the same genus, e.g., you may see two species of Stagnicola, or two species of Planorbella. The planorbid snails, especially Armiger and some Gyraulus, may be very small. See snail identification sheet.

12. **Invertebrate Lab Data Sheet Page 3 has "Other Taxa to Include in the Total Taxa Metric."** This is where you record the presence of **fingernail clams**, the different **kinds of Dipterans** and the different **kinds of Crustaceans** you find in your samples. This data will be transferred to the Metric Scoring Sheet Page 4 **for the Total Taxa Metric.**

13. **IMPORTANT NOTE:** the Guide gives names and images of taxa you are likely to see in wetlands, but there may be other taxa present in the different groups we are analyzing. If you observe taxa that are not pictured in this key but are in the major groups in the key, then record their presence on your data sheets.

INVERTEBRATE LAB DATA SHEET PAGE 1   ENTER DATA HERE FIRST

Site Name	**Site Number**	**# of DN** samples taken:				
Date analyzed	Date sampled	**# of BT traps** set:		**# BT sample jars:**		
LEECH TAXA METRIC		**Put 1 where the taxon was seen in any sample**				
NOTE: **each row** represents a **DIFFERENT taxon** or kind		**DN**	**BT 1**	**BT 2**	**BT 3**	**Taxon Presence (put 1)**
Glossiphonidae (describe or name the different taxa)						
Large, mottled leeches						
Macrobdella decora						
Other kinds(describe or name them)						
Record total leech taxa at far right (add the Taxon Presence column)				**Total # of Leech Taxa:**		

		Record counts of individuals here			
CORIXID PROPORTION METRIC (BOTTLETRAPS ONLY)		**BT 1**	**BT 2**	**BT 3**	**Total Count by row for all BTs**
a. Corixid bugs (count juveniles and adults)					
b. Bugs that are not corixids					
c. Beetle larvae					
d. Adult beetles					
e. Record total count of bugs and beetles at far right		**Sum Total Count (add a, b, c, d):**			
f. Compute the ratio of Corixid bugs (a.) to the Total Count (e.) at far right			**Corixid Ratio (a/e):**		

INVERTEBRATE LAB DATA SHEET PAGE 2 ENTER DATA HERE FIRST

Site Name	**Site Number**	**# of DN** samples taken:
Date analyzed	Date sampled	**# of BT traps** set: **# BT sample jars:**

DRAGONFLY-DAMSELFLY TAXA METRIC (Odonata Taxa)	**Put 1 where the taxon was seen in any sample**				
NOTE: **each row** represents a **DIFFERENT taxon** or kind	**DN**	**BT 1**	**BT 2**	**BT 3**	**Taxon Presence (put 1)**
Dragonflies Aeshnidae family (list different types you see)					
Dragonflies Corduliidae family					
Dragonflies Gomphidae family					
Dragonflies Libellulidae family (list different types you see)					
Damselflies Lestidae					
Damselflies Coenagrionidae					
Damselflies Other					
Record total # of dragonfly and damselfly at far right (add Presence column)			**Total # of Odonata Taxa:**		

MAYFLY-CADDISFLY TAXA FOR ETSD METRIC	**Put 1 where the taxon was seen in any sample**				
Mayflies (describe each different type you see, or give names)	**DN**	**BT 1**	**BT 2**	**BT 3**	**Taxon Presence (put 1)**
Caddisflies (describe each type you see, or give names)					
Record total # of mayfly and caddisfly taxa at far right (add Presence)		**Total # of Mayfly and Caddisfly Taxa:**			

INVERTEBRATE LAB DATA SHEET PAGE 3 **ENTER DATA HERE FIRST**

Site Name	**Site Number**	**# of DN** samples taken:
Date analyzed	Date sampled	**# of BT traps** set: **# BT sample jars:**

SNAIL TAXA METRIC		**Put 1 where the taxon was seen in any sample**				
NOTE: **each row** represents a **DIFFERENT taxon** or kind		**DN**	**BT 1**	**BT 2**	**BT 3**	**Taxon Presence (put 1)**
Planar snail	Helisoma					
Planar snail	Gyraulus					
Planar snail	Planorbella (do you see one or two types?)					
Planar snail	Planorbula					
Planar snail	Promenetus					
Planar snail	Other					
Spired snail	Aplexa					
Spired snail	Fossaria					
Spired snail	Lymnaea stagnalis					
Spired snail	Stagnicola elodes					
Spired snail	Stagnicola reflexa					
Spired snail	Physa					
Spired snail	Other					
Record total # of snail taxa at far right (add Presence column)				**Total # of Snail Taxa:**		

OTHER TAXA TO INCLUDE IN THE TOTAL TAXA METRIC	**DN**	**BT 1**	**BT 2**	**BT 3**	**Taxon Presence (put 1)**
Fingernail Clams (*used also in the ETSD metric*)					
Dipterans: Chaoborus					
Dipterans: Mosquito larvae					
Dipterans: Ceratopogonidae (biting midges)					
Dipterans: Chironomidae (midges)					
Dipterans: Stratiomyidae (Odontomyia)					
Dipterans: Other					
Crustaceans: Amphipods					
Crustaceans: Clam shrimp					
Crustaceans: Crayfish					
Crustaceans: Fairy shrimp					
Crustaceans: Isopods (Asellus)					
Crustaceans: Other (don't count ostracods, Daphnia)					
Total up these taxa to add to total for total taxa metric. Add up Presence column.			**Total of other taxa for taxa metric:**		

METRIC SCORING SHEET PAGE 1

SCORING INDIVIDUAL INVERTEBRATE METRICS for a wetland site

Site Name ________________________ **Site Number** ______ **County** ____________

Team Leader _____________________________ **Phone #** ___________________

Date sampled ___________________ **Date samples analyzed** __________________

NUMBER OF DN SAMPLES TAKEN FOR THIS SITE (usually one): ___________
Number of BT samples taken for this site (usually 6 traps pooled to 3 samples): ___________

There are six metrics.

1. **The data for each metric is recorded in your Invertebrate Lab Data Sheets Pages 1, 2 and 3.**
2. **Transfer the data from the lab sheets to these Metric Scoring Sheets Pages 1 - 4.**
3. **Score each metric on the Metric Scoring Sheets.**
4. **Total the metric scores for your site on Metric Scoring Sheet Page 5. Assess the site.**
5. **Then transfer the metric scores and IBI score total to the IBI Score Table where you can show the scores for all the wetlands you survey.**

1. Leech Taxa Metric: The total number of kinds or taxa of leeches in Dipnet (DN) plus bottletrap (BT) samples. Use data from Invertebrate Lab Data Sheet Page 1.

A. Number of kinds of leeches from BT and DN samples _____________

Transfer the Total # of Leech Taxa data from Invertebrate Lab Data Sheet, Page 1

B. Score for Leech Metric: _____________

Enter 5, 3 or 1 here. Use scoring criteria below.

Scoring for leech taxa metric

Total # kinds	Score
4 or more	5
2 - 3	3
0 - 1	1

Notes

C. Record the Leech Taxa Metric score on Metric Scoring Sheet Page 5, and in the IBI Scoring Table.

METRIC SCORING SHEET PAGE 2

Site Name ______________________ **Site Number** ________ **Date Sampled** ____________

2. Corixidae Proportion Metric: Proportion of *Corixidae* to the total beetles and bugs (including *corixids*) in all BT samples (6 traps pooled to 3 samples). Record totals for BT 1, 2 and 3. Use Invertebrate Lab Data Sheet Page 1 (lines a., e. and f.)

Total for all BT samples:

A. Count of *corixids* (line a.) ____________

B. Count of all bugs and beetles (line e.) ____________

C. *Corixids* as % of total count (line f.): ____________

> **NOTE:** the total in line B includes corixids, beetle larvae, adult beetles, and non-corixid bugs.

D. Score for Bug Metric (5, 3 or 1): ____________

Use the scoring criteria below:

Scoring for Bug Metric

Sample Results	Score
Ratio A/B < 33%	5
Ratio A/B 33% - 67%	3
Ratio A/B > 67%	1

Notes

E. Record the Corixidae Proportion Metric Score on Metric Sheet p. 5 and IBI Scoring Table.

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3. Dragonfly-Damselfly (Odonata) Metric: The number of kinds of dragonfly and damselfly larvae in the DN AND BT samples. Use data from Invertebrate Lab Data Sheet Page 2.

A. Number of kinds of damselfly larvae: ____________

B. Number of kinds of dragonfly larvae: ____________

C. Sum of A + B (= total kinds of dragons and damsels): ____________

D. Score for Dragonfly-Damselfly Metric (5, 3 or 1): ____________

Use the scoring criteria below.

Scoring for Odonata Metric

Sample Results (C.)	Score
4 or more taxa	5
3 taxa	3
0 to 2 taxa	1

Notes

E. Record the Dragonfly-Damselfly Metric Score on Metric Sheet p. 5 and the IBI Scoring Table.

Site Name ______________________________ **Site Number** _________ **Date Sampled** _______________

<u>4. ETSD Metric</u>: Total <u>number of kinds</u> of mayflies (*Ephemeroptera*) and caddisflies (*Trichoptera*) + presence of fingernail clams (*Sphaeriidae*) + presence of dragonfly larvae in the DN and BT samples. Use data from the Invertebrate Lab Data Sheet Page 2 and Page 3 (fingernail clams).

A. Number of kinds of mayflies: _______________

B. Number of kinds of caddisflies: _______________

C. Fingernail clams are present (score 1 if present, 0 if none): _______________

D. Dragonfly larvae are present (score 1 if present, 0 if none): _______________

E. Sum of A + B + C + D: _______________

F. Score for ETSD Metric (5, 3 or 1): _______________

<u>Scoring for ETSD Metric</u>

Sample Results	Score
4 or more	5
2 - 3	3
0 - 1	1

<u>Notes</u>

H. Record the ETSD Metric Score on Metric Scoring Sheet Page 5 and the IBI Scoring Table.

<u>5. Snail Metric</u>: The number of taxa or kinds of snails in the DN and BT samples.
Use data from Invertebrate Lab Data Sheet Page 3.

	<u># of Taxa</u>
A. Number of kinds of planar snails:	_____________
B. Number of kinds of spiral snails:	_____________
C. Sum of A + B:	_____________
D. **Score for Snail Metric (5, 3 or 1):**	_____________

<u>Scoring for Snail Metric</u>

Sample Results	Score
4 or more taxa	5
3 taxa	3
0 to 2 taxa	1

<u>Notes</u>

E. Record the Snail Metric Score on Metric Scoring Sheet P. 5 and the IBI Scoring Table.

Site Name ______________________________ **Site Number** _________ **Date Sampled** _______________

6. <u>Total Invertebrate Taxa Metric:</u> Sum up the number of the listed taxa (kinds) from your Invertebrate Lab Data Sheets Pages 1, and 3.

A. Total number of taxa of **leeches** ____________
(Lab Sheet Page 1)

B. Total number of taxa of **dragonfly and damselfly** larvae ____________
(Lab Sheet Page 2)

C. Total number of taxa of **mayflies and caddisflies** ____________
(Lab Sheet Page 2)

D. Total number of taxa of **snails** ____________
(Lab Sheet Page 3)

E. Total number of taxa of **Crustaceans** ____________
(Lab Sheet Page 3)

F. Total number of **Dipteran** taxa ____________
(Lab Sheet Page 3)

G. **Fingernail clams** are present (put 1) ____________
(Lab Sheet Page 3)

H. Total Taxa: Sum A+B+C+D+E+F+G = ____________

I. Score for Total Taxa Metric Score (5, 3 or 1) ____________
Use criteria given in the box below.

<u>Scoring for Total Taxa Metric</u>

Total Taxa	Score
11 or more	5
6 - 10	3
0 - 5	1

<u>Notes</u>

J. Record the Total Taxa Metric Score on Metric Sheet p. 5 and the IBI Score Table.

Site Name ______________________ **Site Number** _____ **County** _____

Team Leader __________________________ **Phone #** ____________

Date sampled _________________ **Date samples analyzed** ___________

Local Sponsor (city, other) ______________________________________

Metric	**Metric Score (5, 3, or 1)***
1. Leech Taxa	________
2. Corixid Proportion	________
3. Dragonfly-Damselfly	________
4. ETSD Taxa	________
5. Snail Taxa	________
6. Total Taxa	________
7. Total IBI Score (add # 1 – 6)	________

Interpretation of Site IBI Scores: Example

Scores and associated quality ratings are given as an example. The range of possible invertebrate IBI scores was trisected for the three assessments of wetland condition.

Total IBI Score	**Assessment**
23 – 30	Excellent
15 – 22	Moderate
6 – 14	Poor

ASSESSMENT OF CONDITION OF WETLAND: ____________________

***transfer metric scores from the Metric Scoring Sheets Pages 1 – 4.**

Transfer the metric scores and the Total IBI Score to the IBI Scoring Table. The IBI Scoring Table is where you summarize the scores for all the wetlands you are surveying.

Notes:

IBI SCORE TABLE FOR INVERTEBRATE IBI FOR WETLANDS

Interpretation of Wetland IBI Scores: Suggested scoring criteria below are given as an example. The range of the total possible IBI points (6 - 30) was trisected.

	Total IBI Score For a Wetland Site	**Assessment**
CITIZEN MONITORING OF WETLANDS	23 - 30 points	Excellent condition
	15 - 22 points	Moderate condition
	6 - 14 points	Poor condition

STEPS FOR COMPUTING THE IBI SCORE

1. Enter your data in the **Invertebrate Lab Data Sheets** pages 1 - 3
2. Fill out the **Metric Scoring Sheets** Pages 1 - 4 to score metrics.
3. Transfer Metric Scores to the **IBI Scoring Table** and sum IBI score.

Team Leader　　Phone #　　Community of team　　County

SCORING TABLE

				Metric Scores (5, 3 or 1) From Metric Scoring Sheets Pages 1-4							
Site Name	**Site #**	**Date Sampled**	**Date Processed**	**Leech**	**Corixid**	**Odonata**	**ETSD**	**Snail**	**Total Taxa**	**Total IBI Score**	**Assessment**

TIPS FOR DOING INVERTEBRATE IDENTIFICATIONS

1. **Dragonfly and damselfly mouth parts:** use two pairs of forceps, one to hold the body, the other to spread out the mouthpart (labium) away from the head under the microscope.

2. **Leech eyes:** press the anterior end down with forceps so you can view the anterior end flattened out under the microscope. Look carefully, eyes get trapped within the segments in the leeches body and can be hard to see, especially in dark specimens.

3. **Leech anterior vs. posterior end:** the posterior sucker of leeches is usually much larger than the sucker-like mouth on the anterior (front) end.

4. **Planorbid snails, how to tell top (anterior) from bottom:** examine the snail to see which of the coiled sides has the deepest indentation. The top of a planorbid snail is less indented than the bottom (posterior end). In some snails you have to look carefully to make this distinction.

5. **To tell the coiling direction of snails.** Hold the snail with its top (anterior end) facing up and its opening facing towards you. If the opening is on the right side, it is a right-coiled snail. If the opening is on the left side, it is a left-coiled snail.

6. **To see differences among some planorbid snails**, look at the shape of the coil. In Gyraulus the coils are almost like a round tube of clay, in Planorbula, it is as if a flat plate was pressed on top of the coils to flatten them.

7. **Mayflies:** tails may be broken, gills may be broken off. Sometimes there's only a gill or two left on the mayfly. Look for other specimens in your samples to see if they are more intact. Also, the antennae may be broken.

8. **Caddisflies:** look to see if the larva has a hump on its back. You'll need to take it out of the case to do this. To confirm it is a caddisfly, see the pair of tiny hooks on the fleshy end of the caddisfly. Look for differences in the pattern on the top of the head. Look for the antennae on the head. They are always small, but some are longer than others.

9. **Bugs:** immature bugs may have incomplete wing pads. Long skinny adult bugs like Ranatra and Hydrometra have very skinny wings lying against the body.

10. **Diptera: the fleshy prolegs** in midges and other Diptera (true flies) are not true legs, they are not jointed hard legs.

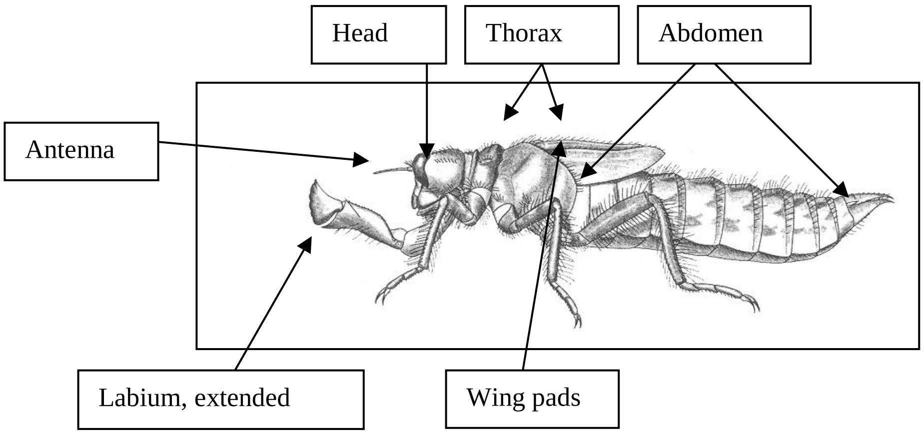
11. **You may have different ages** of the same taxon in your sample. Do your best to see if they are the same taxon or not.

12. **Work on one group of invertebrates at a time,** e.g., leeches or dragonflies. Have all the specimens picked out from your bottletrap and dipnet samples and examine similar ones together. If necessary, line up all the different kinds (taxa) together to assure yourself they are different taxa. In training we have seen people taking out one specimen at a time and examining it by itself. It is better to examine them together.

13. **Lighting and viewing:** be sure that both the top and bottom lights of your microscopes work, and use them. Use a pen light to give additional lighting, especially on darker specimens.

Glossary for wetland macroinvertebrates with illustrations

Insect Body Structure: 3 Body Divisions, head, thorax and abdomen. Legs and wings are attached to the thorax.



Abdomen. The abdomen is the posterior or rear-most section of the three sections of the insect body (head, thorax, abdomen). In mayflies and some caddisflies, there are gills attached to segments of the abdomen.

Antenna (singular), antennae (plural). A pair of segmented appendages located on the head above the mouthparts and usually sensory in function. Crustaceans have two pairs of antennae, insects have one pair.

Anterior. Anterior refers to the front, or head end of the organism. Posterior refers to the rear or tail end.

Arachnids are a group within the Phylum Arthropoda that includes the mites, scorpions and spiders. The adults have four pairs of jointed legs. In water mites, the immature stage has only 3 pairs of legs, but the adult mites have 4 pairs of legs. We don't count them in the wetlands IBI.

Arthropoda. Arthropoda is a major Phylum of invertebrates. It includes the Class Crustacea, Class Arachnida, and Class Insecta (or Hexapoda, referring to the 6 legs).

Bugs. Are the Order Hemiptera, a kind of insect with piercing mouthparts (except Corixidae, see Key). **NOTE:** do not refer to all insects as "bugs." There are many orders of insects, not just bugs.

Carapace. The carapace is the outer covering of crustaceans as in crayfish, clam shrimp and amphipods. The exception is the fairy shrimp, which lack a carapace.

Dipteran (singular), Diptera (plural). An order of insects called the true flies. Adults have two wings rather than four found in most other adult insects. Diptera are a very diverse group.

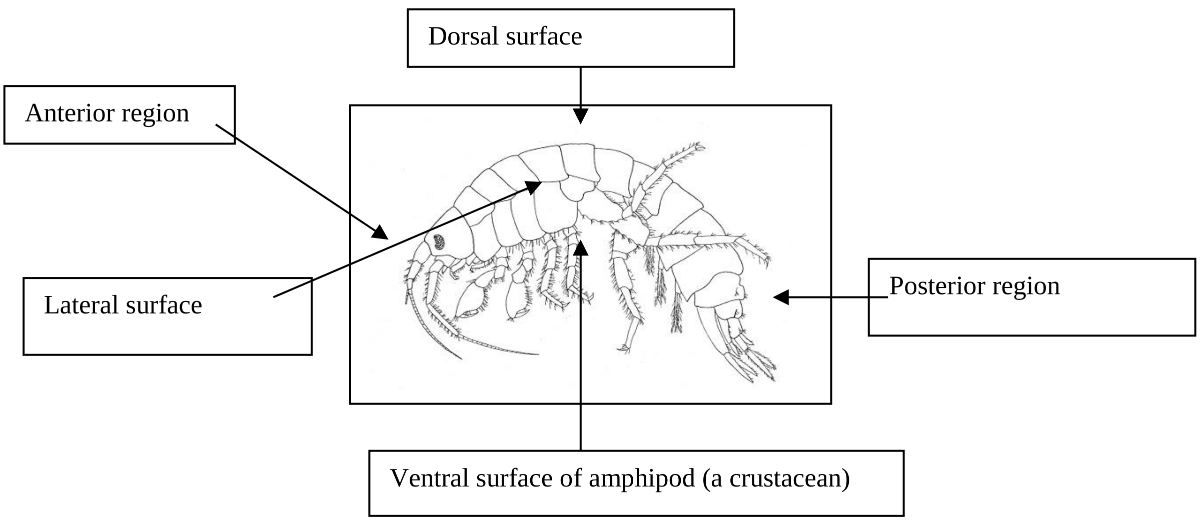
Aquatic dipteran larvae lack wing pads and do not have 3 pairs of jointed legs attached at the thorax. Some larvae (like the Chironomidae midges) have fleshy prolegs that aren't jointed legs.

Dorsal. Dorsal refers to the back surface of the organism. Ventral refers to the underside, or "belly" surface of the organism. See illustration on next page

Family. Family is a category in the classification of organisms. A family is comprised of one or usually more than one genus. The genera have a common evolutionary origin, and are often clearly separated by body characteristics (morphology) from the genera of other families. Family is between the categories of order and genus (or tribe).

Genus (singular), genera (plural). Genus is a category in the classification of organisms. A genus is comprised of one, or usually more than one species that are related to each other in body characteristics (morphology) and evolutionarily. Genus is the principal category between family and species.

Head capsule. A hardened capsule over the head of most insect larvae. See illustration located by prolegs in this glossary.



Labium. The labium is part of the structure of the mouthparts of an insect. It is essentially the lower "lip." In dragonfly and damselfly larvae, the labium is highly modified into a hinged structure that can be projected rapidly outwards to grab invertebrate prey and bring them to the mouth. See illustration at the beginning of the glossary.

Larva (singular), larvae (plural). The larva is an immature stage that develops from the eggs and precedes the pupal stage.

Lateral. Lateral refers to the left and right sides of the organism.

Lateral filaments. These would be filaments projecting from the sides of the organism.

Macroinvertebrates. These are larger invertebrates that are visible to the eye. It usually does not include the smaller invertebrates like Daphnia (water fleas) or copepods and ostracods.

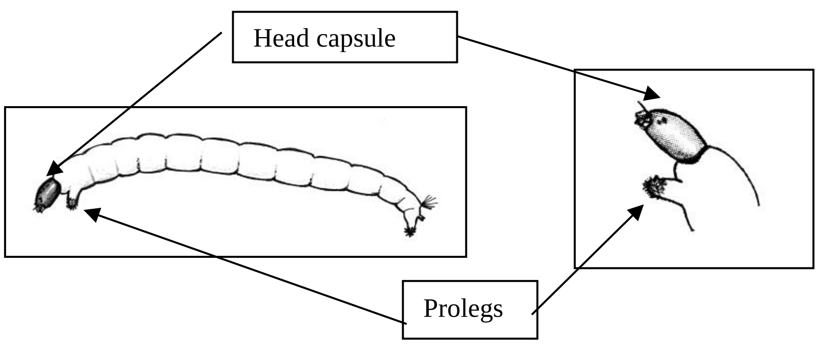
Operculum. In snails, the operculum is a flat, disk-shaped hard covering that fits into the opening of the snail. It looks like a small pick for a guitar. When the snail retreats into the shell, the operculum covers it up. This is found only in the gilled snails, not in the lunged snails. If empty shells are collected, the operculum will not be present because it is attached to the body of the snail.

Operculum. In the mayfly families of Caenidae and Trichorythodidae, the operculum refers to the plate that lies over the stack of gills on the abdomen.

Order. Order is a category in the classification of organisms. An order is comprised of one or more families that are related to each other evolutionarily and in body characteristics (morphology). Order is a category between family and class.

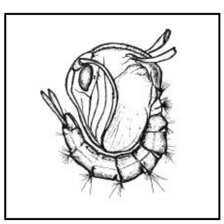
Planorbid snail. Planorbidae is a family of snails that have a disc-shape or a very low spire. The width of the shell is greater than the height of the shell.

Posterior refers to the rear or tail end of the organism. Anterior refers to the front or head end.



Prolegs. Prolegs are fleshy, non jointed legs found in some insect larvae. They can be located at the anterior or posterior end.

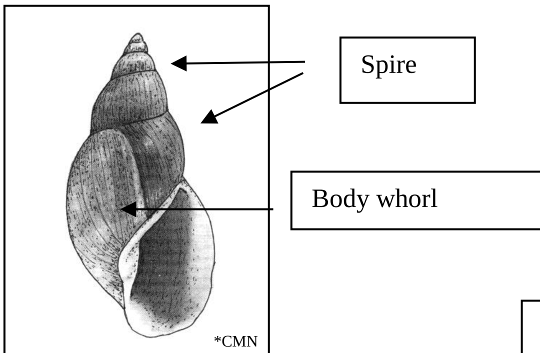
Pupa (singular), pupae (plural). In developing insects, the pupa is the stage between the larvae and the adult. Usually the pupal stage does not feed. The larval body is metamorphosing into the adult insect.



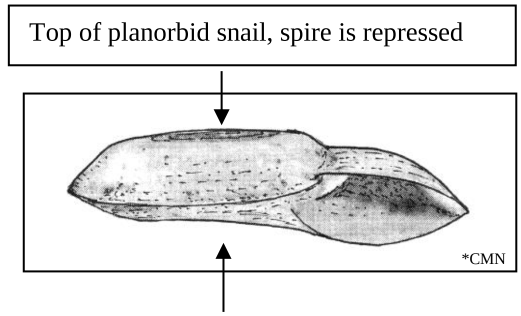
Mosquito pupa or "wriggler"

Raptorial. An insect with raptorial legs has legs that are adapted for grasping live prey. The front legs of the giant water bug are raptorial.

Spire. In snails, the spire is the main portion of the shell that extends above the opening of the shell. In flattened, disk-shaped snails (planorbid snails), the spire is completely flat at the top of the snail. To tell top from bottom in a planorbid snail, you need to find which side is LEAST indented. This would be the top.



Right-coiled snail. Opening is to the right when the snail is held upright facing you.



If you could see underneath, you'd see there is a deeper indentation on the bottom of the planorbid snail than on the top of it. The opening is on the right when the snail is held upright facing you, therefore this snail is right-coiled.

Taxa (plural), taxon (singular). A taxon is a group of organisms that is distinct from other groups of organisms. A taxon can be at any taxonomic level (order, family, genus, species). If you count a genus as a taxon, then you would not count its family as a taxon, because that family is already represented by the genus. Total taxa refers to the total number kinds of unique organisms you have. You may have some taxa identified at the genus level (e.g. Caenis mayfly) and some identified only at the family level (e.g., fingernail clams, family Sphaeriidae).

Thorax. The thorax is the body region of an insect that is between the head region and the abdominal region. It carries the wings and the legs. See illustration with "abdomen."

Ventral. Ventral refers to the underside, or "belly" surface of the organism. Dorsal refers to the back side or surface of the organism.

Whorls. The whorl of a snail refers to the coils in the shell. One whorl is one complete turn of the coil. Mature snails will have 4 or more whorls. The largest whorl, called the body whorl, is at the opening to the snail. It is the first whorl produced as the snail grows.

Wing pads. Wing pads are the developing wings in the immature insect larvae. They do not cover the abdomen. These can be seen in the illustrations of mayfly larvae, dragonfly larvae and damselfly larvae. Adult wings are seen in the illustration sheets on adult aquatic beetles and bugs. They cover the abdomen almost completely.

Taxonomic names of typical wetland invertebrate groups. Phylum, Class, Order, Family.

Phylum Annelida: worms

Class Hirudinea: Leeches

Family Glossiphonidae
Family Erpobdellidae
Family Hirudinidae (includes bloodsucking leeches)

Phylum Mollusca: molluscs (the taxonomy has been revised, these names are what we have in the pictorial key in the Guide)

Class Pelecypoda: Bivalve molluscs, clams

Family Unionidae (freshwater mussels, not usually in depressional wetlands)
Family Sphaeriidae (fingernail clams)

Class Gastropoda: Snails

Family Lymnaeidae pond snails, lunged snails
Family Physidae tadpole snails, lunged snails
Family Planorbidae ramshorn snails, lunged snails
Family Valvatidae gilled snails, less likely in depressional wetlands

Phylum Arthropoda (arthropods)

Class Crustacea

Order Amphipoda amphipods, also called scuds or sideswimmers
Order Anostraca fairy shrimp
Order Conchostraca clam shrimp
Order Decapoda crayfish
Order Isopoda sow bugs

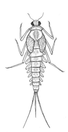
Class Insecta

Order Coleoptera Beetles

Family Dytiscidae predaceous diving beetles
Family Gyrinidae whirligig beetles
Family Haliplidae crawling water beetles
Family Hydrophilidae water scavenger beetles

Order Diptera

Family Ceratopogonidae biting midges
Family Chaoboridae phantom midges
Family Chironomidae chironomid midges; many kinds, some are sensitive, some are tolerant
Family Culicidae mosquitoes
Family Stratiomyidae soldier flies



Order Ephemeroptera Mayflies
Family Baetidae
Family Caenidae
Family Siphlonuridae

Order Hemiptera True bugs

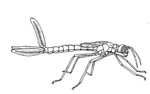
Family Belostomatidae giant water bugs
Family Corixidae water boatmen
Family Gerridae water striders
Family Hydrometridae marsh treaders, marsh measurers
Family Nepidae water scorpions
Family Notonectidae backswimmers
Family Pleidae pigmy back swimmer

Order Odonata Dragonflies and Damselflies

Suborder Anisoptera (dragonflies)

Family Aeshnidae
Family Corduliidae
Family Gomphidae
Family Libellulidae

Suborder Zygoptera (damselflies)



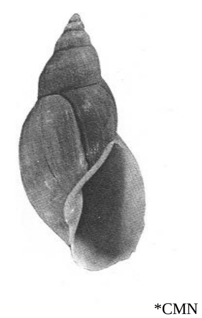
Family Coenagrionidae
Family Lestidae

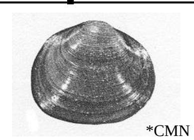
Order Trichoptera Caddisflies

Family Hydroptilidae
Family Leptoceridae
Family Limnephilidae
Family Phryganeidae
Family Polycentropodidae

General Key to Wetland Macroinvertebrates: Begin Here! Pages given in keys are to Key Pages → **KEY PAGE 1**

Hard (lime) shells
MOLLUSCS: SNAILS and CLAMS, see PAGES 14 - 15

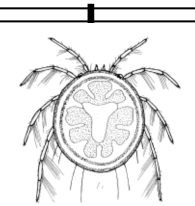




Fingernail clam
3 - 10 mm

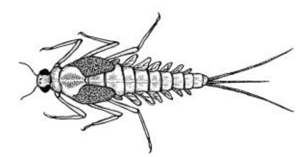
Has obvious external legs that are jointed and in pairs; has three body divisions

4 pairs jointed legs in adults, no antennae, no wings. Spiders and mites.
ARACHNIDS

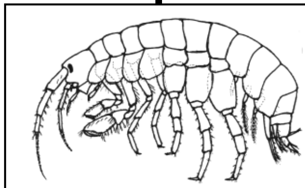


Water mites (Hydracarina) are small, aquatic arachnids only .5 – 3 mm diameter. They are active swimmers, very round, opaquely colored black, brown or red.

3 pairs jointed legs,
1 pair of antennae
INSECTS PAGE 2

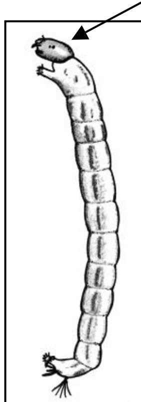


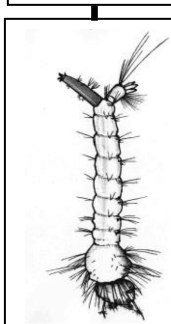
5 or more pairs jointed legs, 2 pairs antennae, no wings, no wing pads **CRUSTACEANS PAGE 12 - 13**



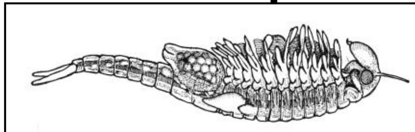
Lacks obvious external jointed legs; may have fleshy prolegs

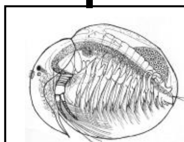
Has distinct, brownish head capsule, and/or tail brushes or tails.
DIPTERANS PAGE 11



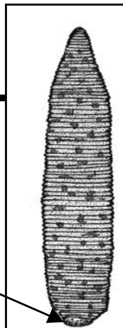


Has 5 or more pairs of legs mostly concealed under carapace, or has 10 or more leafy appendages
CRUSTACEANS PAGE 12 - 13

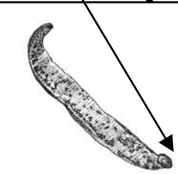




Worm-like, no obvious hard head capsule, sucker at rear end larger than front sucker
LEECHES, PAGE 16 - 18



Sucker at rear end



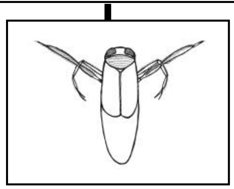
Insects (Class Insecta): 3 obvious pairs of jointed legs, 1 pair of antennae

KEY PAGE 2

Has wing pads that do not cover body and are not mature wings, or, has no wings

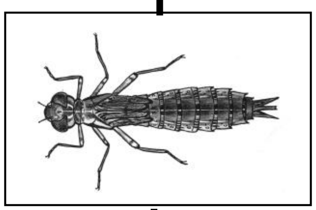
Has mature wings that cover the body: mature Coleoptera (beetles) and Hemiptera (bugs). GO TO KEY PAGES 8-10

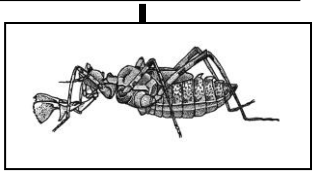
Has immature wingpads AND piercing mouthparts or cone-shaped mouthpart: immature Hemiptera (true bugs). **Go to Page 9**



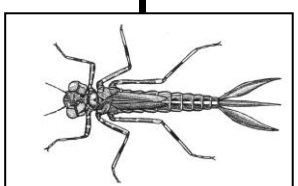
Has wing pads, and either 3 long tails or short stout spines on the end. **No piercing mouthparts.**

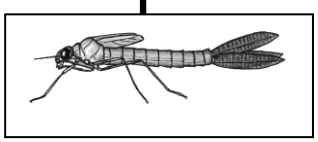
Stout spines on end, body is wider than head, has folding, hinged labium: **DRAGONFLY LARVAE PAGE 3**



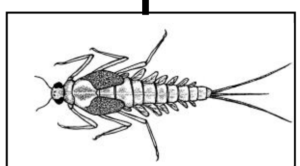


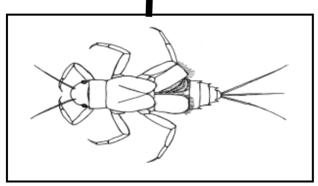
3 tails are **elongated oval plates** at end, has folding hinged labium, body narrower than head: **DAMSELFLY LARVAE PAGE 4**





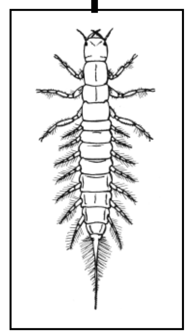
3 tails are very thin, rounded, has gills along abdomen: **MAYFLY LARVAE PAGE 7**



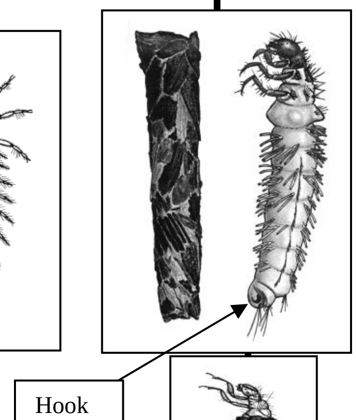


Has no wing pads

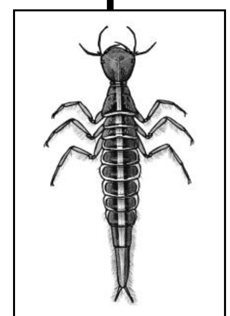
Has lateral filaments and a single projection from the end: **alderfly**, Sialis (Order Megaloptera). Rarely seen in wetlands.

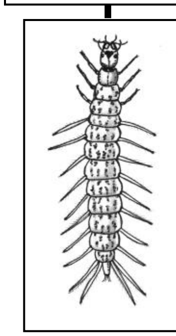


Usually lives in a tube or case, has a pair of rear prolegs which each end in a brownish, tiny hook (hook may be hard to see): **CADDISFLY LARVAE PAGES 5 - 6**



If lateral filaments are present, the larvae lack hooks at end, and lack a long single projection from the end: **BEETLE LARVAE, PAGE 10**



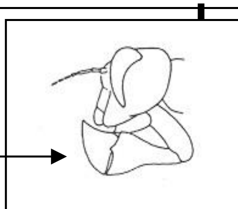


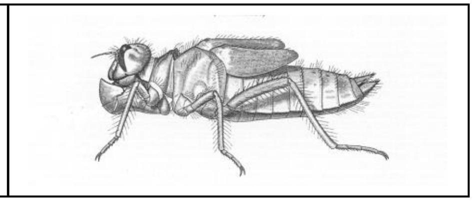
Dragonfly larvae, Order Odonata, Suborder Anisoptera. How to identify the families of dragonflies in wetlands

KEY PAGE 3

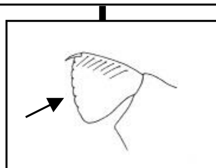
Pry open the mouthparts with forceps and view under microscope

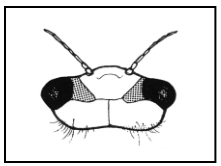
Labium is spoon-shaped rather than flattened

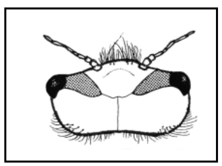


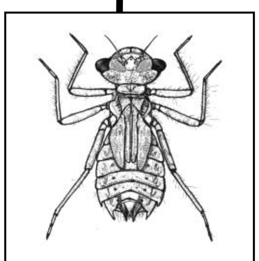


Outer lobe of labium is smooth-edged, or has shallow indentations: **skimmer dragonflies, Libellulidae.** We have many Libellulids in wetlands. Look also for differences in the eyes, viewed from top.

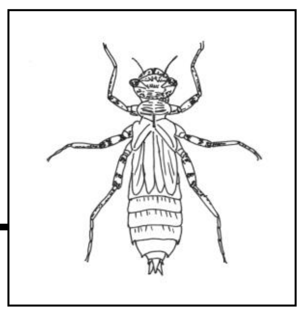




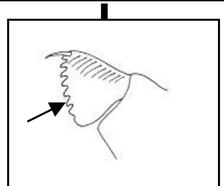


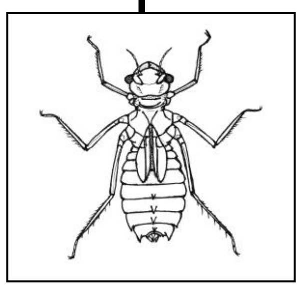


Two kinds of Libellulids



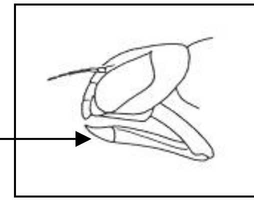
Outer lobe of labium has indentations on edge: Green eyed (as adults), **emerald dragonflies, Corduliidae**. Sometimes it is difficult to distinguish from labium of Libellulidae

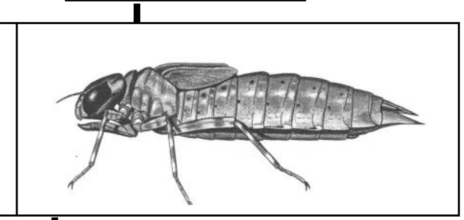




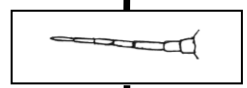
Labium is flattened

Labium

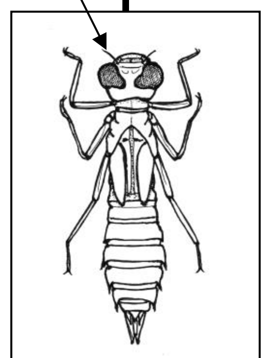




Antennae slender, tapered: **darner dragonflies, Aeshnidae**

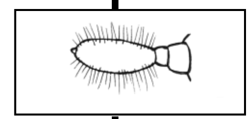


Fine antennae in **Aeshnidae**

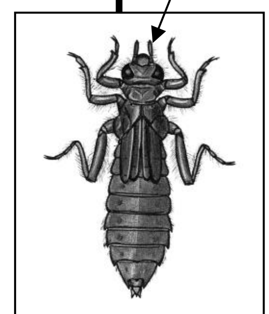


In **Aeshnidae**, we may see Aeshna (above) or Anax.

Antenna short, club-shaped: **clubtail dragonflies, Gomphidae**



Club-shaped antennae in **Gomphidae**



Gomphids are more likely found in bigger water bodies or streams.

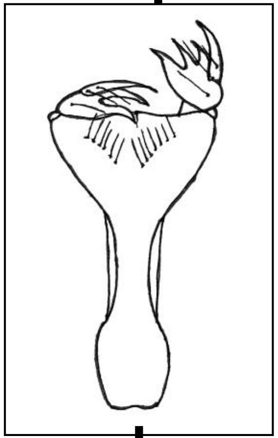
Damselfly Larvae in Wetlands: Order Odonata, Suborder Zygoptera

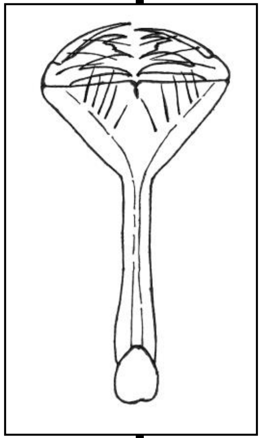
KEY PAGE 4

To tell apart the two major families of damselflies, you need to look at the special hinged labium that lies beneath the mouth. You need to tease it away from the mouth to see its shape. It is used to capture invertebrates and bring them to the mouth. Use two pair of forceps.

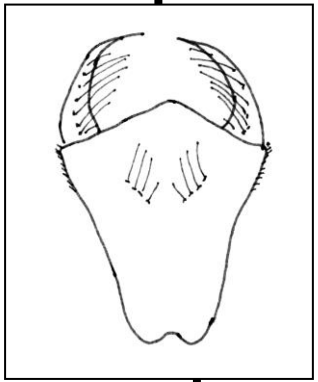
Damselfly family: Lestidae
Lestidae has a labium that has an elongated, narrow base and a distinct "Y" shape

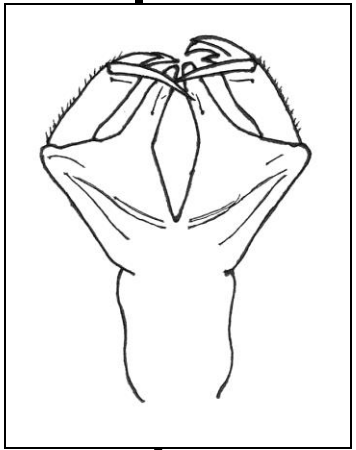
Damselfly family: Coenagrionidae
Coenagrionidae has a labium with a wider base and not as elongated



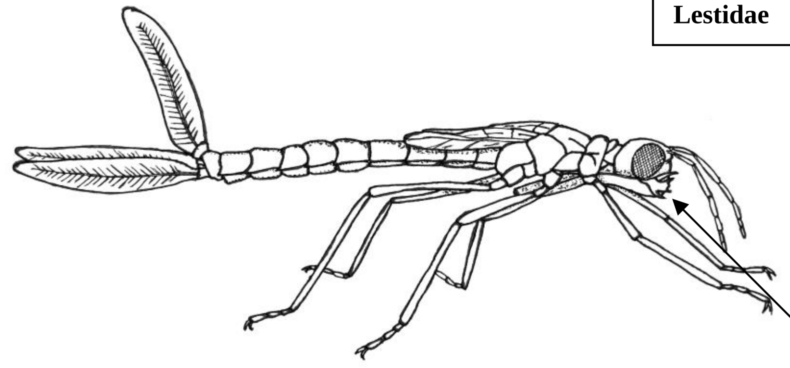


Labium, isolated from Lestidae (on left) and from Coenagrionidae (on right). Viewed top down.

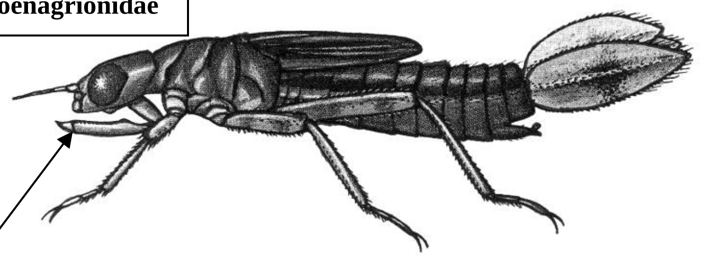




Lestidae



Coenagrionidae

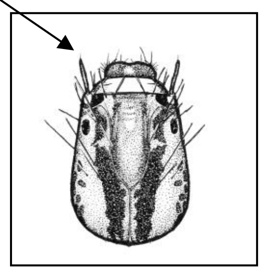


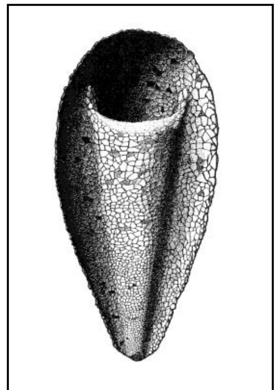
Labium (side view) folds up under the mouth. It is used to capture other invertebrates to eat. Damselflies are predators.

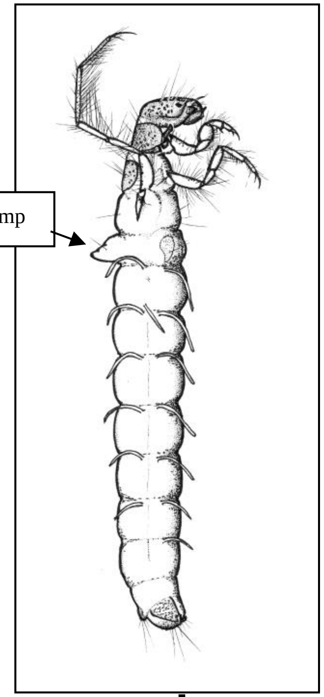
Caddisfly larvae (Order Trichoptera) in wetlands and their cases

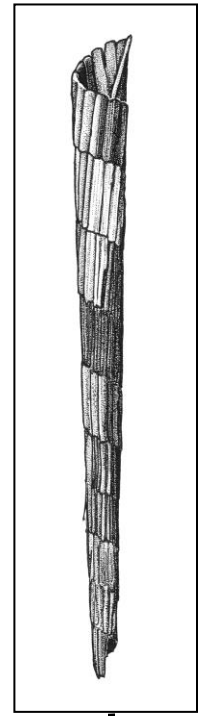
KEY PAGE 5

This page: Family Leptoceridae, **antennae are relatively long,** but look carefully. They are thicker than hairs, have only one segment. Head of Leptocerus shown below.

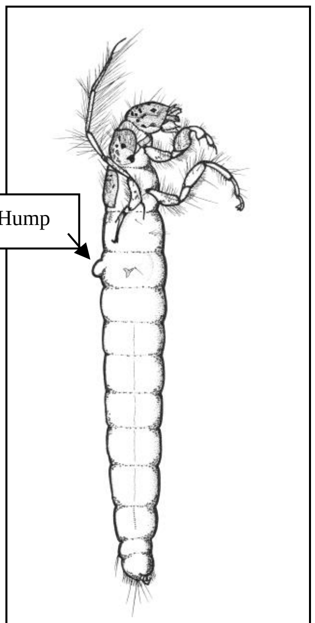


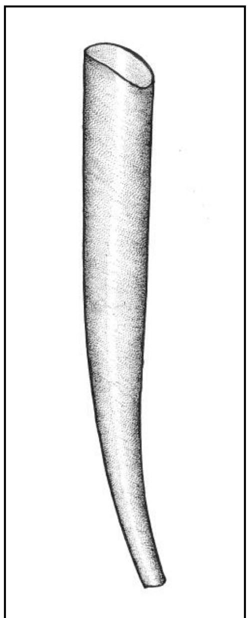




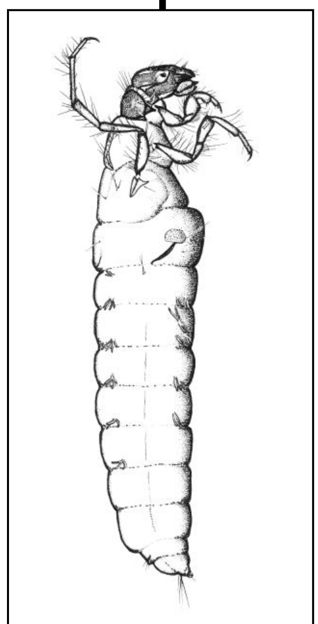


Genus Triaenodes and case, to 33 mm, has hump on back

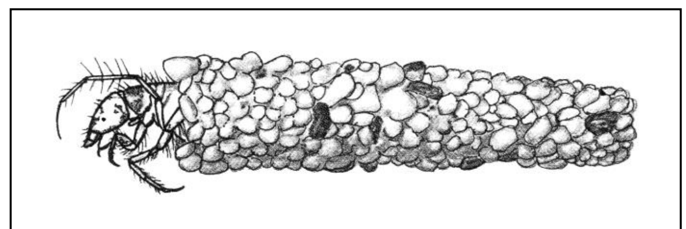




Genus Leptocerus and case of silk, to 9.5 mm



Genus Ceraclea and case (above) to 13 mm. No hump on back.



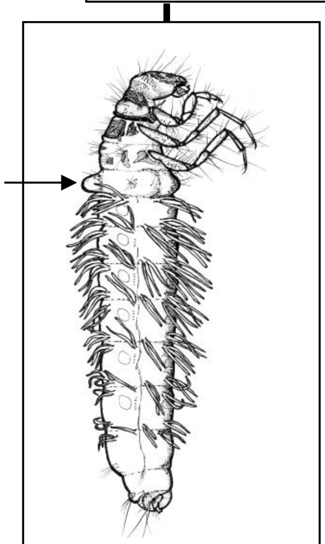
Genus Oecetis, to 15 mm. Has hump on back. In its case of sand grains.

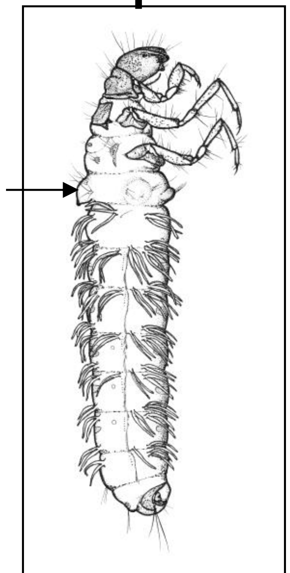
Caddisfly larvae (Order Trichoptera) in wetlands and their cases

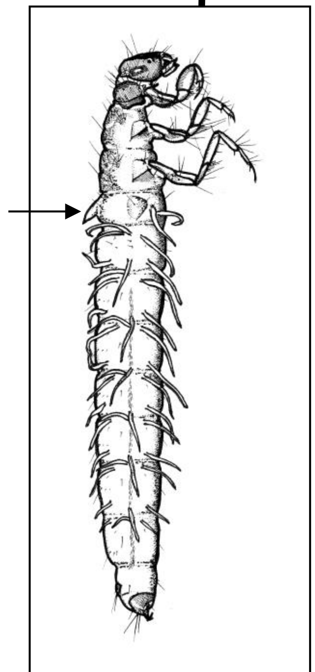
KEY PAGE 6

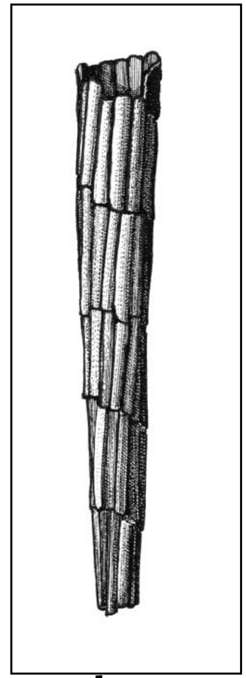
Family Limnephilidae, has very short antennae very hard to see; many kinds of cases in this family

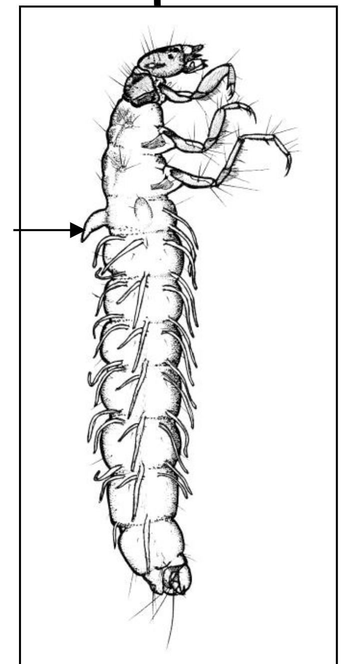
Family Phryganeidae, large larvae, to 40 mm or more when mature



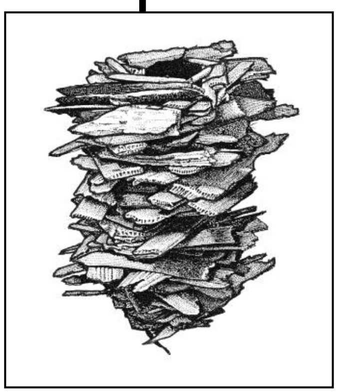




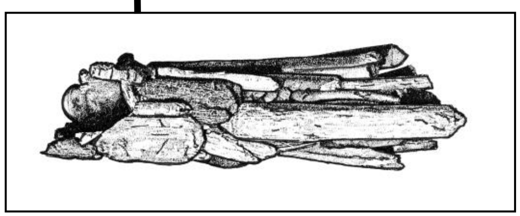




Genus Limnephilus and case to 29 mm

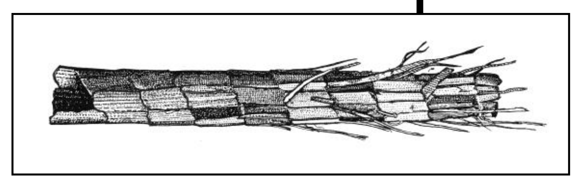


Anabolia and case, to 29 mm



Phryganea and case, to 60 mm; has dark stripes on top of head

Banksiola and case, to 45 mm



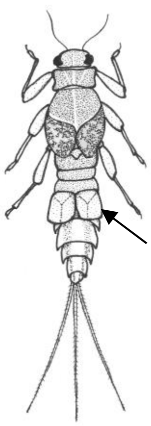
Mayflies (Order Ephemeroptera) in wetlands

KEY PAGE 7

Mayfly larvae have 3 pairs of obvious external jointed legs, they have wing pads and usually 3 thin tails at the end. Some members of the family Baetidae have only two tails, or the center tail is shorter. Many mayfly larvae have gill plates along the abdomen with which they collect oxygen from the water and through which they exchange ions from their blood. The families Caenidae and Trichorythidae have their gills located underneath a pair of gill coverings (operculum) located on the upper abdomen. Both of these families are found on the substrate and are less likely to be actively swimming in the water. **NOTE: gills are fragile, and may be lost from abdomen.**

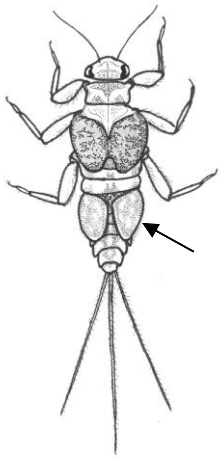
You may see other kinds of mayflies than those pictured here. Look at the antennae length. Look at the shape of the gills along the abdomen. Some mayflies will have divided gills, some will have gills that appear almost feathery. Look for irregular vs regular "veins" in the gill plates (tracheation)

Family Caenidae. Common, gills are tucked under two rectangular plates (arrow); silt accumulates on body hairs and acts as camouflage in silty water; very small, only 2.5 – 4 mm long.



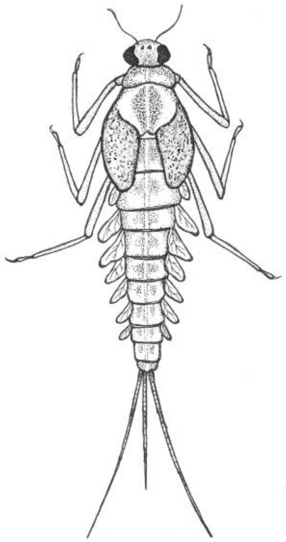
Genus Caenis

Family Trichorythidae. Gills are tucked under two triangular plates (arrow); are crawlers; body 3 – 7 mm long.

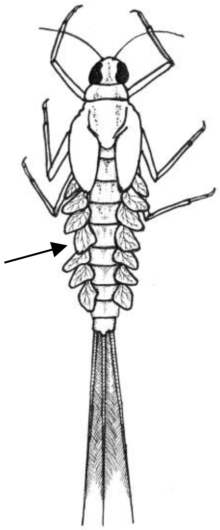


Genus Trichorythodes

Family Baetidae. Gills are oval plates along the sides of the segments of the abdomen, but some are irregular and more veined (arrow, right image); relatively long antennae; swimmers; body 4 – 9 mm long.

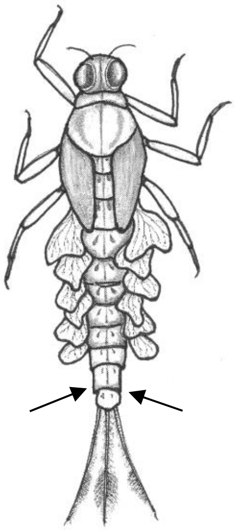


Genus Baetis



Genus Callibaetis

Family Siphlonuridae. Antennae are relatively short. In some species the gills are irregular-shaped plates along the sides of the abdomen, but in other species the gills are regular shapes; fast swimmers, body 9-16 mm. May have sharp points on last body segment (not shown, at arrows).



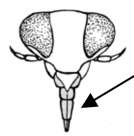
Genus Siphlonurus

Adult True Bugs (Hemiptera) and adult beetles (Coleoptera): obvious external legs AND mature adult wings

KEY PAGE 8

Wings are leathery, compressible, not rigid, **has piercing mouthparts** (except Corixidae, see separate sheet **PAGE 9**): **aquatic bugs, order Hemiptera.** In immatures, the wings are not complete over the body.

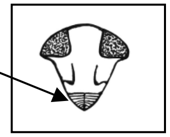
Wings are hard, not compressible has chewing mouthparts: **adult water beetles, order Coleoptera**. Many adult beetles have long hairs on legs for swimming. **BEETLES GO TO PAGE 10**

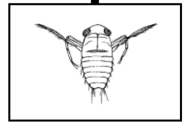


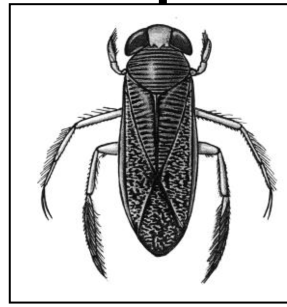
Mouth forms a **narrow pointed, piercing beak**

Mouth forms a **wider, cone-shaped beak**, swims right side up, front legs short, scooplike, adults 5 – 7 mm: **water boatmen, family Corixidae (juvenile and adult Sigara below). GO TO PAGE 9**

Corixid beak

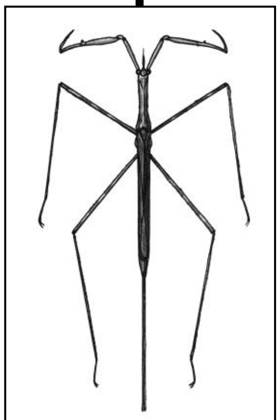






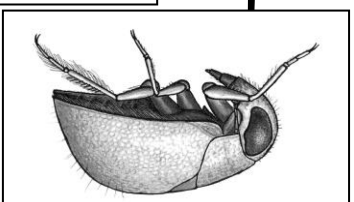
Does not live on surface of water

29-32 mm long, has long stout breathing tube projecting from end: **water scorpion, family Nepidae (Ranatra)**

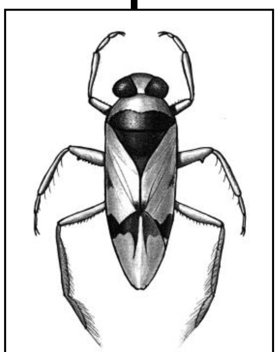


Does not have a long tube projecting from the end

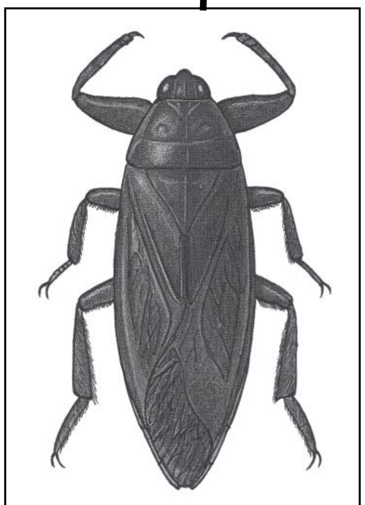
Less than 3 mm, dark brown hard convex body, swims on back: **pigmy backswimmer, family Pleidae (Neopleia)**



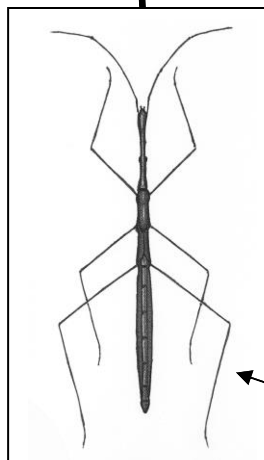
Hind legs elongate, flattened and hairy, swims on back, body softer, often partly white with red eyes: **backswimmer, family Notonectidae (Notonecta)**



20-65 mm, body flattened and oval, front legs are raptorial: **giant water bugs, family Belostomatidae (Lethocerus).**

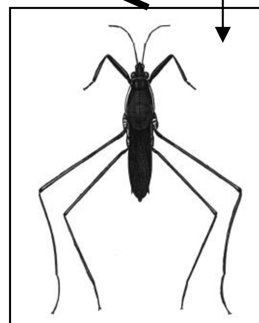


Lives on surface of water, antennae are much longer than head: **families Hydrometridae (Hydrometra) and Gerridae (Gerris, right figure)**



Delicate, lighter colored, wings hard to see

Robust, dark colored



Bugs (Order Hemiptera). How to tell Corixid bugs (Family Corixidae) from other bugs

KEY PAGE 9

Corixid bug, water boatman, ventral view. Note the rounded beak; note the short brushy front legs.

Wide, cone-shaped beak

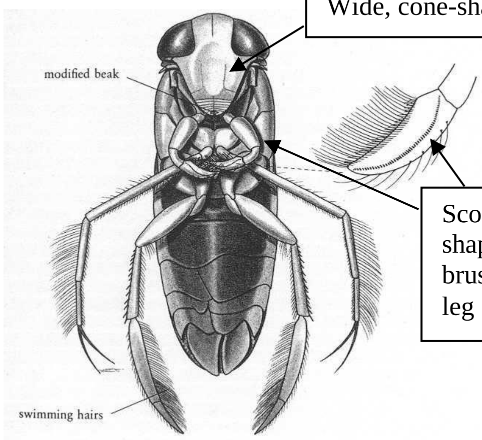
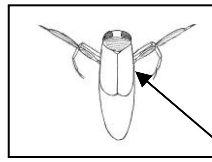


Figure 10.14. *Sigara* adult, ventral (fore tarsus enlarged)

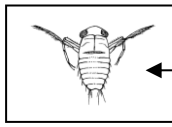
Scoop-shaped, short, brushy front leg

Corixid bugs (family Corixidae) have a modified beak. It is more rounded and wide than other aquatic bugs, which have an elongated, pointed beak with which they pierce into their prey to suck up the prey's juices.

Adults wing pads cover body, adults are about 5-7 mm, juveniles are smaller. Dorsal views.



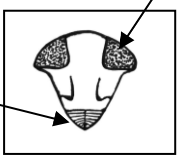
Immature corixid with immature wing pads

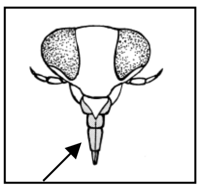


Juvenile corixid

Corixid head with wide beak

Eye

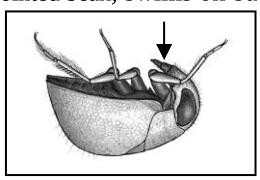




Pointed beak of **non-corixid** bug

Non-corixid bug, has a pointed beak

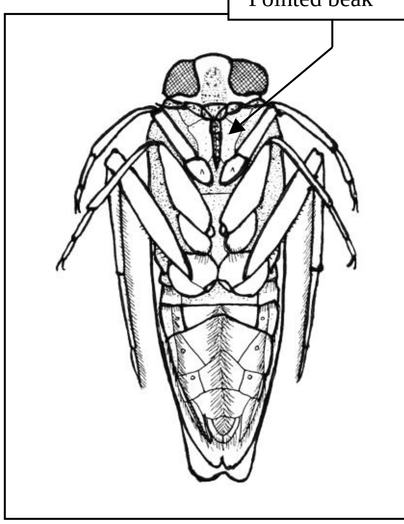
Pigmy back swimmer has pointed beak, swims on back



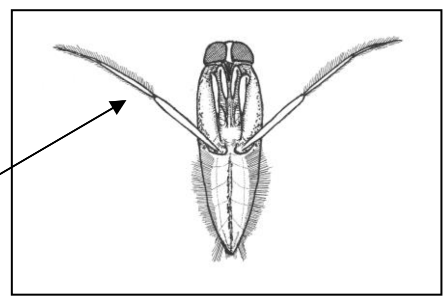
Life size, approximate, is less than 3 mm

Non-corixid bug, a **backswimmer**, or **Family Notonectidae**, 4-16 mm. Note the pointed beak; the long thin front legs. Ventral view.

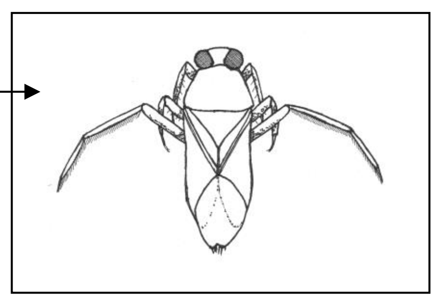
Pointed beak



Backswimmer, on its back (ventral view). A non-corixid bug. Note elongated rear legs used to swim.

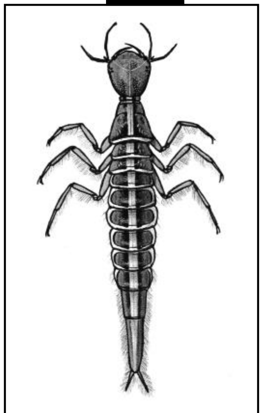


Backswimmer, dorsal view

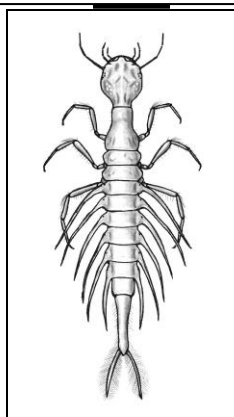


Beetle larvae and adult beetles in wetlands (representative examples)

Dytiscidae: predaceous diving beetles, mandibles sickle-like



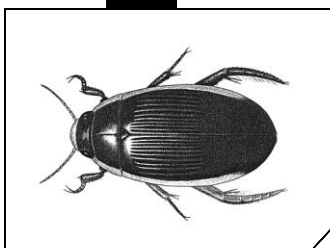
Dytiscus larva to 4.8 cm

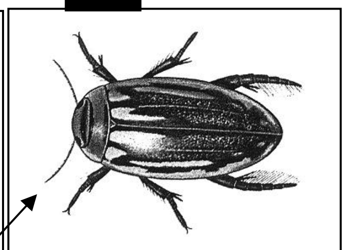


Coptotomus larva

Beetle larvae have **no wing pads**, lack hooks at end, lack long single projection from end

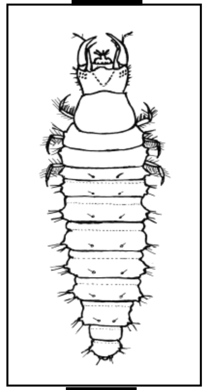
Beetle adults have mature, hard wings and chewing mouthparts



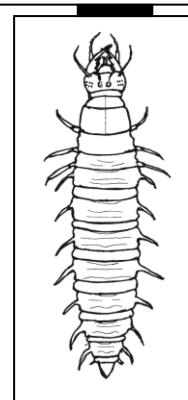


Adult Dytiscidae 2.5 – 2.8 cm, **antennae are threadlike**, not club-shaped. Predaceous diving beetles.

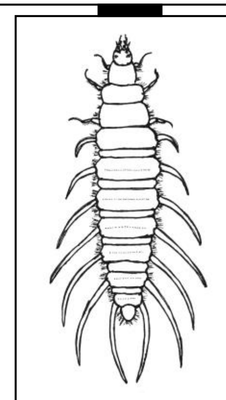
Hydrophilidae: water scavenger beetles; mandibles thick



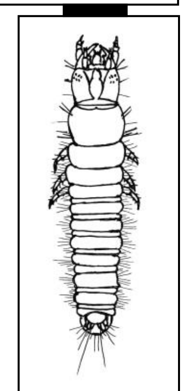
Tropisternus larva to 1.5 cm



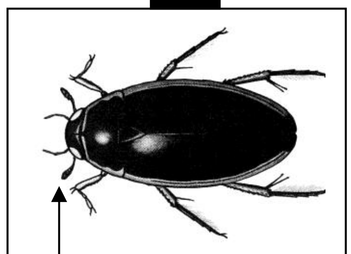
Hydrochara



Berosus, adult below

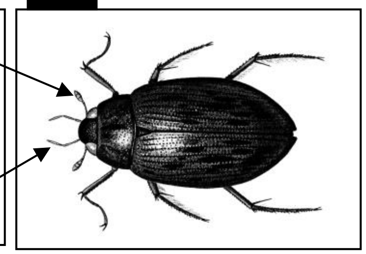


Enochrus

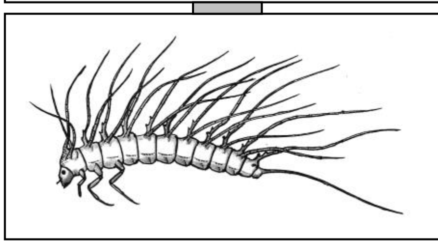


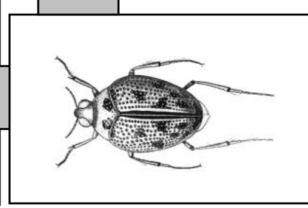
Adult 8 – 10 mm. The fine projections are not the antennae. The **club-shaped antennae** point sideways, often lie against the head.

Antennae club-shaped, usually lie flat on head, may be tucked under **(Hydrophilidae)** Fine projections are **not** the antennae



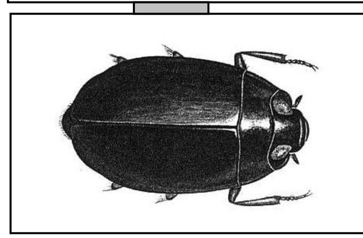
Haliplidae: crawling water beetles, Peltodytes

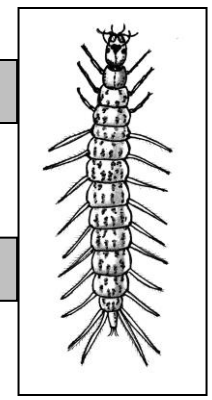




Peltodytes 2-6 mm, usually spotted, has large plates overlapping base of rear legs on ventral surface.

Gyrinidae, whirligig beetles, **Dineutus** larva and adult, 3-15 mm, swims on surface, look for 4 separate eyes, 2 up, 2 down



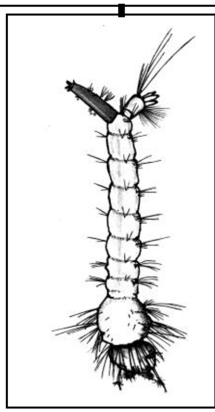


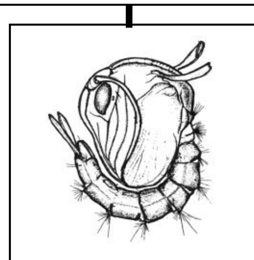
ORDER DIPTERA, TRUE FLIES

Dipteran larvae have **no obvious external jointed legs**. They have a **head capsule** and/or tail brushes or tails (but see the pupae). This page shows some Dipterans (true flies) in wetlands.

KEY PAGE 11

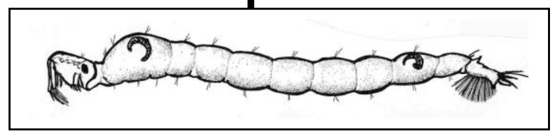
Family Culicidae: mosquitoes. Larva has a breathing tube at the rear, either hangs at surface or the cattail mosquito larva punctures the stems of cattails to get air. Feeds on microorganisms coating surfaces of plants and bottom. Sensitive to pesticides but develop resistances. Larvae 3-15 mm. Some species (but not all) carry diseases.

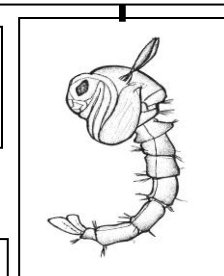




Mosquito pupa has a large head end, it wriggles to the surface.

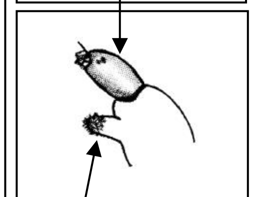
Family Chaoboridae: Chaoborus, the phantom midge larva. Is glassy clear in life, opaque white when preserved, it lies horizontally in the water and is predatory on Daphnia, mosquito larvae and other small invertebrates. Sensitive to pesticides. Pupa is shown at right below. 1-2 cm long.





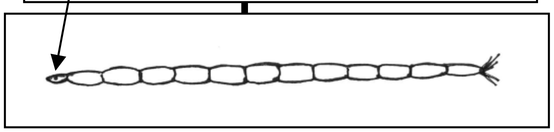
Family Chironomidae: has prolegs, most are non-biting midges. There are many kinds of chironomids in wetlands, and the number of kinds (genera) goes down when pollution increases. There is one type of chironomid that makes red blood (hemoglobin) and is able to tolerate lower oxygen conditions in wetland sediments. In wetlands, the presence of some red chironomids does not necessarily indicate pollution (they are considered "pollution indicators" in streams). What is a good indicator in both wetlands and streams is finding many kinds of chironomids. They are killed by BTI, a pesticide used to control mosquitoes. They are very important in the food web of wetlands. They are eaten by many of the predatory invertebrates in wetlands. 2mm – 30mm long.

Head capsule

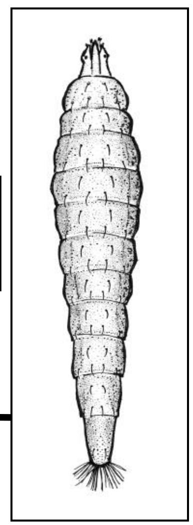


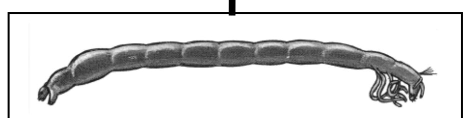
Proleg

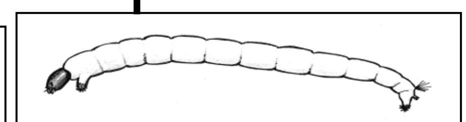
Family Ceratopogonidae, has no prolegs, are biting midges. Very stiff in life, long and thin. Tiny head capsule. Around 1 cm long.



There are several other kinds of Dipterans in wetlands. Some have larvae that are sluggish and lie near the surface. **Family Stratiomyidae**, the brownish soldier fly is an example. Head capsule is hard to distinguish in this kind of larva. 1 – 5 cm. Brush at end.





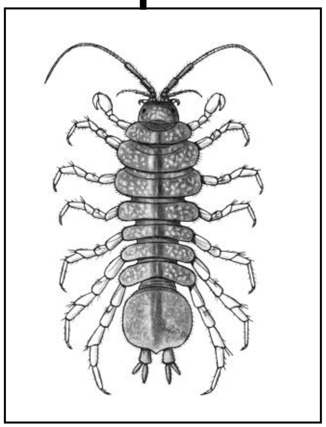


Some midge larvae are gray, green or white (right), others are red (above) from hemoglobin in their blood.

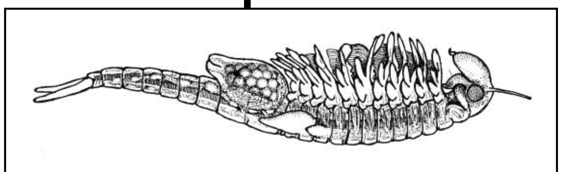
Crustaceans in Wetlands. Class Crustacea

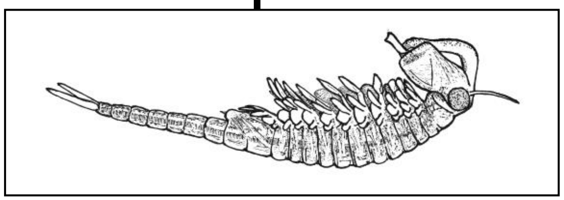
KEY PAGE 12

7 pairs of laterally projecting legs, body flattened dorso-ventrally, crawls on the bottom: **Order Isopoda, isopods.** to 2 cm long.



Fairy Shrimp: has 11 pairs of flattened appendages, no carapace, swims on back, 1.5 – 2.5 cm long. Female with eggs (top figure), male with enlarged clasping antennae. **Order Anostraca**

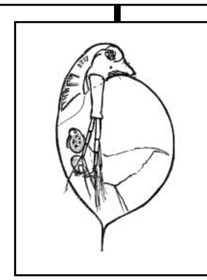




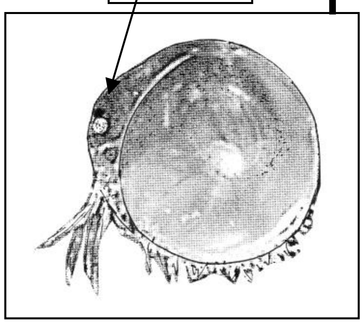
Body flattened laterally, swims on its side, 7 pairs of jointed legs: **Amphipods or scuds. To 2.5 cm long.** **GO TO Page 13** →

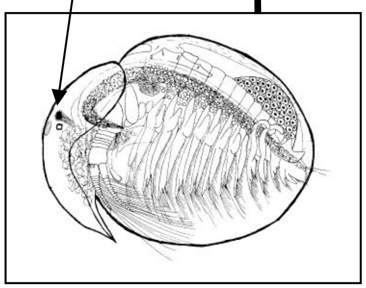
Five pairs of walking legs, front pair of enlarged claws: **Decapoda, Crayfish.** **GO TO Page 13** →

Microscopic, swim in water. May have eggs in dorsal brood space. Not counted as macroinvertebrates.
Daphnia, water fleas (Order Cladocera). 1- 3 mm long.

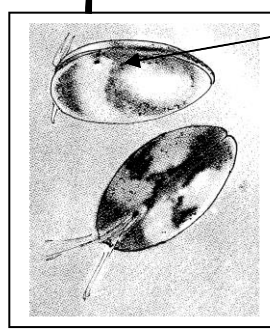


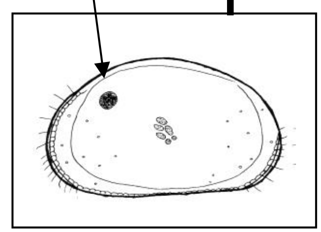
Clam shrimp are rounded, 4-7 mm, pinkish in life; eye spot is at front end. Legs not usually visible through the leathery, compressible carapace. **Order Conchostraca**. We do record clam shrimp. Swims and crawls.





Seed shrimp, oval, carapace is hard, not compressible or leathery. 2-5 mm, usually < 2.5 mm long; eye spot is off center, not at front end. **Order Ostracoda**. We don't count them as macroinvertebrates.





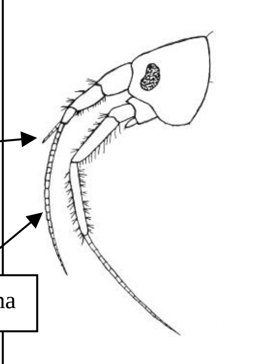
Crustaceans in Wetlands. Class Crustacea. Order Amphipoda and Order Decapoda

KEY PAGE 13

Order Amphipoda. Body flattened laterally, 7 pairs of jointed legs, swims on sides. **Amphipods or "scuds."**

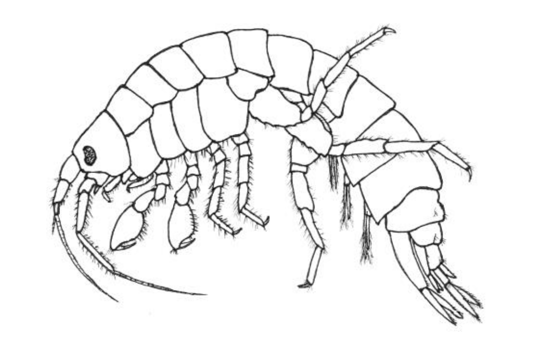
There is **no accessory flagellum** on the first antenna: **Hyalella**. Small, 4 – 8 mm long. Look carefully. Not pictured.

There is a little **accessory flagellum** on the first antenna.



First antenna

Gammarus has **3-7 segments** in its accessory flagellum (this requires very careful viewing!). Larger amphipod, to 2.2 cm long.

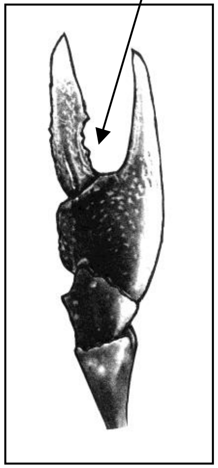


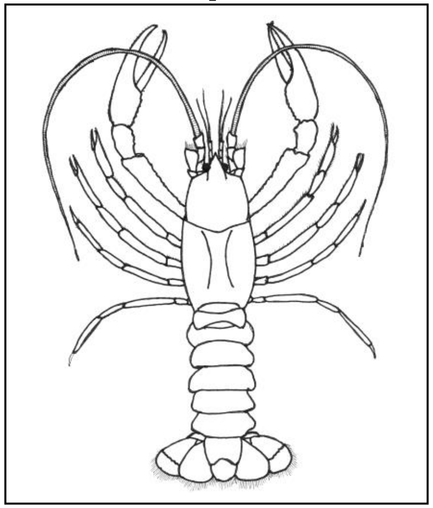
Crangonyx and Pseudocrangonyx (no picture) have **only two segments** in the small accessory flagellum (you must look carefully with the microscope!). Larger amphipods, to 2.2 cm long.

Order Decapoda. Crayfish. Five pairs of walking legs, front pair are enlarged claws (chela).

Two kinds of crayfish you might see in wetlands are **Orconectes immunis**, which can burrow into the mud and has a notch in the inner edge of the "thumb" of its claw, and **Orconectes rusticus**, the exotic rusty crayfish which has rusty colored spots on either side of the thorax.

Notch in chela of Orconectes immunis





SNAILS Common in Wetlands (first page of 2 pages)

KEY PAGE 14

SNAILS common in Wetlands (second of two pages): FAMILY PLANORBIDAE

KEY PAGE 15

HAS LUNG

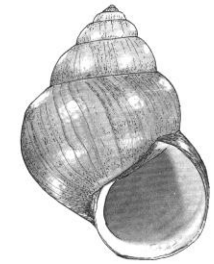
over opening, called "pond snails

) over openi

occur in streams and lakes. Left, Campeloma. Right, Oriental Mystery snail, exotic species to 63 mm.

Cover

*CMN

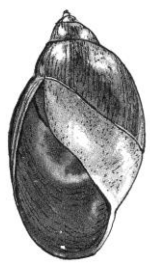


*CMN

FLATTENED DISC SHAPE. Family Planorbidae. **GO TO Key Page 15**

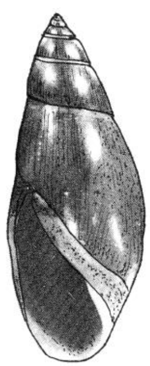
ELEVATED SPIRE SHAPE. Shell height is given in mm.

LEFT COILED (opening is on the left side)



*CMN

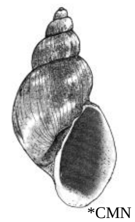
Physa, to 24 mm, most are smaller, very common



*CMN

Aplexa, 18 mm, dark and shiny in life, opening smaller than Physa's, more likely in ephemeral wetlands

RIGHT COILED (opens on right side when held vertically)



*CMN

Fossaria 8-9 mm, small with 4-5 turns in shell

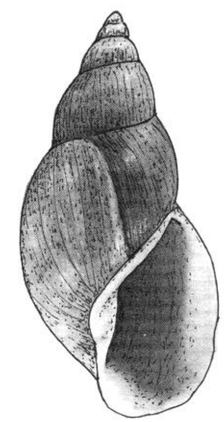
*CMN

Acella to 25 mm, very thin

Stagnicola reflexa, to 35 mm, may be striped

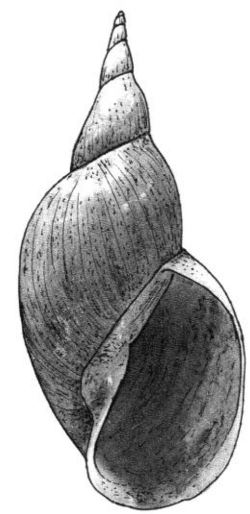
*CMN

Stagnicola elodes, to 32 mm, evenly wide



*CMN

Lymnaea stagnalis, to 56 mm, thin shell, sharp point, wide whorl above the opening of the shell.

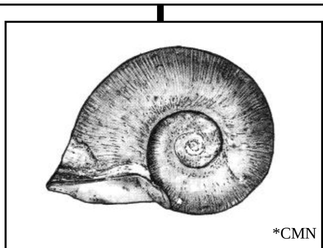


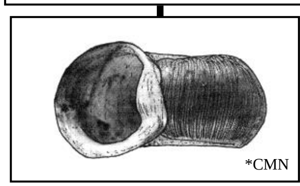
*CMN

Family Planorbidae. Flattened disc shape. Shell width is given (in mm). See Tips in Guide Page 23 how to tell top from bottom and coiling.

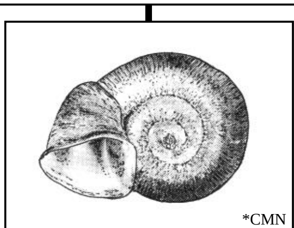
LEFT COILED

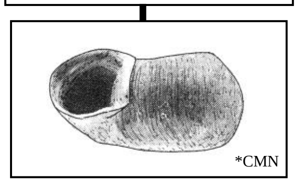
Planorbella trivolvis (formerly Helisoma) to 32 mm wide; top and side





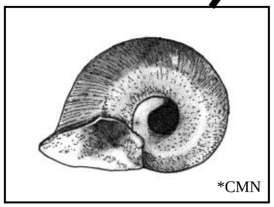
Planorbella campanulata (formerly Helisoma) to 15 mm; top and side views

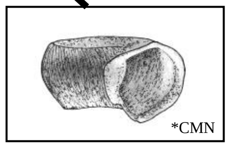




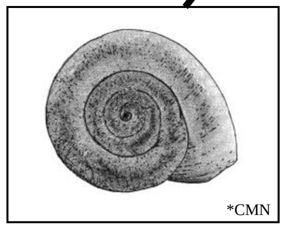
RIGHT COILED

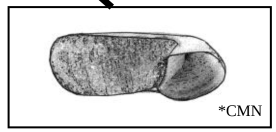
Helisoma anceps, to 20 mm wide



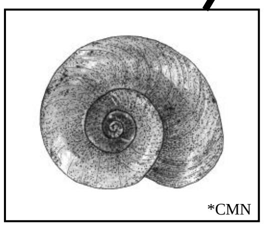


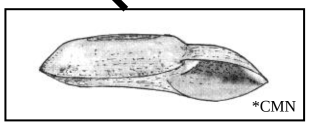
Planorbula 8 mm, look for white "teeth" just inside shell opening. Coils are even and flat across the top of the snail.



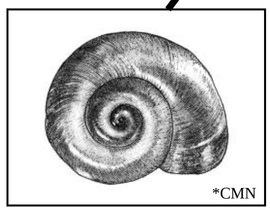


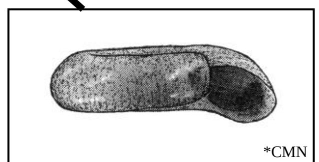
Promenetus 7–9 mm wide, note the acute edges in side view

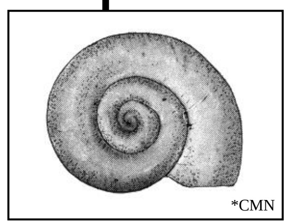




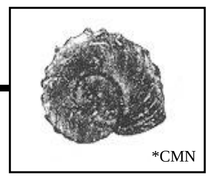
Gyraulus 5-8mm, coils rounded. Two species are shown, and side view. Note rounding of coils in side view.







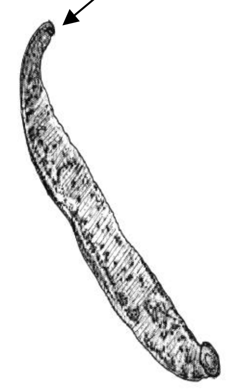
Armiger, very tiny, 3mm, often has longer spines project from edge than pictured here.



Leeches (Order Hirudinea) in Wetlands: Background

KEY PAGE 16

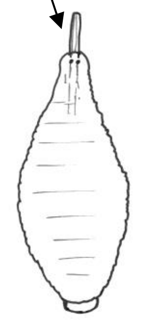
Mouth, anterior end



Sucker on posterior end

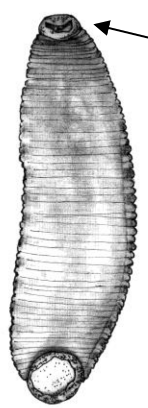
Leeches are members of the Phylum Annelida, which includes worms. Leeches have more than 20 body segments and no projecting stout hairs (setae). Most worms have setae. Leeches have a sucker at the posterior end larger than the mouth end. The anterior end has eyes and the mouth, these structures differ among the kinds of leeches. Leeches eat a variety of invertebrate prey types, or feed on amphibians, turtles, fish or birds. Only a few leeches (like Macrobdella) suck blood from mammals.

Proboscis extruded for feeding



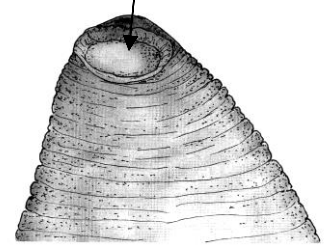
Family Glossiphonidae: mouth is a tiny pore in the front sucker. **Small** leeches (1/2" – 2.5") with a flattened, **pear-shaped body**. Poor swimmers, usually creep over substrates. Females carry their eggs and young on the underside. Eyes various.

Glossiphonid leeches feed with a structure **(proboscis)** that projects out from the front and sucks juices from prey such as snails and insects, turtles and frogs. The food type differs for the species of leech. The anterior end is not filled with an open pore of the mouth. **GO TO PAGE 17 Family Glossiphonidae**

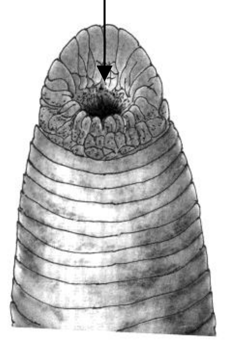


Anterior end of Glossiphonid leech with proboscis not extruded, no open mouth area, ventral view

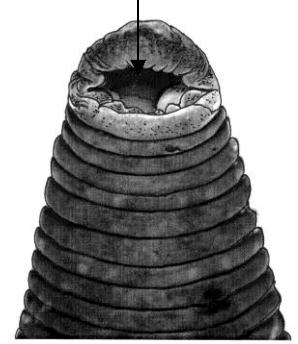
Sucker on posterior end



Family Erpobdellidae:
worm-like or ribbon-like body shape, elongated, moderate, size body: (roughly 1-4" long). Mouth is an obvious opening in anterior end. for swallowing prey whole.
GO TO PAGE on Families Erpobdellidae and Hirudinidae Page 18



Family Hirudinidae: large (4-12"), thick leeches with various patterns.   Some have hidden jaws and "teeth" in anterior end. Eye pattern an arched array of five pairs of eyes. **GO TO PAGE on Families Erpobdellidae and Hirudinidae Page 18**

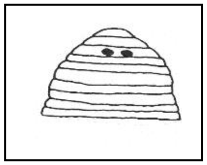


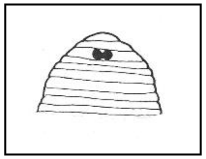
Leeches (Order Hirudinea) in Wetlands: Family Glossiphonidae

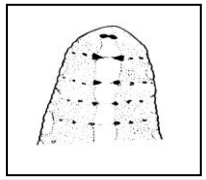
KEY PAGE 17

FAMILY GLOSSIPHONIDAE: the mouth is a tiny pore in the front sucker. When feeding, a proboscis extrudes from the pore to penetrate invertebrate or vertebrate prey. Proboscis is usually hidden. Small leeches with a **flattened, pear-shaped body, head is narrower than the body.** They are poor swimmers, usually creep over substrates. Glossiphonid females carry their eggs and young on the underside.

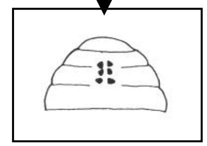
Glossiphonid species differ in the number or pattern of the **eyes, and the body patterns**. Eyes are tiny dark spots at the very front end of the leech, dorsal side. Placobdella has just one pair of eyes, while Glossiphonia has three pairs of eyes arranged in a vertical row.

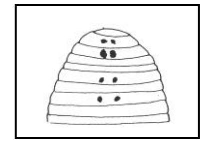




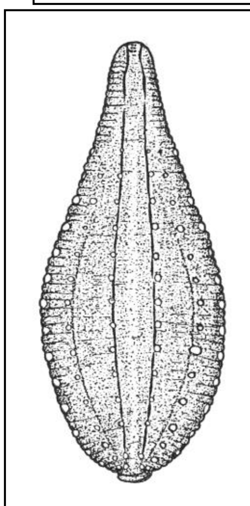


One pair of **eyes** (left three), closest figure shows accessory pigments below one true pair of eyes. To right, 3 pairs and 4 pairs are shown. Press top of head down to view under microscope.

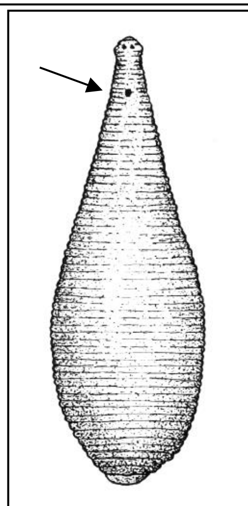




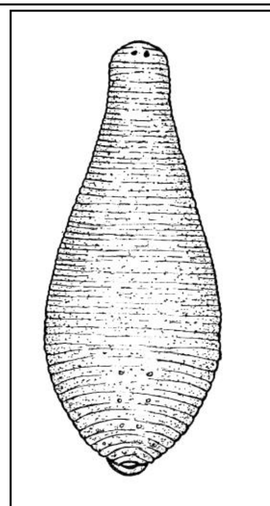
Eyes are difficult to see in contracted, preserved specimens. **Look for body patterns**, look for patterns of bumps (papillae) on the surface, or for stripes (Glossiphonia). Look for a dark small patch near the head (Helobdella). A few species are shown below.



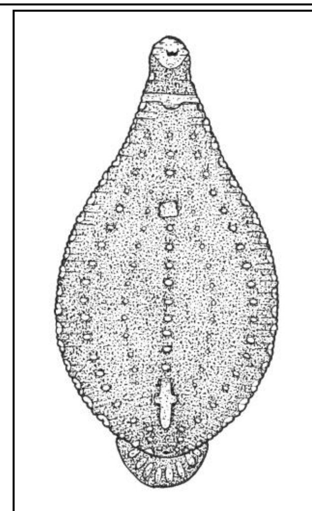
Glossiphonia complanata less than 20 mm long; 3 pairs of eyes



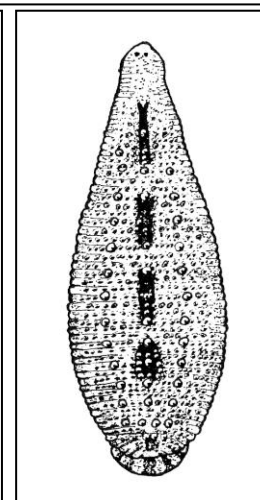
Helobdella stagnalis, 9-14 mm, one pair eyes; note dark patch near head



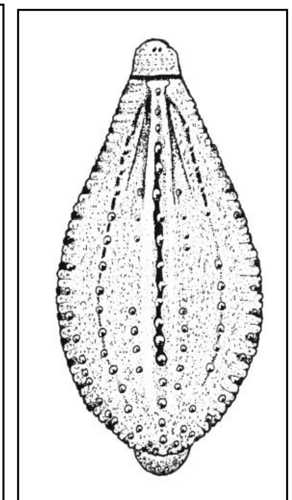
Helobdella fusca



Batracobdella, 1-2 cm



Placobdella ornata, a beautiful leech, decorated with papillae! 2-4 cm. One pair eyes.



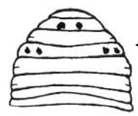
Placobdella papillifera to 1.5 cm

NOTE: you may see other genera and species!

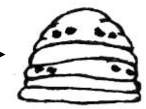
LEECHES in Wetlands: Families Erpobdellidae and Hirudinidae

KEY PAGE 18

FAMILY ERPOBDELLIDAE: worm-like or ribbon-like leeches, roughly **1- 4"** long, mouth is pore-like opening in the front end

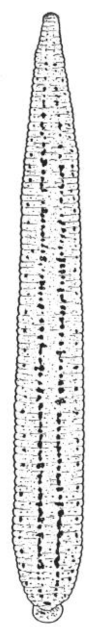


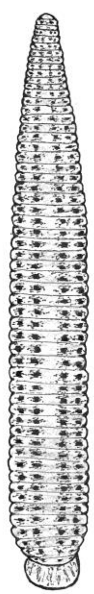
Eye patterns, dorsal view, hard to see in preserved specimens



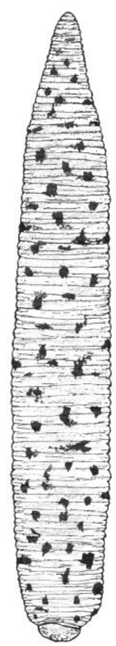
Erpobdella punctata. Worm-like body shape, striped. Sometimes the pattern varies, or is not visible, especially in preserved specimens. Increases in pollution.

Egg case



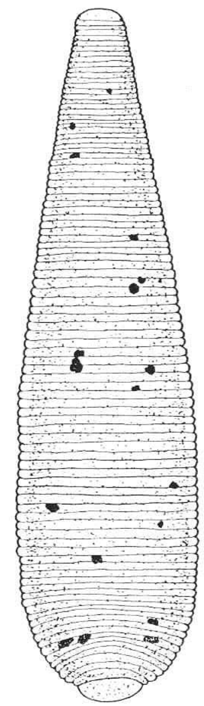


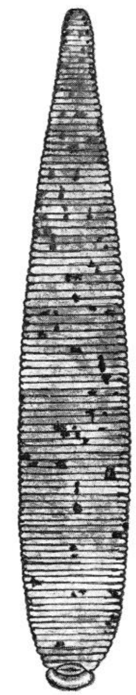
Nephelopsis. Flat ribbon-like body shape. May be mottled so much it looks solid in color.



FAMILY HIRUDINIDAE: large, thick leeches with various patterns, some have hidden jaws and "teeth." Shown: **Haemopis and Macrobdella**

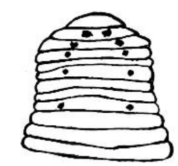
Haemopis grandis, our biggest leech, **6-12"**



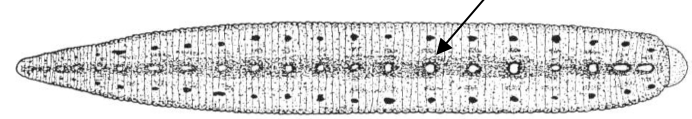


You may be able to see the arched pattern of 5 pairs of single eyes at the front, even in dark specimens.

HIRUDINIDAE EYES



Macrobdella decora 4-6", decorated with rows of orange-red spots down the back, greenish color alive. This one swims, and sucks blood!



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The figures of leeches are from the publication from Roy T. Sawyer: North America Freshwater Leeches Exclusive of the Piscicolidae with a Key to All the Species. 1972. Illinois Biological Monographs 46, University of Illinois Press. Urbana Illinois. Permission was obtained from Dr. Sawyer and from University of Illinois Press.

The following figures were used from Freshwater Invertebrates of the United States, 2nd edition, Robert W. Pennak, 1978, John Wiley & Sons: dorsal view of Aeshna, alderfly Sialis, notonectid Bueno (dorsal and ventral views), beetle larvae Tropisternus, Hydrochara, Berosus, and Enochrus, ceratopogonid midge Palpomyia, Chaoborus larva and pupa, Coenagrionidae labium, corixid adult Sigara, corixid immature nymph, Culex pupa, the amphipod Gammarus, corduliid dragonfly Helocordulia, Lestidae damselfly Lestes, Lestidae labium, clamshrimp Lynceus, water mite, Notonecta, roundworm Rhabditis, snail operculum, ostracod Cypria, crayfish, and the soldierfly Odontomyia. This material is used by permission of John Wiley & Sons, Inc.

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Figures of caddisflies were reproduced with permission from the Royal Ontario Museum of Canada from the second edition of Glenn B. Wiggin's 1977 Larvae of North American Caddisfly Genera illustrated by Anker Odum. University of Toronto Press. Toronto, Canada. ISBN 0-8020-5344-0. The figures used are Anabolia larva and case, Banksiola larva and case, Ceraclea larva and case, Limnephilus larva and case, Phryganea larva and case, Triaenodes larva and case.

The figures from photographs of clam shrimp and an ostracod were used by permission from Matthew Burne from the publication by Matthew Burne and Leo Kenney, May 2001. A Field Guide to the Animals of Vernal Pools. Massachusetts Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program and the Vernal Pool Association. Westborough, MA.

Appendix 2. Sources for identifications of invertebrates

Burne, Matthew and Leo Kenney. May 2001. A Field Guide to the Animals of Vernal Pools. Massachusetts Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program. Westborough, MA.

Clarke, Arthur H. 1981. The Freshwater Molluscs of Canada. National Museum of Natural Sciences. National Museums of Canada. Ottawa, Canada K1A OM8. 446 pp. (has nice photographs and individual descriptions).

Edmunds, Jr., George F, S.L. Jensen, L. Berner. 1976. The Mayflies of North and Central America. University of Minnesota Press. Minneapolis. (not sure if available anymore).

Jokinen, Eileen H. 1992. The Freshwater Snails (Mollusca: Gastropoda) of New York State. New York State Museum Bulletin 482. New York State Museum Biological Survey. Albany. New York.

Klemm, Donald J. 1982. Leeches (Annelida: Hirudinea) of North America. US EPA Cincinnati, OH. EPA-600/3-82-025.

Knopp, Malcolm and Robert Comier. 1997. Mayflies, An Angler's Study of Trout Water Ephemeroptera. Lyons Press. Guilford, CT.

Hilsenhoff, William L. 1995. Aquatic Insects of Wisconsin. Publication Number 3 of the Natural Museums Council. University of Wisconsin - Madison. 79 pp. (not expensive and regional).

Legler, Karl and Dorothy, Dave Westover. 1998. Common Dragonflies of Wisconsin. Revised. $18.95 Available through karlndot@bankpds.com.

McCafferty, W. Patrick with Illustrations by Arwin Provonsha. 1998. Aquatic Entomology. Jones and Bartlett Publishers, Inc. Sudbury, MA.

Merritt, Richard W. and Kenneth W. Cummins. 1996. An Introduction to the Aquatic Insects of North America, 3rd Edition. Kendall/Hunt Publishing. Dubuque, Iowa. 862 pp. (this is used by everyone doing identifications).

Pennak, Robert W. 1978. Freshwater Invertebrates of the United States, 2nd ed. John Wiley and Sons, Inc. NY.

Pennak, Robert W. 1989. Freshwater Invertebrates of the United States, 3rd ed. Protozoa to Mollusca. Wiley Interscience. New York. (has the non-insect invertebrates).

Sawyer, Roy T. 1972. North American Freshwater Leeches Exclusive of the Piscicolidae with a Key to All the Species. Illinois Biological Monographs 46. University of Illinois Press. Urbana Illinois.

Smith, Douglas Grant. 2001. Pennak's Freshwater Invertebrates of the United States. Porifera to Crustacea. 4th ed. John Wiley and Sons, Inc. NY.

Thorpe, James H. and Alan P. Covich. 1991. Ecology and Classification of North American Freshwater Invertebrates. Academic Press, Inc. Boston. (covers all invertebrates).

Wiggins, Glenn B. 1996. Larvae of the North American Caddisflies (Trichoptera), 2nd edition. University of Toronto Press. Toronto.

Appendix 3. Basic Equipment and Sources of Equipment

Equipment per team of citizens

Chest high waders (be sure they fit the heel tightly)
Dipnet, D frame Aquatic Dip Net 52" handle 425-A46 Wildco
Tote tray to hold 2 Coleman cooler trays for sampling Fleetwood large Tote Tray,
Part # 51201-0100 Dick Blick
Two Coleman white cooler trays to fit into Tote tray to hold sampling screen Coleman
Two white plastic trays for sorting invertebrates 10 x 13 x 1.5" or 9.75 x 7.75 x 1.5 " Bioquip
Sorting screen to fit over cooler trays for dipnetting; ½" hardware cloth screen
attached to 1x1" wood frame 12" x 16" (handmade)
20 sample containers, e.g. 16 oz white plastic wide mouth jars
Two squirt (wash) bottles, cut tip to get stronger flow
One compass
One clear plastic ruler
One gallon 95-100% alcohol (can get at home supply stores)
Twelve bottletraps with brackets and 4 ft plastic rods or dowels Don Wik
One log book for field notes
Forceps Bioquip at least two pair, preferably 4 Part # 4731 Fine Forceps Bioquip

Suppliers

Wildlife Supply Company Buffalo, NY 800- 799-8301 www.wildco.com
Dick Blick Art Materials Tote #51201-0100 www.dickblick.com
Coleman Co. trays part # 5270-1171 www.coleman.com
Bioquip Gardena, CA 310 324 0620 www.bioquip.com
Don Wik Prototype Fabrications Menomonie, WI 715-664-8699
dwik_protofab@hotmail.com