STREAM

MATERIALS INVENTORY	
• Laminated photos of macro-invertebrates • Petri dishes • Magnifying glasses • “Critter Keeper”	• Metal tray • Plastic folding table • Specimen jars

ADVANCE PREPARATION

Key preparation is rounding up enough macro-invertebrates (critters) to show the students some variety and, hopefully, some surprises. The instructor needs to collect and identify the critters in advance. Some research on the types of animals to be found is required. Approximately 30 - 45 minutes is needed in the morning to find new planaria (flatworms), caddis/cranefly larvae and whatever else you can collect and to set up the displays on the table.

MORNING SETUP

Collecting critters for the day and readying their display.

- Look under stones and collect leaf debris in stream. Gently wash in shallow pan to separate macroinvertebrates from substrate.
- Planaria need to be placed in petri dishes with sufficient water. Enough planaria should be collected so that every 2-3 students can share a petri dish when making observations.
- Cranefly larvae, salamanders, crawfish, etc. should be placed in the “Critter Keeper” with moist leaves and rocks for hiding under.
- Locate some regular sowbugs for comparison with aquatic sowbugs.

Set out the laminated photos and guides and magnifying glasses on table.
Set petri dishes near the leafpack or planaria in the metal tray.
Suggest below noted teaching topics to high schoolers.

END OF THE DAY CLEANUP

Planaria, mayflies, scuds and sowbugs should be returned to the stream.
Cranefly larvae or salamanders (separated) can be kept for one day in the “Critter keeper” if kept cool and moist with leafs or rocks for cover.
Laminated sheets should be wiped dry and returned to bin.
Petri dishes and metal tray should be rinsed out in the stream and returned to bin.
Leave table in place from day to day.
All materials need to be packed up for the next instructor for the following morning.

INSTRUCTION:

Objective: Students will view stream as an important ecosystem/community to be respected. Understand the importance of trees and prevention of pollution to stream habitat.

[Set ground rules, gather kids around table or near stream, explain that if they listen and learn first, then they might be allowed to explore along (not in) stream after for few minutes.]

1. What type of habitat are we at now? [Students came down the hill from the soccer field, and are now lower/deeper into the valley]

   - forested stream valley, encourage students to look around
   - stream is a headwater tributary to Painters Run, which flows into Chartiers Creek, then after several miles into the Ohio River, and then 1,000 miles into the Mississippi, then another 1,000 miles to the Gulf of Mexico
   - make comparison to digging sand at the beach
   - where does the water in the stream come from?
   - rainfall? Did it rain recently? If not, and stream is still flowing, it is because rainfall fell up the hill, infiltrated into the ground, then traveled slowly (weeks/months) through the rock downhill to where the stream has cut a deep gouge into the valley
   - ground water seeps and springs all along the stream feed it even when it is dry
   - runoff from driveways, roadways, hills add to the water in the stream and so more water flows during wet periods
   - this stream is called "intermittent" (make comparison to intermission of movie or hockey game) because it flows most of the year, but dries up after long periods without rain, usually in late summer or fall

[Walk with kids over to stand on bridge and ask them to say what the stream is made of]

2. What makes up a stream?
   - water
   - dirt
   - rocks
   - leaves, sticks
   - sides of a stream are called the bank, bottom of the stream is the bed. These are shaped by moving water
   - Ask if they see all the tree roots along the banks. These hold the soil in place and prevent erosion. Without trees and vegetation along the banks we would lose most of the soil and the water would be so muddy it could not support life.
   - Ask how else the trees help the stream. Shade keeps the water cool. Hot sunny weather could heat the water up until too warm or too much algae for animals to live in.

2. **SUGGESTED HIGH SCHOOL ASSISTANT TOPIC:** What can pollute the water in the stream?

 - Try to get kids to give potential sources of pollution around the park
 - Examples: chemicals used in yards, driveways, mud from erosion, salt from winter roads
 - Heat can be pollution too. If streams don't have enough shade, the water heats up and cannot support any life.
 - Clean, clear, cool, and fast-moving water is best for animals to live in

3. What do you think lives in this stream?
 - Remember intermittent (dries up in summer), so could fish live here?
 - salamanders
 - aquatic earthworms
 - crustaceans - crayfish, aquatic sowbugs and scuds
 - <u>Macroinvertebrates</u> are animals without backbones that are small but big enough to be seen ('macro' vs. 'micro') with just your eye.
 - Ask what you think macroinvertebrates eat. Many are vegetarian and eat leaves, algae, or other organic material ("detritus") that collect in the stream—sometimes called shredders, grazers, or filter feeders.
 - Some are predators and eat other macroinvertebrates.

The macroinvertebrates are very useful to scientists because different kinds have different tolerance to pollution, meaning we can use macroinvertebrates as indicators to measure how healthy a stream is.

4. Before allowing kids to examine or sort through specimen, introduce the idea of life cycle:

 - Leaves = food, so when is it the best time to be a macroinvertebrate that lives in the stream?

 - Autumn leaf fall is the bonanza time when macroinvertebrates feast on all the shed leaves from deciduous trees before winter. [Show leaf packs pulled from stream and explain that they are last years' leaves that fell and stayed in the stream all winter.] The life cycle in the stream is structured around the leaf fall so that most of them are born from eggs laid in the summer, grow as larvae/nymphs that crawl around sometimes in the same leaf pack all winter sheltered under the snow and ice, then finish transformation into flying insects in the spring or summer to start the cycle all over. Compare this with metamorphosis of butterflies that happens over a few months.

 A. Show specimens you have collected and explain that after they learn, if there is time they can help look for more specimen from extra material in the tray or along the stream.

SUGGESTED HIGH SCHOOL ASSISTANT TOPIC: Discuss planaria using laminated cards, below information, and specimen. Pass out the petri dishes with planaria. One for every group of 2-3 students. YOU, the instructor, choose the groups. Place the petri dish on one child's flat open hand and give the other group member the magnifying glass. Ask them if they can see the eye spots.

Planaria are simple creatures commonly called flatworms that live in and near water, usually on the underside of rocks

.

- They move in a smooth wave-like manner, much like large amoeba or flat slugs.
- They have a simple nervous system with their head being more sensitive than the tail, and eyespots to detect light and dark. Why would detecting light/dark be important? Explain where they live (under rock).
- Their mouth is in the middle of their body. Much like starfish, they feed by wrapping themselves around food and secreting digestive enzymes to absorb.

Superpowers of Planaria are:

- They can repair damage by regenerating any part of their body, even if cut in half. Each half will regenerate into new planaria.
- They can detect chemicals through their 'skin' in the water to find food.
- Planarians are capable of learning, and upon decapitation, the bodies with newly regenerated heads will remember what they learned. In the 1950s and 1960s, scientists studying memory trained planarians to respond to certain stimuli, and not only did they remember, but if you cut their heads off and allowed the bodies to regenerate a new head, many of the regenerated worms actually remembered their training, so store information throughout their body, not just in their head (muscle memory)
- There are Land Planarians (*Bipalium pennsylvanicum*) that can be up to several inches long and feed on earthworms, from Asia, but which have been found around Philadelphia after escaping from universities.

B. If have larger creatures, hold them in your hand and let everyone see. We are not only teaching the students about ecosystems, but also to not be freaked out by nature. If appropriate, ask if anyone would like to hold larger creatures over the tray, but only give to children who have moistened hands and have not recently used sanitizers or creams.

C. Discuss individual creatures' life cycles.

Refer to attached detailed life history for caddisfly, cranefly, and scuds for background.

Other teaching points:

- Salamanders and crawfish can go in and out of the water for short periods of time, but need to stay moist to breath. Other fully aquatic animals must stay in the water to breathe, like fish.
- "Riffles" (miniature rapids) and "leafpacks" are the best places to find macroinvertebrates, since they have higher oxygen levels and a diversity of rocks and gravel to collect food and provide cover. Riffles form where materials (sediment, detritus, etc) have been deposited by high water levels.
- Meander is what we call the curves in the stream, which are caused by the force of water cutting into softer soil as it churns downhill in straight lines, then it slowed and deflected by harder rocks, soil, or trees.
- In winter, the bottom of the stream is like the inside of a "river sleeping bag" because it is kept just above freezing by warmer groundwater and insulated from freezing air by snow and ice.

<u>BONUS if time allots and manageable behavior:</u>

Allow kids to stand along stream bank and GENTLY look under rocks or sift through water with hands to collect leaves that may contain more macroinvertebrates. Leaves can be washed in basin to release organisms. RETURN all specimens collected to stream at end of day!

GROUND RULES:

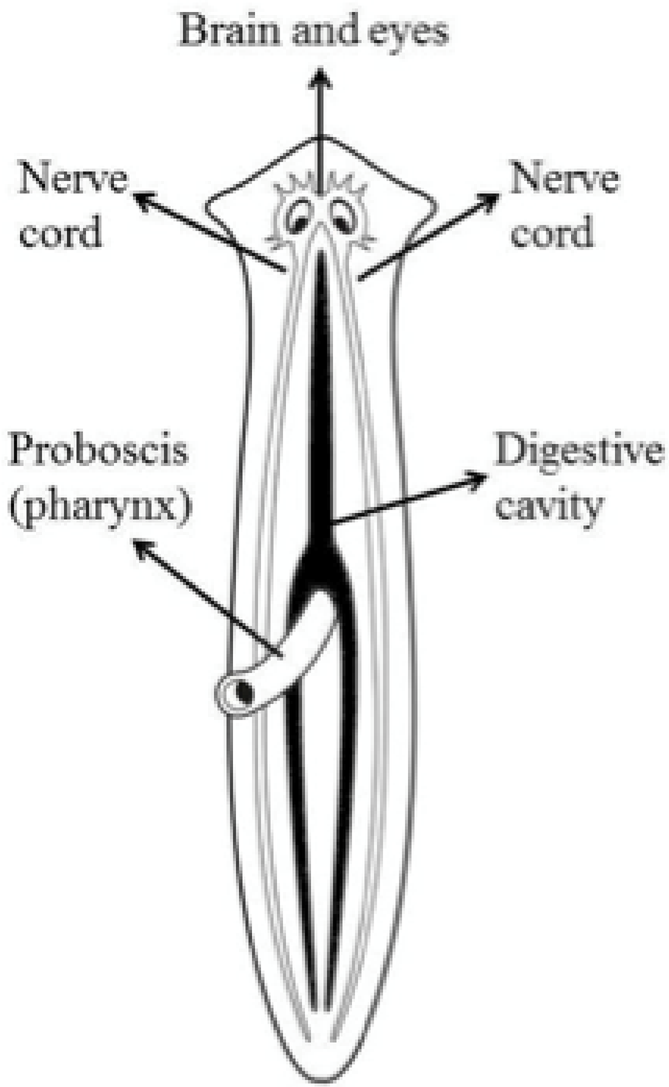
-Set the boundaries first……..from the culvert crossing upstream to the first stream meander is a good distance. Ask the parents and teachers to monitor the boundaries.

-Tell students <u>NOT</u> to step in or jump over the water. (Ask them "What happens if you step in the water?") You might need to place some stepping stones in a few spots on the first day.

-Only help search IF gentle and careful not to damage delicate creatures

-Tell students to look along both sides of the stream, look under rocks and leaves, but put the rocks back exactly like they were (Remind students that each hiding spot is actually "someone's" home, so be respectful)

Measure stream flow with ping pong ball (OPTIONAL): With a premeasured piece of 10 ft rope mark start and end points with cones along a straight section of stream. Get timer ready and have high school student release ping pong ball a few feet before the start point. Stop timer when ball crosses end mark, and retrieve from stream.


Brain and eyes
Nerve cord
Nerve cord
Proboscis (pharynx)
Digestive cavity

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Caddisfly – Trichoptera

The **caddisflies**, or order **Trichoptera**, are a group of insects with aquatic larvae and terrestrial adults. There are approximately 14,500 described species, most of which can be divided into the suborders Integripalpia and Annulipalpia on the basis of the adult mouthparts. Integripalpian larvae construct a portable casing to protect themselves as they move around looking for food, while Annulipalpian larvae make themselves a fixed retreat in which they remain, waiting for food to come to them. Also called **sedge-flies** or **rail-flies**, the adults are small moth-like insects with two pairs of hairy membranous wings. They are closely related to the Lepidoptera (moths and butterflies) which have scales on their wings; the two orders together form the superorder Amphiesmenoptera.

The aquatic larvae are found in a wide variety of habitats such as streams, rivers, lakes, ponds, spring seeps and temporary waters (vernal pools). The larvae of many species use silk to make protective cases, which are often strengthened with gravel, sand, twigs, bitten-off pieces of plants, or other debris. The larvae exhibit various feeding strategies, with different species being predators, leaf shredders, algal grazers, or collectors of particles from the water column and benthos. Most adults have short lives during which they do not feed.

Caddisflies are useful as bioindicators, as they are sensitive to water pollution and are large enough to be assessed in the field. Caddisfly larvae can be found in all feeding guilds in freshwater habitats. Most early stage larvae and some late stage ones are collector-gatherers, picking up fragments of organic matter. Other species are collector-filterers, sieving organic particles from the water using silken nets, or hairs on their legs. Some species are scrapers, feeding on the film of algae and other periphyton that grows on underwater objects in sunlight. Others are shredder-herbivores, chewing fragments off living plant material while others are shredder-detritivores, gnawing at rotting wood or chewing dead leaves that have been pre-processed by bacteria and fungi; most of the nutrients of the latter group come from consumption of the bacteria and fungi. The predatory species either actively hunt their prey, typically other insects, tiny crustaceans and worms, or lie in wait for unwary invertebrates to come too close. A few species feed opportunistically on dead animals or fish.

Like mayflies, stoneflies and dragonflies, but to a somewhat lesser extent, caddisflies are an indicator of good water quality; they die out of streams with polluted waters.] They are an important part of the food web, both larvae and adults being eaten by many fish. The newly hatched adult is particularly vulnerable as it struggles to the surface after emerging from the submerged pupa, and as it dries its wings. The fish find these new adults easy pickings, and fishing flies resembling them can be successful for anglers at the right time of year.

The adult stage of a caddisfly may only survive for a few weeks; many species do not feed as adults and die soon after breeding, but some species are known to feed on nectar. The winged insects are nocturnal and provide food for night-flying birds, bats, small mammals, amphibians and arthropods. The larval stage lasts much longer, often for one or more years, and has a bigger impact on the environment. They form an important part of the diet of fish such as the trout. The fish acquire them by two means, either plucking them off vegetation or the stream-bed as the larvae move about, or during the daily behavioural drift; this drift happens during the night for many species of aquatic larvae, or around midday for some cased caddisfly species, and may result from population pressures or be a dispersal device. The larvae may drift in great numbers either close to the bottom, in mid-water or just below the surface. The fish swallow them whole, case and all

Cases

Caddisflies are best known for the portable cases created by their larvae. About thirty families of caddisfly, members of the suborder Integripalpia, adopt this stratagem. These larvae eat detritus, largely decaying vegetable material, and the dead leaf fragments on which they feed tend to accumulate in hollows, in slow-moving sections of streams and behind stones and tree roots. The cases provide protection to the larvae as they make their way between these resources.[21]

The case is a tubular structure made of silk, secreted from salivary glands near the mouth of the larva, and is started soon after the egg hatches. Various reinforcements may be incorporated into its structure, the nature of the materials and design depending on the larva's genetic makeup; this means that caddisfly larvae can be recognised by their cases down to family, and even genus level. The materials used include grains of sand, larger fragments of rock, bark, sticks, leaves, seeds and mollusc shells. These are neatly arranged and stuck onto the outer surface of the silken tube. As the larva grows, more material is added at the front, and the larva can turn round in the tube and trim the rear end so that it does not drag along the substrate.

Caddisfly cases are open at both ends, the larvae drawing oxygenated water through the posterior end, over their gills, and pumping it out of the wider, anterior end. The larvae move around inside the tubes and this helps maintain the water current; the lower the oxygen content of the water, the more active the larvae need to be. This mechanism enable caddisfly larvae to live in waters too low in oxygen content to support stonefly and mayfly larvae.

Larva with portable case of rock fragments

Larva emerging from case made of plant material

Larval case of Limnephilidae made of bitten-off plant pieces (Left)

Case of *Limnephilus flavicornis* made of snail shells

Fixed retreats

In contrast to larvae that have portable cases, members of the Annulipalpia have a completely different feeding strategy. They make fixed retreats in which they remain stationary, waiting for food to come to them. Members of the Psychomyiidae, Ecnomidae and Xiphocentronidae families construct simple tubes of sand and other particles held together by silk and anchored to the bottom, and feed on the accumulations of silt formed when suspended material is deposited. The tube can be lengthened when the growing larva needs to feed in new areas. More complex tubes, short and flattened, are built by Polycentropodidae larvae in hollows in rocks or other submerged objecte, sometimes with strands of silk suspended across the nearby surface. These larvae are carnivorous, resembling spiders in their feeding habits and rushing out of their retreat to attack any unwary small prey crawling across the surface.

Silk domes

Larvae of members of the family Glossosomatidae in the suborder Spicipalpia create dome-shaped enclosures of silk which enables them to graze on the periphyton, the biological film that grows on stones and other objects, while carrying their enclosure around like turtles. In the family Philopotamidae, the nets are sac-like, with intricate structure and tiny mesh. The larvae have specialised mouthparts to scrape off the microflora that get trapped in the net as water flows through.

Nets

Net made by a larva of the suborder Spicipalpia

The larvae of other species of caddisfly make nets rather than cases. These are silken webs stretching between aquatic vegetation and over stones. These net-making larvae usually live in running water, different species occupying different habitats with varying water speeds. There is a constant drift of invertebrates washed downstream by the current, and these animals, and bits of debris, accumulate in the nets which serve both as food traps and as retreats.

Development and morphology

Caddisfly larvae are aquatic, with six pairs of tracheal gills on the underside of the abdomen. The eggs are laid above water on emergent twigs or vegetation or on the water surface. The larvae are long and roughly cylindrical. [26] In case-bearing species, the heads are heavily sclerotinised while the abdomen is soft; the antennae are short and the mouthparts adapted for biting. Each of the usually ten abdominal segments bears a pair of legs with a single tarsal joint. In case-bearing species, the first segment bears three papillae, one above and two at the sides, which anchor the larva centrally in the tube. The posterior segment bears a pair of hooks for grappling.[18] There are five to seven larval instars, followed by an aquatic pupa which has functional mandibles (to cut through the case), gills, and swimming legs.[6]

The pupal cocoon is spun from silk, but like the larval case, often has other materials attached. When pupating, species that build portable cases attach them to some underwater object, seal the front and back apertures against predators while still allowing water to flow through, and pupate within it. Once fully developed, most pupal caddisflies cut through their cases with a special pair of mandibles, swim up to the water surface, moult using the exuviae as a floating platform, and emerge as fully formed adults. They can often fly immediately after breaking from their pupal cuticle. Emergence is mainly univoltine (once per year) with all the adults of a species emerging at the same time. Development is within a year in warm places, but takes over a year in high latitudes and at high elevation in mountain lakes and streams.[6]

The adult caddisfly is a medium-sized insect with membranous, hairy wings, which are held in a tent-wise fashion when the insect is at rest. The antennae are fairly long and threadlike, the mouthparts are reduced in size and the legs have five tarsi (lower leg joints).[18] Adults are nocturnal and are attracted to light. Some species are strong fliers and can disperse to new localities,[25] but many fly only weakly.[18] Adults are usually short-lived, most being non-feeders and equipped only to breed. Once mated, the female caddisfly lays eggs in a gelatinous mass, attaching them above or below the water surface depending on species. The eggs hatch in a few weeks.[27]

ADULT

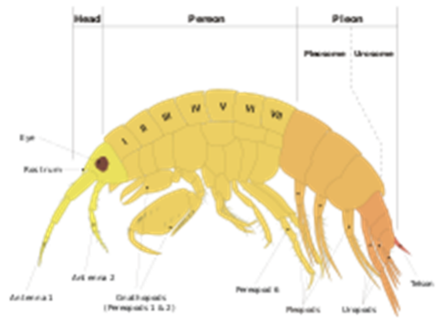
LARVA

Scuds - Amphipoda

An order of malacostracan crustaceans with no carapace and generally with laterally compressed bodies. Amphipods range in size from 1 to 340 millimetres (0.0394 to 13.4 in) and are mostly detritivores or scavengers. There are more than 9,900 amphipod species so far described. They are mostly marine animals, but are found in almost all aquatic environments. *Etymology and names.*

The name *Amphipoda* comes, via the New Latin *amphipoda*, from the Greek ("different") and ("foot"), in reference to two kinds of legs that amphipods possess. This contrasts with the related Isopoda, which have a single kind of thoracic leg.[3] Particularly among anglers, amphipods are known as *freshwater shrimp*, *scuds* or *sideswimmers*.

Anatomy



The body of an amphipod is divided into 13 segments, which can be grouped into a head, a thoraxand an abdomen.The head is fused to the thorax, and bears two pairs of antennae and one pair of sessile compound eyes.[6] It also carries the mouthparts, but these are mostly concealed. The thorax and abdomen are usually quite distinct and bear different kinds of legs; they are typically laterally compressed, and there is no carapace.[6] The thorax bears eight pairs of uniramousappendages, the first of which are used as accessory mouthparts; the next four pairs are directed forwards, and the last three pairs are directed backwards.[6] Gills are present on the thoracic segments, and there is an open circulatory system with a heart, using haemocyanin to carry oxygenin the haemolymph to the tissues. The uptake and excretion of salts is controlled by special glandson the antennae. The abdomen is divided into two parts: the pleosome which bears swimming legs; and the urosome, which comprises a telson and three pairs of uropods which do not form a tail fan as they do in animals such as true shrimp.[6]

Amphipods are typically less than 10 millimetres (0.39 in) long. The size of amphipods is limited by the availability of dissolved oxygen.

Reproduction and life cycle

Mature females bear a *marsupium*, or brood pouch, which holds her eggs while they are fertilized, and until the young are ready to hatch.[6]As a female ages, she produces more eggs in each brood. Mortality is around 25%–50% for the eggs. There are no larval stages; the eggs hatch directly into a juvenile form, and sexual maturity is generally reached after 6 moults. Some species have been known to eat their own exuviae after moulting

Crane fly is a common name referring to any member of the insect family **Tipulidae**, of the order Diptera. Crane flies are sometimes known as **mosquito hawks** or **daddy longlegs**, a term also used to describe opiliones or the family Pholcidae, both of which are arachnids.
The larvae of crane flies are known commonly as leatherjackets

Crane fly larva

Adult

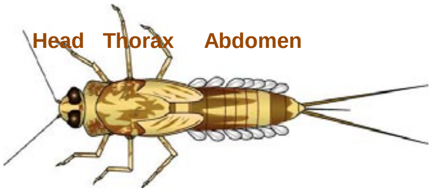
Crane flies are found worldwide, though individual species usually have limited ranges. They are most diverse in the tropics, and are also common in northern latitudes and high elevations.
The larva is elongated, usually cylindrical. The posterior two-thirds of the head capsule is enclosed or retracted within the prothoracic segment. The larva is metapneustic (with only one pair of spiracles, these on the anal segment of the abdomen), but often with vestigial lateral spiracles (rarely apneustic). The head capsule is sclerotized anteriorly and deeply incised ventrally and often dorsolaterally. The mandibles are opposed and move in the horizontal or oblique plane. The abdominal segments have transverse creeping welts. The terminal segments of the abdomen are glabrous, often partially sclerotized and bearing posterior spiracles. The spiracular disc is usually surrounded by lobe-like projections and anal papillae or lobes.

Ecology

Larval habitats include all kinds of freshwater, semiaquatic environments, including moist to wet cushions of mosses or liverworts, in decaying wood or sodden logs, in rich organic earth and mud, in wet spots in woods where the humus is saturated, in leaf litter or mud, decaying plant materials, or fruits in various stages of putrefaction.

Larvae can be important in the soil ecosystem, because they process organic material and increase microbial activity.[6] Larvae and adults are also valuable prey items for many animals, including insects, spiders, fish, amphibians, birds, and mammals.

The larvae of some species consume other living aquatic insects and invertebrates,[10] which could potentially include mosquito larvae.]Many adults, however, have such short lifespans that they do not eat at all. Despite widely held beliefs that adult crane flies (or "mosquito hawks") prey on mosquito populations, the adult crane fly is anatomically incapable of killing or consuming other insects.

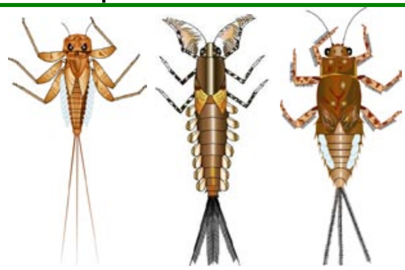


Small minnow mayfly

What is an insect? An insect is an invertebrate (an animal with no spine) that has three-pairs of legs (except Diptera) and three body divisions; the head is the location of the mouth, antenna and eyes; the thorax is the attachment site for the legs and wing pads; and the abdomen, which often has a variety of structures attached including filaments gills and tails. Gills are usually leaf-like, plate-like, or thin filaments. Tails can be long and thin, hairy, webbed or paddle-like. Most of the **benthic macroinvertebrates** you will encounter during stream surveys are aquatic larva or nymphs of insects. Most adult stages are not aquatic but the beetles are the exception. The majority of the insects are described and illustrated on page one and the top of page two; non-insect group descriptions and Illustrations begin on page two.

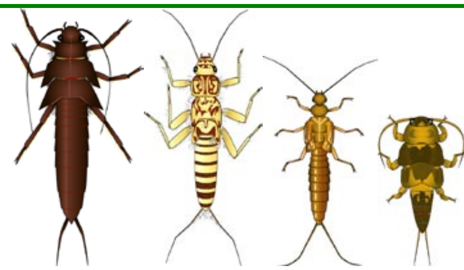
Insect Groups

Instructions provided at the bottom of page two



Mayflies

(Order **Ephemeroptera**): Three-pairs of legs with a single hook at the end; three some-times two tail filaments; gills attached to the abdomen, which may sometimes be covered and difficult to see. Mayflies exhibit several types of move-ments (or habits); swimmers, clingers, crawlers and burrowers. (**VS-M**) (**M**)



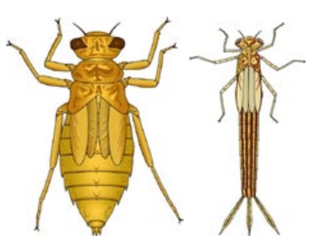
Stoneflies

(Order **Plecoptera**): Three-pairs of legs with two-hooks at the end; two tail filaments; no gills attached to the abdomen but some kinds may have gills near the top of the abdomen; gills if visible, mostly on the legs and thorax. (**S-VL**) (**M**)

Case-building caddisflies

(Order **Trichoptera**): Grub-like soft body and a hard head; Three-pairs of legs located on the upper third of the body; tail is small and usually forked, sometimes fringed with hairs; gills are scattered on the underside of the abdomen. The case (retreat) is a relatively solid structure made of a variety of stream-bed materials held together by silk. (**VS-L**) (**M**)

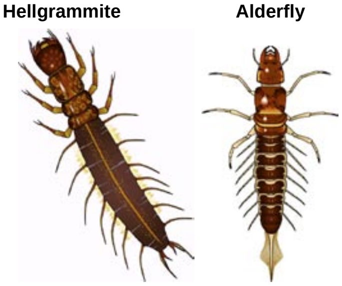
Dragonfly **Damselfly**



Dragonflies and **Damselflies**

(Order **Odonata**): Three-pairs of legs; large eyes; long spoon-like jaws; no tails on the abdomen. Dragonflies have a broad shaped abdomen, while the Damselfly abdomen is much narrower. Damselfly gills are attached to the end of the abdomen, they look like tails. (**M-VL**) (**M**)

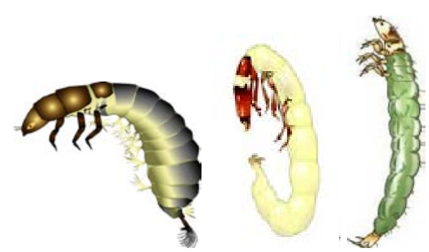
Hellgrammite **Alderfly**



Fishflies and **Alderflies**

(Order **Megaloptera**): Three-pairs of legs; large pinching jaws; eight-pairs of filaments attached to the sides of the abdomen. Fishflies also called **hellgrammites** have a two-hooked tail, whereas Alderflies have a single tapered tail and are usually much smaller and lighter in color. (**M-VL**)

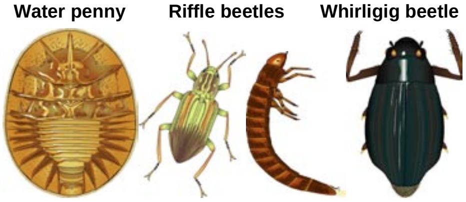
Common netspinner **Finger-net** **Free-living**



Net-spinning caddisflies

(Order **Trichoptera**): Similar characteristics as above but the abdomen usually has more abundant gills, especially the **common netspinner** (family **Hydropsychidae**). The net-spinner's retreat is also made of a variety of streambed materials, which are held together more loosely by fine strands of silk. The **free-living caddisfly** (right) does not build a case or net. (**S-L**) (**M**)

Water penny **Riffle beetles** **Whirligig beetle**



Beetles

(Order **Coleoptera**): Three-pairs of legs; body usually covered by a hard exoskeleton. The Most common kinds collected are the **water penny** and **riffle beetles** (left-right), but others kinds are also found. (**VS-L**) (**M**)

True flies

(Order **Diptera**): Usually the body is segmented with some type of visible features either along the body, or at the head or tail regions (i.e. head, tails, prolegs, whelps etc.). This order is the only aquatic insect without fully developed legs in the larval stages. Dipterans are very diverse order with many aquatic varieties. Several common kinds are described here. (**M**)

Non-biting midge

(Order **Diptera**; family **Chironomidae**): Segmented body with a visible head; two leg-like projections at the front and rear. Sometimes they are bright **red** in color. (**VS-M**)

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Crane fly

(Order **Diptera**; family **Tipulidae**): No legs, no visible head; plump body with lobes along the segments; may have structures that look like tentacles, lobes or one bulb at the end of the body. (**S-VL**)

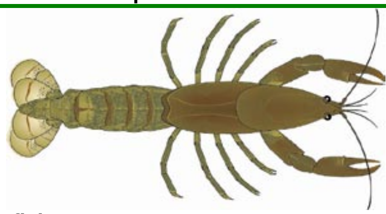
Black fly

(Order **Diptera**; family **Simuliidae**): Body has a bowling-pen shape (lower is wider than the upper); there are multiple brushes/fans on the head and a ring of hooks on the abdomen. (**VS-M**)

Watersnipe fly

(Order **Diptera**; family **Athericidae**): Plump body, looks very much likes a caterpillar; on the underside there are structures that look similar to legs but are not segmented; the tail is forked and fringed with hairs. (**S-L**)

Non-Insect Groups



Crayfish

(Class **Crustacea**; order **Decapoda**): Five pairs of legs, the first two usually have large claws; large flipper-like structure at the end of the abdomen. (**M-VL**)

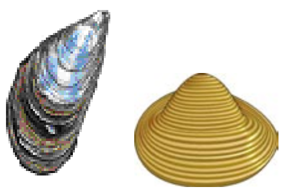
Scud/Sideswimmer

(Class **Crustacea;** order **Amphipoda**): Seven pairs of legs, the first two may be claw-like; body is somewhat higher than it is wide. Usually swims with a sideways motion. (**S-M**)

Aquatic sowbug

(Class **Crustacea;** order **Isopoda**): Seven pairs of legs, the first two may be claw-like; very long antenna; body is wider than it is high, giving the animal a fairly flattened appearance. (**S-M**)

Mussel **Clams**



Clams and **Mussels**

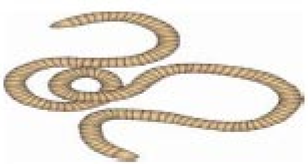
(Class **Bivalvia**): Fleshy body enclosed between two-hinged shells; the shape and ridge spacing of the shells can determine different kinds. **Mussels** are usually larger than clams and have dark colored oblong shells. (**VS-VL**) (**M**)

Operculate snails

(Class **Gastropoda**; sub-class **Prosobranchia**): Fleshy body enclosed by a single shell, which is usually coiled in an upward spiral. The opening of the shell is covered by an operculum (door). (**VS-L**) (**M**)

Non-operculate snails

(Class **Gastropoda**; sub-class **Pulmonata**): Fleshy body enclosed by a single shell, which is sometimes coiled upward but also may lie flat or have a conical shape. The opening of the shell is not covered by an operculum. (**VS-L**) (**M**)



Aquatic worms

(Phylum **Annelida**; class **Oligochaeta**): Body is long with numerous segments along its entire length; has no visible head or tail. (**VS-VL**)

Leeches

(Phylum **Annelida**; class **Hirudinea**): Body is long and thin or slightly widened; 34–segments along its length, but there appears to be many more. (**S-VL**)

Flatworms

(Class **Turbellaria**): Soft elongate body without segment; head triangular shaped with eyes on top, which give the animal a cross-eyed appearance. (**VS-L**)

http://www.dep.wv.gov/sos

Sizes illustrated not proportional

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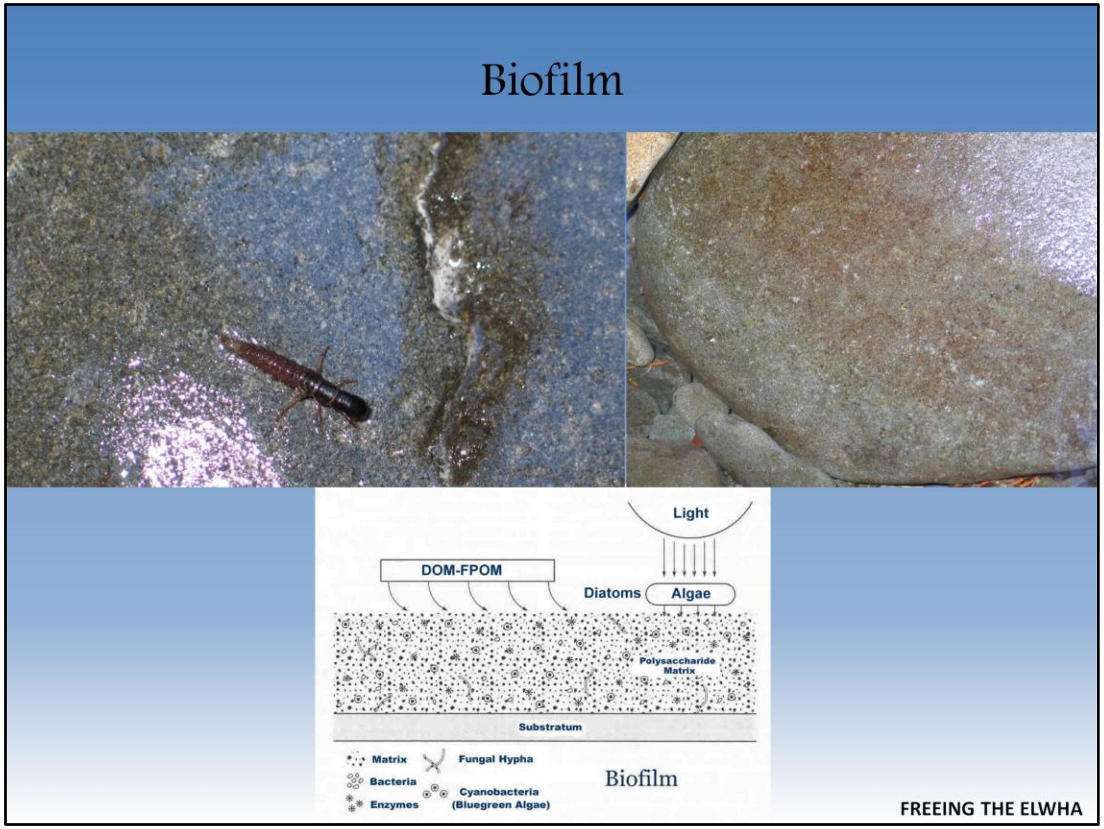
Instructions: Identification is easier when the organism is viewed in the same orientation as its illustration. Illustrations are drawn mostly in top and side views; the water penny is shown in underside view. The (**M**) symbol indicates that multiple kinds may be collected from the group (Order or Class). Use **morphological** features as your basis for identification; the size and color are often variable and influenced by environmental factors. Only a few of the many kinds possible are illustrated. (**Size range in mm**)

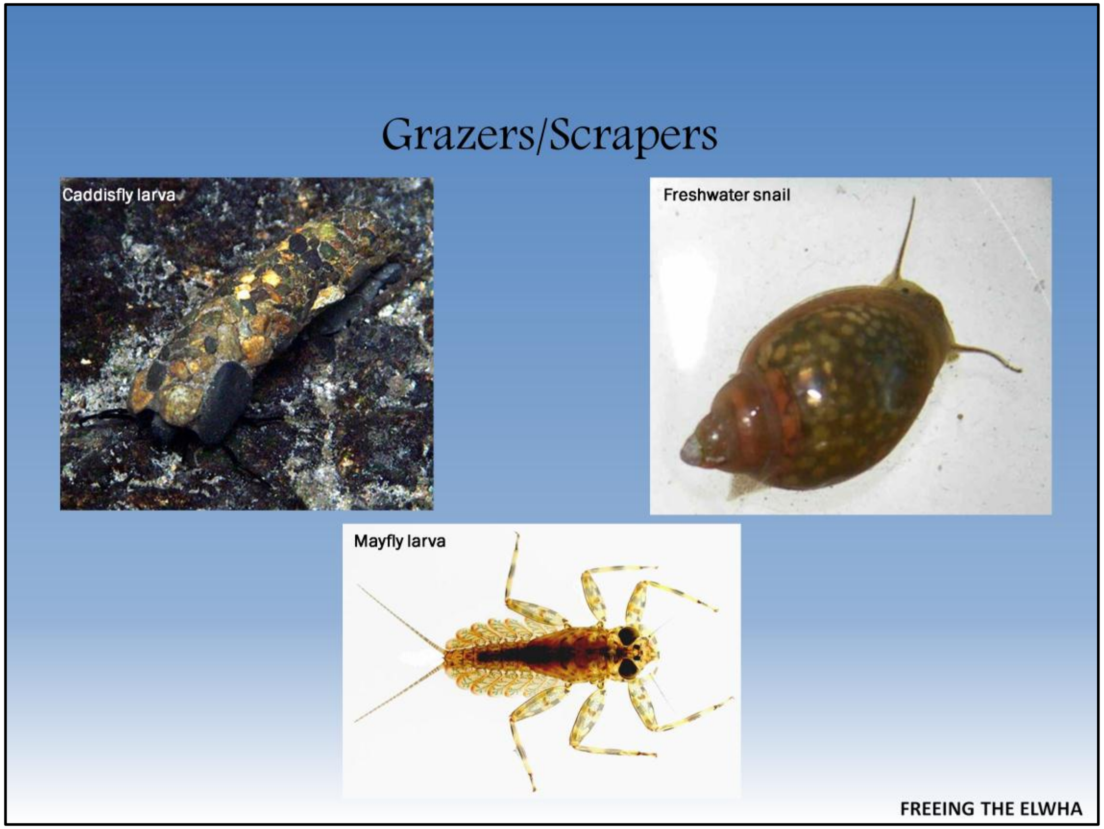
Size categories: > 50 Very large (**VL**); 50 - 30 Large (**L**); 29 -10 Medium (**M**); 10 - 5 Small (**S**); < 5 Very small (**VS**)

Note: This field guide will help you identify common aquatic invertebrate classes and orders, and a few families. You should always refer to a more complete guide for verification of family level identification. Eventually, you will be able to identify a wide variety of families in the field.

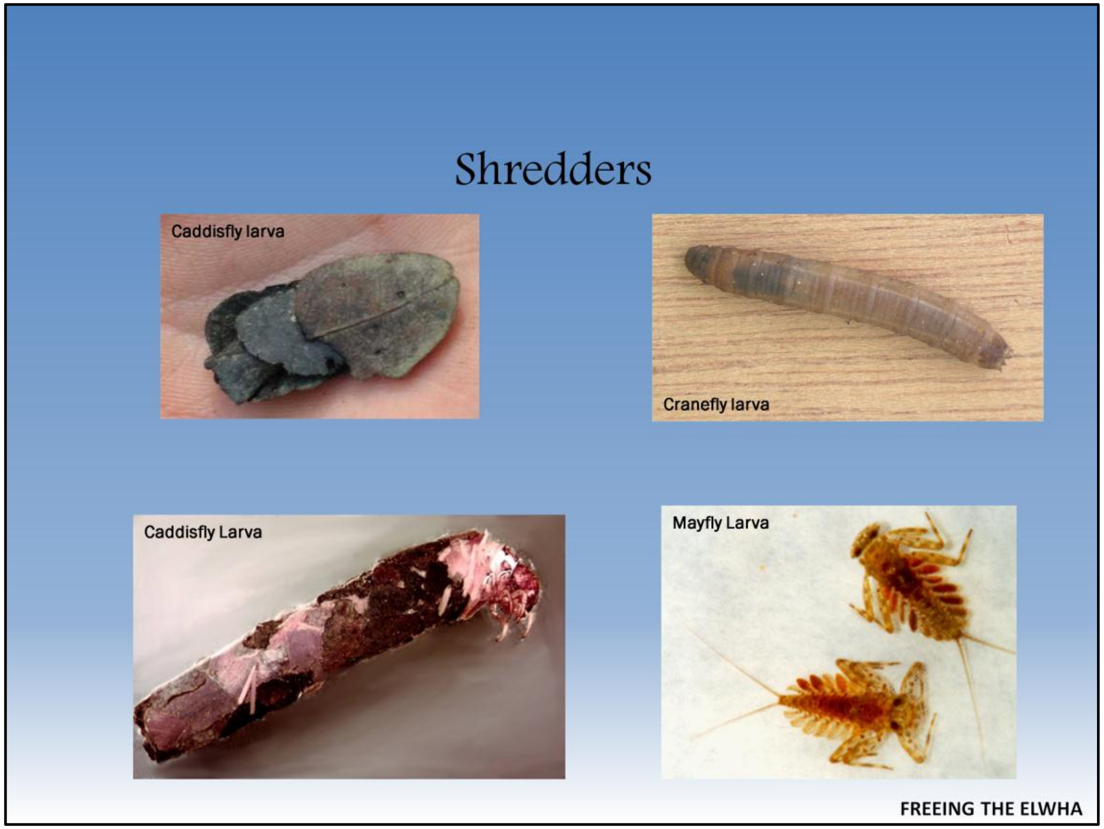
Illustrations courtesy of the Cacapon Institute (http://www.cacaponinstitute.org/) and artist Jennifer Gillies; used with permission



Biofilm consists of a complex community of algae, bacteria, fungi, and protozoans living in a matrix of secretions that adhere to solid surfaces like rocks and aquatic vegetation. The algae (the reddish-brown substance on the rocks above) do photosynthesis. The algae secretes substances that are fed upon by bacteria, fungi, and single-celled organisms. In addition, an accumulation of detritus and other organic materials captured in the matrix provide other sources of food.

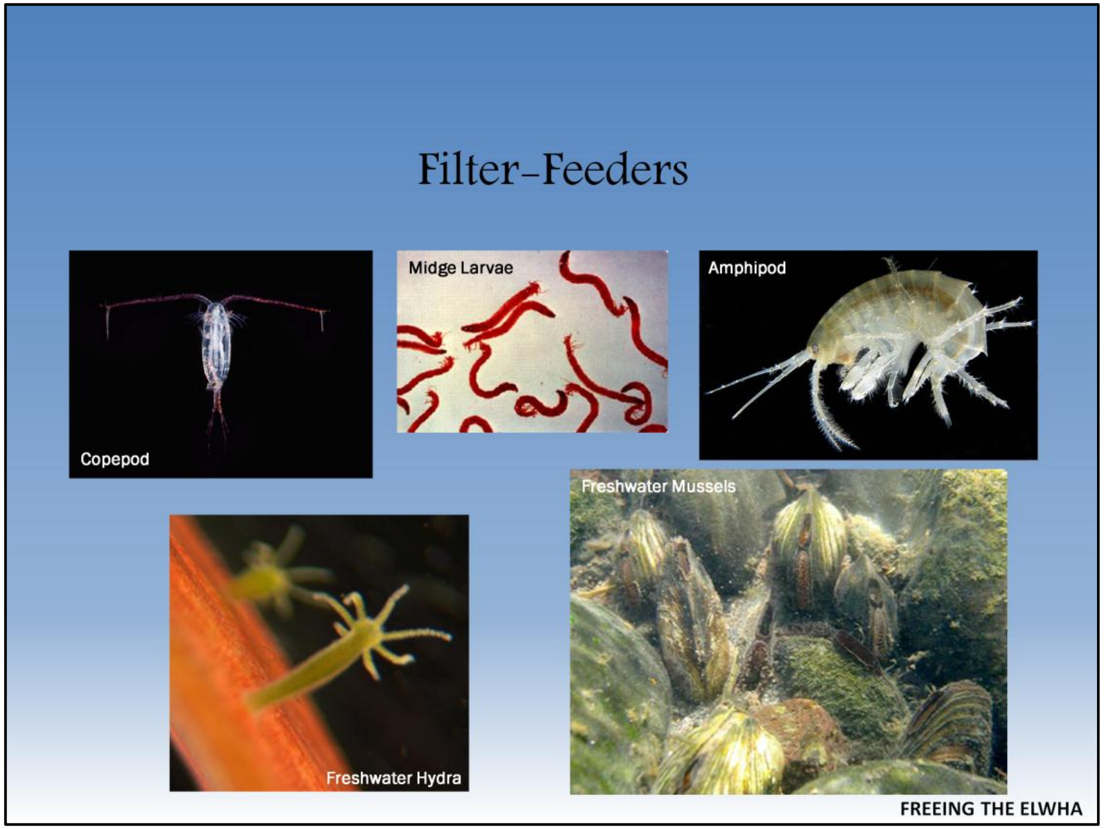


Grazers and scapers are animals that specialize on feed on the biofilm layers. They use rasping mouthparts to scrape the biofilm and algae off of the rocks and vegetation. Caddisflies that live in rockty substrates make protective casings from small stones that are cemented together with silk and saliva.



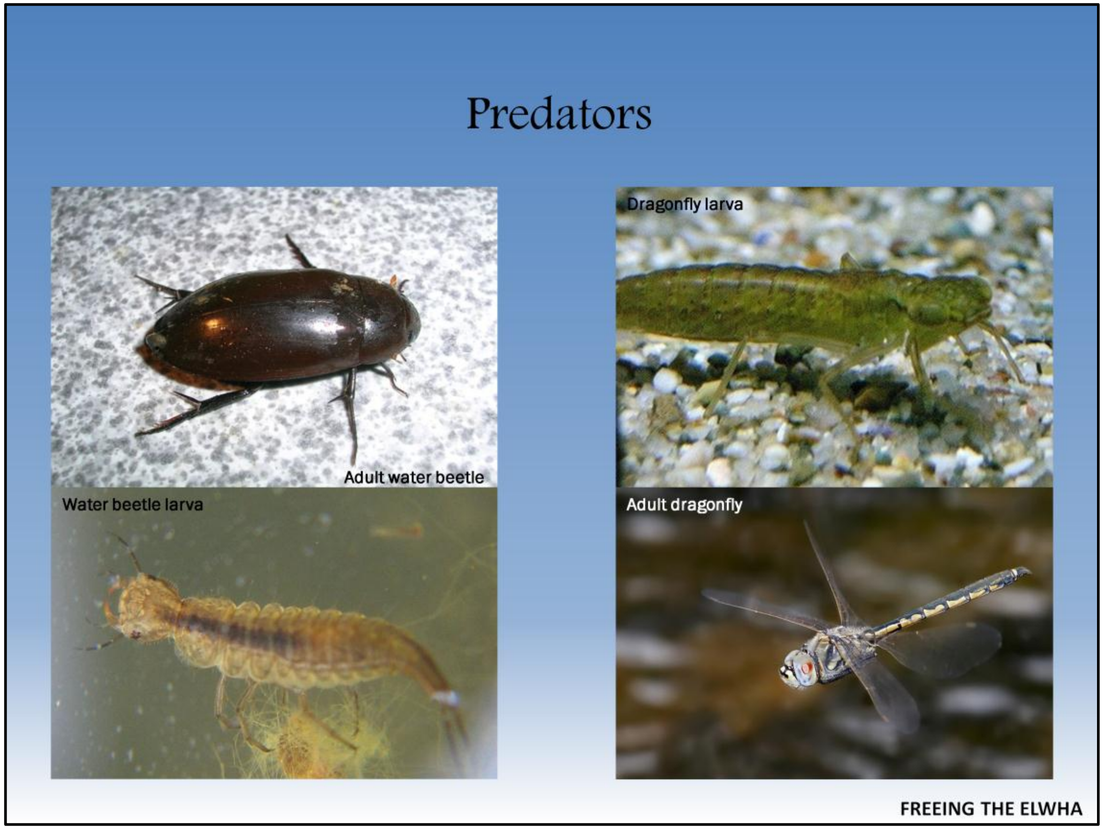
Shredders wander the stream bottom looking for vegetation that has fallen into the water. Using their tearing mouthparts, they rip and shred the leaves as they feed. Some, like the caddisfly larva, even use those shredded leaf pieces to make their protective casings.

Another group of aquatic insects are the collector/gatherers. These insects primarily wander the stream bottom scavenging for dead organisms, detritus, or other food particles that get lodged between rocks or in deep pools.

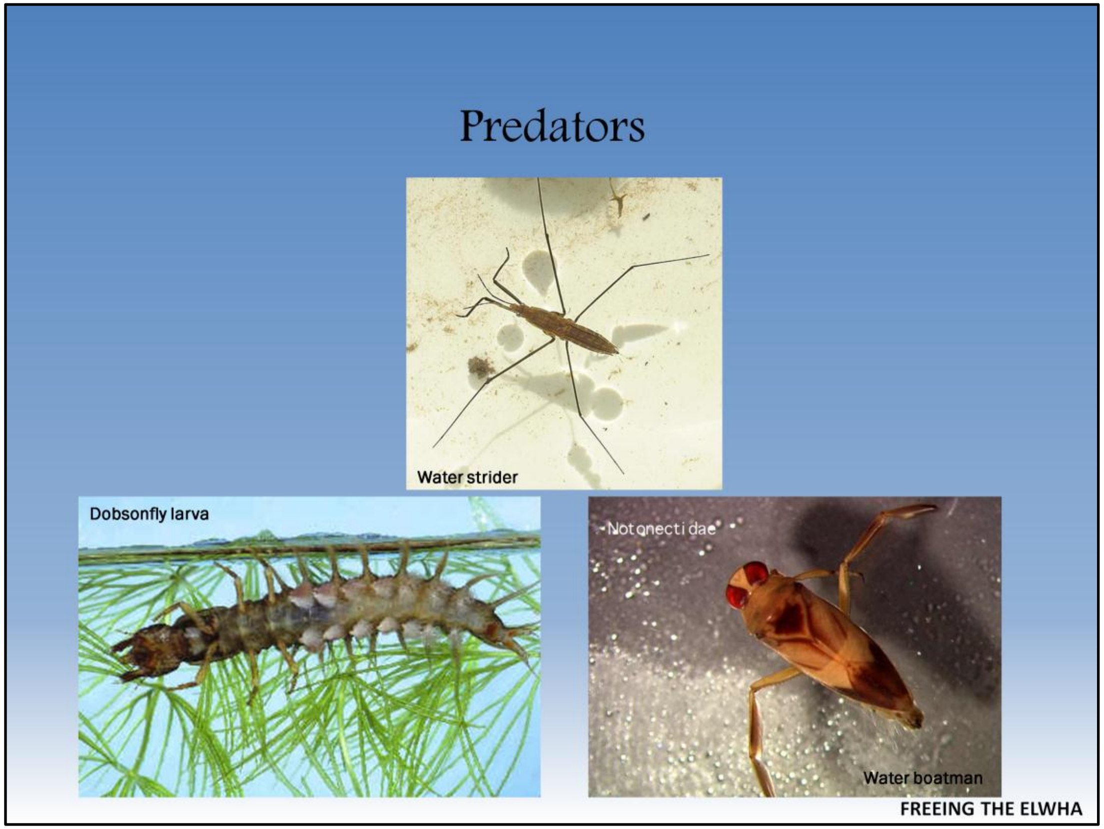


Filter-feeders either swim through the water or sit sessile on the bottom filtering out particles that float by in the current. Often these are pieces of vegetation ripped up by shredders or tiny strips of biofilm dislodged by grazers, which are then sent downstream with the current. In addition, detritus from decaying plants and animals also provide a source of food.

Some filter-feeders, like hydra and amphipods are actually predatory, feeding on live organisms that happen to drift on by.



Some species of invertebrates are predators in both the larval and adult stages of their life. The water beetle and dragonfly larva are vicious predators of other aquatic insects, tadpoles, and even small fish. As adults, they continue searching for prey either by swimming under water, as water beetles do, or flying directly above the surface as dragonflies do.



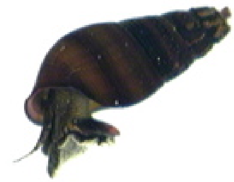
Other predators include the water strider, which searches for fallen insects on the surface of the water. Water boatmen are very similar to water beetles in swimming down and between the rocks looking for aquatic insects. However, water boatmen are actually true bugs, not beetles.

The dobsonfly larva is a large and voracious predator. It spends most of its life in the larval stage, only emerging as a huge adult with massive mandibles to breed for a few days before its death.

Aquatic Macroinvertebrates


flatworm


aquatic earthworm


snail


clam


mussel


water mite


scud


aquatic sowbug


crayfish


water boatman


water strider

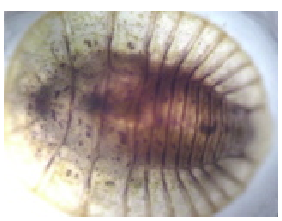

whirligig beetle


riffle beetle larva


riffle beetle adult


predaceous beetle larva

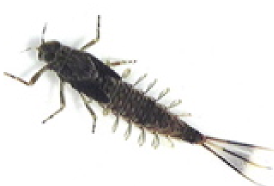

predaceous beetle adult


water penny


dragonfly


damselfly


dobsonfly


ameletid mayfly


small minnow mayfly


small minnow mayfly


flat-headed mayfly

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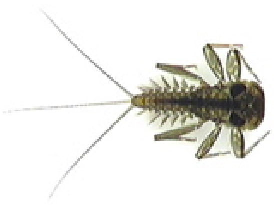
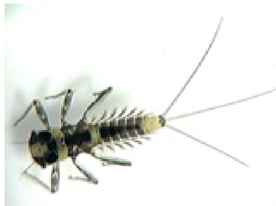
Aquatic Macroinvertebrates


flat-headed mayfly


flat-headed mayfly


spiny crawler mayfly


spiny crawler mayfly


spiny crawler mayfly


prong-gill mayfly


golden stonefly


little yellow stonefly


little yellow stonefly


little brown stonefly


little green stonefly


slender winter stonefly


giant stonefly


net-spinner caddisfly


northern case-maker caddisfly


northern case-maker caddisfly


saddle-case-maker caddisfly


free-living caddisfly


finger-net caddisfly


black fly


midge


midge


crane fly


crane fly

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