Monitoring Macros!

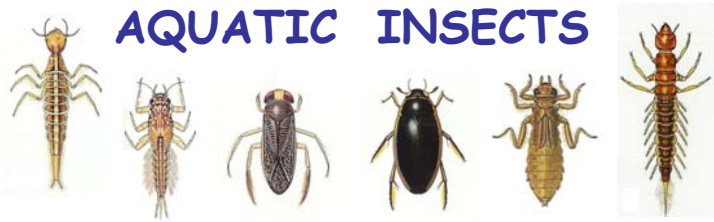
An Identification Guide to Aquatic Macroinvertebrates

Developed by Gary Kreamer & Brianna Barkus

For the DE Adopt-a-Wetland Program, Feb. 2003 (revised July 2007)

PAGE 1 Master Key to Aquatic Invertebrate Groups

AQUATIC INSECTS



Though varying much in appearance, all insects share certain characteristics, If you find a critter with a segmented body plan, a distinct head region, and 3 pairs of legs, it is an insect. Wings or wing pads and a pair of antennae are also apparent in some forms.

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CRUSTACEANS

This group includes crustaceans that can be seen with the naked eye. Like their insect cousins, they have a segmented body plan, a specialized head, jointed legs, and a hard exoskeleton, but tdiffer in having more than 3 pairs of legs and in having 2 pairs of antennae.

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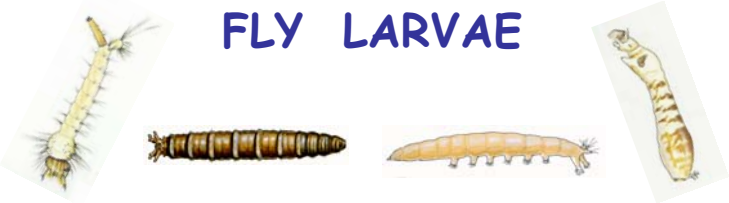
FLY LARVAE



Flies are insects, but since their larvae are wingless, legless and worm-like, they are separated here. In contrast to the real worms (see box opposite), most fly larvae have a distinct head and mouth, and leg-like appendages at either or both ends of the body.

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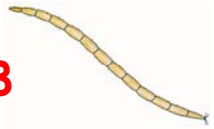
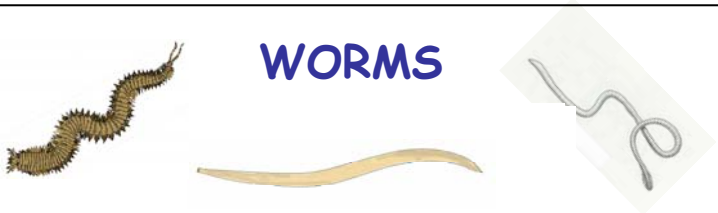


WORMS



This group comprises a variety of aquatic 'real worm' types, including sand worms, roundworms, flatworms, horsehair worms, leeches and some earthworms. The soft bodies may appear segmented or not, head and mouthparts tend to be obscure, and legs are lacking.

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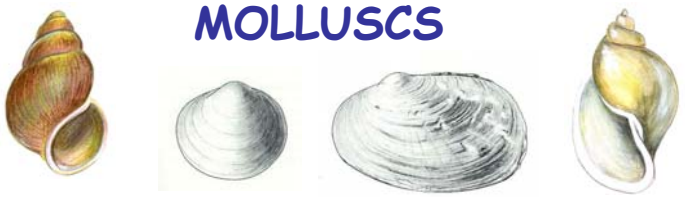
MOLLUSCS



This group covers clams and snails, animals having a hard shell of calcium and no leg-like appendages. Though the wide range of forms precludes thorough treatment, some types common to freshwater, along with a few troublesome invasives, are featured.

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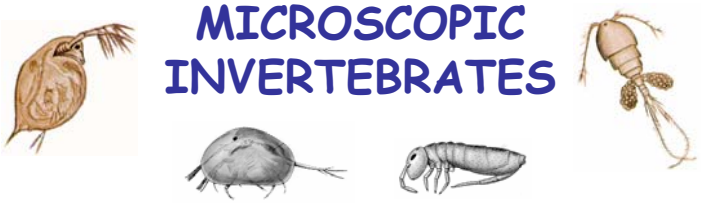
MICROSCOPIC INVERTEBRATES



This group features smaller life forms best viewed with a microscope, including various kinds of micro-crustacea. At certain times, large numbers of these critters can be seen darting to and fro through a sample of water, like small pink flecks in a living soup.

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Illustrations from: McAfferty (1981), Kenney & Burne (2000), Lippson & Lippson (1998), and Reid (1987)

Aquatic Invertebrate Groups

Background

CRUSTACEANS

The success and dominance of insects in the invertebrate fauna of freshwaters is mirrored in some ways by crustaceans in the marine environment, where a variety of crabs, shrimps and smaller representatives abound. But crustaceans are also well-represented in freshwater (moreso than insects are in saltwater), including several members of the macrofauna that do well in streams, ponds and wetlands, and key elements of the microscopic zooplankton (described in more detail below) that play a vital role in aquatic food webs. Like insects, crustaceans are arthropods, meaning they have jointed legs, a segmented body plan, and a hard, exoskeleton that they shed several times as they grow.

AQUATIC INSECTS

Aside from the ocean depths, aquatic insects can be found in just about every conceivable aquatic habitat on earth, from pools of glacial meltwater in the arctic to hot springs, from small rain puddles to great salt lakes, from pristine mountain streams to putrid sewage lagoons. As on land, insects are by far the most diverse group of animals occupying freshwater environments, featuring an astonishing array of forms, lifestyles and adaptations for moving, feeding, breathing and living in the water world. Add to that, the vital role they play in aquatic food webs, the fascination some forms foster in fly-fishing anglers, and their significance as bio-indicators of water quality, and one can see why aquatic insects are well worth knowing and monitoring.

WORMS

This grouping comprises a catch-all for a variety of life forms all sharing a superficially-similar looking worm-like body plan. This includes the three kinds of annelids or segmented worms (earthworms, marine worms and leeches), as well as the separately classified and unsegmented flatworms, roundworms and horsehair worms. Although simple in appearance, some of these forms (i.e. the marine worms, leeches and roundworms), can be fairly specialized in structure and habits. Although habitats are also varied, like true fly larvae, many of the worms are pollution-tolerant, and some, especially the tubificids, can reach quite high densities in waters polluted with sewage or other organic wastes.

TRUE-FLY LARVAE

As a group, true fly larvae are the most diverse of aquatic insects, and by far the most tolerant of a wide range of environmental conditions, including species that thrive in such extreme habitats as hot springs, arctic bogs, salt lakes, torrential mountain streams, streams with pH as low as 2 (from acid mine drainage), and sewage lagoons. In terms of adaptations to the aquatic realms, they are likewise impressive, from the burrowing deer fly and tube-building midges, to the black flies that cling to rocks in stream rapids and the mosquitoes that hang from the surface of stagnant pools and puddles snorkel-breathing. Though they may appear ugly and simplistic, the worm-like body plan of the true fly larvae seems to serve them well.

MOLLUSCS (CLAMS & SNAILS)

Like crustaceans, molluscs reach their greatest diversity and abundance in marine habitats, but have also evolved a variety of forms adapted to freshwater. This includes members of both clam and snail classes. Many of the clam forms, including freshwater mussels in streams, and fingernail clams in lakes and vernal pools, play an important water-cleansing role in such habitats as filter feeders of fine organic matter. Similarly, freshwater snails, through their capacity for scraping algae and detritus off the substratum and aquatic plant surfaces, can serve a key function in transforming organic matter in aquatic food webs. Both groups, however, include introduced invasive forms that are proving ecologically troublesome.

MICROSCOPIC INVERTEBRATES

Although these life forms appear as mere specks in the water when viewed with the naked eye, in terms of sheer numbers and significance in aquatic food webs, they matter quite a lot. This is certainly so for the four kinds of micro-crustaceans featured, especially the water fleas and copepods, which - as key elements of the zooplankton in most aquatic habitats - serve as food for various aquatic insects, small fish, and other organisms. These micro-crustaceans, along with the tiny water mites and aquatic springtails, are also common and abundant parts of the fauna in vernal pools and other temporary wetlands, where at certain times, the water is so thick with their numbers that it literally appears a living soup of micro-life.

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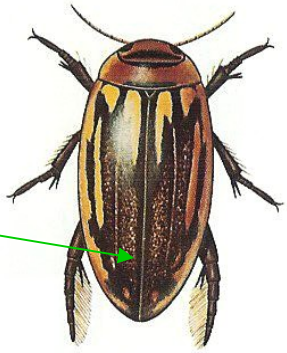
Illustrations from: Kenney & Burne (2000), Lippson & Lippson (1998), Reid (1987) and McAfferty (1981)

Master Key to Aquatic Insect Groups

WATER BEETLES (ADULT FORMS)



This group covers a variety of sizes, shapes and habits. All feature thick, hardened outer wings that meet in a straight line down the back. Most are active swimmers and breathe by surfacing to replenish a bubble of air carried on or under their wings, legs or antennae.

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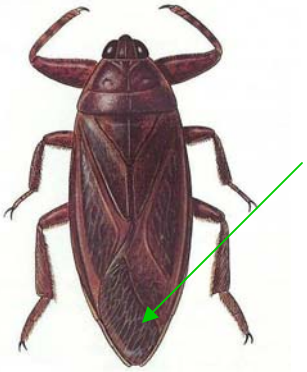
WATER BUGS (ADULT FORMS)



Bugs differ from beetles in that the lower tips of the outer wings are transparent, soft and overlapping. Some have oar-like legs for swimming, while others are suited for walking on water, crawling or climbing on plants. Mouthparts are needle-like and suited for piercing.

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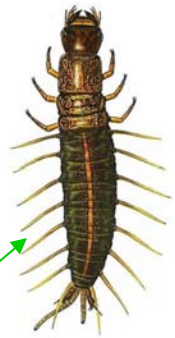
LARVAL BEETLES AND FISHFLIES



This group includes larval forms of certain beetles, and similar-looking fishfly or alderfly larvae. The shape is elongate-segmented, with 3 pair of legs visible, but no wings or wing pads; most have abdominal filaments and jaw-like mouthparts.

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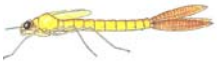
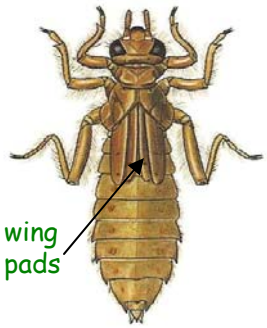
MAYFLY, STONEFLY & DRAGONFLY NYMPHS





This group includes immature forms of dragonflies, damselflies, mayflies and stoneflies. All share a life cycle in which a water-dwelling nymph stage transforms/emerges into an terrestrial, flying adult form. All feature wing pads on their back, a prominent head, gills (not always visible) and 6 legs.

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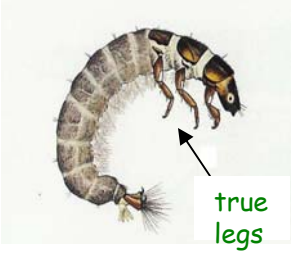
CADDISFLY LARVAE MORE BEETLE LARVAE



This group features mostly larvae with elongate, caterpillar-like forms, a hardened head, short antennae, no wing pads and six legs. This includes larvae of the case-building and net-spinning caddisflies, certain like-looking beetles, and the distinctive water penny, all of which favor stream habitats over the still waters of ponds and wetlands.

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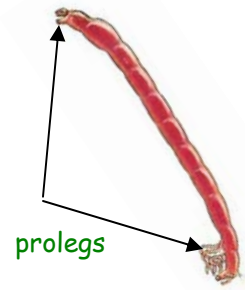
TRUE FLY LARVA (MAGGOT-LIKE FORMS)



This group includes aquatic larvae of insects classified as 'true flies'. All are soft-bodied, grub/maggot-like, and differ from all other groups on this page in not having 6 segmented legs (though some have fleshy prolegs at their front and/or tail ends). Head & mouthparts in some forms are small and inconspicuous.

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Aquatic Insect Groups

Background

WATER BUGS

Like their somewhat similar beetle relatives, most water bugs swim well, get oxygen by capturing/holding bubbles of air on some part of their body, and feature immature and adult life forms that are aquatic-adapted. But in contrast to the jaw-mouthed, biting beetles, water bugs have piercing (beak-to-needle-like) mouthparts, and larval forms that look like smaller versions of the adults. Like the beetles, water bugs occupy a wide variety of habitats, including streams, ponds and vernal wetlands, where they comprise an important part of the aquatic food chain. Some water bugs (e.g. water boatman) stridulate – make sound by rubbing two body parts together (e.g. legs over head or wings) - though scientists are not sure why.

ADULT WATER BEETLES

Next to the flies, beetles comprise the most advanced and diverse group of insects adapted to living in water, including over 1000 known species in North America alone. Like the flies, they feature an egg-larva-pupa-adult life cycle. But in contrast to flies (which typically have aquatic larvae turning into aquatic pupae that transform to terrestrial flying adults), most aquatic beetles have aquatic-adapted larval and adult stages, with the in-between pupa stage occurring on land (though adults can leave the water to fly, facilitating dispersal to new areas). As a group, water beetles have evolved many fascinating adaptations for living in water, including mastery of the "bubble-breathing" strategy for obtaining oxygen.

AQUATIC 'NYMPHS'

This group comprises 3 primitive orders of aquatic insects: the dragonflies, mayflies and stoneflies. All produce larvae (sometimes called nymphs) having distinct wing pads on the thorax, which transform by incomplete metamorphosis (meaning there is no in-between pupal stage) to fully-winged, land-dwelling flying adult forms. This well-worth-watching 'hatching' process is accomplished by the mature larval form crawling out of the water and up on to a stick, rock, plant or other object, shedding its last larval skin, and gradually spreading out its new wings, before flying off to commence the reproductive phase of the life cycle. Stonefly/mayfly nymphs are clean-stream indicators; dragonfly/damselfly nymphs favor still water habitats.

BEETLE & FISHFLY LARVAE

Although this group cuts across two orders of insects with quite distinct adult forms, the larval stages are sufficiently similar-looking to cause some confusion. All those covered here feature an elongate centipede-shaped body, with three widespread pairs of legs, chewing mouthparts (as belies their predatory habits), no wings or wing pads, and (in most, but not all, cases) spine-like to gill-like processes arising from the sides of the abdominal segments. Although the fishflies and alderflies differ from most of the beetles in having adult, flying forms that are non-aquatic, both groups share the larval habit of crawling out of the water to pupate, typically in damp soil or under rocks not far from the water's edge.

TRUE FLY LARVAE

Despite their often diminutive size, and simplistic body form, true fly larvae are the most diverse (over 3500 species), widespread and highly evolved of the aquatic insect orders, and the group that is tolerant of the widest range of environmental conditions. One reason for their amazing success lies in their rapid life cycles, with many kinds producing several generations a year. As with the caddisflies and beetles, metamorphosis is complete, but unlike beetles, most flies with aquatic larvae also have aquatic pupae, with emergence to adult form taking place at the water surface. In some kinds, female adults require a blood meal prior to egg-laying, making them pests to humans and other animals. As a group, they serve as key links in aquatic food webs.

CADDISFLY & MORE BEETLE LARVAE

Caddisfly larva represent a unique and fascinating group of aquatic insects, and along with the two beetle forms included here, comprise critical components of the stream rapids bottom fauna. Many of the caddis larvae construct distinct cases, nets or tubes to which they retreat, while others roam freely in the habitat. All use silk in some way, spun from special glands found in the lower lip area. Though as a group, diversity and numbers tends to be highest in stream/river waters that runs fast and clean (making them valued as clean water indicators), some kinds also do well in the slower moving waters of ponds, lakes and even temporary wetlands, and some (especially of the net-spinning types) are reputed to be pollution-tolerant.

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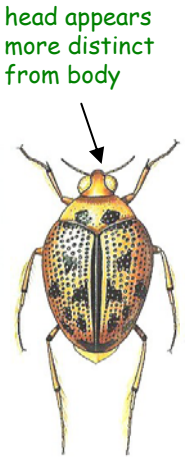
Water Beetle Adults

CRAWLING WATER BEETLES



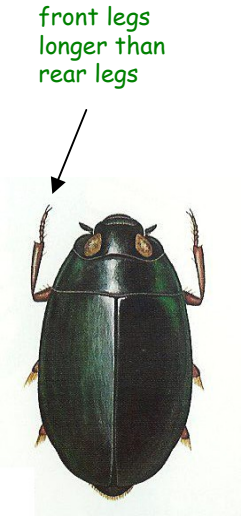
These beetles are small (less than 1/4" in length) compared to other beetles shown here.

They are usually brown or yellow with black spots; rows of tiny holes on wings give them a striated look

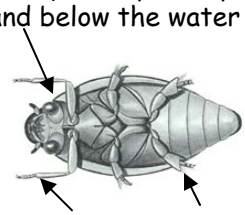
Notice also how the head on this macro extends out from it's body.

They are usually found around aquatic vegetation, often in or on clumps of filamentous algae.

WHIRLIGIG BEETLES



This shiny black beetle swims fast in "schools" on the water surface. It has unique, 2-part eyes to see above and below the water surface.



The front legs are well-developed, but mid and hind legs are shorter (often not visible from above) and flattened like paddles for rowing.

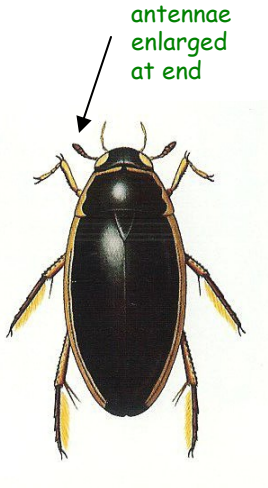
WATER SCAVENGER BEETLES

These shiny-black beetles are deeper-bodied than their more flattened diving beetles cousins.

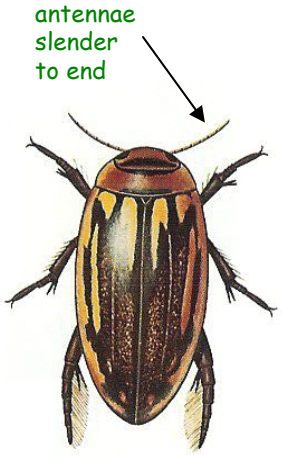
Unlike other beetles shown, the antennae are clubbed at the end.

In swimming, it appears less smooth than the diving beetles; the hind legs beating alternately giving it a herky-jerky motion.

When scavenger beetles surface for air, they do so head first.



PREDACEOUS DIVING BEETLES



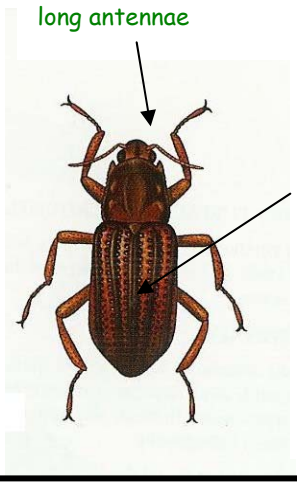
Diving beetles vary much in size and color, from black or brown to a mix of both.

Unlike water scavengers, the antennae are thin to the end.

Diving beetles are smooth swimmers, stroking their hind legs in unison as it goes.

When diving beetles surface for air, they do so with the tail up and head down.

RIFFLE BEETLES

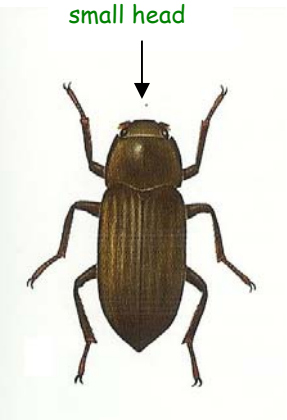


These small beetles prefer the swifter, rocky waters of streams and lake shores.

The hardened outer wings feature vertical rows of fine indentations, giving them a pock-marked appearance.

The shape is more cylindrical than oval; both antennae and legs are longish for its size, with each leg ending in two prominent claws.

LONG-TOED WATER BEETLES



Due to their small size (<1 cm), these beetles are not as often seen as others shown here.

The head is withdrawn into the thorax making it, barely visible.

The hind legs lack the hairy fringes typical of the diving and scavenger beetle types.

Under magnification, the base of the antennae look like teeth in a comb.

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Water Beetle Adults

Background

WHIRLIGIG BEETLES

This is the only beetle type specially adapted for living on the water surface. It's eyes are split (into two pairs) so that one set sees on top of the water, while the other see things below the water surface. This no doubt aids them in hunting their prey, including small insects that fall into the water and get trapped in its surface tension.

Whirligig beetles are excellent swimmers, using their flattened rear legs as paddles to propel themselves rapidly about.

Although whirligigs are easy to see, fish and other macros tend not to eat them, as they exude secretions that make them taste bad!

CRAWLING WATER BEETLES

This beetle gets its name from its habit of crawling around the aquatic habitat, often in mats of algae and on other aquatic plants, which they consume for food by piercing the strands and extracting cell contents.

Like others on this page, crawling water beetles bubble-breathe. But unlike the others, they do this by carrying their air bubble in two places: beneath their wings, and on a special expanded plate at the base of their hind legs.

Compared to other water beetles, crawling water beetles are not good swimmers, using the air bubble attached to their legs to float them up (rather than swimming up) to get more air!

PREDACEOUS DIVING BEETLES

This is the most diverse family of aquatic beetles, featuring a variety of sizes, shapes and colors. Diving beetles, both adults and larvae, will eat anything they can catch, even tadpoles, small fish and salamanders!

Diving beetles are nature's scuba divers! They breath by way of an air bubble carried under their wings, which they refresh by sticking their tail-end up at the water surface.

Relative to other water beetles, diving beetles are smooth swimmers, moving their legs in unison like you would in rowing a boat. They also have small hairs on their legs that help make each stroke more powerful!

WATER SCAVENGER BEETLES

The water scavenger beetle gets its name from what it eats - feeding typically on decaying animal matter; though some consume live prey and/or plant material.

These beetles look similar to diving beetles, but are more convex (deeper) bodied in profile, have club-ended antennae (which are often hidden under their head), and beat their legs alternately in swimming.

Like other beetles, water scavenger beetles "bubble-breathe", but differ in surfacing head-up, and holding one antenna out in the air, allowing fresh air to move down it and around the body, replenishing the supply held under their wings.

LONG-TOED WATER BEETLES

Long-toed water beetles are unique among insects in having aquatic adults and terrestrial immature stages, the latter living in damp soil or decaying vegetation in the vicinity of the streams, swamps or pools where the adults are found.

Like riffle beetles, they cling tightly to rocks, stones and woody debris, and have a small head that can retract partway into the thorax for protection.

They can sometimes be found crawling along the water bottom or shoreline. Not a lot is known about the life cycle and habits of these seldom-seen creatures.

RIFFLE BEETLES

These small, but sturdy, beetles are typically found in the cooler, swifter, riffle areas of streams and rivers, where their streamlined shape and double-clawed feet allow them to cling securely to stones and rocks in the current. A few species can be found in ponds and wetlands, mostly in association with aquatic plants. Most species eat algae for a living, though a few are known to dine on detritus.

As other beetles, riffle beetles are bubble breathers, but they are so efficient at replenishing their air supply from the highly-oxygenated waters they live in, that they rarely, if ever, have to surface for air.

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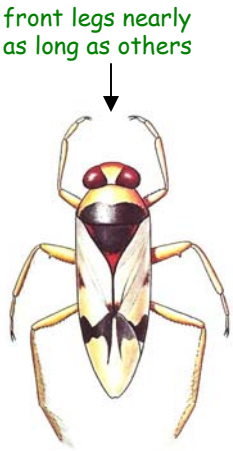
Water Bugs

BACKSWIMMER

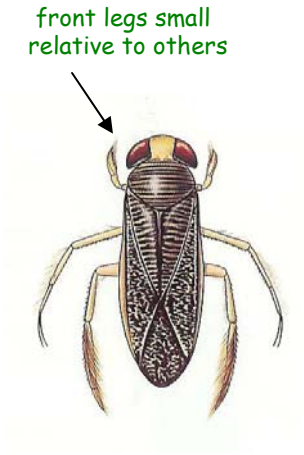


This slender, back-stroking macro has long front legs for catching/holding prey and oar-like back legs for swimming.

They are often found resting belly-up on the water surface with hind legs held forward to quickly swim out to catch prey.

Handle all true (water) bugs with care! They have needle-like mouthparts that can inflict a painful bite!

WATER BOATMAN

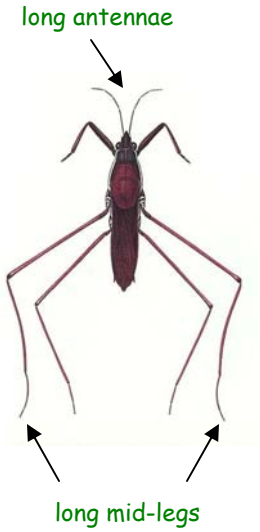


This macro tends to be dark gray/brown with yellowish wavy lines on its top side, giving it a fine-striped look.

The head is larger and front legs smaller than the back-swimmer, but the back legs are similarly long and oar-like.

In contrast to their backswimmer cousins, water boatman do their swimming top side up!

WATER STRIDER

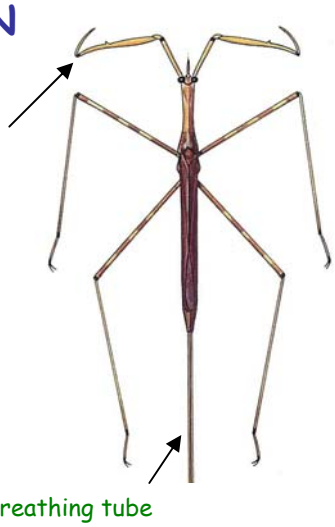


This macro can be found with others of its kind skating across the still waters of ponds, creeks and wetlands.

The body is slender, with long legs and conspicuous antennae.

Despite their spider-like look, striders have only 6-legs and are thus insects.

WATER SCORPION

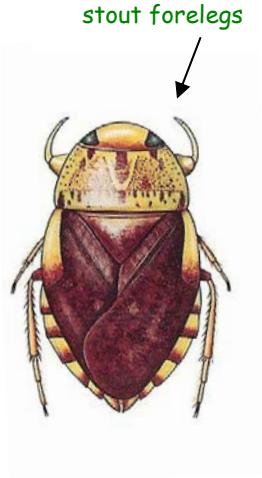


This stick-shaped macro has strong, elbowed front legs for grasping its prey.

Its long, thin mid and back legs are well-adapted for climbing on vegetation.

It is often found resting with its tail-end up, its long snorkel tube sticking out above the water surface.

CREEPING WATER BUG

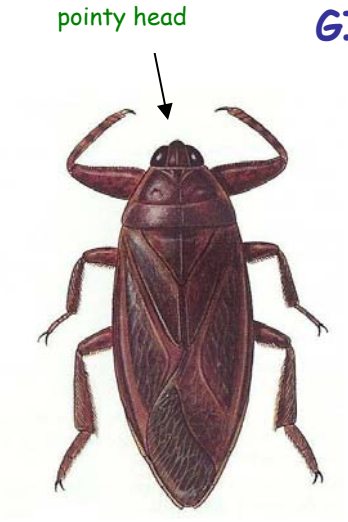


This robust macro has a beetle-shape, but is actually a true bug, with the outer wings softer and overlapping to make a V-pattern.

Notice the strong front legs - an adaptation for catching its prey.

When resting, this bug will fan its hind legs in an effort to keep freshly-oxygenated water flowing over the air bubble on its belly.

GIANT WATER BUG



This flat-bodied macro can get quite large (>1 inch).

Notice its point head, and it's sturdy front legs, held forward to catch its prey.

It is often found hanging down at the water surface, with its rear-end breathing tubes poking into the air.

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Water Bugs

Background

WATER BOATMAN

Water boatmen are one of the most widespread aquatic insects. Unlike other water bugs, they have beak-like (not needle-like) mouthparts and favor a diet of plant material and detritus rather than animal prey.

If you look at a boatman's underside as it swims, you can see a silvery sheen – this is a bubble of air that is held in place under the boatman's wings, extending down its belly. This bubble acts as a gill, and can be replenished by uptake of dissolved oxygen from the water, with the movement of the oar-like hind legs in swimming helping it to do so. Boatman also resurface often to replenish this air supply. Male boatmen stridulate, making chirping sounds under-water by rubbing pegs on their front legs across their head.

BACKSWIMMER

The Backswimmer is aptly named! It can be found hanging upside down at the water surface with its oar-like hind legs held forward ready to pounce on unfortunate prey, which it then grasps with its spiny forelegs and pierces with its needle-like mouth, sucking out the prey's juices. Backswimmers can give a painful bite, so handle with care!

Both backswimmers and boatmen exemplify a form of camouflage coloration called countershading. When upside down and viewed from below, the back-swimmer's light-colored back merges with sunlight; when looked down on from above, it's dark-colored belly blends with the water, making it hard for predators to find it from either view.

WATER SCORPION

This critter is misnamed 'scorpion' because it was thought that they the long structure on its rear was a stinger, but it is actually a pair of breathing tubes!

This macro is often found hanging motionless, head down in the water with its snorkel-like tube projecting into the air. It practices 'still hunting' in this position, stick-like in camouflage, with its strong, spiny forelegs held out like a praying mantis as it lies in wait for its prey. Any prey so caught are pierced with the needle-like mouth and the juices are then sucked out of it.

Water scorpions are clumsy swimmers. They are often found climbing on plants or crawling on pond bottoms.

WATER STRIDER

These insects are sometimes called skaters, because they have special hairs on their feet that don't get wet, allowing them to "skate" along the water surface.

They can be found gliding the surfaces of a wide range of aquatic habitats, including one group that inhabits coastal waters and the open ocean..

Like most water bugs, striders are piercer-predators, sucking out the juices of any unfortunate prey they capture, often flying insects that fall into the water from above. Special sensors located on the strider's feet enable them to pick up vibrations in the water to help locate their prey.

GIANT WATER BUG

The giant water bug has many nicknames: "toe biter" because of the painful bite it can inflict if stepped on, and "electric light bugs" because they often swarm around lights in summer just like moths.

Giant water bugs can consume animals 50 times bigger than themselves, including tadpoles, frogs and fishes! It can do this because it injects digestive enzymes into its prey to liquefy its innards, which it then sucks out like a critter slurpee through its needle-like beak.

In some species, the female lays her eggs on the back of the male, who carries them protectively, fanning them with his hind legs to keep them aerated.

CREEPING WATER BUG

The creeping water bug gets its name for its habit of creeping/crawling along pond bottoms and aquatic plants in search of prey, which includes other aquatic insects, small crustaceans, and anything else they can overpower and grasp in their strong front legs.

They breathe by collecting an air bubble and holding it under their wings. Like other water bugs, some air is also held in fine hairs along its underside, giving them a silvery sheen from that view. In captivity, they can be observed stroking their hind legs forward to ventilate that air supply.

Some creeping water bugs even live in hot springs!

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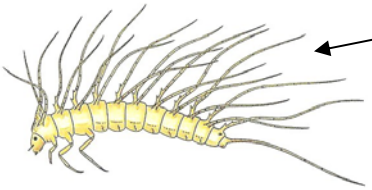
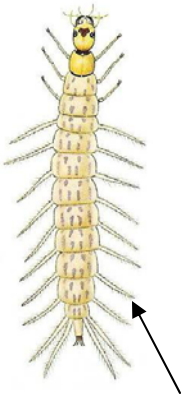
PAGE 5 Water Beetle & Fishfly Larvae (elongate forms)

CRAWLING WATER BEETLE LARVAE



Due to their small size, crawling water beetle larvae are seldom seen. Those that are often look like little porcupines, with long hair-like projections on the back. Don't get confused if this larva looks dead, as they tend to play dead when disturbed.

WHIRLIGIG BEETLE LARVAE



This creature has a long, narrow, slightly flat, and centipede-like look to it.

Be careful not to mistake it for the fishfly, which has a broader head and biting, pincer-style mouthparts.

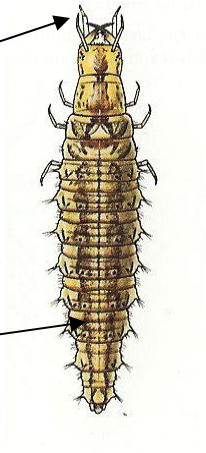
Note also the spine-like gills along this macro's abdomen.

WATER SCAVENGER BEETLE LARVAE

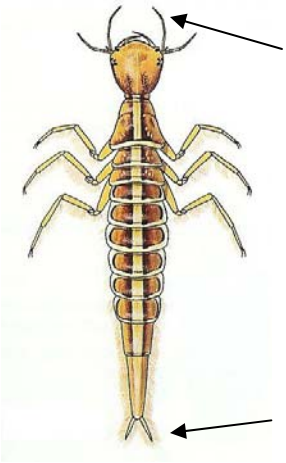
Notice the strong, toothed jaws on this creature! Yes, they can pinch!

Though these larvae appear short and stubby, each does have six legs, which they use for crawling.

Don't mistake this for the diving beetle larva! Water scavenger larvae are fatter, have a wrinkled look and lack that tapering-to-a-point rear-end and forked tail.



PREDACEOUS DIVING BEETLE LARVAE

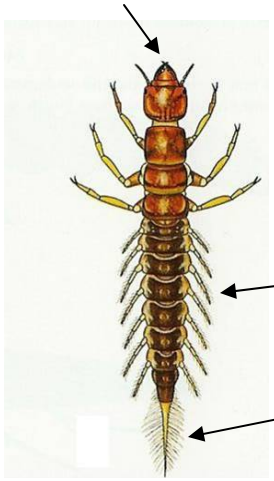


This creature has slender, sickle-shaped, toothless jaws that they use to latch on to, then suck the juices out of, unfortunate prey.

This creature is often found hanging upside down from the surface of the water, still-hunting for prey.

Notice also the long jointed legs, tapering abdomen and forked appendage at its rear end.

ALDERFLY LARVAE



This macro also has large, toothed pinching jaws.

Notice also the long, finely-haired sets of legs.

Long spine-like filaments extend from each of the abdominal segments.

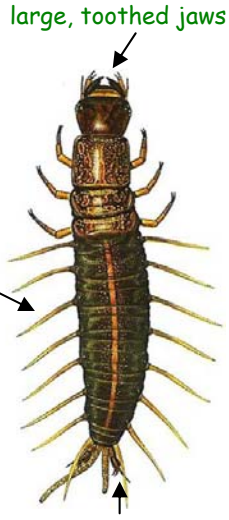
A distinctive single, long, hairy, tapering filament projects from the tail end.

FISHFLY LARVAE

These larvae have a long, wide, flattened body, with a broad, dark head and prominent jaws.

They have three pairs of legs but also spine-like projections going all the way down the body. The latter are actually pieces of skin that protect the gills.

If you look closely, you can see a set of clawed prolegs at the tail end of this critter.



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Water Beetle & Fishfly Larvae (elongate forms) Background

WHIRLIGIG BEETLE LARVAE

Whirligig larvae are climbers, and can often be found on submerged plants or other debris. They are also voracious predators, feeding on worms, midges, other small aquatic organisms, and even others of their kind!

They have feathery gill filaments on the sides of each lower body segment for respiration, but can also absorb oxygen directly through their soft skin tissue.

When larvae are ready to become adults they use a sticky substance to glue pieces of vegetation, mud, or sand together to form a dome-shaped pupal chamber, within which they transform to the beetle phase.

CRAWLING WATER BEETLE LARVAE

Crawling water beetle larvae live in mats of filamentous algae, and other forms of aquatic vegetation; which, along with their small size, slow movements, and camouflaging hair-like projections, makes them somewhat hard to find.

They are mainly algae-eaters (*Spyrogyra* being a favorite). Depending on the type, they pierce, chew or bite their way into the cell and suck out the juices.

If you should happen to find this macro, look for its habit of playing 'possum' (appearing still and motionless), which no doubt (given its camouflaged look), serves as an adaptation for avoiding predation.

PREDACEOUS DIVING BEETLE LARVAE

Like adults of their kind, predaceous diving beetle larvae come to the water surface to get fresh air by sticking their tail up and out of the water.

Diving beetle larvae are called "water tigers" because they are vicious hunters of just about anything they can catch, including tadpoles, fish and other creatures larger than themselves. Special channels in their sickle-shaped jaws inject brown digestive juices into their prey, quickly killing it and dissolving its insides, creating a critter-juice cocktail that is then sucked up through those same jaws. We have seen diving beetle larvae in captivity do this to large dragonfly nymphs, leaving only an empty shell behind.

WATER SCAVENGER BEETLE LARVAE

Water scavenger beetle larvae are climbers/crawlers, laying in wait or moving slowly along the bottom in search of prey. They are described as "engulfer-predators", using their strong, toothed, pincer-like jaws to catch and crush all kinds of aquatic critters, even the hard shells of small snails and clams.

Water scavenger larvae breath air directly through tiny holes, called spiracles, on their butt, a feature that results in the larvae (in contrast to the adult beetles they become) spending much of their time hanging upside down at the water surface, with their butt sticking out into the air.

FISHFLY LARVAE

Though most larval fishflies (and their dobsonfly cousins, called 'hellgrammites') prefer the swift, rocky rapids of streams, some kinds are adapted to living in vernal pools, swamps and other temporary wetlands. The spine-like gills, along with a pair of tail-end siphons, enable these larvae to live in such stagnant, often low-oxygen, water bodies, surviving dry periods by burrowing under logs or other debris until the water returns. In stream-dwelling forms, strong claws on the legs help them hold on to rocks, where, if dislodged, they swim backwards crayfish-like.

As the strong, pincer-style jaws imply, fishfly larvae are fierce predators, feeding on various insect larvae.

ALDERFLY LARVAE

Alderfly larvae resemble their fishfly cousins, but are more pollution-tolerant and seldom live in fast water, preferring the more sluggish-water, soft-bottom habitats, particularly where dead plant material and other forms of fine detritus have accumulated.

In such places, they are predators, crawling along and burrowing into soft mud, in search of prey to consume.

Alderfly larvae lay their eggs on plants that overhang the stream, pond or wetland; when the eggs hatch, larvae fall into the water to undergo the aquatic part of the life cycle. Like their fishfly cousins, adult alderflies are terrestrial.

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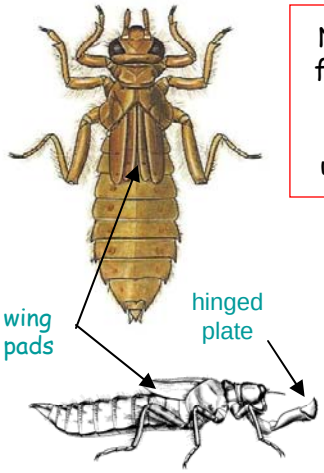
Nymphs of Dragonflies, Mayflies & Stoneflies

DRAGONFLY NYMPHS

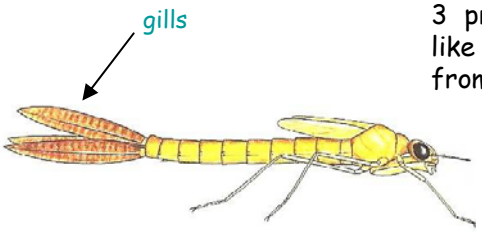
Nymphs of dragonflies and damselflies occupy a wide variety of freshwater habitats and vary much in size, shape and coloration. All have prominent heads with large, lateral compound eyes, three pairs of widespread legs, wing pads on their back, and a unique, hinged, retractable lower lip they extend to catch prey.



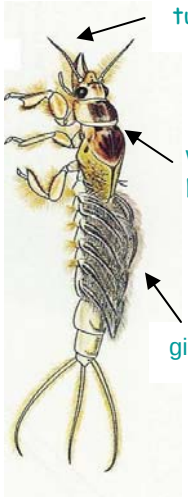
Dragonfly nymphs are more robust, with head not as wide as abdomen, and have internal, rectal gills.

DAMSELFLY NYMPHS

Damselfly nymphs are more slender & delicate-looking, have a head that is broader than the rest of the body, and feature 3 prominent leaf-like gills extending from the tail end.



BURROWING MAYFLY NYMPHS

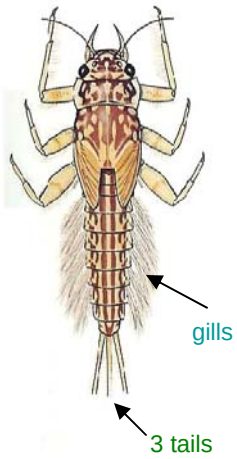


Burrowing mayfly nymphs have a shelf-like plate and tusks on the head. Front legs are broad and shovel-like. All these features are adaptations for borrowing.

SWIMMING MAYFLY NYMPHS

Mayfly nymphs come in a great variety of forms. Most favor streams. The two shown here are ones you may find in pond/wetland habitats. Like dragonflies, wing pads and 3 pairs of legs arise from the thorax. In contrast to stoneflies, nearly all mayflies have three (rarely two) threadlike tails, and gills are usually visible along the sides of the abdominal segments (rather than under the thorax as stoneflies).

Swimming mayflies (also called "minnow" mayflies) feature a delicate, more stream-lined shape, more slender legs and flat disk-like gills.



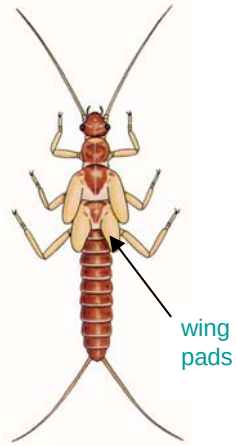
COMMON STONEFLY NYMPHS

Stonefly nymphs prefer the cool, clean, running waters of woodland streams. Like mayflies, they feature: a flattened shape (an adaptation for attaching to rocks in stream rapids), but have only 2 tail filaments (instead of 3); gills attached to the thorax (not the sides of the abdomen), and (usually) longer antennae. There are many more kinds of stoneflies than those shown here.

These stoneflies feature small tufts of gills around the area where the legs attach. Like most stoneflies, the two tails and antennae are long and slender.

WINTER STONEFLY NYMPHS

Winter stoneflies are named for their habit of mating in winter, when they can often be found in clusters on bridges and other streamside structures.



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Nymphs of Dragonflies, Mayflies & Stoneflies Background

DAMSELFLY NYMPHS

Damselfly nymphs occupy many of the same habitats as their dragonfly cousins, share a similar life cycle and body plan, and feature a structural adaptation for feeding unique to the animal world. The latter consists of a retractable, hinged lower lip, that is normally held under its head like a mask (covering the other parts of the mouth), but can be extended well beyond its expected reach to catch and retrieve prey. The hunting ability of these nymphs is aided by big eyes on the side of the head, allowing for 360° field-of-vision.

Nymphs of damselflies are often found clinging to, or crawling on, aquatic plants. They have 3-leaf-like gills at their tail end, which also aid them in swimming.

DRAGONFLY NYMPHS

Dragonfly nymphs can be found burrowing, sprawling or crawling around the bottom of just about any slow-water, freshwater body you dip your net into. In these habitats, they play a key role in the food web, both as food for fish and as predators of many other animals. Once caught in the sharp lobes of its hinged lip, prey are quickly brought back to the mouth. Small creatures are consumed whole; larger ones are torn into pieces by its jaws, then swallowed.

Dragonfly nymphs breathe by pumping water in and out of a gill chamber inside their rear end. By filling this chamber with water, then shooting it out rapidly, nymphs can jet-propel themselves forward in spurts.

SWIMMING MAYFLY NYMPHS

The two swimming mayfly nymphs featured here represent but a few of the diversity of their kind. Although most favor rocky-bottom riffle areas of streams (including several clean-water indicators), some occupy the stiller, softer-bottom habitats of ponds and wetlands. As such, they feature a wide variety of body shapes, sizes and adaptations for breathing, moving and feeding.

Though some mayfly nymphs cling, climb, crawl or burrow, 'minnow' mayfly nymphs (as they are also called) swim well, using their long tails with rapid up and down undulations of the abdomen to dart in short spurts from one place to another. Unlike most mayflies, they are tolerant of degraded water.

BURROWING MAYFLY NYMPHS

In contrast to most other mayfly types, burrowing nymphs favor habitats where sediments are soft, as befits their burrowing habits. Using their shovel-like front legs, and a specialized plate and pair of tusks at the front of their head, these nymphs construct U-shaped tunnels with holes at both ends. Within these burrows, they ingest particles of sediment, along with bits of organic matter brought in from above by undulating their feathery gills.

As other mayflies, when burrowing nymphs crawl out of the water to emerge as adults, they have no mouth, and thus do not feed Their only reason-for-being in their few days of adult life is to mate and lay a new generation of eggs in the water.

WINTER STONEFLY NYMPHS

Of all the groups covered in this guide, stoneflies are the least likely to be found in ponds or wetlands, being almost exclusively confined to fast, cool, rocky waters of streams, where along with caddisflies and mayflies, they serve as bio-indicators of good water quality. Stonefly nymphs are flattened and streamlined in shape, and crawling in habit, as befits their need to hide and attach themselves under rocks in currents.

Winter stoneflies consume leaf litter, and are unique among aquatic insects in emerging from aquatic-larval to land-adult stage during the cold-weather months, when they can be found communing on bridges and other streamside structures A few kinds are found in cool-water, temporary, spring-fed seeps.

COMMON STONEFLY NYMPHS

Common stonefly nymphs represent a widespread group, preferring the rocky rapids of small, cool streams, though some are known to inhabit slacker-current stream edges. In such places, they often occupy leaf packs, presumably due to the abundance of prey organisms available therein. To supplement their high oxygen needs, nymphs can create currents over their gills by repeated raising/lowering of the body, using a kind of "push-up" motion with their legs.

There are many more kinds of stoneflies than covered here. Emergence of these to the adult flying form, along with the equally-varied mayfly and caddisfly types, provide ample subject matter and inspiration for anglers who tie flies.

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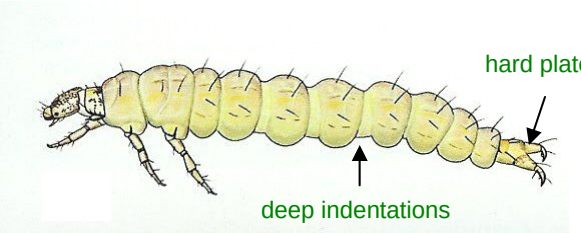
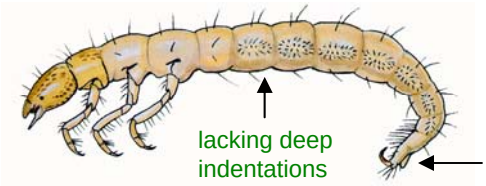
PAGE 7 Caddisfly Larvae & Miscellaneous Beetle Larvae

FREE-LIVING CADDISFLY LARVAE



All caddisfly larvae feature an elongate, caterpillar-like body, a hardened head, short antennae, no wing pads, 3 sets of legs and a pair of clawed prolegs at the tail end. Larvae of the free-living kind are usually green, have deep constrictions between each abdominal segment, feature a hard plate on top of the last segment, and possess long, sharp, curving claws at their tail-end.

TRUMPET-NET & TUBEMAKER LARVAE



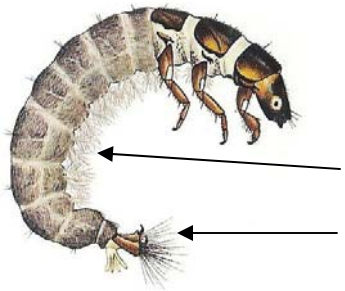
Larvae in this family construct trumpet-shaped nets or loose tubes in which they retreat, but are usually collected free from those fragile dwellings. They resemble free-living caddis larvae, but are not green, the abdominal segments are not deeply indented, and the last of those segments is soft (not hardened) on top. Sharp claws are present at their tail end.

CASE-DWELLING CADDISFLY LARVAE

This is what the insect looks like in its case

Larvae of several caddisfly families construct cases of various shapes, using stones, sediments, plant debris and other materials in the environment. Case content and design provide keys to identifying the various kinds. Larvae retreat into their cases for protection, but will project their head and legs out to move about and feed. They have sharp claws at their tail end.

NET-SPINNING CADDISFLY LARVAE

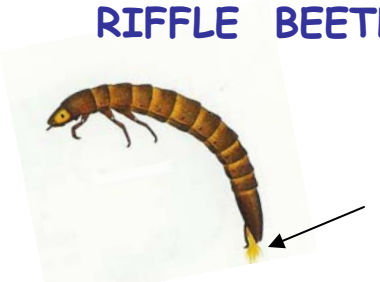


When placed in a pan of water, this larva will lay on its side in a C-shape.

Notice the branched gill filaments on its belly and the brush-like structures at the tail end.

Larvae in this group spin mesh nets of silk in current, into which they retreat and trap food items within. They are usually collected free of their net dwellings.

RIFFLE BEETLE LARVAE

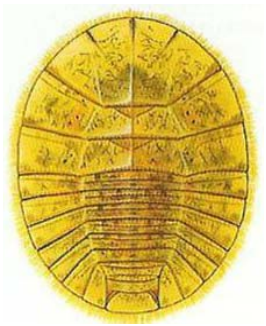


clawed prolegs lacking; tail segment has hinged lid over a space holding a brush-like tuft of gills

Although riffle beetle larvae resemble caddis larvae in shape, closer inspection reveals key differences:

- riffle beetle larvae tend to be dark brown-red;
- all body segments are hard (caddis abdomen is soft);
- lack clawed prolegs at tail-end (present in caddis);
- gills absent under the abdomen (unlike net caddis).

WATER PENNY LARVAE



Water pennies - true to their name - have the distinct round, flattened look of a copper penny.

On the top, they look like a segmented shell, with no appendages; when flipped over, one can see 3 pairs of legs and tufts of gills on the abdomen.

Water pennies attach to rocks in fast-water streams.

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Larvae of Caddisflies & Certain Beetles

Background

TRUMPET-NET & TUBE-MAKER LARVAE

The family of trumpet-net & tube-maker caddis larvae live in a variety of silken retreats. Some spin pouch to funnel-shaped nets in slow-moving parts of streams from which they filter small invertebrates to eat, while others build flat coverings or loose tubes on rocks, logs or aquatic plants, from which they pounce out to ambush prey. In some forms, silken threads are placed strategically around the retreat opening, so that when an approaching critter bumps into them, the caddis senses the vibration and comes out to attack.

Although most tube-maker and trumpet-net caddis larvae prefer stream habitats, some can also be found along the shallow shores of pond, lakes or reservoirs.

FREE-LIVING CADDISFLY LARVAE

Unlike other caddis types, free-living caddis larvae do not construct case, net or tube retreats, but crawl freely along rocks in the swift-current streams they frequent. As they crawl along, they spin a strong silk thread and attach it to the substrate. This, combined with the sharp hooks on their tail-end prolegs, keeps them from washing downstream in the swift current.

Though some eat algae, plants or detritus, most free-living caddis are predators of small invertebrates. Due to the lack of outer casing, free-living caddis tend to be vulnerable to pollution, and thus serve as bio-indicators of healthy water quality. Their nick-name "rock-rollers" stems from their habit of rolling rocks into a pile for constructing their pupal chamber.

NET-SPINNING CADDISFLY LARVAE

Net-spinner caddis larvae favor the rocky-riffle areas of streams and rivers, using the spaces between rocks, sunken woody debris or submerged plants to construct their distinctive silken retreats. As all caddis, silk is spun from special glands in the lower lip. In netspinner types, the silk is woven into an open-mouthed mesh net at the front end of a tubular retreat in which the larva resides. The net faces into the current like a fishing seine, from which it filters small organisms and bits of organic matter brought down with the flow. Different net-spinner species spin characteristic mesh-size nets, with coarser-net types feeding more on small invertebrates and plant bits, and finer-mesh ones selecting algae and fine detritus.

CASE-DWELLING CADDISFLY LARVAE

The majority of caddisfly families have adopted the larval strategy of case-dwelling, using silk to glue together pieces of various sediments, plant materials and even snail shells into an astonishing array of structures. These cases are portable homes, providing both camouflage and physical protection from predators, serving as ballast for anchoring them in currents, and aiding in various feeding strategies.

Although in nature each kind of caddis makes its own distinctive case type, artisans in Europe have coaxed captive caddis (when deprived of normal substrates) to weave in similar-sized flecks of gold, gems and other minerals, creating, colorful, living art forms!

WATER PENNY (BEETLE) LARVAE

This very distinctive-looking creature inhabits moderate to fast-current sections of streams, where they attach to the underside of rocks and stones. In addition to their flattened form and flexible shape, water penny larvae feature a dense fringe of short, specialized hairs around the edge of their shell, enabling them to tightly grip on to rock surfaces in the current, from which they are not easily dislodged.

Water pennies have a specialized diet, grazing diatoms and other algae from the rock surfaces they inhabit, using the fine inner edge of their jaws like a paint scraper. They are sensitive to sediment pollution, Little is known about the non-aquatic, adult form.

RIFFLE BEETLE LARVAE

Riffle beetle larvae favor the same kinds of habitats as adults of their kind – with most occurring in fast-moving, rocky sections of streams and small rivers. In such habitats, they cling to rocks and other debris, using the sharp claws at the end of their legs to hold fast in the current. Like water pennies, most riffle beetle larvae feed by scraping algae from stone surfaces, though some consume detritus.

Riffle beetle larvae have a unique hinged, trap-door like lid on the underside of their tail-end, from which a set of gills can be extended for breathing and withdrawn when not in use, providing protection from ongoing abrasion by sediments carried in the current.

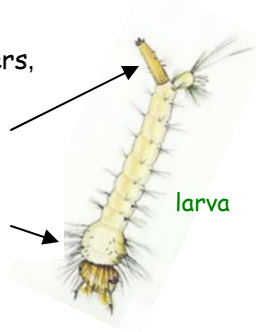
Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource and Environmental Control, 2007) for use by volunteer wetland monitors and educators with the Mac-Pac (macroinvertebrate monitoring) field loan kits.

True-Fly Larvae (grub-like creatures)

MOSQUITO LARVAE & PUPAE

This macro frequents stagnant waters, where it stands on its head, poking its tail-end breathing tube up into the air.

If you look closely at the head end, you'll see brushes of long fine hairs.



Mosquito larvae are called 'wrigglers' and pupae 'tumblers', for the unique way each form moves in the water.

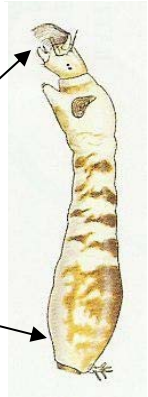
BLACK FLY LARVAE

Black fly water favor stream rapids, where they attach themselves by silk threads to rocks and other debris.

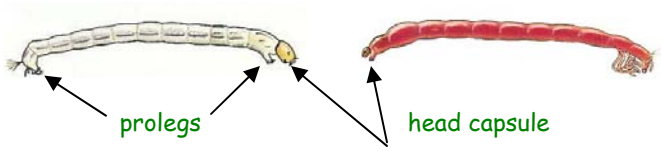
Clumps of fine hairs at the top of the head open and close like a fan, filtering food items brought in with the current.

Notice the fattened rear-end, giving the larvae a distinctive vase-like shape.

Like most aquatic fly larvae, black fly larvae are on the small side (<1 cm)



NON-BITING MIDGE LARVAE

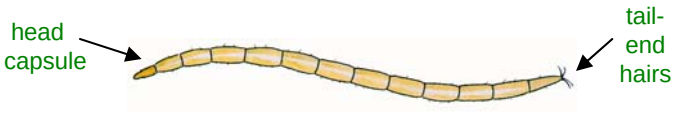


Midge larvae comprise one of the most abundant, diverse and widespread of the aquatic insect groups.

Don't let the worm-like look confuse you – note the hard, head capsule and paired prolegs at each end.

Though certain groups have a conspicuous blood-red color, other body colors range from white to dark-green. Some construct tubes in soft mud from which they feed.

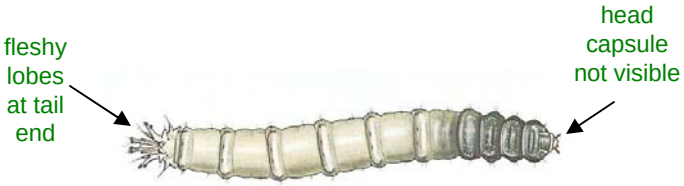
BITING MIDGE LARVAE



Biting midge larvae, with their smooth snake-like form, and lack of prolegs, brushes and other appendages, look even more worm-like than the non-biting midges, and even thrash about in a kind of worm-like fashion.

However, a careful look shows a distinct head capsule at its front end and tufts of fine hairs at the tail end. The smooth, shiny body is typically clear to whitish.

CRANE FLY LARVAE

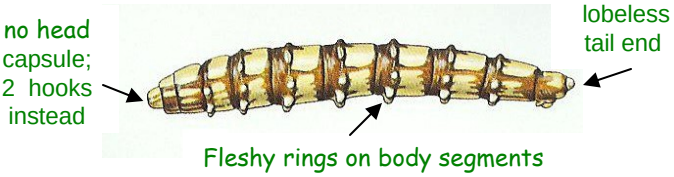


Crane fly larvae, along with those of deer and horse flies, tend to be larger (1-10 cm in length) and much fatter looking than their midge and mosquito cousins.

Although a normal head capsule is present, it is usually withdrawn into the head so as not to be visible.

Crane fly larvae segments often feature fleshy lumps or short hairs; fleshy lobes protrude from its tail end.

DEER & HORSE FLY LARVAE



Like crane fly larvae, deer/horse fly larva are robust and cylindrical, but can be distinguished as follows:

- the deer/horsefly larval body tapers at both ends
- in place of a head capsule are two fang-like hooks
- there are no lobes, prolegs or tubes at the tail-end
- the abdominal segments feature 3-4 pairs of fleshy structures, forming a series of rings on the body.

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Illustrations on this page are from *Aquatic Entomology* (McAfferty, 1981), permission of Jones & Bartlett Publishers

True-Fly Larvae

Background

BLACK FLY LARVAE

Black fly larvae, in contrast to most other fly larvae, favor stream rapids, where they attach their tail-end to rocks and other debris using silk strands spun from their mouth. Fan-like brushes on the head aid them in filter-feeding fine particles of algae and detritus suspended in the current. Different species show varying current preferences, with some occurring only in torrential habitats, and others favoring almost sluggish conditions. Tolerance to pollution, likewise varies with the species, from ones only found in clean mountain streams, to species that have adapted to attaching themselves to all manners of man-made materials found in polluted urban stream settings. When overabundant, they can be pollution indicators.

MOSQUITO LARVAE & PUPAE

In contrast to black flies, mosquito larvae favor still to stagnant water habitats, including pools, puddles, old tires and other temporarily wet places, often where dissolved oxygen is low or lacking, Both larval and pupal forms have a siphon tube for breathing they stick out of the water, the pupa's extending from the head end and the larva's from the tail.

Larvae can be found hanging upside down just below the water surface, Specialized brushes on the head create currents that sweep algae, bacteria and fine particles of suspended detritus into the mouth. Some species feed directly on sediments and a few prey on small invertebrates, including other mosquito larvae.

BITING MIDGE LARVAE

Biting midges (also called no-see-ums) are a large family of flies having aquatic or semi-aquatic larval and pupal stages. Aquatic forms are associated with soft-sediment, still-water habitats. Some kinds can be especially abundant in thick mats of algae.

Orientation of the mouthparts in biting midge larvae reflects its feeding habits: those with forward-directed mouths typically being predators of other invertebrates (particularly non-biting midges) and those with downward mouths favoring detritus.

Biting midge larvae are burrowers, sprawlers and swimmers, the latter in a snake-like whipping motion.

NON-BITING MIDGE LARVAE

Larvae of >1000 species of non-biting midges inhabit a wide range of aquatic habitats in North America, from the fastest rivers to the stillest ponds, from the deepest lakes to small vernal pools, from fresh to salt marshes, and from clean to severely polluted waters.

Although some roam freely, most larvae construct thin open-ended tubes made from fine sediment particles, the spoils being often abundant in bottom samples. Within its tube, the larva wriggles its body to keep a current of water pulsing through, from which it extracts its food. Bright-red forms have hemoglobin, an adaptation for success in low-oxygen environments Midges play a major role in the breakdown of organic matter, and comprise key links in aquatic food webs.

DEER & HORSE FLY LARVAE

Deer and horse fly larvae also occupy a wide variety of aquatic habitats, including some species that are especially prolific in salt marshes. In such places, these robust worm-like forms can be found burrowing through the soft bottom, alternately extending and contracting their bodies, using their welt-like body rings to displace the mud as they go.

Deer fly larvae are mostly predators, using the hard, fang-like hooks inside their pin-sized head to slash holes inside the body of their prey, into which they then insert their retractable head to partake of the fluids and soft parts inside. Aquatic worms are favored food items, as these are often abundant in the muddy marsh and pond bottoms they favor.

CRANE FLY LARVAE

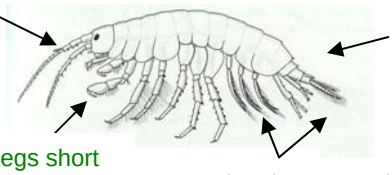
Crane flies comprise another diverse group of true flies, including numerous kinds with immature aquatic stages. Larval habitats range from stones/debris in stream riffles to the rich mud edges of bottomland swamps and marshes. A few kinds live in the intertidal zone of brackish waters, while others favor more semi-aquatic to terrestrial places.

One large gray form (referred to as "leather jackets") is especially common in packs of leaf litter from wood-land streams, where it plays a key role in shredding fallen tree leaves, transforming nutrients and energy contained therein for use by other life forms in the ecosystem. A few crane fly larvae are predators.

Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource and Environmental Control, 2007) for use by volunteer wetland monitors and educators with the Mac-Pac (macroinvertebrate monitoring) field loan kits.

Macro-Crustaceans

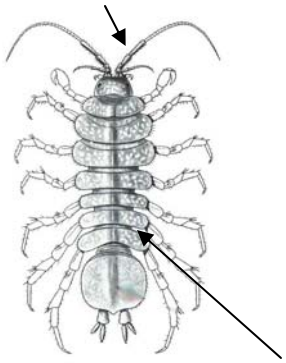
AMPHIPOD (Sideswimmer/Scud)



The easiest way to identify an amphipod is by its habit of rolling over on its side while swimming, with its many legs appearing to trail behind it as it moves forward.

It also has a flattened side-to-side look, and two pair of long antennae that are nearly equal in length.

ISOPOD (Aquatic Sowbug)

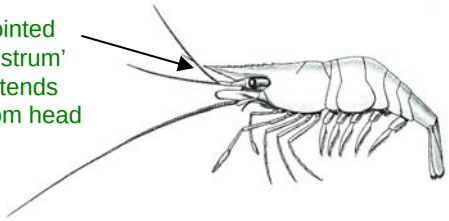


Unlike amphipods, isopods are flattened top-to-bottom, do not swim on their side (being better suited for crawling) and have one pair of antennae much longer than the other.

Only the front pair of legs are adapted for grasping.

Note the shelf-like projections of the leg-bearing segments.

GRASS SHRIMP

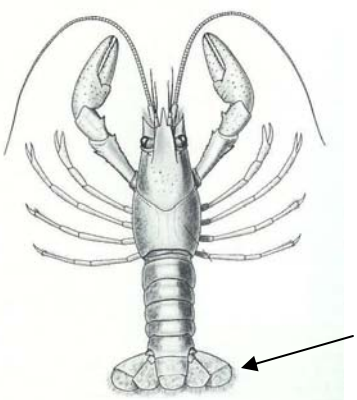


The grass shrimp's body appears almost transparent, enabling it to blend in well with its water background.

There are 5 pairs of walking legs, arising from a single fused segment (unlike amphipods and isopods where each leg pair arises from separate segments).

There are two pair of antennae: one long, one short.

CRAYFISH (Crawdad)



Like shrimp, crayfish have two unequally-sized pairs of antennae and 5 pairs of walking legs.

However, the front legs of crayfish are modified into large, pincer-claws.

The broad, paddle-like 'tail flipper' is used to propel itself rapidly backward if disturbed.

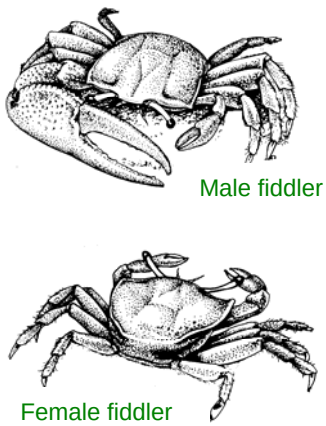
FAIRY SHRIMP

This small, brightly-colored, and rarely seen, crustacean is found only in vernal pool wetlands, during late winter.

Fairy shrimp swim on their backs, beating their 11 pairs of 'gill-leg' appendages to propel them along.

Females carry a mass of eggs in a brood pouch under the abdomen; males have a specially-modified pair of claspers on the head for grasping females in mating.

FIDDLER CRAB



This small crab can be found in large numbers on the mud banks and flats of tidal streams.

There are 5 pairs of walking legs and one short pair of antennae.

Males have one of the front claws noticeably larger than the other; Females have front claws equal in size.

Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource and Environmental Control, 2007)
Illustrations on this page are from: Lippson & Lippson (1998), Reid (1987) and McAfferty (1981)

Macro-Crustaceans

Background

ISOPOD (Aquatic Sowbug)

These flattened, gray-brown, leggy critters tend to inhabit shallow waters, particularly vernal pools, where they hide out amidst the bottom debris, feeding on plant detritus, associated microbes and scavenged animal remains. Male isopods clasp the female under them while mating; the two are often found swimming or crawling along so paired. Females brood their eggs in a protective pouch on the underside of the body formed by plate-like extensions of the segments where the legs attach. Movements of those plate-like structures help to keep the eggs oxygenated. Young remain in the pouch for 20-30 days after hatching. Aquatic isopods are relatives of terrestrial pill bugs. Like amphipods, they inhabit both fresh and saltwater.

AMPHIPOD (Sideswimmer/Scud)

Amphipods are also known as sideswimmers or scuds, for the way they propel themselves on their side in swimming, using short rear-directed appendages to push forward. They resemble isopods in having seven pairs of legs and in brooding their eggs in a pouch held under and between the legs. Amphipod males carry the female on their back during mating – in captivity, some have been seen swimming together so paired for as long as a week! After hatching, young spend another week in the pouch before release. Scuds are fairly widespread in their habitats, including stream, pond, spring, wetland and marine environments. Most are omnivore-detritivores. High amphipod diversity can be a clean-water indicator for saltwater habitats.

CRAYFISH (Crawdad)

Crayfish vary much in appearance, habits and habitats. Some prefer streams/rivers, others inhabit ponds and still others are adapted to living in seasonal wetlands. The latter tend to be burrowing in habit, excavating tunnels below the surface, in which they find refuge at night and moisture during dry periods. A chimney-like structure, made up of excavated spoils, can be seen at the soil surface where these crayfish tunnel. In addition to using their large pinching claws for defense, crayfish can lose legs when attacked and regenerate them on the next molt. When threatened, crayfish escape backwards in quick bursts by flipping their tail. Crayfish tend to be omnivorous, and are a favored food of bass, raccoons and water snakes.

GRASS SHRIMP

In contrast to crayfish, as a group, shrimp are much more successful in the marine environment. There are, however, some freshwater types, and one group - the grass shrimp – that does well in tidal streams of moderate to minimal salinity. In such habitats, grass shrimp often hide amongst aquatic plants, where they can be quite abundant and comprise a key link in converting fine detrital material to food for fishes. Shrimp are active swimmers, using paddling motions of their under-belly appendages to move forward, and crayfish-like abdominal bends to jet-propel quickly backwards. As with crayfish, grass shrimp egg masses are brooded under the abdomen. The transparent body provides camouflage from predators.

FIDDLER CRAB

Fiddler crabs are the earthworms of the tidal marsh, the entrances to their many burrows giving a swiss-cheese-like look to the intertidal mud banks and flats they favor. The easily-recognized one-large-clawed males, along with smaller, equal-size-clawed females, come out of their burrows in droves at low tide during the warm weather season, where they can be seen scooping up (small claw to mouth) bits of algae and detritus left behind by the tides. The large claw of the male, is useless in feeding and fighting; it serves mainly a posturing function, taking the form of a jerky waving motion to claim territory and attract mates. Fiddler crabs play a key role in salt marsh ecosystems, providing food for wading birds, raccoons & terrapins.

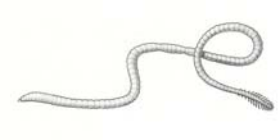
FAIRY SHRIMP

Fairy shrimp are fascinating, but seldom-seen animals, unless you know when and where to search for them. The 'when' is mid to late winter, and the 'where' is vernal pool habitats, in which these critters literally spring to life (from encysted eggs laid the previous year), grow fast, reproduce, lay a new batch of eggs to survive the coming dry season, and then disappear as quickly as they arose. Their delicate, colorful forms swim upside down, beating their unique 'gill-legs' in waves to both move and respirate, as well as to create currents for filter-feeding fine bits of matter from the water. Mature males can be distinguished from females by the larger head with antennae-modified mating claspers, and by the absence of a brood pouch.

Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource and Environmental Control, 2007) for use by volunteer wetland monitors and educators with the Mac-Pac (macroinvertebrate monitoring) field loan kits.

AQUATIC EARTHWORMS

smooth, segmented body plan



some kinds live in tubes in soft sediments

Included here are freshwater relatives of earthworms, with which they share a similarly simple worm body plan – featuring a soft, smooth body with no specialized areas (head/mouth/antennae/etc.).

On closer look, you'll see that the body is divided into similar-looking segments, with bundles of small hairs projecting from each segment but the first.

SAND (MARINE) WORMS

head often clearly discernable

segments coarse with extensions & bristles

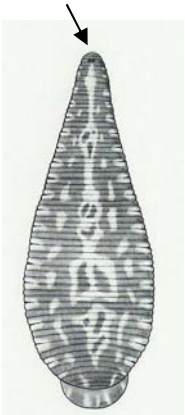
Unlike their freshwater-dwelling earthworm cousins, sand worms occupy brackish to marine habitats, where they appear in various sizes, colors and forms.

Segmentation is pronounced, with each segment bearing a pair of side appendages called parapodia, which in many forms support hair-like bristles.

Specialized body structures are often visible, such as: jaw-like mouths, tentacles or other appendages.

LEECHES

front sucker



rear sucker

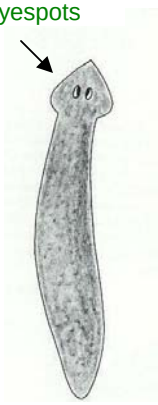
This vase-shaped macro looks like a worm smushed on one end!

Like oligochaetes & polychaetes, the body is segmented, but there are no hairs or projections on the segments, and a distinct sucker is visible at both ends of the body.

Notice its inchworm-like way of moving, alternately gripping the substrate with each end, as it loops its way along the bottom.

FLATWORMS

triangular head with eyespots



This gray-brown to black macro gets it name from its very flattened (top-to-bottom) form. There is no body segmentation.

Most aquatic flatworms have a triangular head with 2 eyespots on top, situated in such a way as to give them a "cross-eyed" look!

They move along the bottom by a distinctive gliding motion.

ROUNDWORMS

blunt to rounded at mouth end

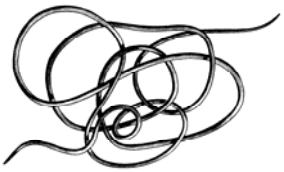
tapered at rear end

body clear and unsegmented

Roundworms (also called nematodes) resemble aquatic earthworms by their worm-like shape, but on closer, look, you'll see they have no body segments or hairs, and are tapered at one end. Most are colorless.

Roundworms come in various sizes and forms, with most being quite small and difficult to distinguish. Most swim in a distinctive whipping/thrashing motion.

HORSEHAIR WORMS



very long, thin, unsegmented & tangled looking

As the name (and drawing) suggests, horsehair worms are especially thin and long (up to 3 feet!), but usually appear so coiled and tangled, as to defy measurement.

Like the roundworms, their bodies are not segmented. Horsehair worms are clear to yellow or black in color. Some kinds are found in vernal pool wetlands.

Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource and Environmental Control, 2007)
All illustrations on this page are from McAfferty (1981), with the exception of the sand worm (from Reid, 1987).

SAND (MARINE) WORMS

Sand worms, marine worms, bristle worms or *polychaetes* (meaning "many hairs") are among the names given this diverse and abundant group of brackish/saltwater adapted worms. In contrast to their smoother-bodied earthworm cousins, sand worms have a more strongly segmented body and a rough, bristly look to them. This includes bristle-bearing extensions of segments that varyingly resemble legs to gills to paddle-like structures, and head regions that may have beak-like jaws, tentacles or other appendages. The form of such structures is useful in identifying types. Habits also vary widely, including ones that crawl, swim, burrow or live in tubes, and those that are predators, scavengers or detritivores.

AQUATIC EARTHWORMS

In contrast to marine worms, aquatic earthworms – also called *oligochaetes* – prefer freshwater habitats, and are simpler and less intimidating in appearance. Although there are a variety of kinds, most are small and inconspicuous, and unless you're an expert, are very hard to identify. Like earthworms, most kinds feed on mud and detritus, and help break down organic matter and mix/aerate the soil. One common form, called *Tubifex*, is long and red; they build vertical tubes in soft sediments, in which they suspend head-end down into the mud (to feed) and tail-end waving out into the water (to create currents). These worms can be very abundant in low-oxygen, high-organic waters, such as those polluted by sewage wastes.

FLATWORMS

The most common place to find flatworms is on rocks or other substrates in slow moving water, but they can occur in a variety of other aquatic habitats as well. This includes the temporary waters of vernal pools, ditches and puddles, where the larvae survive dry periods by becoming encysted on leaves and other bottom detritus. When you find flatworms in a sample, their unique shape and cross-eyed look make them hard to misidentify, though they often roll up into a ball-like blob when netted. To move, they secrete a fine layer of mucus on the substrate, upon which they create currents by waving small hairs on their under-surface, allowing them to creep along in a smooth, gliding fashion. Most scavenge dead animal matter.

LEECHES

Although a few leeches suck animal blood and conjure up considerable fear in some individuals about wading in waters where they might live, aquatic leeches rarely feed on warm-blooded animals, and most in fact, are scavengers of dead animal matter. Although some, such as the kind pictured, are balloon-shaped, many have a more uniform body width before tapering to the head end. They all have a powerful suction pad on their rear-end for anchoring them to substrates, and some also have a suction pad surrounding the mouth at the front. These pads, in concert with muscular contractions of the body, assist the leech in moving, by alternately attaching one end after the other and flipping over, kind of like a slinky moving down stairs!

HORSEHAIR WORMS

These critters go by two common names, both relating aspects of appearance to myth and magic. The name 'horsehair worms' stems from the once-held belief that they were actually hairs from a horse's mane that fell into the water and miraculously sprang to life. They are also called 'Gordian worms' relating to their typically twisted look, as in the Gordian knot of Greek mythology. In actuality, their life cycle is pretty bizarre and twisted in its own right. Adults lay eggs on leaves or detritus in vernal pools. An insect comes along and eats that material, from which the eggs hatch into baby worms that eat away its host's insides. A full-grown worm eventually bursts out and falls into the water as an aquatic adult, completing the cycle.

ROUNDWORMS

By sheer numbers and range of occurrence, one could argue that roundworms are the most abundant animal group on the planet. This includes forms adapted to habitats as varied as ice, hot springs, marine soils and sewage lagoons, and others that live as parasites in nearly every animal and plant species found on earth. Long thought to be evolutionarily more primitive than other worms, it's now known that their simple body plan is reduced from the more complex, and that they are actually more closely related to arthropods, with which they share the habit of shedding their skin as they grow. Though most are too small to catch in nets, if you observe a small worm-like critter swimming in a thrashing S-shaped manner, it is likely a roundworm.

Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource and Environmental Control, 2007) for use by volunteer wetland monitors and educators with the Mac-Pac (macroinvertebrate monitoring) field loan kits.

FINGERNAIL CLAMS

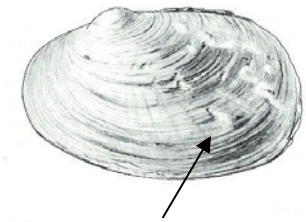
small, thin, smooth light-colored shell with faint rings

This tiny (<.5") clam is usually light colored and plain-looking.

The shell is thin, smooth and fragile, with rings not clearly-grooved as in other clams.

These clams are common on the bottom of vernal pools.

FRESHWATER MUSSELS



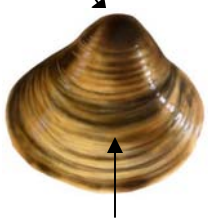
large (1-10" across) clams with thickly-grooved, bumpy shells

Mussels have large, thick, deeply-ringed shells that come in many shapes & colors.

Some have wrinkles, bumps, ridges and/or pigmented areas on parts of the shell.

ASIAN CLAM

prominent umbo (knob)



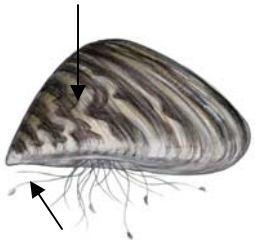
widely-spread and deeply-ridged rings

This introduced clam species can be found in high densities in many streams and rivers.

The thick, 1-2" wide, shell has a prominent knob and widely-spaced, deeply-ridged rings. Color varies from gray-black to yellow-green.

ZEBRA MUSSEL

zebra-like stripes



shell tapers to narrow point at hinged edge

If this clam, another invasive species, were as easy to get rid of, as it is to identify, it would not be so troublesome!

Notice the distinctive D-shaped shell with alternating, zebra-like dark/light bands. Length is from <1" to up to 2".

PHYSID SNAILS

This group of air-breathing aquatic snails features the typical tapering-to-a-spire shell with no operculum.

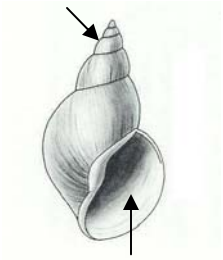
In physid snails, when the tip of the shell is held upward with the opening facing you, the opening faces to the left.

shell has spire

opening faces left; lacking operculum

LYMNAEID SNAILS

shell has spire



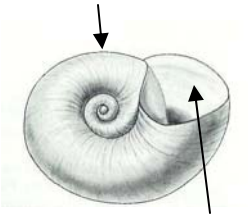
opening faces right; lacking operculum

Like the physids, lymnaeids appear spiral/spire-shelled, and lack an operculum.

In contrast to the physids, when the tip of a lymnaeid shell is held upward with the opening facing you, the opening faces to the right.

PLANORBID SNAILS

shell coiled and lacking spire



operculum lacking

This family of small, fairly common, snails has the shell distinctly coiled and flattened when viewed from the side.

There is no elongate spire or operculum (hard covering over the shell entrance).

GILL-BREATHING SNAILS

has operculum (cover over shell opening)

Gill-breathing snails differ from air-breathing ones in having an operculum or cover over the shell opening when the snail is inside.

This group encompasses several families, and a variety of shapes, colors and sizes, with many being abundant on aquatic vegetation

Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource and Environmental Control, 2007)
All illustrations on this page (except the Asian Clam) provided courtesy of: Gina Mikel www.scientificillustrator.com

Mollusks

Background

FRESHWATER MUSSELS

Freshwater mussels are a diverse and intriguing group. Most kinds prefer the moderate current shallows of large, clean rivers, a habitat type not as common as it once was, explaining why many species in this group are declining. In contrast to the other clams shown here, mussels produce larvae that are dependent on specific fish hosts, with some species using worm-like lure extensions of their mantle to draw fish close to them prior to larval release. Like other clams, mussels help clean water by filtering fine organic matter.

FINGERNAIL CLAMS

Fingernail clams, also known as 'pill clams', get their name from their small size, which is typically about the size of a child's fingernail. Because of their thin shell, they are one of the few clams that can survive in low-calcium, acidic waters. They are also an indicator species for vernal pools, where they crawl along and burrow into the pool bottom, filter-feeding by way of a pair of small tubular siphons. They survive dry periods by burrowing into sediments and going into a resting state until rain water replenishes the pools.

ZEBRA MUSSEL

The Zebra Mussel showed up in the Great Lakes in the late 1980's and has since spread rapidly elsewhere. It thrives in various habitats, wherever there is ample oxygen and rich algae to feed on. These clams are so efficient at algae removal that they may drastically simplify aquatic food webs. They are also the only freshwater clams that can attach in clusters to solid objects (using tufts of fine fibers), allowing them to do well even in fast water situations, and leading them to clog the insides of pipes, costing billions of dollars.

ASIAN CLAM

The Asian clam (Corbicula) first appeared in the Pacific Northwest in 1938, and has now spread to nearly every U.S. state, except those cold winter states to the north. Like the freshwater mussels they seem to be displacing, Asian clams favor riverine habitats, where their high filtering rates allow them to grow rapidly and reach densities as high as 10,000/m2. Unlike mussels, a fish host is not needed to reproduce; a single Asian clam can brood as many as a million tiny eggs that hatch into miniature adults.

LYMNAEID SNAILS

The lymnaeids, along with the physids and planorbids, belong to the 'pulmonate' or air-breathing group of snails. In contrast to the gilled snails, these snails have a cavity in their body that holds air, requiring them to come to the surface every so often to replenish it. The lymnaeids, or those that have the opening on the right, are a diverse and widespread group, occurring on both firm-surfaces (rocks, wood and aquatic plants) and soft-bottom habitats, where they typically scrape food from the substrate.

PHYSID SNAILS

Physids resemble their lymnaeid cousins, but have the shell opening facing left. They are also quite common and widespread, particularly in softer, siltier-bottom habitats. As with other pulmonate snails, physids have no operculum (cover to enclose the shell opening when the snail is inside). In contrast to gilled snails, these snails (because they lack gills that must be kept moist) are able to hibernate in mud when conditions become adverse, such as when the bottom of shallow ponds freeze over or when vernal pools dry up.

GILL-BREATHING SNAILS.

In contrast to air-breathing snails, this diverse group of snails feature internal gills with many leaflets for uptaking oxygen from the water. They also have an operculum or cover at the base of their foot that closes up the shell opening when the snail is inside. Often found in abundance on aquatic plants, most scrape algae from the surfaces using their rasping, tongue-like radula. One introduced species, Bithynia, can also filter suspended algae using its gills, making it very successful in nutrient-rich, algal bloom waters.

PLANORBID SNAILS

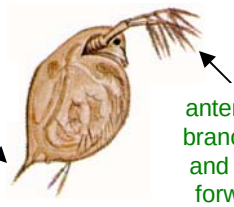
Planorbids comprises a unique and easily-identified family of small, coiled, spire-less snails, including ones with such catchy common names as: gyros, rams-horns and sprites. These snails, like certain worms, midges and fairy shrimp, have hemoglobin in their blood, allowing them to occupy habitats having low dissolved oxygen, such as small, warm ponds, and shallow vernal pools. In such places, they play a key role in breaking organic matter down into finer pieces, thus enhancing nutrient cycling and energy flow in the ecosystem.

Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource and Environmental Control, 2007) for use by volunteer wetland monitors and educators with the Mac-Pac (macroinvertebrate monitoring) field loan kits.

Microscopic Invertebrates

Background

WATER FLEAS

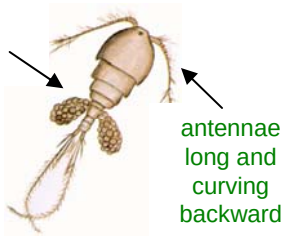


This small crustacean is about the size of this dot •

They swim in a jerky, hopping motion through water, the action aided by oar-like stroking of the antennae.

Multiple legs can also be seen at work under the semi-transparent shell which often ends in a terminal spine.

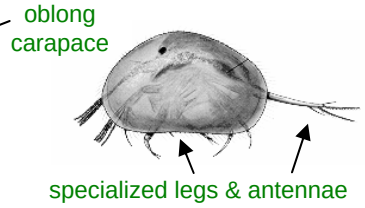
COPEPODS



Copepods are small rocket-shaped crustaceans, with segments tapering gradually from front to tail.

There are a pair of long curving antennae at the head, 6 pair of legs beneath, and a long, forked tail filament. A pair of egg sacs adorn the sides of mature females.

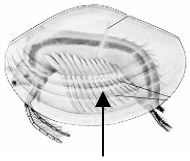
SEED SHRIMP

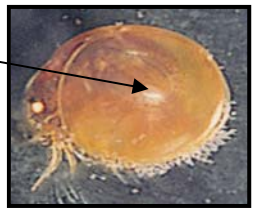


These minute crustaceans look like tiny oblong clams, but look closely and you'll notice antennae and legs sticking out as they dart jerkily through the water.

Larger kinds are often darkly banded (as photo above). In magnification, tiny hairs can be seen along the shell.

CLAM SHRIMP

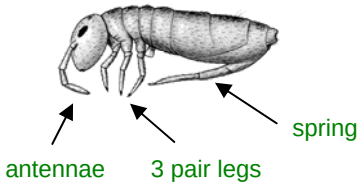




Like seed shrimp, clam shrimp feature a small multi-legged crustacean body inside a clam-like carapace.

Clam shrimp tend to be more robust and spherical in shape than the oval/oblong seed shrimp, and the shell is semi-translucent, with fine growth rings sometimes visible across the shell.

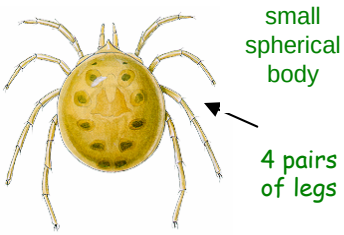
AQUATIC SPRINGTAILS

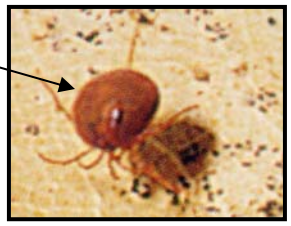


Springtails are minute, wingless, globular insects that are especially abundant in soil; some kinds are also quite numerous on the water surface of vernal pools.

Along with 6 legs and a pair of antennae, springtails have a unique under-body, tail-end structure that is released like a spring to propel themselves forward.

WATER MITES





These small, spherical, spider-like creatures come in all colors, with their eight legs beating rapidly as they swim hurry-scurry style through the water.

Under magnification, you may notice that the legs have fine hairs along their base and 2 claws at the ends.

Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource & Environmental Control, 2003)
Photos courtesy of Kenney & Burne (2000). Illustrations: Lippson & Lippson (1998), Reid (1987) & McCafferty (1981).

Microscopic Invertebrates

Background

COPEPODS

Copepods have a more shrimp-like appearance than the other micro-crustacea featured on this page, and if one has a lens or microscope to observe them, they are fairly easy to identify. In addition to conspicuous long antennae, forked tail filaments, and paired egg sacs (in females), copepods feature six pairs of legs, with the first pair modified for feeding and the rest used in swimming. Most are silvery-gray to light-pink in color. There are three major groups of copepods, corresponding to three different feeding strategies: one kind grazing on bottom detritus, another filter-feeding on plankton, and the other being predators of various other aquatic micro-organisms. A few marine forms, called 'fish lice', are parasitic on fish.

WATER FLEAS

Also known as daphnia or cladocera, these tiny crustaceans are not fleas at all, but are so named for their herky-jerky, hopping manner of swimming in the water, using their long, branched forward-stroking antennae to propel them along. At times, particularly in the shallow rich, early-warming waters of vernal pools, populations of these creatures can explode to where - if you dip a jar in the water - it appears as a pink soup of them. The life cycle that makes this happen is quite unusual, with the first batch of eggs produced each year being all female, and males not being produced until later in the season. Water fleas create currents with their legs to bring small food particles to the mouth area, where they are ingested.

CLAM SHRIMP

Clam shrimp are another one of those small, seldom-seen kinds of crustaceans that are well-adapted to, and at times abundant in, vernal pool wetland habitats, producing drought resistant eggs to help them survive year-to-year. Like their seed shrimp cousins, they have a clam-like carapace (shell), that (unlike a true clam) holds a bunch of small legs inside. There are 10-32 pairs of legs (many more than the seed shrimp), and the carapace of the clam shrimp typically shows a series of fine growth rings, these being left as a product of the molting process. Clam shrimps can be found moving along the bottom substrate, where they beat their legs to create currents of water from which they strain algae, bacteria and detritus.

SEED SHRIMP

Seed shrimp or 'ostracods' are another group of micro crustaceans that are abundant and important in many aquatic ecosystems, if one has the wherewithal and interest in searching for them, Like the clam shrimp, they have a bivalve (double-shelled) carapace (outer shell), that may make you think you have a tiny clam. But if you look closely, you'll notice three pairs of small shrimp-like legs and a set of antennae (often modified for digging or swimming) sticking out from under the shell. Seed shrimp tend to be smaller (<3 mm), more oblong, and more active swimmers than the larger (2-5 mm), rounder, more sedentary clam shrimp. Most ostracods are free-living filter feeders, but one kind lives on the gills of crayfish.

WATER MITES

Water mites are relatives of spiders, with which they share the 8-legged, no antennae and two-fanged mouthparts, body plan. But in contrast to spiders, which (but for a few exceptions) are highly successful on land, mites have evolved a great diversity of forms that are also widespread in water, particularly in the still, shallow waters of ponds, lakes, swamps, marshes and vernal pools. In such places, their small, globular, colorful bodies can be seen swimming awkwardly, often in and around aquatic plants; but when all those legs stop kicking, they sink quickly to the bottom. Many mites are piercer-predators, a few feed on plants, and all larvae (and some adults) are parasites, attaching themselves to, and feeding on, various aquatic insects.

AQUATIC SPRINGTAILS

If Olympic medals were handed out in the animal kingdom on the basis of how fast or far critters can go for their size, springtails would compete strongly in all jumping events. Such skills are facilitated by a unique spring-like structure (called the 'furcula') that is held tightly under the body at rest, but released rapidly like a spring to launch them forward. Although most prevalent in soils, some springtails are semi-aquatic to fully aquatic, with the latter often found in great numbers on the water surface of vernal pools, where they feed on algae, bacteria and other small bits of organic matter. One kind, called 'snow fleas', can often be found in dense dark mating congregations on surfaces of snow during late winter/early spring.

Developed by: DE Adopt-a-Wetland Program (DE Department of Natural Resource and Environmental Control, 2007) for use by volunteer wetland monitors and educators with the Mac-Pac (macroinvertebrate monitoring) field loan kits.