Macroinvertebrate Identification

Group 1: Very Intolerant of Pollution

Stonefly

- **Nymph**: Stonefly nymphs are aquatic with 6 legs and a segmented abdomen bearing 2 long antenna-like "tails" and two long antenna on the head. They have tuft-like gills that are positioned at the bases of the legs and on the underside of the body.
- **Adult**: Adults have two pairs of wings that are clear, membranous, finely veined, and rest closely down the back of the body. Their antennae are long and stonefly adults are typically dull, dark, and drab brown, yellow, or sometimes green.[1]
- **Lifecycle:** Incomplete metamorphosis. Stoneflies live for 1-2 years underwater in the immature, larval form. When growth is complete, usually in the summer, the nymph crawls out of the water (often onto stones, hence the name), molts, and emerges as a winged adult. The adults die soon after reproducing.
- **Ecosystem**: Because stoneflies require clean, well-oxygenated water, their presence is a sign of fast-moving clean water with much oxygen. When stoneflies disappear from a stream where they used to live, it is a sign that something is wrong with the water.**Error! Bookmark not defined.**

[1] https://education.mdc.mo.gov/discover-nature/field-guide/stonefly-larvae

Mayfly

- **Nymph:** Mayfly larvae are slender and soft-bodied, lack wings, have a series of feathery external gills attached along the sides or on the top rear portion of the abdomen, and have smaller eyes than adults. Often have a flattened head that helps them to adhere to rocks in fast-flowing water.[2]
- **Adult:** Adult mayflies are slender and soft-bodied. They have 4 membranous, extensively veined wings held upright and together, like a butterfly. There are 2 long cerci. They have short antennae and large compound eyes. The forewings are much longer and often overlap the hindwings.
- **Lifecycle:** Incomplete metamorphosis. Mayflies are the only insect to have 2 "adult" molts. They begin life as eggs laid on the surface of the water that sink to the bottom. The aquatic nymphs of mayflies creep around rocks and vegetation. After months or years of growth (depending on the species), they float to the surface and molt to an adult that only lives long enough to reproduce.

- **Ecosystem:** Mayfly naiads are great pollution police.[3] They are very sensitive to chemical pollution and can only thrive in pristine water conditions. Areas where mayflies are present reflect clean water. Creeks, streams, and rivers that see annual swarms are consistently free of toxic chemicals, so such a sight is a good thing for the ecosystem.

Riffle Beetle

- **Larva:** Riffle beetle larva have a hardened, stiff appearance over their entire body. They resemble tiny torpedoes with circular rings around body and are typically grey or brown in color. A white tuft of gills can be drawn-in and out from their end segment. Usually 1- 6 mm.[4]
- **Adult:** Oblong, oval, hard; true "beetle" appearance with 6 legs. 1-6 mm. Black in color. Adults walk very slowly underwater and are found more often than larvae.

- **Lifecycle:** Complete metamorphosis. Both adults and larvae are aquatic. Eggs are laid underwater on plant material.
- **Environment:** Riffle beetles indicate clean, oxygen rich, fast-moving bodies of water. They are slightly more tolerant to pollution than others in Group 1.

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[2] https://education.mdc.mo.gov/discover-nature/field-guide/mayfly-larvae
[3] https://www.insectidentification.org/insect-description.php?identification=Mayfly
[4] https://mdc.mo.gov/discover-nature/field-guide/riffle-beetle-larvae

Caddisfly

- **Larva**: Caddisfly larvae are aquatic, slender, and have a segmented abdomen that is usually hidden within a homemade shell built from grains of sand, bits of leaves and twigs, and other debris. The head has chewing mouthparts and there are 3 pairs of legs at the front of the body. 0.5 to 1 inch long.[5]
- **Adult:** The adults are moth-like, holding their wings like a shield over their backs. The forewings are hairy. The antennae are long, usually as long as the rest of the body. 1.5 inches long.
- **Lifecycle**: Complete metamorphosis. Larvae enter a pupal stage before becoming adults. The pupae are usually protected by their casing. When that stage is nearly complete, they cut open the case, swim to the surface, undergo the final molt, and begin flying. Adults focus only on reproduction.
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- **Environment:** As larvae, most creep along rocks and other submerged objects in the clean waters of streams, rivers, and springs, where the movement of the water increases the oxygen level. Presence indicates pristine water quality. Caddisflies are intolerant of low oxygen levels.

Right-Handed (Gilled) Snail

- **Larva/Adult:** With point held up, the opening is on your right and faces you. There is a plate-like covering over the shell opening.[6]
- **Lifecycle:** Snails do not undergo any conspicuous metamorphosis as they grow and develop. Juveniles look much like their adults with small and less coiled shells. Gilled snails may live 2 – 3 years and generally have separate male and female individuals.
- **Ecosystem:** As indicated by the name, these snails have gills and breathe underwater. Consequently, they require clean and well-oxygenated water to live.[7]

[5] https://mdc.mo.gov/discover-nature/field-guide/caddisfly-larvae
[6] https://mdc.mo.gov/discover-nature/field-guide/gilled-aquatic-snails-prosobranch-pond-snails
[7] https://ecm.idem.in.gov/cs/idcplg?IdcService=GET_FILE&dID=83320603&dDocName=83322408&Rendition=web&allowInterrupt=1&noSaveAs=1

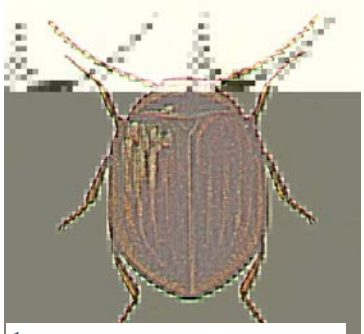
Dobsonfly

- **Larva:** Larvae are aquatic, flattened, and black, brown, or tan. They almost look like centipedes. The head has a pair of sharp pincers that can deliver a painful bite. There is a pair of hooked, leg-like appendages at the hind tip that help keep the animal from being swept away in the water current. Larval length: 2-3 inches.[8]
- **Adult:** Males have tentacle-like appendages for mouth parts and cannot bite. Females have strong pincher jaws and can deliver a painful bite if agitated. Both genders are a taupe color and have large wings that cover the body when viewed from overhead. Adult length: can exceed 3½ inches, with wingspan up to about 5 inches.[9]

- **Lifecycle**: Complete metamorphosis. Egg masses resembling bird droppings (to protect them from predators) are laid on branches or rocks next to streams. After hatching, the larvae crawl or fall into the water, where they spend the next 2 - 3 years. Once grown, they crawl out of the water, form a cocoon, and emerge in spring as adults. Adults focus only on reproduction.
- **Ecosystem**: Larvae need high quality, well-oxygenated water. Dobsonflies are only present in very clean environments because they are intolerant of pollution.

Water Penny

- **Larva**: Water Penny larvae look like copper penny-colored legless ovals. On their underside, they have 6 legs in the thorax region and tiny, feathery gills. Some species are more circular than others. Larva are nearly 0.5 inch long.[10]
- **Adult:** Looks like a typical beetle: six legs, black or brown, oval, flattened beetles, usually wider at the hind end than in the front.
- **Lifecycle:** Complete metamorphosis. Water pennies are similar to other beetles, except that the larva is flat and looks like a penny instead of a grub. The larvae may take more than a year to mature. When they are large enough to pupate, they do so either underwater, still attached to stones, or in the soil near the stream.
- **Environment:** Water penny larvae cling to the undersides of rocks and other submerged objects in flowing, unpolluted water. They cannot cling to stones or rocks is compromised in waters that have overgrown algae or deep sediment. They cannot tolerate pollution, warm temperatures, high sedimentation, and high amounts of algae and fungi.



[8] https://education.mdc.mo.gov/discover-nature/field-guide/hellgrammite
[9] https://www.insectidentification.org/insect-description.php?identification=Dobsonfly
[10] https://mdc.mo.gov/discover-nature/field-guide/water-penny-beetle-larvae

Group 2: Moderately Intolerant of Pollution

Damselfly

- **Nymph:** Large eyes and long legs. Grey, green, or brown in color. 6 thin legs. The lower jaw is scoop-like and covers most of the bottom part of the head. The abdomen ends in 3 leaf-like gill-plates resembling tails.[11]
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- **Adult:** Adult damselflies are colored like brilliant gemstones and have 2 pairs of wings held together over the body that are membranous and elaborately veined. Adults have slender, long abdomens, and large eyes. The antennae are short and the 6 legs are poor for walking but good for perching.[12]
- **Lifecycle:** Incomplete metamorphosis. Nymphs live for a long time—some species live for 5 years underwater before becoming adults. Nymphs undergo several molts as they grow.
- **Environment:** Indicate slow moving water, such as streams, ponds, or lakes.[13]

Dragonfly

- **Nymph:** Look similar to damselfly nymphs, but thicker. Aquatic with 6 legs, large eyes, and small wing buds on the back of the thorax. Gills are located inside the rectum. The lower jaw is scoop-like and covers most of the bottom part of the head.[14]
- **Adult:** Adult dragonflies have slender, long abdomens, and 2 pairs of wings that are usually outstretched horizontally, membranous, and elaborately veined. The hindwing is wider at the base than the forewing. Large eyes that cover the head with short antenna and 6 legs.[15]
- **Lifecycle**: Incomplete metamorphosis. Nymphs live for a long time—some species live for 5 years underwater before becoming adults. Nymphs undergo several molts as they grow.
- **Environment:** Dragonfly nymphs breathe continually in-and-out with the gills in their rectum, making them highly dependent on the aquatic environment. Ponds with high concentrations of chloride and metals typically had lower dragonfly abundance, as well as those with high chloride, which likely originates from winter road salting.[16]

[11] https://mdc.mo.gov/discover-nature/field-guide/damselfly-larvae
[12] https://mdc.mo.gov/discover-nature/field-guide/damselflies
[13] https://pondinformer.com/damselfly-zygoptera/
[14] https://mdc.mo.gov/discover-nature/field-guide/dragonfly-larvae
[15] https://mdc.mo.gov/discover-nature/field-guide/dragonflies
[16] https://doi.org/10.1016/j.envpol.2020.114472

Scud

- **Identification:** Scuds are often described as “shrimplike sowbugs.” Scuds have several body segments with legs, gills, and other appendages, two pairs of antennae, and are flattened sideways. They are white to clear to pink with black eyes.[17]
- **Lifecycle:** Scuds are born to look very similar to their adult form. They are simply much smaller and lack reproductive paraphernalia. They undergo several molting phases to reach their mature size. Some species go through 8 or 9 molting phases.
- **Environment:** Scuds range from being sensitive to tolerant to many pollutants and environmental stresses, but some species are very sensitive to the presence of heavy metals. Their densities are usually highest in pristine waters. Indicate calcium and nutrient-rich water clear of sediments and pollution.

Crayfish

- **Nymph/Adult:** Looks like a miniature lobster. Depending on species, adult size ranges from 7/8 inch to more than 6 inches.
- **Lifecycle:** Crayfish are born to look very similar to their adult form. They continually molt until they reach their full size.[18]
- **Environment:** Crayfish are a good indicator of water quality in streams. Changes in pH and high levels of dissolved oxygen content are stressful to crayfish in freshwater ecosystems. A lower pH can stunt growth of crayfish, with lasting effects even after the pH returns to normal levels.[19]

[17] https://mdc.mo.gov/discover-nature/field-guide/scuds-sideswimmers-amphipods
[18] https://mdc.mo.gov/discover-nature/field-guide/crayfishes
[19] https://www.researchgate.net/publication/235660782_Effect_of_pH_on_growth_and_survival_in_the_freshwater_crayfish_Austropotamobius_pallipes

Aquatic Sowbug

- **Nymph/Adult:** Sowbugs are Isopods, not insects. Bean-shaped with many small legs under gray, or occasionally orange, segmented armor plates. Look like a mini armadillo, or a pill bug/roly-poly. Wider than high, and walk slowly along surfaces.[20]
- **Lifecycle**: Isopods hatch from eggs and look like tiny versions of the adults. As they grow, they molt in two phases: first the back half, later the front half.
- **Environment:** Freshwater aquatic isopods can be found in water rich with organic materials. Sowbugs can tolerate organic waste, so can be found in streams that are beginning to recover from sewage pollution. Some of the most common species tolerate pollutants; their presence in a stream can indicate a lowered water quality.

Cranefly

- **Larva:** Light grey to greenish-brown in color with black splotches. Cylindrical in shape and taper slightly at both ends. The larvae look like worms and do not have legs. Range from 5 mm to 4 cm.
- **Adult:** Also known as “daddy long legs.” Have a long, thin body, with thin, smoky wings and extremely long legs.
- **Lifecycle:** Complete metamorphosis. A female crane fly lays up to 300 eggs either under water or in soil near water. Larva can take 3 months to 5 years to develop, depending on the species. Adults live for several days—just long enough to reproduce.[21]
- **Environment:** A high density of craneflies indicate decent water quality (water that isn't too polluted, but probably has some degree of turbidity and stagnation), particularly if mayflies and stoneflies are also abundant. The aquatic larvae are sensitive to pollution; a decline in numbers may suggest that pesticide runoff from lawn treatments is harming stream life.[22]

[20] https://mdc.mo.gov/discover-nature/field-guide/aquatic-pillbugs-sowbugs-aquatic-isopods
[21] https://www.orkincanada.ca/pests/flies/crane-flies/#:~:text=A%20female%20crane%20fly%20lays%20up%20to%20300,cause%20damage%20to%20plant%20roots%20in%20large%20concentrations.
[22] https://education.mdc.mo.gov/discover-nature/field-guide/crane-fly-larvae

Clam/Mussel

- **Nymph/Adult:** Two shells attached by a hinge; can be large or small.
- **Lifecycle:** Mussels have a complex life cycle with five stages. Male mussels release sperm, which are filtered from the water by females. The fertilized eggs sit in the gills of the female where they develop into larvae called *glochidia*, which are parasitic and attach to their host, usually a fish. They do not harm their hosts; they ride their hosts until they can morph into a tiny mussel/clam, and then fall off.[23]
- **Environment:** Because mussels are sensitive to habitat disturbance and pollution, they are good indicators of the overall health of aquatic ecosystems and water quality. Can tolerate slightly higher pH levels.[24]

Group 3: Fairly Tolerant of Pollution

Midge

- **Larva:** Midge fly larvae are thin, cylindrical, segmented bodies. Their heads are typically darker than the rest of the body, which is usually light olive green, tan, or clear.[25]
- **Adult:** Adult midges look like mosquitoes. They are small, with long, narrow wings and long legs.
- **Lifecycle:** Complete metamorphosis. As larvae, most midges live at the bottoms of ponds, lakes, and other aquatic habitats. Some species live in other types of moist places, like damp soil. Most spend 1 to 3 years as larvae. The pupae are aquatic, breathe air, and as an adult, a midge may live only a few weeks.
- **Environment:** Midges tolerate high pollutant loads and low oxygen levels. The presence of midges is often an indicator of water quality issues.[26]

[23] https://mrbdc.mnsu.edu/sites/mrbdc.mnsu.edu/files/public/pdf/askexpert/mussel_lifecycle.pdf
[24] https://www.montgomerycountymd.gov/water/streams/mussels.html
[25] https://education.mdc.mo.gov/discover-nature/field-guide/midge-fly-larvae
[26] https://www.tinkerscreek.org/wp-content/uploads/2017/12/Midges-and-Mayflies.pdf#:~:text=The%20presence%20of%20midges%20alone%20could%20be%20an,North%20America%2C%20surrounding%20areas%20with%20good%20water%20quality.

Planaria (Flatworm)

- **Nymph/Adult:** Flat or ribbon-like. They have a left and right side, and what amounts to a back, a belly, and a head. They have 2 eye spots.
- **Lifecycle:** Planaria are hermaphrodites, meaning that each individual animal has male and female anatomy. Planaria are known for their ability to regenerate when cut into pieces. Some species reproduce by splitting their bodies into two.[27]
- **Environment:** Indicate poor water quality. Planaria can tolerate pH changes and are tolerant to pollution, but are affected by changes in dissolved oxygen content.

Black Fly

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- **Larva:** Worm-like and legless. Two fan-like structures near the head.
- **Adult:** Typically have short antenna, large wings, large eyes, and are small (1/16 inch). Black flies typically referred to as gnats and are much smaller than a house fly.[28]
- **Lifecycle:** Complete metamorphosis. Females lay 200-500 eggs in or on flowing water, or attached to wet surfaces. The number of larval stages ranges from 4-9, with 7 being the usual number.
- **Environment:** Fairly tolerant of pollution. Indicate swift-flowing water and too many nutrients.

[27] https://mdc.mo.gov/discover-nature/field-guide/turbellarians-planarians-free-living-flatworms

[28] https://www.dep.pa.gov/Business/ProgramIntegration/Vector-Management/BlackFly/Pages/default.aspx#:~:text=Black%20flies%20are%20about%201%2F8%22%20in%20length%2C%20and,and%20sometimes%20delivering%20a%20painful%20and%20itchy%20bite.

Leech

- **Nymph/Adult:** Leeches are black or brown segmented worms with flattened bodies and speckled or striped patterns.
- **Lifecycle:** Leeches are hermaphrodites, meaning that each leech is both male and female.[29]
- **Environment:** Leeches are more likely to be present in warm, stagnant bodies of water that are crowded with submerged vegetation. Leeches can also indicate running water of very poor quality. Environmental stressors, such as warming because of low flows, or low dissolved oxygen levels from algal blooms, can result in an imbalance in the leech population.[30]

Group 4: Very Tolerant of Pollution

Aquatic Worms

- **Identification**: Segmented, earthworm-like bodies that are cylindrical, not flat. No head, legs, or visible mouth. Most are red, tan, brown, or black.
- **Lifecycle:** Aquatic worms are hermaphroditic, meaning that each worm is both male and female. There is no separate larval stage; the young are simply small and immature. As they grow, their length increases by forming new segments just in front of the rearmost section.[31]
- **Environment:** These worms are associated with detritus, muck, still water, and lower oxygen levels. They are generally found in stagnant water with soft mud bottoms. High numbers are considered indicators of very poor water quality. They can survive in water more polluted and oxygen deprived than almost any other species.[31]

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[29] https://mdc.mo.gov/discover-nature/field-guide/leeches

[30] https://www.hobbyfarms.com/water-quality-aquatic-insects-leech-scud-caddisfly/#:~:text=Presence%20Means%3A%20Leeches%20are%20more%20likely%20to%20be,result%20in%20an%20imbalance%20in%20the%20leech%20population

[31] https://education.mdc.mo.gov/discover-nature/field-guide/tubificid-worms-tubifex-worms

Left-Handed (Lunged) Snail

- **Identification:** With point held up and shell opening facing you, opening is on your left.
- **Lifecycle:** Lunged snails are hermaphroditic, meaning each individual snail has both male and female qualities.
- **Environment:** Since lunged snails breathe and store air, they are somewhat tolerant of environments with poor water quality. Indicate nutrient enriched conditions and poor water quality. Can tolerate slightly higher pH levels.[32]

Rat-tailed Maggot / Hoverfly

Photograph by Walter Reeves, The Georgia Gardener.

- **Rat-tailed maggot:** The rat-tailed maggot is the larval form of the adult hoverfly. The larva has a long organ on their rear which functions like snorkel and permits the larva to breath underwater. This can be up to 7x the length of the body and looks like a long tail, hence the name.[33]
- **Hoverfly:** Many hoverflies are wasp or bee mimics. Some flies look like honeybees, some resemble hornets, and some are bumblebee mimics. Invasions of wasps often turn out to be banded hoverflies.[34]
    - **Lifecycle**: Complete metamorphosis. Form a pupa after the larval stage that is short and thick. After the larval stage they form a pupa which is shorter and thicker. Pupate on land.
- **Environment:** It lives in stagnant, oxygen-deprived water, with a high organic content. It is fairly tolerant of pollution and can live in sewage lagoons and cesspools. Common in dank and decaying environments like compost, the margins of ponds, and in tree rot holes.[35]

Photograph by David A. Iliff, Cheltenham, England.

[32] https://therouge.org/creature-feature-freshwater-snails/
[33] https://forthriverstrust.org/invertebrates/rat-tailed-maggot/#:~:text=The%20larva%20has%20a%20long%20specialised%20organ%20at,form%20a%20pupa%20which%20is%20shorter%20and%20thicker.
[34] https://www.discoverwildlife.com/how-to/identify-wildlife/how-to-identify-hoverflies/
[35] https://entnemdept.ufl.edu/creatures/livestock/rat-tailed_maggot.htm

Blood Midge

- **Larva:** Midge fly larvae are thin, cylindrical, segmented bodies. Their heads are typically darker than the rest of the body. Blood midges are bright red from the hemoglobin molecules within their narrow bodies.[36]
- **Adult:** Once a Midge fly has emerged from its pupa stage it looks a lot like a mosquito. They are small, with long, narrow wings and long legs and a very short mouth tube that cannot bite people.
- **Lifecycle:** Complete metamorphosis. As larvae, most midges live at the bottoms of ponds, lakes, and other aquatic habitats. Some species live in other types of moist places, like damp soil. Most spend 1 to 3 years as larvae. The pupae are aquatic, breathe air, and as an adult, a midge may live only a few weeks.[36]
- **Environment:** Because blood midge larvae have a lot of hemoglobin, they are better able to survive in low-oxygen, nutrient-rich water than normal midges. They are very pollution-tolerant.[37]

Additional guidance can be found in the following sources:

"Field Guide." *Missouri Department of Conservation*, https://mdc.mo.gov/discover-nature/field-guide.

Volunteer Stream Monitoring Training Manual 2019. Hoosier Riverwatch, https://ecm.idem.in.gov/cs/idcplg?IdcService=GET_FILE&dID=83320603&dDocName=83322408&Rendition=web&allowInterrupt=1&noSaveAs=1.

WV Save Our Streams' BMI-ID Field Guide. https://dep.wv.gov/WWE/getinvolved/sos/Documents/Benthic/WVSOS_MacroIDGuide.pdf.

[36] https://mdc.mo.gov/discover-nature/field-guide/midge-fly-larvae

[37] https://scioly.org/wiki/index.php/Water_Quality/Macroorganism_List#Blood_Midge