

Dedicated to the Memory of Commissioner Enoch S. "Inky" Moore Jr.

PLAY

Spring
2006

Pennsylvania • League • of • Angling • Youth



Six Legs Underwater *by Walt Dietz*

Anglers sometimes wonder which bait to use when fishing. Most of us are familiar with baits like corn, cheese and dough balls. We might also use live baits like minnows or worms. But there is another bait. It's easy to collect. You can even wait until you get to your fishing spot to obtain it. Do you have any idea what it might be? Here is a clue: Lift a rock the next time you go fishing. Then take a close look.

You guessed right if you were thinking "aquatic insects." Bass, panfish, trout, carp, suckers and catfish eat aquatic insects. There are plenty of these tasty treats in our ponds, streams and rivers. There are lots of different kinds and sizes.

Aquatic insects are more than food for fish. They are also important in the aquatic ecosystem. Some are predators. They eat other insects and small fish. Other aquatic insects eat plants. Still others are the garbage collectors of the stream because they eat dead animals and litter (dead plants, leaves and debris). Some scientists even use aquatic insects to tell them about the quality of the water—just like a canary in a coal mine. They measure how many kinds of insects live in certain waterways and how many of each kind of insect live there.

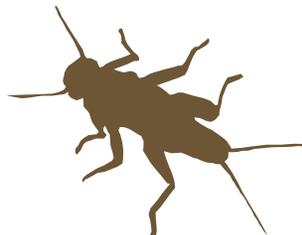
Let's take a closer look at aquatic insects—where they live, their life cycle and how we can use them for bait.



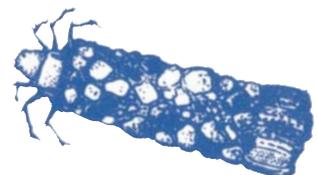
Which one should I eat?



Mayfly



Stonefly nymph



Caddisfly larva

Family Affair

Aquatic Insect Family Tree

Aquatic insects are like other insects. They have six legs, three body segments, antennae, and sometimes wings. They also have an exoskeleton (a skeleton on the outside of the body). That helps them move food and objects much heavier than their own weight. A caddisfly larvae can make and

carry its own house of pebbles and sticks everywhere it goes!

Aquatic insects are different in one way from the insects we see on land. They are adapted to live part of their lives underwater. This family tree shows some of the aquatic insect groups.

Kingdom:
Animalia
(animals)

Phylum:
Arthropoda
(jointed-foot invertebrates)

Class:
Insecta
(insects)

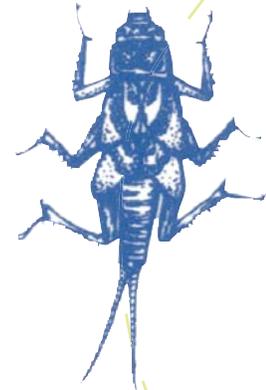
Mayflies (Ephemeroptera)



Left to right: Burrowing mayfly nymph; minnow mayfly nymph; flat-headed mayfly nymph

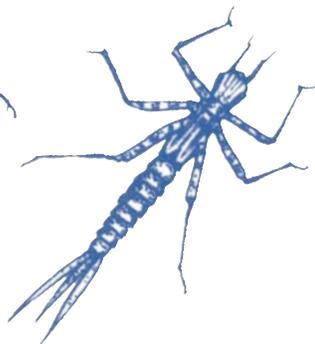
Stoneflies (Plecoptera)

Giant stonefly nymph; roach stonefly nymph; common stonefly nymph

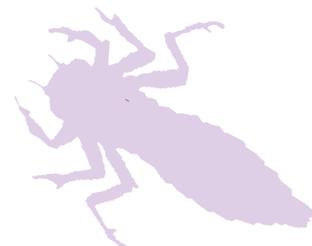


Above: Common stonefly nymph

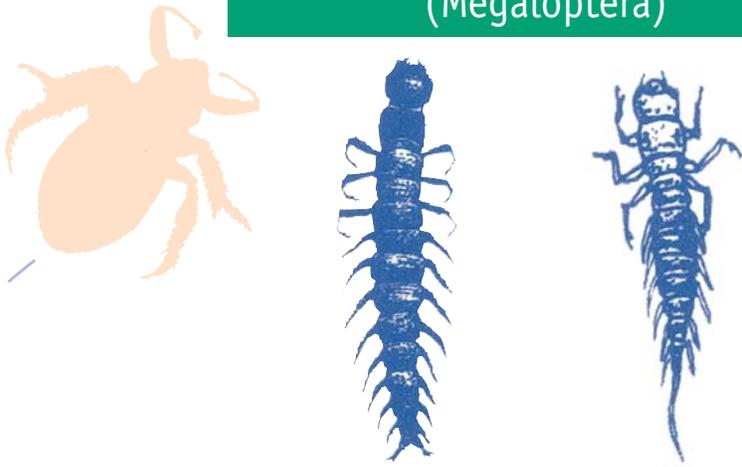
Dragonflies and damselflies (Odonata)



Left to right: Dragonfly nymph; damselfly nymph

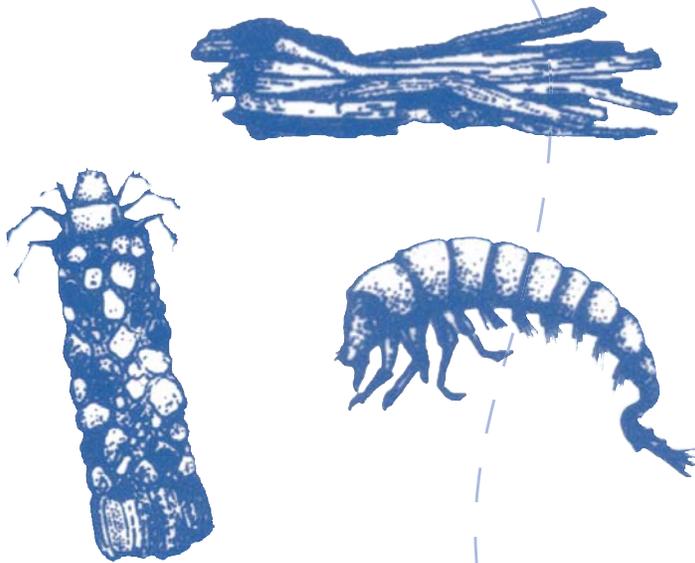


Alderflies, dobsons and fishflies (Megaloptera)



Left to right: Dobsonfly larva (hellgrammite); alderfly larva

Caddisflies (Trichoptera)



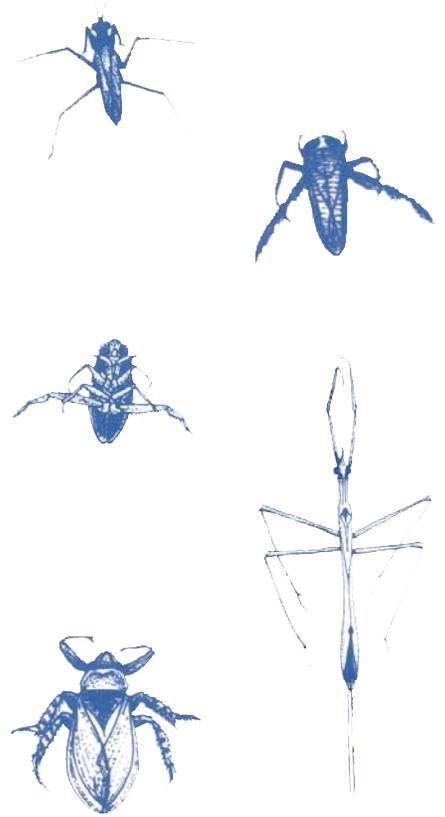
Top: Stick case-maker caddisfly larva
Bottom left to right: Stone case-maker caddisfly larva; net-spinning caddisfly larva

Beetles (Coleoptera)



Left to right: Water penny (larva); whirligig beetle; predaceous diving beetle

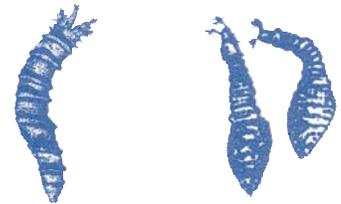
True bugs (Hemiptera)



Top to bottom (left to right): Water strider; water boatman; backswimmer; water scorpion; giant water bug

True flies (Diptera)

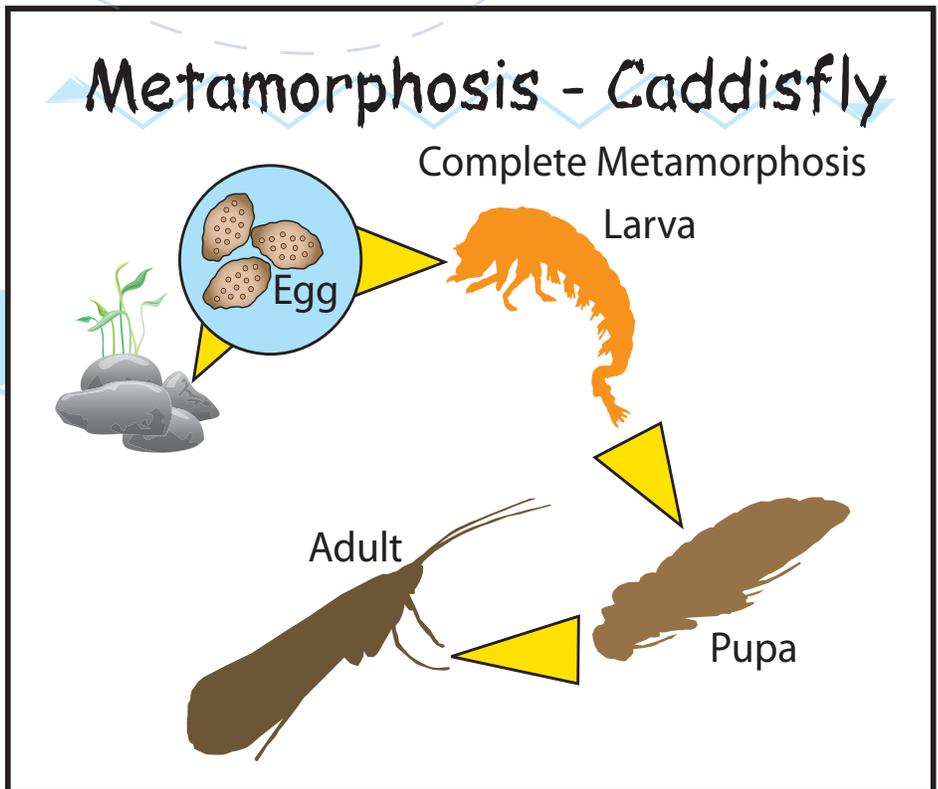
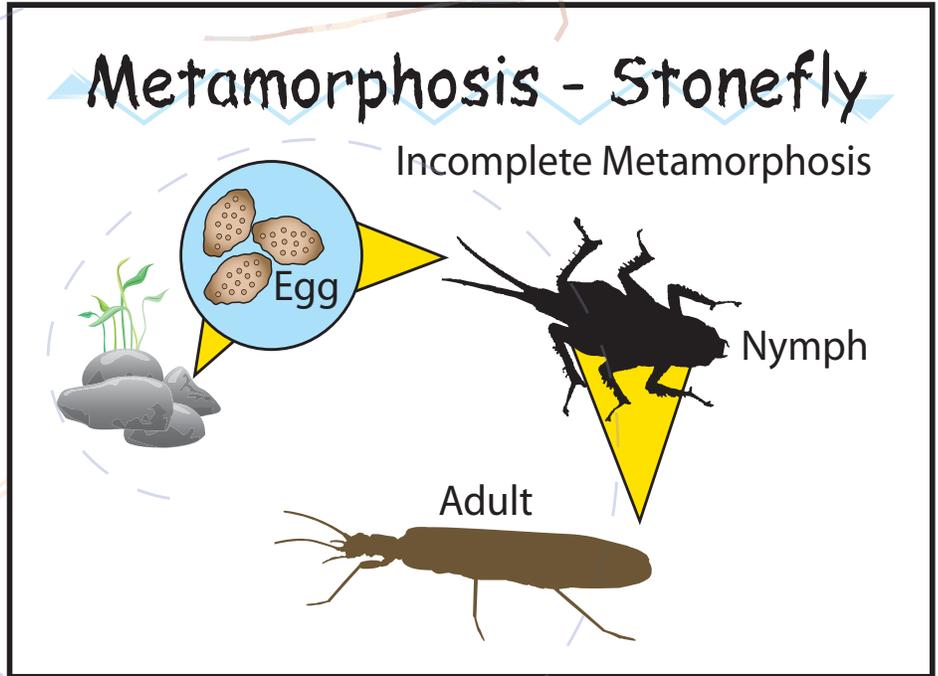
Cranefly larva; mosquito larvae; blackfly larva



Left to right: Cranefly larva; blackfly larva

A Bug's Life

All insects go through a life cycle as they grow. Their bodies change through each stage. We call these changes metamorphosis (met-a-'morph-o-sis). Some insects go through three changes, called incomplete metamorphosis. They have an egg, nymph and adult stage. Other insects go through four changes, called complete metamorphosis. They have an egg, larva, pupa and adult stage. Sometimes we use the term "hatch" to describe a nymph or larva that is changing into an adult. The insect appears to be "hatching" right out of the water to become an adult.



All insects go through a life cycle as they grow. We call these changes

....metamorphosis.

(met-a-'morph-o-sis)

A Wet World

Aquatic insects are different from land insects in some ways. They are adapted to underwater life during the larval or pupal stage. Some also live on or under the water during the adult stage. These critters, like the mayfly nymph, have gills. They may take in oxygen through the skin like the

chironomid, a type of fly larva. Some aquatic insects, like the mosquito larva, draw air through a tube. Others, like the adult backswimmer, carry a gas bubble.

Aquatic insects also have some unique feeding adaptations. Check out some of the ways these insects get their dinner.

PREDATORS

Pursue or wait for prey



Predaceous diving beetle

GRAZERS

Scrape algae, food and bacteria off rocks



Water penny

SHREDDERS

Eat pieces of leaves and dead plant parts



Giant stonefly nymph

COLLECTORS

Gather or filter food from the water



Net-spinning caddisfly larva

PLAY

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Match the Hatch

Knowledge of aquatic insects can make you a better angler. It helps to know which insect and life stage a fish is eating. Then you will know which bait or lure to use. Ever try a stone fly for trout? Or how about a hellgrammite for bass? They work great!

What do you do if you see trout feeding on caddisflies, or a bluegill feeding on whirligig beetles? Catch one of these

insects. Take a close look. Compare it to the lures in your tackle box. Then fish with the lure that looks most similar. You might choose a tiny brown caddisfly lure. Or maybe a small black popper. We call this process "matching the hatch."

Here is a quiz to test your aquatic insect knowledge. Match the larva or nymph to the adult stage.

It's the Law

Did you know that fishing regulations also apply to aquatic insects?

They are considered "fishbait." A fishing license is required if you are 16 or older. Anglers are allowed to possess up to 50 combined species of aquatic invertebrates at a time, including mudbugs (damselfly and dragonfly nymphs) from rivers or streams. An unlimited number of mudbugs can be possessed if taken from ponds or lakes.

To learn more about aquatic invertebrates, check the following fact sheets on the Commission's web site, www.fish.state.pa.us. Visit our Education Resources Catalog on the education page.

Types of Aquatic Insects:

- Caddis Flies
- Dobsonfly
- Dragons & Damsels
- Mayflies
- Stoneflies
- Pond and Stream Study Guide

Aquatic Insect Life Cycles & Adaptations:

- ENA or ELPA
- Macroinvertebrate Feeding Frenzy
- PLAY - Why Fish Need Trees (Aquatic Leaf Eaters)
- Water Walkers

1. Caddisfly larva



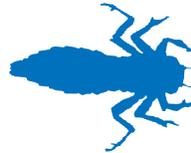
2. Stonefly nymph



3. Mayfly nymph



4. Dragonfly nymph



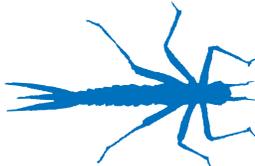
5. Hellgrammite



6. Crane fly larvae



7. Damselfly nymph



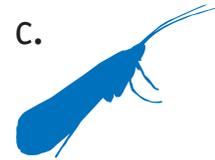
a.



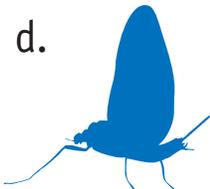
b.



c.



d.



e.



f.



g.



Answers
1. c; 2. g; 3. d; 4. f; 5. a; 6. e; 7. b

Critter Collectors

Aquatic insects make some of the best baits. They are easy to capture. Head down to the stream and turn over some rocks. Then collect them by hand. You can also use a kitchen strainer, small net or homemade kick seine. Check out our "Critter Collectors" fact sheet. It shows how to make a kick seine from window screen. Set the net downstream of some rocks. Turn them over. Disturb the stream bottom. The current does all the work. It will wash the critters into your net. Be careful with those hellgrammites! Grab them on the head, directly behind their pincers.

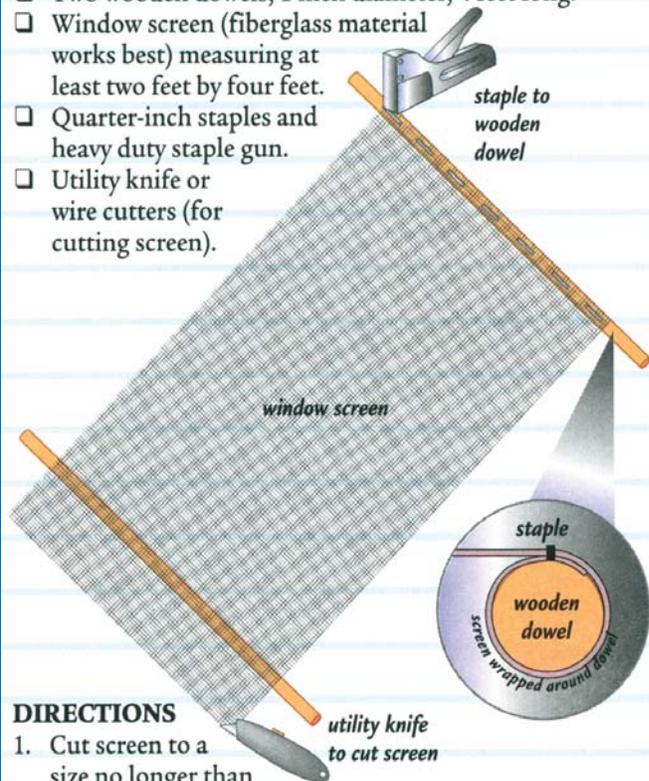
Whirligig beetles, diving beetles, water boatmen, backswimmers and other water bugs can also be used for bait. They are tricky to capture. Use a long-handled net to scoop them from the water's surface. You'll have to be quick!

Most nymphs and larvae can be kept in a container of water. They include mayflies, dragonflies and damselflies, caddisflies, crane flies and hellgrammites. They need cold water with lots of oxygen. You'll need to collect them right before you go fishing. Or replace the old water with fresh cold water once in a while. Stonefly nymphs are best kept in a container with cool wet moss.

Kick Seine

Materials needed:

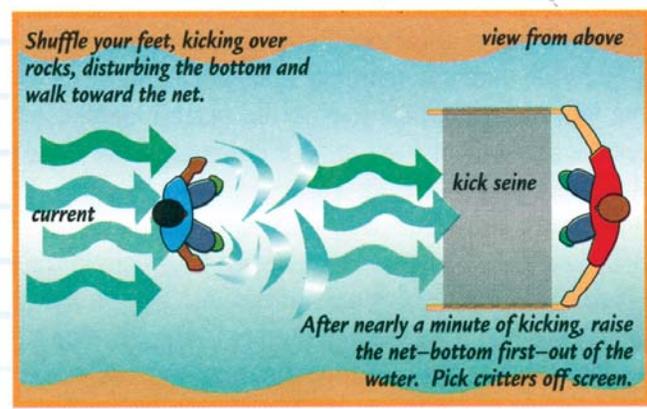
- Two wooden dowels, 1 inch diameter, 4 feet long.
- Window screen (fiberglass material works best) measuring at least two feet by four feet.
- Quarter-inch staples and heavy duty staple gun.
- Utility knife or wire cutters (for cutting screen).



DIRECTIONS

1. Cut screen to a size no longer than four feet. Fish and Boat Commission regulations limit the length of nets and seines to four feet. Seines larger than four feet require a special scientific collector permit.
2. Lay dowels along shorter edge of screen, lining up the bottom of screen with the bottom of dowels.
3. Wrap screen around dowel, one complete wrap. Staple screen to dowel rod, placing staples every six inches or so.
4. Repeat process on other dowel.

To use a kick seine: one or two persons



ENA or ELPA? BY RICH WOOD

illustration-Ted Walke

As kids grow, their bodies begin to change. Their bones strengthen, they grow taller, and they usually have to wear larger clothes. Insects grow the same way.

These changes are called metamorphosis (met-a-morph-o-sis). Aquatic bugs are no different. Many insects begin

their lives underwater, and then live the rest of their lives out of the water flying! These critters may go through three changes, called incomplete metamorphosis, or four changes, called complete metamorphosis. An easier way to remember the difference is ENA or ELPA.

ENA

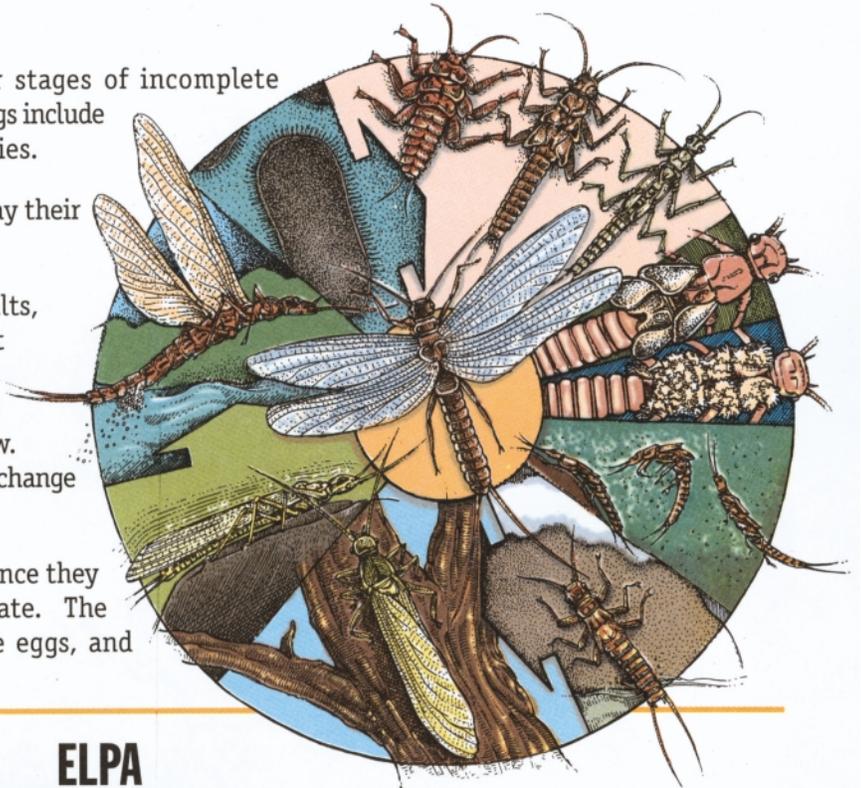
ENA are the three letters that stand for stages of incomplete metamorphosis: **Egg**, **Nymph**, and **Adult**. ENA bugs include stoneflies, mayflies, dragonflies, and damselflies.

Eggs: Insects with incomplete metamorphosis lay their eggs in water.

Nymphs: Some nymphs look just like the adults, but without wings. Some look very different from the adult. They live on rocks, sticks, leaves, algae, or anything else that may be underwater.

Nymphs may shed their skin as they grow. This is called molting. When mature, the nymphs change into adults.

Adults: The adults emerge from the nymphs. Once they become adults, they fly from the water to mate. The females then return to the water to lay more eggs, and the cycle begins again.



caddisfly stages

ELPA

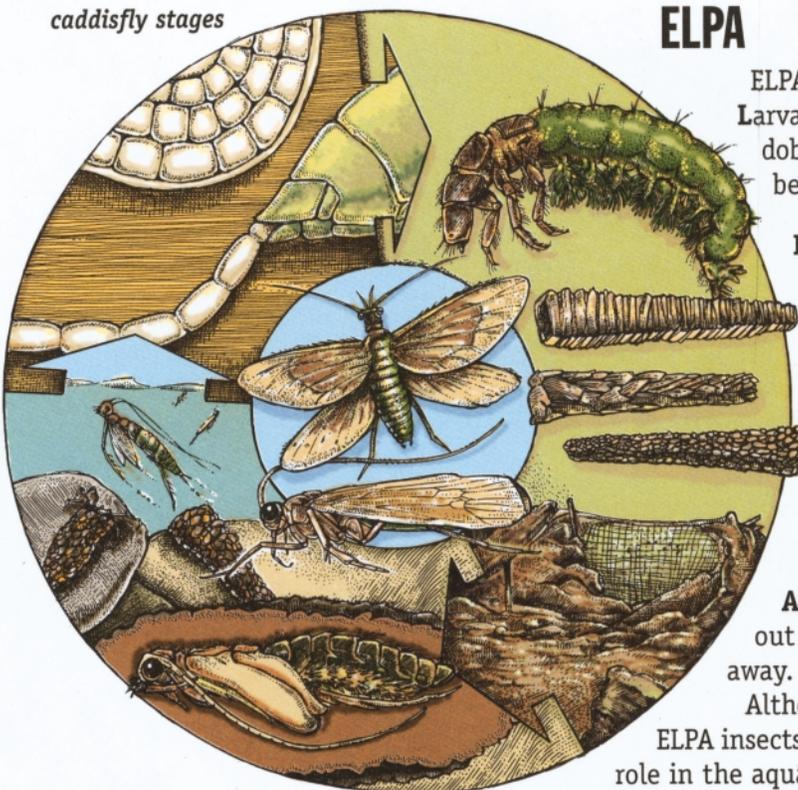
ELPA are the stages of complete metamorphosis: **Egg**, **Larva**, **Pupa**, and **Adult**. ELPA bugs include caddisflies, dobsonflies, crane flies, midges, mosquitoes, and water beetles.

Eggs: ELPA bugs hatch from eggs laid in the water.

Larva: Larvae hatch from eggs. Many larvae have soft bodies. Caddisfly larvae build cases of small pebbles or sticks around their bodies.

Pupa: Some pupa may look just like a cocoon. They may be inactive and not feed on anything. During the pupal stage, the critter is preparing for its final change into an adult.

Adult: Once changed into an adult, the pupa comes out of its "cocoon." It swims to the surface and flies away. The adults mate, and eggs are laid in the water. Although there are many differences between ENA and ELPA insects, one thing is certain: They all play an important role in the aquatic food chain.





SMART

Angler's Notebook

by Carl Richardson

Caddis Flies

Caddis flies are aquatic insects found in nearly all of Pennsylvania's waters. Some caddis species are at home in small mountain streams, while others prefer the depths of our large rivers and lakes. Like butterflies and moths, caddises go through complete metamorphosis. Use the letters *ELPA* to help remember the four stages in complete metamorphosis: Egg, larva, pupa and adult.

EGG

Each egg is very small and round. One egg is about the size of the period at the end of this sentence. Depending on species, the female lays the eggs in clusters of 30 to 300 eggs. The clumps stick to the bottom and hatch in two to four weeks.

LARVA

Caddis larvae look much like worms with six legs. The larvae produce silk, and many use it to build protective cases. They make tube or purse-shaped cases out of grains of sand, sticks and other vegetation. One species makes a case that looks like a snail shell. Some species carry the case. Others attach it to rocks. Larvae crawl on the rocks eating algae and other plants. A few species build silken nets to filter food out of the water. In many Pennsylvania streams there is a green-colored caddis larva that is a predator. It does not build a case.

PUPA

Nearly a year after it hatches, the larva constructs a cocoon. The larva enters the cocoon and becomes a pupa. A pair of wings develops while inside the cocoon. After about two weeks in the cocoon the pupa appears and swims to the surface. For each kind of caddis this happens at the same time each year.

ADULT

Many adults emerge from the pupae just below the water's surface. Others emerge on the surface.

Fish gobble both the emerging pupae and the adults. Adult caddis flies look much like small moths. The adults fly to trees and bushes along the water and after several days will mate there. After mating, the female flies her fertilized eggs to the water. Depending on the species, the egg clusters are deposited on the surface or the female swims the clusters to the bottom. Adult caddis flies often live for months after mating.

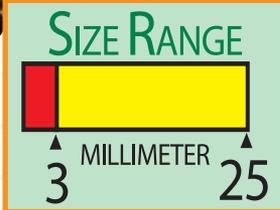
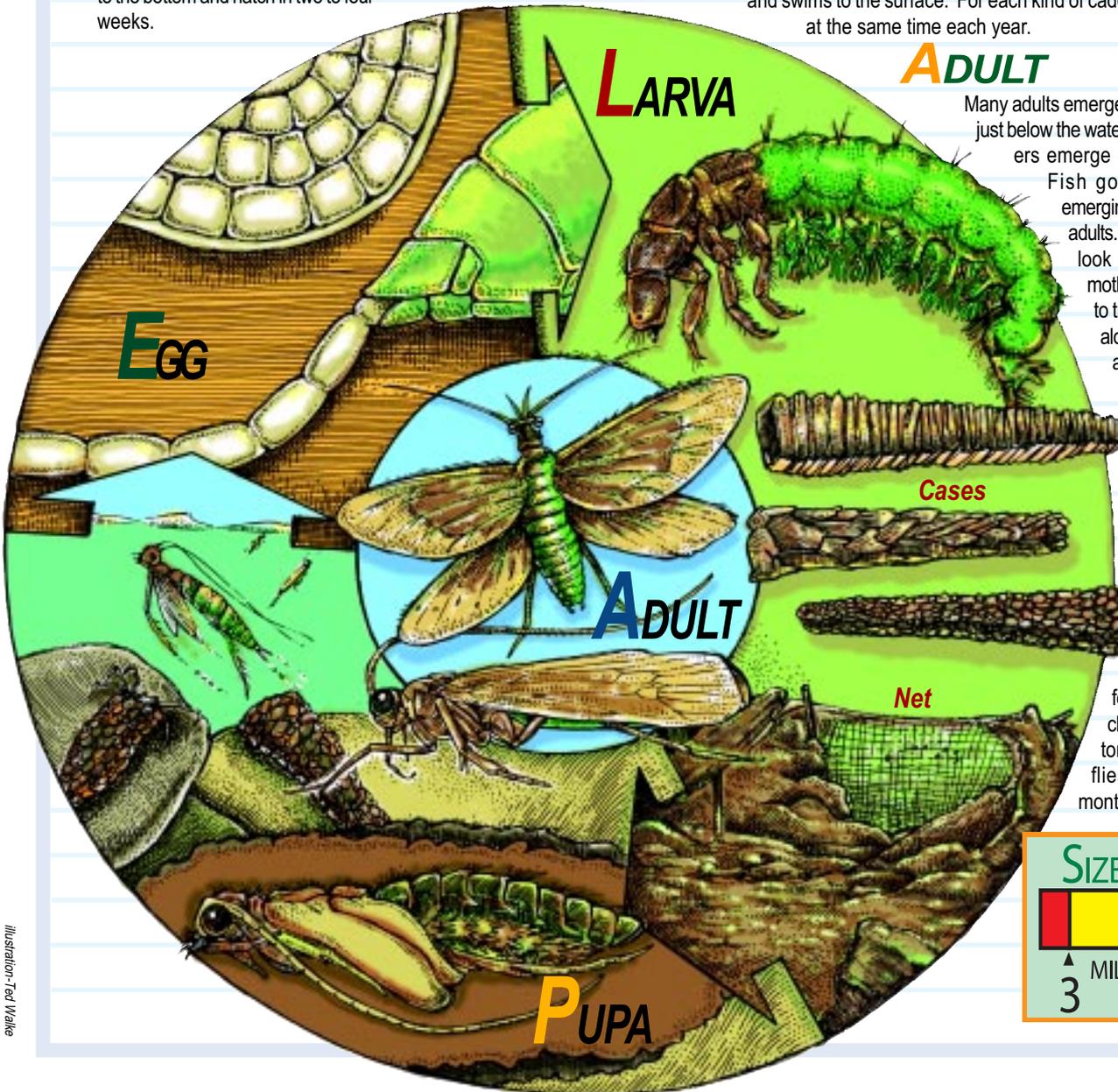


Illustration: Ted Walke



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Angler's Notebook

by Carl Richardson

Mayflies

Mayflies are important food items for many fish, especially trout. There are more than 700 kinds of mayflies in North America. Pennsylvania is home to some 300 different species. Mayflies go through a change called metamorphosis. Unlike butterflies that have four stages (egg, larva, pupa, adult), mayflies go through three stages. This is incomplete metamorphosis. Use the letters ENA to remember each step: Egg, nymph and adult.

EGG

The period at the end of this sentence is larger than the eggs of most mayflies. Most eggs have hair-like projections that make them stick to the bottom. Eggs hatch after a month, but some types of mayfly eggs take as long as three months to hatch. From the egg, a nymph emerges.

NYPH

The nymphs of some mayflies burrow into the bottom. Others swim about freely, cling on rocks or crawl around on the bottom. Some are predators; others eat live or decaying plants. As they eat and grow, nymphs shed their skins. One mayfly sheds some 45 times. Most mayflies live in streams and some rivers, but there are a few that live in lakes and ponds.

Nearly all Pennsylvania mayflies live as nymphs for one year. At the end of this stage the mature nymph changes into an adult. This happens at the same time every year for each species when water temperature and day length are just right.

The hatch: When nymphs shed their skins and become adults. Some mayfly nymphs swim to the surface, hatching along the way. Others hatch on the bottom and the adult swims to the surface, or they hatch at the surface. Fish go on feeding binges when this happens.

ADULT

The first stage in an adult mayfly is called a dun. The dun cannot reproduce. Duns that survive hatching and reach the surface aren't safe, yet. Fish often feast on the duns as they rest on the surface. Bats, birds and other insects eat them as they fly away from the water. The duns fly to streamside trees and brush. Most Pennsylvania mayflies change again into a reproducing stage called a spinner. This usually happens within a day or so of hatching.

Usually at nightfall, the spinner flies back toward the water to mate. Mayflies mate in big clouds, with the males diving and dipping to attract a mate. Each female may lay as many as 1,200 eggs. She either drops her eggs to the water from above the surface, swims to the bottom to lay eggs, or lands on the water and lays eggs on the surface. After mating, the mayfly dies, and often falls on the water's surface. These dead mayflies are also eaten by fish.

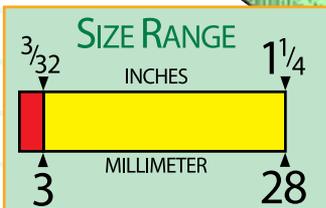
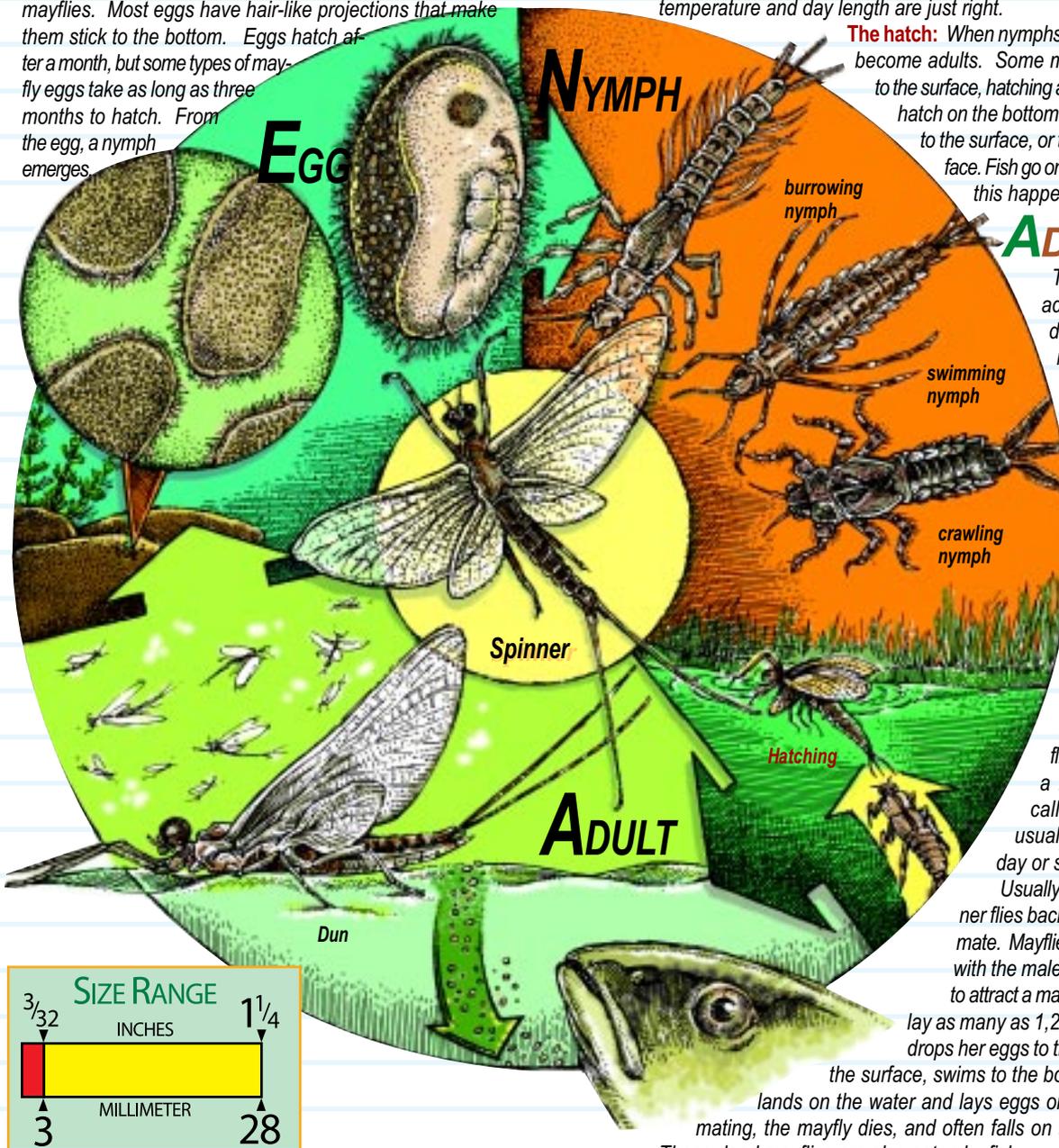


Illustration - Ted Walke



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Stoneflies

The scientific name for this order of insects is *Plecoptera*, which in Latin means “braided wing.” The wings of adults have numerous veins, making them appear braided. Stoneflies, as you can guess, live in habitats with plenty of stones. They prefer fast-moving, clear streams with a bottom of rocks and stones. Small mountain brooks and large streams in wooded areas usually have plenty of this type of habitat, and often many stoneflies.

Stoneflies, like mayflies, have incomplete metamorphosis. The stages of incomplete metamorphosis include egg, nymph and adult, or “ENA.”

NYPH

Stonefly nymphs have two tails and two sets of wing pads or plates. They also have gills on the middle body segment near their legs. Mayflies may have two tails, but their gills are on the last body segment. The nymphal stage of most stoneflies is one year. There are a few species here that take as long as three years to mature. Stoneflies crawl about and cling to the rocky bottom, sheltered from the current. In small streams, many species feast on leaves falling from streamside trees. In larger waters they graze on other aquatic vegetation, like that slime or the scum that covers rocks. There are some stoneflies that are predatory.

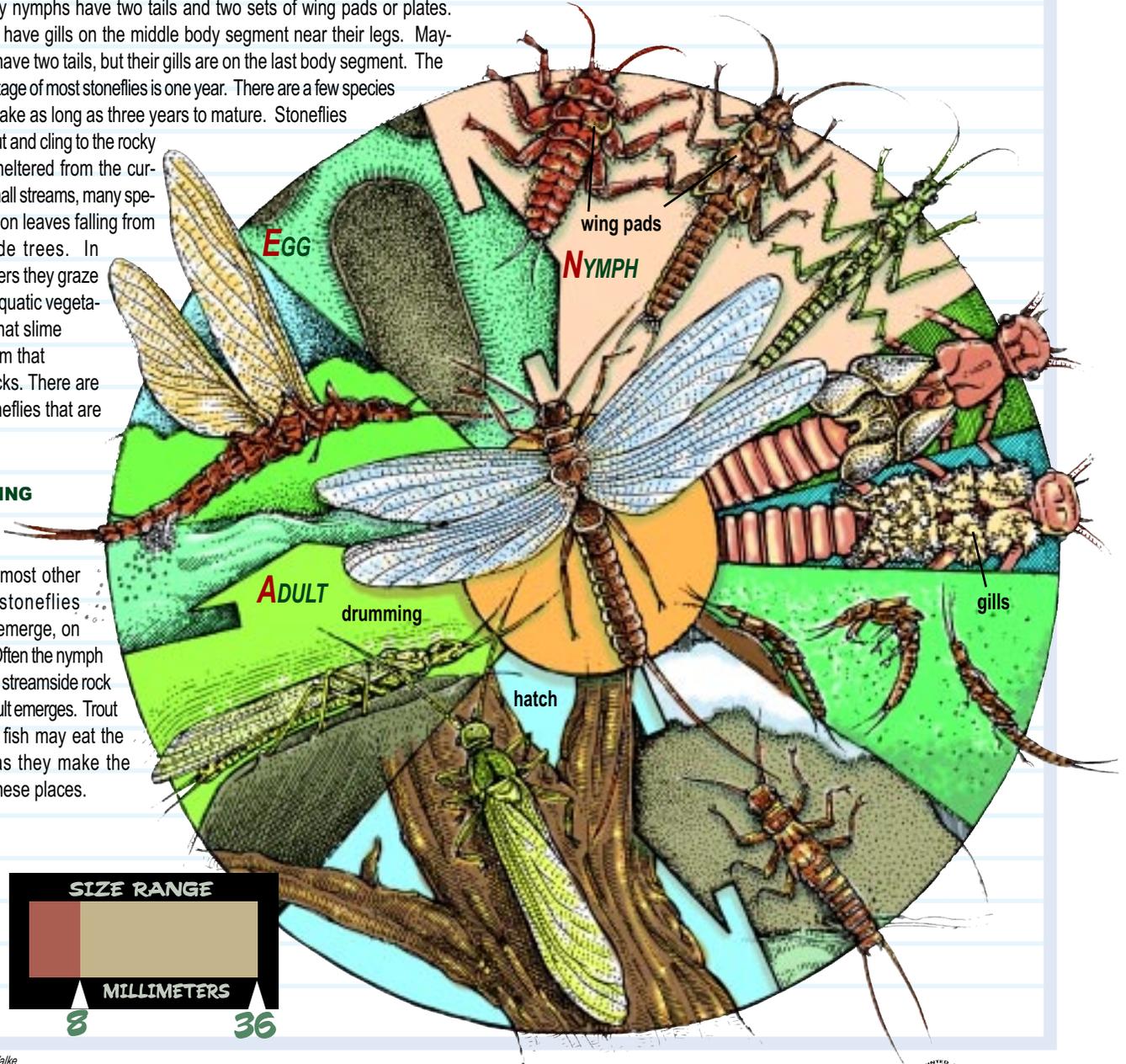
HATCHING

Unlike most other insects, stoneflies hatch, or emerge, on dry land. Often the nymph crawls to a streamside rock and the adult emerges. Trout and other fish may eat the nymphs as they make the move to these places.

ADULT

The wings of adult stoneflies fold back flat over the body. Caddisflies also have “laid back” wings, but they almost form a tent over the body. After hatching, the adults fly to streamside vegetation, where they may live from a few days to a few weeks. Many adults do not eat, but those that live as adults longer do eat vegetation, pollen or nectar.

The adults attract mates by “drumming”—bouncing up and down on their vegetation perches. They mate on this vegetation and the female takes the fertilized eggs to the water to deposit them. She may skate across the surface, dropping egg packets. This is often when trout eat the adults. A bushy dry fly skated across the surface at this time can bring slashing strikes.



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Angler's Notebook

by Walt Dietz

MACROINVERTEBRATE FEEDING FRENZY

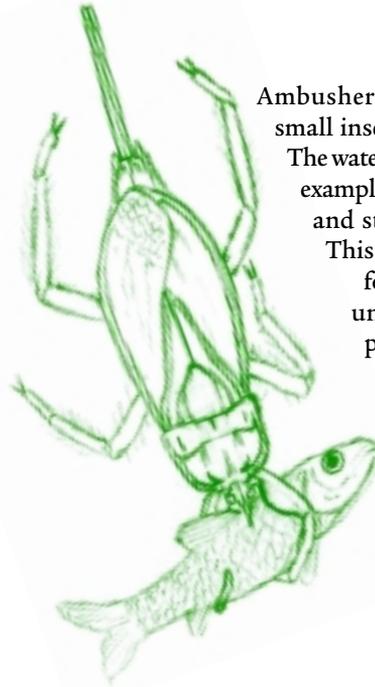
We usually don't give much thought to how aquatic macroinvertebrates (animals without backbones) get their food. They often go unnoticed because of their small size. But they still have to eat to survive. And just like any other animal group, they have different forms of feeding. Many are passive herbivores. They feed on plant material as a deer would munch on grass. Some are voracious predators that hunt prey as a lion hunts. There are even scavengers that feed on detritus. Let's take a closer look at how these aquatic critters feed.

PREDATORS

Predators are mobile animals that kill and eat their prey. Pursuit hunters like the predaceous diving beetle chase their prey. They are good swimmers, and they pursue a variety of aquatic animals and small fishes. The larvae are sometimes called "water tigers" because of their voracious nature. They even eat their own kind if they get the chance.



Some dragonfly nymphs are searchers. They move along the bottom in search of less mobile prey. These dragonflies have great eyesight and long legs that let them navigate the muddy bottom. They also have a long spoonlike lower lip called a labium. They extend it with lightning speed to capture prey. Crushing mouthparts then make quick work of the meal.



Ambushers lie in wait until a small insect or fish swims by. The water scorpion is a perfect example with its camouflage and sticklike appearance. This water bug uses long forelegs to strike out at unsuspecting prey. Its piercing proboscis makes the perfect straw for sucking out body fluids.

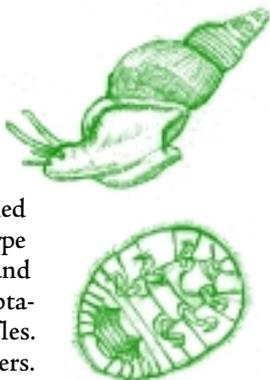
PARASITES

Parasites get their food by taking advantage of other animals. There are many types and almost every aquatic animal has one. The spongillafly larva feeds on freshwater sponges. It uses needle-like mouthparts to suck cells from sponge tissue. Water mites cling to the feet or hide under the wings of water bugs. They suck body fluids through a special mouthpart, called a capitulum. Parasitic flatworms burrow and live in the body of dragonflies. Even the smallest critters have parasites. Even the tiny rotifer has tinier flagellates living inside its bladder. Other aquatic parasites include leeches, fish lice and larval clams called glochidia.



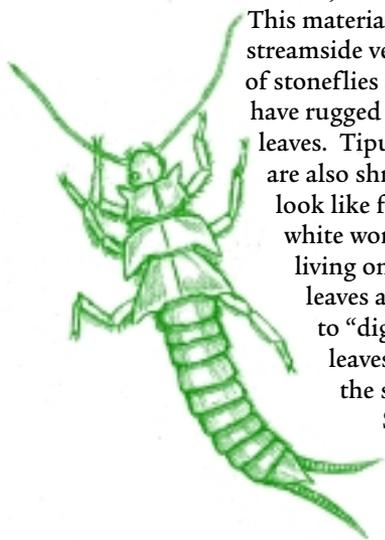
GRAZERS

Grazers feed on algae, fungi or bacteria attached to rocks and other surfaces. Grazers have specialized stomachs to help digest plant material. Snails scrape algae from rocks and plants with a rasplike tongue called a radula. The water penny is another type of scraper. It has a flattened body and suction cups on its feet. These adaptations help it cling to rocks in the riffles. Many mayfly nymphs are also scrapers.



SHREDDERS

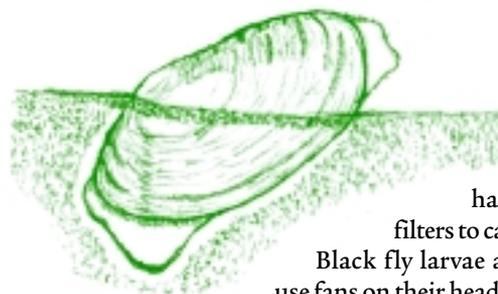
Shredders eat large (greater than 1 mm) pieces of organic materials, like leaves, evergreen needles, wood and other plant parts. This material comes primarily from streamside vegetation. Some species of stoneflies are shredders. They have rugged mouthparts to chew up leaves. Tipulid, or crane fly, larvae are also shredders. Crane fly larvae look like fat, olive-green to pale-white worms. Bacteria and fungi living on the surface of the leaves also get eaten. They help to “digest” and soften the leaves and other materials in the shredder’s stomach.



Shredders are very dependent on streamside vegetation. The wastes of shredders provide nutrition to another group—the collectors.

COLLECTORS

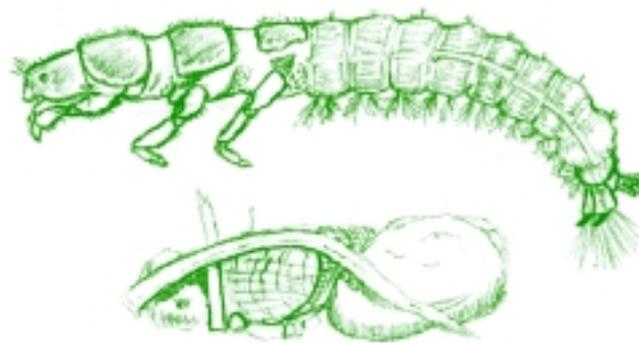
Collectors gather or filter food from the water. Collectors feed on smaller (less than 1 mm) pieces of organic materials, which drift in the current. These smaller pieces may have passed through a shredder upstream. Freshwater clams and mussels are an efficient example. Filter feeders strain food particles as an aquarium filter cleans water. An inhalant siphon sucks water into the cavity and over the gills. Algae, plankton and other bits of food are filtered. The water is then shot out an exhalant siphon. This system allows bivalves to eat and breathe at the same time!



Some collectors have external filters to capture food.

Black fly larvae and midges use fans on their heads to capture food particles in the current. The fans are then cleaned off in their mouths. There are other types of suspension feeders that use special appendages. They include protozoa, bryozoa (moss animals), rotifers and water fleas.

Other aquatic animals have unique ways of capturing suspended food. They trap their dinner. Some caddis larvae build nets similar to a spider’s web. The net faces into the current and catches detritus. The caddis larva eats the detritus and net at the same time. It then turns around and spins a new one.



SYMBIONTS

Neither animal is harmed in a symbiotic relationship, but one or both may benefit. The peritrich is a protozoan that enjoys this lifestyle. It attaches to crustaceans, turtle shells and insects. There’s nothing like a free ride to new food and fresh oxygen! Some peritrichs live on the tentacles of hydra (related to jellyfish). Life works out great in this relationship. The peritrich eats food caught by the hydra. It, in turn, keeps the hydra’s tentacles clean.

There are even symbiotic plants. One type of alga lives in the body of hydra. The alga produces food and oxygen. The hydra provides carbon dioxide and a safe place to live. What a way to go through life!

No matter how you slice it, aquatic macroinvertebrates have interesting ways to get food. Take a close look at one of these critters the next time you are near a stream or pond. Take a minute to turn it over. Look at its mouth parts and see if you can figure out how it lives. You just might impress your friends with your guess. ☐



Pond and Stream Study Guide

Interpreting Physical and Chemical Factors

Water Temperature and Fish—Fish Commonly Found in Aquatic Field Studies and Temperature Preferences

COLDWATER FISH

Fish that require water temperatures **less than 70 degrees** to grow and reproduce.



Rainbow Trout



Brown Trout



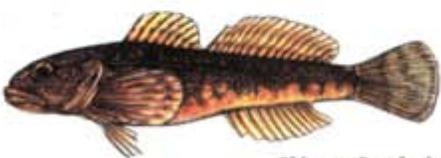
Brook Trout



Blacknose Dace



Longnose Dace



Slimy Sculpin

COOLWATER FISH

Fish that require temperatures **higher than 65 degrees but less than 75 degrees** to grow and reproduce.



Fallfish



Logperch



Creek Chub



Common Shiner



White Sucker



Smallmouth Bass

WARMWATER FISH

Fish that require water temperatures **higher than 75 degrees** to grow and reproduce.



Margined Madtom



Largemouth Bass



Bluegill



Redbreast Sunfish



Rock Bass



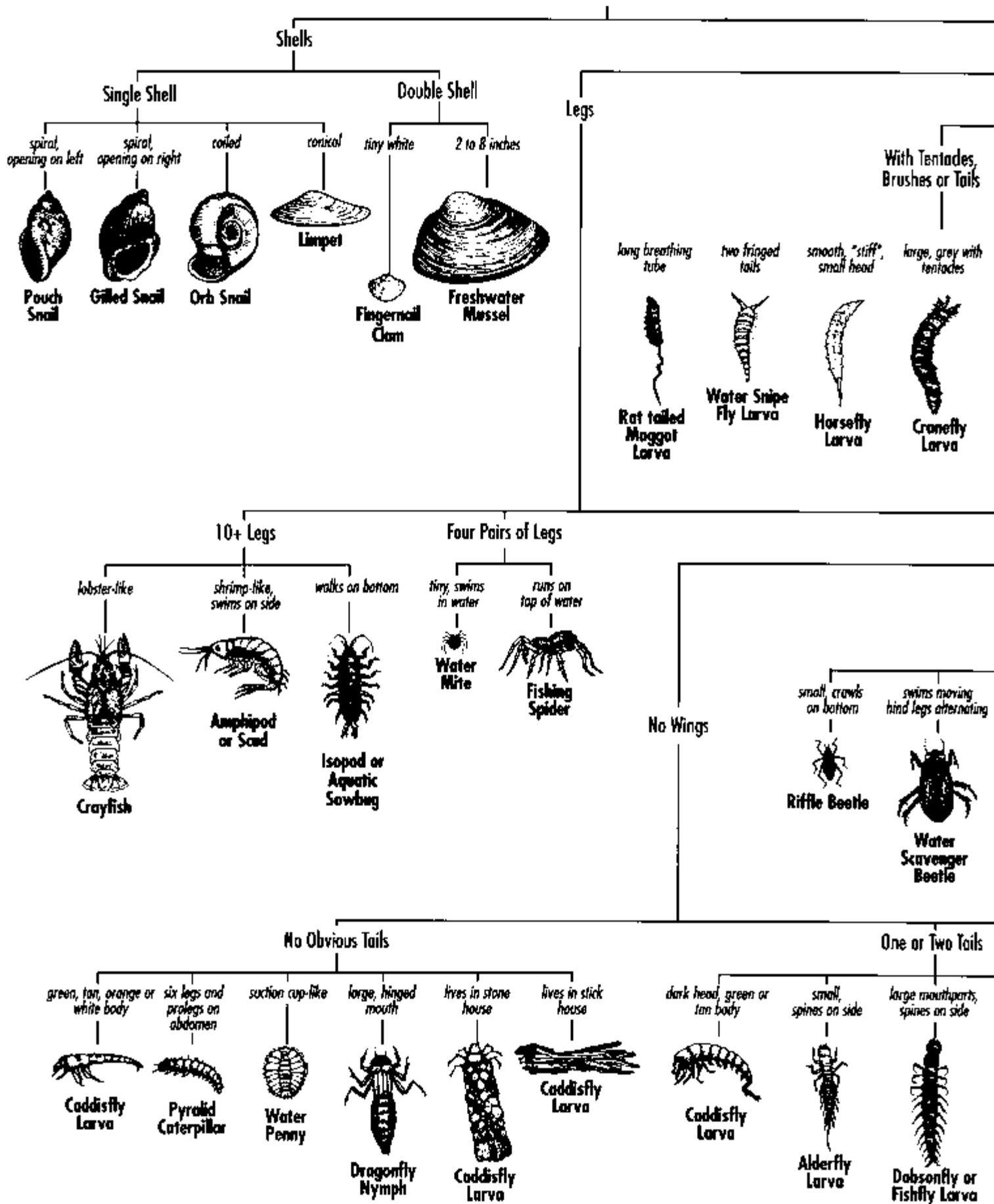
Brown Bullhead

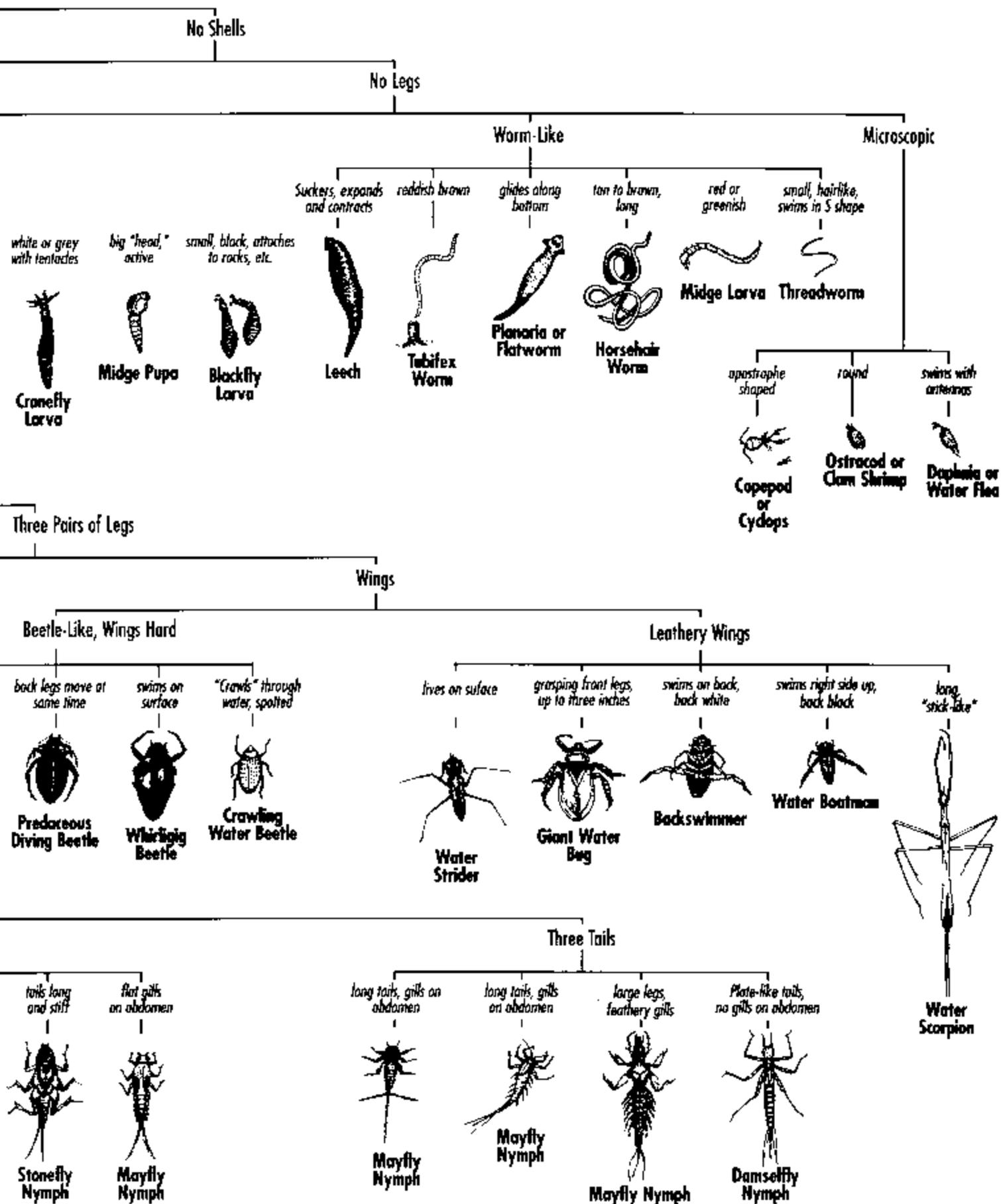


Channel Catfish

Species shown are not in proportion to each other, but are enlarged to facilitate identification.

Key to Macroinvertebrate Life





Dissolved Oxygen (DO) *Dissolved Oxygen Requirements by Fish Community*

Cold Water Fishes: 6 mg/l and above

Warm Water Fishes: 5 mg/l

Solubility of Dissolved Oxygen

Solubility: Amount of dissolved oxygen that distilled water can hold at given temperature

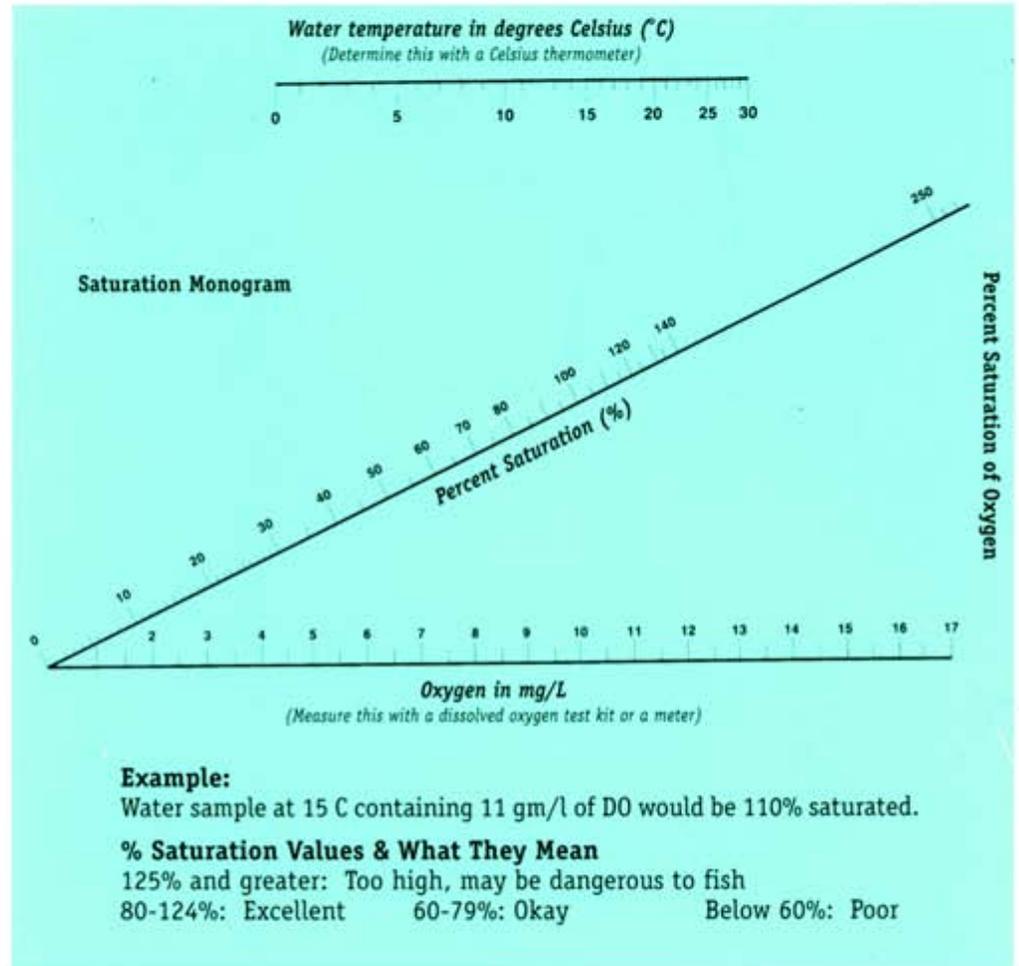
Temperature (C°): Solubility (mg/l)

0:	14.6
1:	14.2
2:	13.8
3:	13.5
4:	13.1
5:	12.8
6:	12.5
7:	12.2
8:	11.9
9:	11.6
10:	11.3
11:	11.1
12:	10.9
13:	10.6
14:	10.4
15:	10.2
16:	10.0
17:	9.8
18:	9.6
19:	9.4
20:	9.2
21:	9.0
22:	8.9
23:	8.7
24:	8.6
25:	8.4
26:	8.2
27:	8.1
28:	7.9
29:	7.8
30:	7.7

Dissolved Oxygen Percent Saturation

Directions

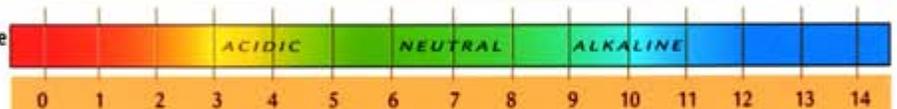
1. Determine water temperature in degrees C, and find that value on upper (temperature) scale. *To convert F to C: $[(F-32) \times 5] / 9 = C$
2. Determine dissolved oxygen and find that value on the lower (DO) scale.
3. Using a straight edge (ruler, piece of paper), draw a line from the temperature value to the dissolved oxygen value. The point at which the line crosses the middle (saturation) scale is the percent saturation of oxygen.



Adapted from: Water, Water Everywhere: Water Quality Factors Reference Unit, HACH, Inc., Loveland CO, 800-227-4224.

pH and Aquatic Organisms

pH Scale



Tolerant ranges for certain species

Mayfly	5.5 to 7.5	Brown trout	5.0 to 9.5	Carp	5.0 to 9.0
Caddisfly	5.5 to 7.5	Brook trout	4.5 to 7.5	Catfish	5.0 to 9.0
Stonefly	5.5 to 7.5	Yellow perch	4.5 to 7.5	Bullfrog	4.5 to 7.5
Snails, clams, mussels	6.0 to 9.0	Smallmouth bass	5.5 to 7.5	Wood frog	4.0 to 7.5
Crayfish	5.5 to 7.5	Pumpkinseed	5.0 to 7.5	American toad	4.5 to 7.5
Rainbow trout	5.5 to 9.5	Fathead minnow	6.0 to 7.5	Spotted salamander	5.0 to 7.5

Alkalinity

(Calcium carbonate:) $CaCO_3$

Freestone Streams

10 mg/l or less: Very sensitive to acid precipitation
 10-20: Somewhat sensitive to acid precipitation
 20mg/l or greater: Not sensitive to acid precipitation

Limestone Streams

75 mg/l or greater