BioMEDIA ASSOCIATES

The Biology of Lakes, Ponds, Streams, and Wetlands Teaching Guide

Exploring fresh water habitats makes a marvelous introduction to the study of living things.

This program examines three kinds of habitats found in lakes, ponds and wetlands.

• the weedy shallows
• the open water
• bottom sediments.

A 15 minute section on stream life shows the striking adaptations that allow organisms to live in flowing water.

Studying living things in their natural habitats is an essential part of biology education. By learning some common names, some basic classification and some of the study methods used for observing aquatic organisms, students will develop the confidence and interest they need to begin exploring fresh water environments on their own. If several days are available for the study of fresh water life, we recommend taking a habitat a day, with discussion and as much follow up observational lab work as possible, including field trips to local wetland habitats.

Lakes, ponds and wetlands naturally grade into each other. They are related over time as lakes fill in becoming ponds, then wetlands, then meadows. This process may take place over several thousand years and is the direct result of eroded material carried in by streams and the constant rain of organic material resulting from biological productivity.

To demonstrate one of the key events in lake-pond-wetland-meadow succession, we suggest setting up a “natural aquarium” at the beginning of the school year. Stock your artificial wetland with plenty of plant and animal life collected from a nearby pond and keep the aquarium where there is plenty of light for photosynthesis. A nylon stocking filled with garden soil, or well aged steer manure, will provide “timed release” of nutrients that will accelerate algae and plant growth. Not only will such a natural aquarium provide a wealth of organisms for class study, but over the school year the bottom sediment will build up, allowing students to estimate the rate of sedimentation in similar wetland habitats. We have seen a buildup of a centimeter or more of bottom sediment over the school year in aquariums that have been allowed to go natural.

The Weedy Shallows

A dip-net sample from the aquatic vegetation captures a number of common pond dwelling insects.

Back swimmers, and the next two insects shown, are members of the Order Hemiptera, the true bugs. Back swimmers carry air bubbles for respiration and have fringed swimming legs, improving efficiency.

What advantages might there be in foraging on the underside of the water's surface film?

Giant water bugs are surface breathers with front legs modified for grasping prey. The females attach the fertilized eggs to the male's back, assuring a clean, well protected substrate for embryological development.

Water scorpions have elongated bodies, long snorkel tubes and raptorial front legs. They hang from the surface in wait for passing prey.

How do these three true bugs, all living in the same habitat, avoid competing with each other for food?

Dragonflies and damselflies belong to the insect order Odonata. Both are predators in their larval stages as well as adults. Some adaptations: Both have large motion sensing eyes and hinged mandibles, tipped with sharp claws. The mandible can snap out, nailing prey animals often nearly as large as the predator. Dragonfly larvae are anal breathers with internal gills. A rapid exhale can shoot the larva away from danger. Dragonflies and damselflies make good aquarium subjects, allowing detailed observation of their feeding behavior, molting, and eventual emergence as adults.

Water tigers, the larval stage of a giant water beetle, are the tyrannosaurs of the weedy shallows. They have no mouths, but instead wield a set of wicked hypodermic mandibles associated with internal pumps that inject digestive enzymes into their prey. In the observation, feeding begins as the water tiger reverses its pumps and begins sucking in the predigested “tadpole soup.” Feeding began about 15 minutes after the attack. Notice the changes in the tadpole’s appearance brought about by the digestive enzymes.

Fishermen associate mayflies with trout streams, but there are also many species adapted for life in still water. Mayfly larvae scrape algae from underwater surfaces or feed on detritus. They can be very abundant, creating a source of food for the insects and fish living in lakes and ponds. Adult mayflies have short lives, in some species only a day, just time to mate and lay eggs that take one to two years to go through the larval sequence. The rows of leaf-like gills lining the abdomen allow mayfly larvae to forage on the pond bottom and other habitats low in dissolved oxygen.

Does the amount of dissolved oxygen affect the rate of “fanning” the gills?

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Hydra and Planaria, “Biology Classics”
A jar of pond water with a hand full of aquatic plants will often contain hydras and planarians, along with a variety of other small invertebrates and protists. Observe how *Hydra* captures prey. Where is its mouth? How does it get rid of indigestible waste? How does it move? How does it reproduce?

Planarians are fascinating creatures to observe. Their feeding tube seems to have a mind of its own as it sucks up blood and bits of tissue.

Fresh Water Annelids, _Chaetogaster_ and _Stylaria_
There are many species of oligochaete annelids (the group that includes earth worms), but two are common in the weedy shallows. *Chaetogaster* is a predator, *Stylaria* a detritus feeder. Both have clear outer skins allowing their anatomy to be studied with a microscope in living specimens. What kinds of adaptations for food capture can be seen in *Chaetogaster*? What could be the function of that proboscis—the long “nose” on *Stylaria*?

Pectinatella, a Fresh Water Bryozoan
Look for these interesting colonial animals in reservoirs and lakes where water levels fluctuate. These bryozoans survive drying by producing statoblasts that contain germinal cells that will develop into the founders of new bryozoan colonies. The statoblasts stick in shoreline vegetation, where they withstand drying and freezing, ready to produce new bryozoans when the water returns.

Protists of the Weedy Shallows

In jars of pond water, lowering oxygen levels will drive many kinds of protists to the surface where they can be picked up for microscopic examination. This series of short observations on some of the more common protists illustrate the variety of ecological roles seen in single cells. They are particularly important intermediaries in pond food chains based on decomposition where the food chain goes: bacteria to protists to insects and small fish.

Rotifers of the Weedy Shallows

On their own limb of life, rotifers give us a peek at what early multicellular life may have been like. Most species have “wheel organs” that generate the water currents that bring in food, and most have a complex chewing organ (the mastax) that grinds up food before it passes into the intestine.

The Open Water Environment

A functional plankton net can be created from a nylon stocking attached to a coat hanger frame. Our deep lake sample (approximately 10 meters down) brought in *Leptadora*, a giant predacious water flea. These transparent hunters capture copepods and smaller water fleas. What could be the function of that huge eye?

Daphnia, the common waterflea, can be found drifting into the weedy shallows where it creates a food source for hydras, back swimmers and others. Great swarms of these small crustaceans create a food source for fish. Daphnia swims using its extended feathery antennae, gradually moving up at night and down by day, covering large vertical distances.

What could be the function of this daily “vertical migration?”

Adaptations for Planktonic Life

The “gulp feeding” planktonic rotifer *Asplanchna* is a transparent animal, a stealthy adaptation for living with schools of hungry fish. Another hazard for planktonic organisms is sinking. Swimming is one way to stay in the water column, but various adaptations have evolved that conserve swimming energy. Planktonic copepods have long bristly antennae, held out like parachutes slowing the sink rate. *Daphnia* uses a stroke and hang swimming style that conserves energy. Many kinds of rotifers have long spines that slow their sink rate. An interesting case of parallel evolution is seen in *Ceratium*, a dinoflagellate and *Kellicottia,* a rotifer—two unrelated organisms. Here a single cell and a complex animal have evolved similar body arrangements beneficial to open water life. The next observation shows the phantom midge larva, one of the few insects adapted for planktonic life. The phantom midge has gas filled floats in each end, keeping it buoyant and horizontal in the water, the best orientation for launching attacks on passing copepods and water fleas. In the observation it grabs a copepod (*Cyclops*) that instantly drops its two egg sacs.

The Bottom Sediment
The bottom of lakes, ponds and wetlands is an environment populated by decomposers, scavengers and detritus feeders. Of greatest importance are the bacteria that break down every bit of organic material falling to the bottom. However, bacterial decomposition uses up oxygen and produces carbon dioxide, making it difficult for aerobic organisms to survive in the mucky bottom ooze.

One worm has adapted to this habitat—*Tubifex*. These worms feed on the rich organic muck, waving their tails in the water to pick up the relatively few molecules of dissolved oxygen available. Their circulatory systems contain a hemoglobin, a molecule with a big thirst for oxygen. With its adaptations for living in a low oxygen world, *Tubifex* can take advantage of a rich food source with little competition. Of course with all that bacteria at work, bacteria feeding protists are abundant, living in the organic ooze that carpets the bottom. It's a good place to start a culture of *Paramecium*, *Vorticella*, *Halteria* and other bacteria feeding ciliates. Where there is sufficient oxygen, ostracods (seed shrimp) and amphipods work over every bit of organic material harvesting detritus, protozoans and bacteria.

Vernal Pools
Vernal pools typically hold snow melt or rain water for a few weeks, and then dry out and bake in the summer sun. It seems impossible for aquatic life to adjust to such hazards, but these pools abound in kinds of species and in numbers of individuals. All have special adaptations that allow them to survive the hot dry summers and freezing winters. These include: hard coated eggs, spores, cysts, or in the case of rotifers, nematodes, and waterbears, a state of abiosis where the animal loses almost all of its water and yet survives, awaiting rehydration.

Streams
Small streams often contain an amazing diversity of living things. This section takes one on a field trip to a typical small stream flowing out of a hilly watershed. Some of the remarkable adaptations observed in stream dwellers: suckers for hanging on in waterfalls, compressed bodies that lower resistance, and behaviors that keep aquatic insects in the safety of under-rock crevices. Feeding adaptations seen include brushes for scraping diatoms from the rocks, nets for trapping food carried by the current, and in slower waters a variety of feeding methods, much like those seen in pond dwellers. Some of the organisms seen: the larval stages of mayflies, blackflies, caddisflies, stoneflies, dobsonflies, water beetles, and midges.

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