Aquatic Invertebrates in Still and Flowing Waters

Overview

Students are introduced to diverse invertebrate organisms and their adaptations for living in water by interpreting the poster. Aquatic Invertebrates in Still and Flowing Waters.

Title
Aquatic Invertebrates in Still and Flowing Waters

Investigative Question
What are some of the common and not so common invertebrates that live in water and what adaptations allow them to exist in aquatic habitats?

Overview
Students are introduced to diverse invertebrate organisms and their adaptations for living in water by interpreting the poster. *Aquatic Invertebrates in Still and Flowing Waters.*

Objective
Students examine drawings of invertebrate organisms found in Illinois and investigate their adaptations for living in water.

Materials
Student Pages 1 through 9; copies of the poster *Aquatic Invertebrates in Still and Flowing Waters.* For your convenience, a mini-poster is shown on the following page; only the full-size posters are used in the activity.
For the extension activity: macroinvertebrate slides; projector.

Time
One and a half 50-minute class periods.

Advance Preparation
1. Copy the student pages.
2. Student groups will need relatively large work areas so that their posters can be laid out for easy viewing. Depending on the classroom, one or two groups may be able to tack posters on a bulletin board and work there.
3. Obtain copies of the poster *Aquatic Invertebrates in Still and Flowing Waters* from publications office http://www.inhs.uiuc.edu/chf/outreach/eduresources/eduposters.html

Introducing the Activity
1. Distribute and discuss Student Page 1. When you are ready to consider the aquatic invertebrates groups diagrammed there, move to step 2.
2. Tack one poster at the front or side of the room and distribute three or four copies around the classroom. Give copies of the key to three or four students who will serve as resource persons.
3. Announce that we are going to be introduced to a few of the hundreds of aquatic invertebrates found in Illinois. Our poster is only a partial group portrait. Following the order shown on Student Page 1, introduce the sponges and ask students to look for a member of this group on the poster. Allow a few minutes for the search before turning to the resource persons for help. Students may be surprised to learn that there are freshwater sponges and that Illinois has a resident sponge. Move on to mollusks and its division into univalve and bivalve members. If members of these groups are not located on the poster in a minute or two, turn to the resource persons. Continue with the remaining groups and their subgroups. Be sure that terms new to the students are understood: vertebrates, invertebrates, segmented, unsegmented, exoskeleton, thorax.

Procedure
1. Distribute Student Pages 2 through 8, giving each student only one of the pages. In a typical class, four or five students will probably receive the same page. Those who received the same page will subsequently be members of the same group. Explain that the class will take a simulated field trip to investigate adaptations of invertebrates for living in water. As homework, each student studies the assigned page and prepares to share that information with the class on the following day. Each student should also formulate at least two questions to ask the class after his or her presentation.

2. On the following day, divide the class into groups according to the student page each student received. Give each group a poster. Allow about ten minutes for each group to organize a report on the adaptations they were assigned. Groups may divide the reporting tasks in a number of ways. For example, one student may serve as the chairperson, introducing each speaker and asking the class for questions after the presentation. One or two students can divide the material for an oral presentation to the class; a third can be in charge of vocabulary words that need special emphasis; a fourth can ask the questions each member contributed as part of the homework assignment. A fifth student can handle the questions at the bottom of the student page, asking all members of the class to locate the appropriate invertebrates on their posters. He or she can record at the chalkboard the number of the question and the names and numbers of each invertebrate mentioned in response to one of those questions. The chairperson or another member of the group should be given a copy of the key to the poster so that he or she can resolve questions if problems in identification arise. Before moving on to the next group, compare the master list at the chalkboard with the possible answers given below. All possible answers need not be discussed, but you may want to note an invertebrate that was not mentioned if its adaptation is of particular interest.

Possible Answers to Questions on Student Page 2:

Breathing under Water (respiration)

Gills: 3, *6,7,* 8,9,10,11,12,13,15,16,17,18, 20, 21,22,27,28,29,31,32,33,36,37,48, 51

Skin: 5, 14, 26, 28, 49

Respiratory tube: 38,44,45,46

Possible Answers to Questions on Student Page 3:

Finding Food

Predators: 1, 2,3, 5, 7,12.17. 21,23, 24, 25, 30, 35, 37,38,43,46,47,50,51, 52

Herbivores: 2. 3,4, 6, 8.10,11,13,15,19, 20, 29, 39,41,47,48,51

Scavengers: 3,4, 5,14,15, 23,25, 26, 27, 28, 29, 36,39,48,49,51

Filter Feeders: 9, 16, 18, 22, 31, 32, 33, 34,45

Possible Answers to Questions on Student Page 4:

Protection/rom Predators

Protective shells or cases: 4, 8,16,18, 20, 39,48

Camouflage or cryptic behavior: 3,4, 5, 6, 7, 8, 10, 16, 18, 20, 21. 29, 30, 37, 38, 46, 48, 50, 51, 52

Possible Answers to Questions on Student Page 5:

Locomotion (living in and moving around the environment)

1. 22-air bubbles; 23-paddle-shaped legs; 25, 30. 35-hairs on legs; 31, 32, 33, 45-hairs; 44-paddle-shaped gills; 47-paddle-shaped legs and hairs
2. Legs with claws: 3, 6, 7, 8, 10, 11, 12, 13, 17, 19, 20, 21, 27, 30, 35, 36, 38, 46, 50, 51
3. leech-5; limpet-4; snails-39,48; flatworms-49
4. earthworms: 14, 28 (push their way through substrate with muscular bodies)
mussel: 16 (pulls with its muscular foot)
burrowing mayfly: 15 (spadelike feet, constructs a burrow)
sludge worms: 26 (muscular body, constructs tubes)

Possible Answers to Questions on Student Page 6:

Life Cycles and Reproduction (noil-insects)

1. crayfish-3, 51; water flea-31
2. snails-39,48; mussel-16; fingernail clam-18
3. Unless the mussel species were able to change its behavior and use another species to raise its glochidia, the mussel species would become extinct after the adult mussels died out.

Possible Answers to Questions on Student Page 7:

Life Cycles and Reproduction (insects)

1. damselfly-1, 21; stonefly-7, 41; mayfly-6, 13, 15,40; dragonfly, 50

2.1
3. 30. The adult, male giant water bug will defend itself from other predators; in the process, it also protects the eggs.
4. phantom midge larva-22; midge larvae-29, 37; mosquito life cycle-42, 45, 44, 2
5. adult beetles-19, 23, 35; larval beetles-10, 11, 17,46; dobson fly-12; caddisfly-8, 20

Possible Answers for Questions on Student Page 8:

Getting Around (dispersal)

1. Can fly:1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17, 19, 20, 21, 22, 23, 24, 29, 30, 35, 38, 40, 41, 42, 43, 44, 45, 46, 47, 50
Cannot fly:3,4,5,14,16,18,25, 26, 27, 28, 31, 32, 33, 34, 36, 39, 48, 49, 51, 52
2. To find a new feeding area, avoid competition, avoid overcrowding, avoid predators, occupy unused habitats, find a mate.
3. 23. Look down for prey and up for enemies and bodies of insects floating on surface.
4. 22

Assessing the Activity

On the chalkboard, generate with the class a master list of specific adaptations (e.g., breathing tubes, paddlelike legs, streamlined bodies). Ask students in all groups to find examples of invertebrates on the poster that illustrate these adaptations. List these invertebrates opposite the adaptations they illustrate.

Extending the Activity

1. Obtain aquatic macroinvertebrate slides or photos that show adaptations for life in an aquatic environment (e.g., the mouthparts of a dragonfly nymph adapted for grabbing prey, top and bottom views; damselfly nymph, gills adapted for breathing at the end of the abdomen; immature mayfly, gills adapted for breathing along the abdomen; water scorpion, a breathing tube or snorkel). As you project each slide, ask students to identify an adaptation that allows the insect to live successfully in an aquatic habitat
2. Do students discover adaptations not presented here (e.g., coloration)?

State Goals

11,12

Concept

Many different invertebrates have adapted to living in water, and these organisms have developed unique structures and functions for living in, around, and under water.

Safety and Waste Disposal

No dangerous or hazardous materials are used.

Student Page 1: Background Information

Scientists who locate, describe, name, and determine the relationships among species are called taxonomists or systematists. In biology, the purpose of classification is to provide a system for organizing a large body of information about living organisms. We rely on a hierarchical system, a series of levels that become increasingly exclusive. As information becomes more specific, fewer organisms can be included (and more excluded) until an individual unit, the species, has been identified. When these relationships are diagrammed, they form a "family tree."
The Animal Kingdom is divided into vertebrates, animals with backbones (mammals, fishes, birds, reptiles, and amphibians), and invertebrates, animals without backbones. The aquatic invertebrates of Illinois demonstrate a wide range of adaptations for living in pond and stream environments. Each of these animals must be able to breathe oxygen, find food, protect itself from predators, move about in its environment, and reproduce. Aquatic invertebrates accomplish these tasks while spending all or part of their lives in or on the water. Hundreds of species of aquatic invertebrates are found in Illinois, and these species use a wide range of strategies to live and reproduce. A sample of these can be seen in *Aquatic Invertebrates,* a poster that we will use to learn more about these organisms. Examples of the invertebrates shown below are illustrated on the poster. On the following page, these invertebrates are listed again, this time with a brief description of their characteristics.

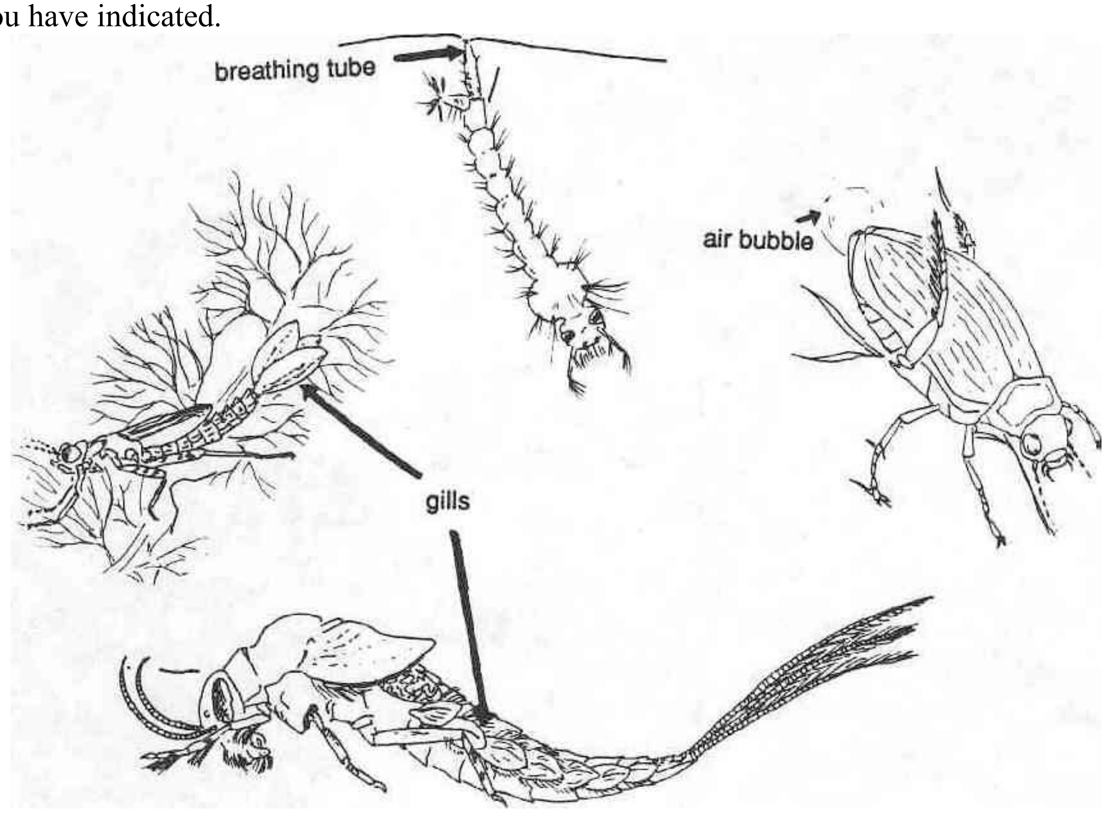
Student Page 2: Breathing under Water (respiration)

All aquatic invertebrates must breathe oxygen. The best source of oxygen is the air. Many aquatic invertebrates take their oxygen directly from the air, even though they live in the water. They may come to the surface and capture air on their bodies (e.g., under the wing covers), with their legs, or with hydrophobic hairs (hairs that repel water) on the outside of their bodies. Some gulp air directly through breathing tubes.

Water also contains dissolved oxygen. Most of this oxygen is picked up by the water at its surface where the water comes into direct contact with the air. Any agitation of the water's surface, such as by wind or current, increases the amount of dissolved oxygen in the water. Aquatic plants also release oxygen into the water during photosynthesis. In addition, cooler water holds more dissolved oxygen than warmer water.

Many aquatic invertebrates take oxygen directly from the water through internal or external gills, directly through the skin, or through the use of a bubble of air which is attached to their bodies and which they take with them below the water's surface. These bubbles can extract oxygen from the water and function as physical gills. Insects either breath through gills or from the surface. Insects that breathe air do not have lungs; instead, they breathe through holes or spiracles that are located either along their bodies or at the end of breathing tubes. The spiracles open into a network of tubes (trachea) that takes oxygen to the cells of the insect. Crustaceans have gills covered by their exoskeletons; they pump water over the gills by fanning some of their legs. Worms can exchange oxygen directly through their skin. Some snails collect air in their shells when they are at the water's surface, others breathe through gills, and others obtain oxygen by pumping water through their bodies. Questions:

1. Refer to the *Aquatic Invertebrates* poster. Find five invertebrates that breathe by using gills, two that breathe through their skin, and four that breathe through respiratory tubes that penetrate the surface.
2. What types of animals use these various methods for breathing? Use the poster key to identity those you have indicated.



Student Page 3: Finding Food

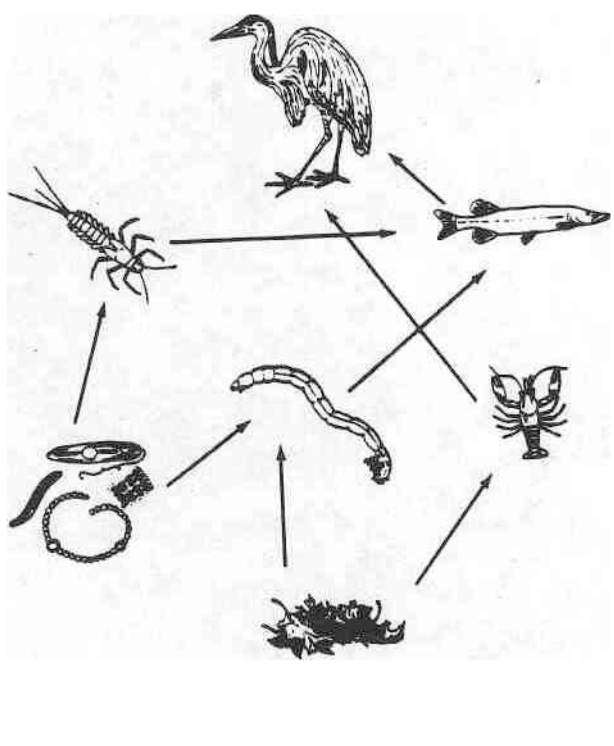
A basic process in aquatic ecology, as in all ecology, is energy flow—the movement of chemical energy within a food chain. A simple aquatic food chain might go something like this. A small crustacean feeds on algae (an herbivore) and is in turn eaten by a small fish which is then eaten by a predaceous beetle larva. When several of these simple food chains interact together with detritivores (decomposers) and omnivores (organisms that eat animal and vegetable matter), they form a more complex structure that we call *a. food web.*

The aquatic environment, like the terrestrial environment, supports herbivores, predators, omnivores, and scavengers. Herbivores graze on aquatic algae, mosses, and other aquatic plants. Predators chase down their prey or wait in ambush for prey to pass by as they hide, camouflaged in plants or under rocks. Predators often have large, sharp mouthparts or grasping claws. Omnivores eat just about anything, plant or animal. Scavengers (detritivores or decomposers) feed on dead and decaying plants and animals. Some invertebrates (filter feeders) filter fine particles of food from the water through netlike structures or by pumping water through their bodies.

When scientists study the structure and functioning of food webs, they use a specialized vocabulary to describe the relationships among organisms. A term often used in the study of food webs and energy flow is *trophic,* a word that comes from a Greek root meaning to nourish. Trophic structure, then, is the nutritional interrelationships among organisms in a particular food chain or web. In this context, the word *nutritional* is virtually synon-omous with the word *energy.*

Questions:

1. Find three of each of the following aquatic invertebrates on the poster: predators, herbivores, and scavengers or filter feeders. Some invertebrates fall into more than one category.
2. Choose ten organisms from the poster that represent several methods of obtaining food. As a class, develop a food web (who eats whom) on the chalkboard. As shown in the food web below, arrows move from the organism being devoured to the one doing the devouring.



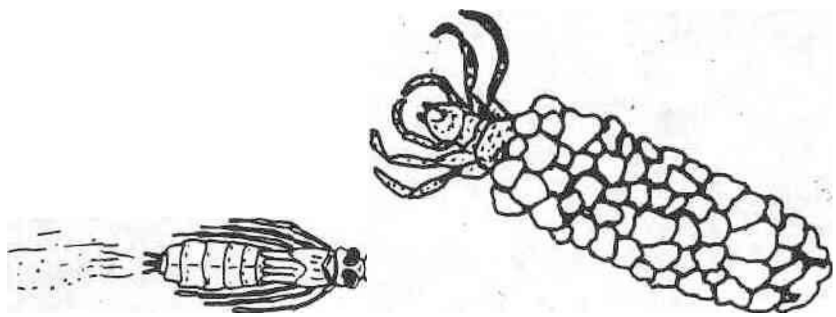
Student page 4: Protection from Predators

To avoid predation, some aquatic invertebrates wear protective shells; others build protective cases of sand, pebbles, or plant material. Some rely on camouflage; others hide under rocks or depend on their ability to flee. An example of structures constructed by an insect are the cases made by caddisflies. These cases serve as both protective covering and camouflage. Some species construct cases from grass blades, some from sand grains and small pebbles, others from sticks or other debris. An interesting example of an adaptation for fleeing is exhibited by dragonfly nymphs. Although a dragonfly nymph is a predator, it can also be prey for a larger, stronger animal. To escape, nymphs use their respiratory apparatus for a double purpose. To breathe, they have a rectal gill. They take in and expel water through the rectum and extract oxygen from the water. When threatened, they expel this water forcefully, making themselves Jet-propelled!

Questions:

1 .Locate on the poster three aquatic invertebrates that have protective shells or cases.

2. Locate five that demonstrate camouflage or cryptic behavior.



Student page 5: Locomotion (living in and moving around the environment)

Aquatic invertebrates have many adaptations that allow them to move about their environment—they may swim, burrow, or climb about on rocks or plants. Swimming invertebrates may have legs modified to function as paddles. Their legs may have clusters (patches) of hairs that act very much like feathers on the wing of a bird and allow the aquatic invertebrate to "fly" under water.

Some invertebrates crawl about on the substrate (bottom surfaces) of the pond or stream; others cling to plants and logs. These invertebrates may have claws that help them cling to various surfaces. Animals that crawl on the substrate of a swiftly flowing stream must be able to cling tightly or be washed downstream. Many have flattened bodies.

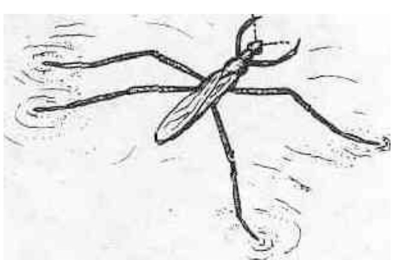
Leeches, a type of worm, cling to the substrate with a "suction cup" appendage. Snails, limpets (a type of snail with an uncoiled shell), and flatworms adhere to the substrate by clinging with the flat undersides of their bodies.

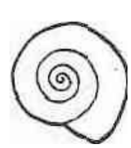
Many aquatic invertebrates burrow in the substrate of a stream or pond. Aquatic earth worms push their way through the soil with muscular contractions of their bodies. Mussels pull their shells along and through the bottom material with a muscular foot. Some invertebrates, such as burrowing mayflies, have legs that are spadelike. Burrowing invertebrates, such as sludge worms or burrowing mayflies, and some midge and caddisfly larvae, may construct tubelike homes on the bottom.

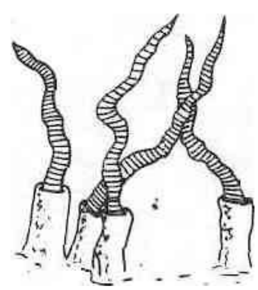
The water's surface is a unique habitat that many aquatic invertebrates are able to exploit. The surface of the water behaves as if there were a film across it. This filmlike property of water is called *surface tension.* Very lightweight animals are able to walk on the surface of the water. In fact, some small invertebrates may actually have difficulty breaking through the surface tension.

Questions;

1. Find three invertebrates that swim through the water and describe one special adaptation that helps each to swim.
2. Find five invertebrates that crawl on or cling to the substrate (rocks, logs, plants) using legs equipped with claws.
3. Find a leech, a limpet, two snails, and a flatworm on the poster.
4. Find examples of aquatic earthworms, mussels, burrowing mayflies and sludge worms on the poster. Compare their adaptations for burrowing.







Student page 6: Life Cycles and Reproduction (non-insects)

Some aquatic invertebrates, such as aquatic worms, mollusks, and most of the crustaceans, live their entire lives in water. Crayfish can leave the water for short periods of time, but most species spend most of their lives in the water. Those that dig burrows with chimneylike entrance holes live near the water. They also return to the water to reproduce. Crayfish mate during the late winter or early spring, and later in the spring the female lays her eggs. She carries them in a mass under her tail. The egg mass looks very much like a raspberry, and a female carrying eggs is said to be "in berry." When the young crayfish hatch, they ride along under their mother's tail for a week or more. After a few days, the fully formed but miniature crayfish are on their own. Very young crayfish can often be found hiding and feeding in masses of algae or among plants in shallow water.

Water fleas are tiny crustaceans. Most of the population are females that reproduce parthenogenically, that is, the eggs develop without fertilization by a male. Water Fleas are born alive. Occasionally, males are produced and mate with some of the females. Eggs produced in this manner are cysts capable of lying dormant for years before hatching.

Aquatic snails, such as ram's hom snails and limpets, are hermaphrodites—which means that each organism has both male and female reproductive organs. Any two snails can mate and fertilize each other's eggs. Male and female river snails, however, are separately sexed. Most aquatic snails in Illinois lay gelatinous masses of eggs on plants and substrate. A few species of snails give birth to live, fully formed young.

Even though fingernail clams look like miniature versions of mussels, they reproduce very differently. Fingernail clams are hermaphrodites. Sperm is released into the water and picked up by the gills, where the eggs are fertilized. The eggs then develop in a brood pouch. Fingernail clams later give birth to fully formed baby fingernail clams, tiny versions of their parents. Most freshwater mussels are either male or female. The males release sperm into the water. Some of these sperm are picked up by the females and their eggs are fertilized in the gills. Early development takes place in the gills, but later, thousands of tiny larvae are released and attach themselves to the gills of fish. Until they are ready to transform into adults, these larvae, or glochidia, live as parasites on the gills of fish. Some species of mussels release their glochidia into the gills of only one species of fish.

Questions:

1. Find a crayfish on the poster; find the water flea.
2. Find two snails, a mussel, and a group of fingernail clams on the poster.
3. If a species of mussel can release its glochidia onto only one species of fish and that fish disappears from the stream or pond, what happens to the-mussel population?

Student page 7: Life Cycles and Reproduction (insects)

Aquatic insects are a very diverse group and demonstrate a wide variety of life cycles and reproductive strategies. Many aquatic insects have immature stages that live in water but adult (reproductive) stages that live near water. Some insects experience incomplete metamorphosis in which the immature stage (nymph) lives in the water. It resembles the adult but lacks wings. The older nymphs develop "wing pads," which are the developing wings. When they molt into adulthood, they leave the water with their now functional wings. Dragonflies, damselflies, true bugs (giant water' bugs, water scorpions, water boatmen and water striders), stoneflies, and mayflies demonstrate this life cycle.

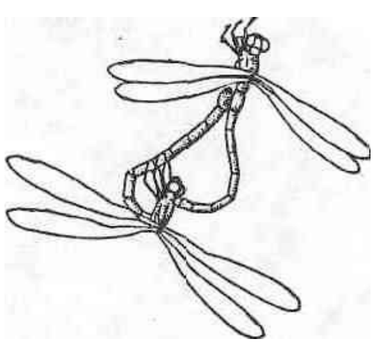
The female giant water bug deposits her fertilized eggs, which may number over one hundred, onto the back of the male by secreting a waterproof glue. The male then carries them with him until they hatch, usually in about ten days.

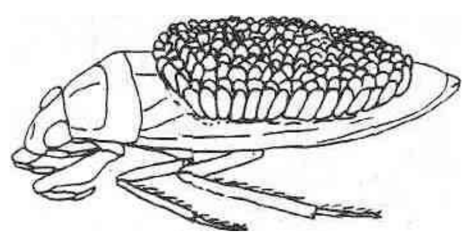
Because dragonflies and damselflies are highly predaceous, getting the sexes together for mating is tricky! Males have developed a unique way to solve this problem. A male takes sperm from the tip of his abdomen and places it in a receptacle near the base of his abdomen. He then seeks out a female, grabs her behind the head with claspers on the end of his abdomen. She then reaches around with her abdomen and couples with the sperm receptacle. After she has been inseminated, both fly off, still in tandem, and she lays her eggs in the water. Often the male does not release the female until she has completed laying her eggs, thus preventing other males from fertilizing her eggs.

Some aquatic insects demonstrate complete metamorphosis in which the eggs hatch into a larval stage that is very different in appearance from the adult. For example, flies, which include mosquitoes and midges, have soft-bodied larvae without segmented legs. When the larva is ready to transform into an adult, it must enter a pupal stage for the change to adult to take place. The larvae of beetles, caddisflies, and dobsonflies have segmented legs and may have a hardened, chitinized body.

Questions:

1. Locate on the poster both nymph and adult damselfies, stoneflies, mayflies, and dragonflies.
2. Locate a pair of damselflies in the process of laying eggs.
3. Look for the male giant water bug with eggs attached. How does this adaptation aid in the survival of its young?
4. Locate larvae of phantom midges and other midges and a complete life cycle (egg, larva, pupa, and adult) of the mosquito.
5. Find three adult beetles, three larval beetles and one larva of the dobsonfly and caddisfly.





Student page 8: Getting around (dispersal)

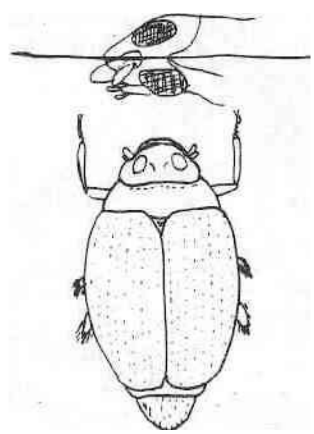
Adults of many aquatic insects can fly; they simply crawl out of the water and fly to a new pond or stream. Crayfish are capable of leaving a stream and trekking across land. In some species of invertebrates, the immature stages live in the water and the adults are terrestrial. Many invertebrates must rely on occasional flooding to relocate to a new area. Sometimes the sticky eggs or the tiny young of snails hitch a ride on the feet of ducks and other water birds.

To move about within a pond or stream, invertebrates crawl or swim. One means of dispersal commonly used by invertebrates in a stream is to allow the current to carry them downstream. Drifting requires very little energy and quickly moves an invertebrate to a new area.

Other insects have very specialized adaptations. Whirligig beetles swim on the surface film of quiet waters. Each of its compound eyes is divided into two parts. The lower part looks under the water while the upper portion looks up into the air. The larva of the phantom midge has bubbles of air trapped inside its body so it remains buoyant and floats near the water surface. \ -

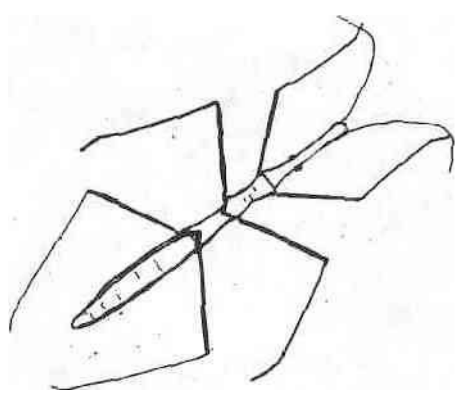
Questions:

1. Find five invertebrates that can move to a new pond or stream by flying at some stage of their life cycles and five that cannot.
2. Why might an aquatic invertebrate disperse to a new location?
3. Locate the whirligig beetle on the poster and note its divided eyes. Why does it need to look both up and down?
4. Find the phantom midge larva on the poster and look for the trapped air bubbles.



Student Page 9: Key for the Poster, *Aquatic Invertebrates*

1. narrow-winged damselfly, adults laying eggs
2. adult mosquito
3. crayfish with chimney burrows
4. freshwater limpet
5. leech
6. flatheaded mayfly nymph
7. stonefly nymph
8. snailcase caddisfly larva
9. blackfly larva and pupa
10. water penny beetle larva
11. riffle beetle larva
12. hellgrammite (dobson fly) larva
13. brushlegged mayfly larva
14. aquatic earth'woraa
15. burrowing mayfly larva
16. freshwater mussel
17. water scavenger beetle larva
18. fingernail clams
19. riffle beetle adult
20. stickcase caddisfly larva
21. narrow-winged damselfly nymph
22. phantom midge larva
23. whirligig beetle adult
24. water strider adult
25. water mites
26. sludge worms
27. aquatic sowbug
28. aquatic earthworm (Branchiura)
29. midge larva
30. giant water bug, adult male with eggs
31. water flea
32.copepod
33. seed shrimp
34. freshwater sponge
35. predaceous diving beetle adult
36. side swimmers or scuds
37. midge larva
38. water scorpion adult
39. ramshom snail
40. mayfly adult
41. stonefly adult
42. mosquito eggs
43. dragonfly adult
44. mosquito pupa
45. mosquito larva
46. water tiger or predaceous diving beetle larva
47. water boatman adult
48. river snail
49. planarians or flatworms
50. dragonfly nymph
51. crayfish
52. fishing spider



Aquatic Invertebrates in Still and Flowing Waters