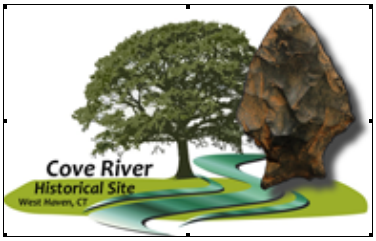
Lesson 4: Air, Air – NOT Everywhere: An Introduction to Insect Breathing Mechanisms

Overview: To develop an understanding of how aquatic insects breathe and the different mechanisms they utilize as adaptations for acquiring oxygen under water.

Objectives: Students will: 1) identify four basic mechanisms for breathing under water; 2) explore how those breathing techniques alter how the insect survives; and 3) create their own aquatic insect based on the student's findings.

Key Concepts: Anatomy, Adaptations, Respiration
Subjects: Biology, Anatomy, Physical Education, Art
Duration: 1 class period (40 minutes)
Setting: In the field, outdoor natural landscape or a large classroom
Season: Any season
Interdisciplinary Connections ***Frameworks:*** None

Environmental Education @ the Cove River Site, and other coastal Connecticut settings.



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Introduction (background): Terrestrial insects do not need to worry about acquiring oxygen because the atmosphere is comprised of more than 20% oxygen. Aquatic insects, however, have special adaptations for breathing, whether they get oxygen from the atmosphere, aquatic plants, or from the water itself. The oxygen content of water bodies depends on many factors, including weather, water movement, temperature, and species composition, but it is always considerably lower than air supplies. This lesson will focus on four basic breathing mechanisms of aquatic insects; air bubble, siphon, gills, and piercing straws, as well as how these mechanisms influence the lives of aquatic insects.

Materials:

- Balloons (or balls is latex allergies)
- Large plastic combs or feathers
- Large straws, preferably hard plastic
- Pencils with a dull point
- Poker chips, about 100-200
- Orange cones (optional)
- Drinking straws, enough for each student
- Clear plastic drinking cups
- Stop watches
- Pencils
- Sketch pads or drawing paper
- Access to water
- Notebook or plain paper

Preparation / Set Up: The example photos will be need to be cut out, and they may be laminated if going to be used in the field.

Engagement: The major purpose of this activity is for students to gain an understanding of the difficulty acquiring oxygen under water and how aquatic insects have adapted to their surroundings.

1. Begin by asking the students if they have ever blown a bubble, whether with gum, in a drink, or with soapy bubbles.
2. Break the class into pairs or groups of three, with each group receiving 2-3 small drinking straws, a plastic cup 2/3 filled with water, a pencil, piece of paper, and a stop watch.
3. Tell the students that their task is to blow a bubble under water with the straw, and another group member will time how long the student can maintain the bubble. That student will then record the time (or the third group member) and the students will switch roles. Each student should use their own straw, they must keep <u>one</u> bubble blown, and the time will end when the bubble bursts or a new bubble is formed.

Exploration: After all the students have had the chance to blow a bubble under water, ask each group to share their best times with the class. Ask the students if they found this task easy or difficult, then ask them to imagine if that bubble was their only air supply and they had to maintain that bubble while hunting for food, finding mates, or being chased by a predator. Many aquatic insects use this method to breathe underwater, since there is not as much oxygen as there is in the atmosphere. For example, diving beetles keep a bubble of air under their elytra (their hard back shell), which allows them to stay under the water longer without returning to the surface – some can stay down their entire lives without need to come back up. (You may show the class the picture of the diving beetle with a clear bubble of air on its abdomen).

There are other methods for breathing under water. Some insects have a siphon like body part at the end of their abdomen, allowing them to suck in air from the water's surface like a straw. There insects, such as mosquito larvae, turn upside down to push their siphon through the water's surface for air, as seen in the photo. Other insects do not go to the surface at all, taking their oxygen from underwater sources. Mayflies, for example (and picture 3), have gills on their abdomens that take oxygen from the water, often waving their gills to increase water flow to breathe. Other insects, like the Elmid beetle in photo 4, use their mouth parts to pierce aquatic plants and take the air trapped inside the plat's stem.

Many of these insects must live in specialized habitats to meet their oxygen needs, such as fast moving rivers, weedy ponds, or locations with year round cold water. Ask the students if they can think of other limitations or adaptations of aquatic insects due to their breathing mechanisms.

To explore this concept further, the next activity asks students to assume the identities and breathing techniques of common aquatic insects. The goal of this activity is not only to explore the four basic breathing mechanisms, but also to have them understand how certain mechanisms can influence aquatic insects' lives and adaptations.

1. In an open area, ask the students to line up, shoulder to shoulder, facing you. If you brought orange cones, you can place them at the ends of the line, or you may use natural markers, such as lining up between trees, sticks, or rocks. You are creating an "end zone" with a large enough area to hold all the students.
2. Break the class into four equal teams; the Diving Beetles, Mayflies, Mosquitoes, and Elmid Beetles. The Diving Beetle team will receive one balloon/ball (bubble), the Mayflies will receive one feather/comb (gills), the Mosquito team will receive one hard plastic straw (siphon), and the Elmid Beetle group will have the dull pencil (piercing mouthparts). Explain to the students that each of these items represents how that aquatic insect breathes.
3. Tell the students that the "end zone" they are standing in represents their air supply, whether it be atmosphere, plant, or from the water. The rest of the open area is their habitat.
4. Each team will start in the air supply. One student at a time will hold the breathing mechanism and venture out into the habitat (open area) to find food. The food they are to collect are the poker chips, which you will spread around the open area evenly.
5. The goal of the activity is to collect as much food as possible before winter (end of game) to survive. However, only the student that is holding the breathing mechanism can go into the habitat – ALL other team members must stay in the air supply or they will suffocate.
6. Based on their breathing mechanisms, each aquatic insect can only stay in the habitat so long before it needs to return to the air supply. To count in this game, each insect team can only collect so many poker chips before it must go back to the group: Diving Beetles: 5 chips, Mayflies: 4 chips, Elmid Beetles: 3 chips, and Mosquitoes: 2 chips.
7. After the breathing insect returns to the group with its chips (an breathing item), they are to deposit the chips into a pile with the team. They hand off the breathing mechanism to another student, and the cycle continues. The game is over when all the chips have been taken up by the insects.
8. Rules: No cheating, no stealing from other groups, no pushing, and be safe.

Explanation: After the game finishes, ask the teams to count their chips, and everyone has

enough to survive the winter. Ask the students why they think certain insects could only be in the habitat so long before returning to the air supply.
Answer:
Diving Beetles: Can hold their large bubble under their elytra.
Mayflies: Take their air from the water, but it limits their size, so they can only carry so much food
Elmid Beetles: Cannot carry as much air with them, and need to tap more plants
Mosquitoes: Stay near the surface, usually do not go too far away from the air source.

Now ask the students to return the poker chips to you, and sit in the clearing. Each student should get a sketch pad/drawing paper and pencil.

1. Ask student to take what they have learned about breathing mechanisms, as well as what they just experienced with how it impacts aquatic insects' lives, to create their own aquatic insect.
2. Student must quickly sketch out the look of their insect and determine the following information for their aquatic insect: size, habitat, breathing mechanism, and food preference.
3. If there is time, students may share with the group, explaining its adaptations and how its breathing technique influences the insect's life.