Lesson Plan

Filter-Feeding in Reef Sponges

Focus

Observe and describe filter-feeding in sponges and explore the ecological role of sponges on coral reefs

Focus Questions

- What characterizes a sponge (Poriferan)?
- What is the feeding method in sponges and how do sponges create the current that draws water into their bodies?
- Why are scientists studying sponges that live on coral reefs?
- What role might sponges play in the ecology of the coral reef?

Learning Objectives

Students will:

- learn about the feeding methods of the simplest multi-cellular animals called sponges.
- record their observations of sponges filter-feeding and create a diagram with descriptions depicting what they observed.
- learn about volume and pumping rates as they relate to sponges on the coral reef.
- learn that organisms at the coral reef interact with one another, sometimes competing for living space.

Grade Level

4-6 (Life Science)

Materials

- ☐ Activity A: Observing the Sponge Using a Tracer Dye
- ☐ Paper and poster boards
- ☐ Markers
- ☐ Activity B: Diffusion Demonstration
- ☐ Shallow clear pan with water
- ☐ Food dyes
- ☐ Hand or electronic fan
- ☐ Student background information sheet
- ☐ Activity C: Sponge Filter-Feeding
- ☐ Activity D: Pumping Rates in the Field
- ☐ Plastic cups or glass beaker
- ☐ Solid object that fits inside glass

Audio Visual Materials

- ☐ Images of sponges (whole and cross sections)
- ☐ Projector or computer
- ☐ Video clip of sponge feeding

Teaching Time

Activity A: 45-60 minutes
Activity B, C, and D: 30 minutes

Seating Arrangement

Groups of 4-5 students seated around tables

Maximum Number of Students

30

Key Words

Sponges, Phylum Porifera, Cells, Energy Oxygen, Filter-feeding, Diffusion, Incurrent Pores, Excurrent Pores, Volume, Pumping Rate, Competition, Collar Cells, Sessile, Larvae

Background Information

Activity A—Observing the Sponge Using a Tracer Dye

Plants, animals, and other organisms are made up of the simplest living units called **cells**. Most cells can only be seen with a microscope. Some very simple animals (protozoans) are made up of only one cell. Most animals, though, are made multi-cellular or made of many cells.

Sponges are the simplest of all of the major animal groups (called Phyla). Their bodies are made up of only two different kinds of cells. They do not have nerve cells or sense organs. They live underwater, usually in seawater, but there are freshwater sponges, too. Sponge **larvae** (young) settle on one hard surface and then live their lives attached to that surface, unable to move around to seek food or avoid predators.

Like other animals, sponges need food, shelter, living space and oxygen to live and reproduce (have young).

The energy needed by sponges and other animals is found in the food they eat. Food is broken down through digestion, freeing up energy that is used for growth and reproduction. Animals also need oxygen. Oxygen is a gas that is found in air and in dissolved in water.

Scientists use dyes to trace the pathway of substances. A dye makes it easy to follow the pathway of liquids like water. Food coloring is a dye.

The video you will be viewing shortly shows a sponge and a diver. The diver is a scientist who is carrying out an experiment using a tracer dye on the sponge. After watching the video, you will be asked to diagram and describe what you observed. Remember, you make observations by using any one or more of your five senses. In this case, it will involve describing what you saw.

Activity B—Diffusion Demonstration

Diffusion takes place when substances naturally spread from areas of higher concentration (more of the substance) to areas with lower concentrations (less of the substance). Diffusion does not require any outside source of energy. For example, when perfume is sprayed into the air on one side of the room, the perfume naturally spreads out from that area of higher concentration to areas where there is no perfume. This process continues until the concentrations are equal throughout the room.

Activity C—Sponge Filter-feeding *

**To be read by students as part of step 5 under the Procedure Section.*

Remember, sponges live attached to the seafloor. Because they are attached, they are called **sessile**. In order obtain food, sponges pass water through their bodies in a process known as **filter-feeding**. Water is drawn into the sponge through tiny holes called **incurrent pores**. Sponges create the current that draws water into the pores using many collar cells, each cell with a whip-like structure called a flagellum and a collar. The collar cells line the channels and chambers found inside the sponge and by waving their flagella back and forth in unison, they create a current that draws the water into the sponge. The **collar cells** are specialized for carrying out this function of creating a current. (See diagram/cross section of tissue).

Water exits through larger pores called **excurrent pores**. As it passes through the channels and chambers inside the sponge, bacteria and tiny particles are taken up from the water as food. The circulating seawater contains oxygen that passes into the sponge cells by simple diffusion. Waste products like carbon dioxide gas and nitrogen and ammonia exit with the water leaving the sponge. Although other animals at the reef are said to filter-feed, the method used by sponges is unique to this simple group of animals. In fact, sponges are named because of the many pores covering their bodies. They belong to the **Phylum Porifera** and may be called poriferans.

Activity D—Pumping Rates in the Field

The scientists seen in the video are studying

the role of sponges on coral reefs in the Caribbean. They want to know how sponges affect the other animals at the reef, especially the corals. In the experiments, scientists use tracer dyes and rulers to determine the **volume** of water flowing through the sponge during a period of time. Volume is a measure of the amount of space something takes up or occupies. This measure of the volume of water pumped during a certain period of time is known as the **pumping rate** of a sponge.

Scientists are interested in the pumping rates of sponges and the total volume of water that is pumped through sponges at reefs during a typical day. The more water that is pumped through the sponge, the faster the pumping rate. The water that exits from the sponge carries waste products like ammonia, nitrogen and Carbon dioxide gas. This waste nitrogen may be fertilizing seaweeds and helping them grow. This may important because seaweeds sometimes compete with corals for space at the coral reef.

Using what is known about sponge pumping rates, scientists can estimate the amount of water being pumped through sponges on the reef they are studying. This might give them an idea of the how sponges affect water quality at the reef. Perhaps, sponges help to clean particles out of the water, but perhaps they also add waste products that help seaweeds. By studying the volume of water being pumped and the waste products, scientists hope to better understand how corals, seaweeds and sponges interact with one another on a coral reef.

Preparation

Activity A—Observing the Sponge Using a Tracer Dye

Provide video clip for students to view on projection screen or on their computers. Make sure students have materials to use for creating their diagrams. You can use dry erase boards, poster boards, plain paper, etc. and markers, pencils, etc. Photocopy one background sheet for each student.

Activity B—Diffusion Demonstration

Place shallow clear plastic container filled with water on a center table. Have food coloring and fan ready to use. Photocopy one background sheet for each student.

Activity C—Sponge Filter-feeding

Set up slide presentation showing a variety of living sponges. Also, have slides or photos ready of cross sections of sponges showing inner channels and collar cells. You may want to post or have available the diagrams created from Activity A. Photocopy one background sheet for each student

Activity D—Pumping Rates in the Field

Place beakers or plastic cups on table. Have water and wax pencil or marker available. Use marker board to show math associated with completing the volume problems. Photocopy one background sheet for each student

Learning Procedure

Activity A—Observing Filter-Feeding in Sponges using a Tracer Dye

1. Have students take turns reading background material in small groups. Review major ideas briefly with class.

2. Have students watch sponge tracer dye video. Repeat video. Explain that they will be asked to diagram and describe what they observe with their senses.

3. Working in groups of 3-5, have the students create a series of diagrams with descriptions showing what they observed taking place on the video. Emphasize that they should work together to draw and describe what they saw.

They should try to draw the sponge and whatever they saw in as much detail as possible. This can also be done with the entire class, especially if it is small.

4. Have each student group explain their diagram briefly. Discuss the diagrams and what the students observed. Ask/answer questions like the following: *What does the diver do? What happens to the dye? Does it appear to enter the sponge? If so, where does it enter and where does it leave? What do you think is inside the sponge?*

5. With the entire class, discuss the movement of the dye. Ask/answer the following questions: *Is the dye acting as if something (a force) is acting upon it? What do you think might be causing the dye to move? What do you think would happen to the dye if nothing were acting upon it to move it along? Does the dye indicate the movement of water through the sponge? Does the dye show the pathway of water through the sponge?*

6. Explain the difference between facts/observations with suggestions, conclusions or explanations as to why the water moved. Point out that it is impossible to say exactly why and how the water moved through the sponge simply by observing the video. It does not have enough information. If the discussion progresses, distinguish what was observed with possible explanations. Ask whether or not these explanations could be tested to see if they are true or not.

Activity B—Diffusion Demonstration

1. Have students take turns reading background material in small groups. Discuss the perfume example with the class.

2. Have students conduct diffusion demonstration. Students watch dye diffuse in a clear shallow dish—this is in contrast to the observed uptake and pumping of the dye in the video. Students observe fan (hand or electric) applied to surface of the water to distribute dye. The fan is a force that moves the dye faster than the process of diffusion. Discuss other ways water can be pumped. Mention mechanical pumps like bilge pumps that move water. The human heart pumps blood to the lungs, where it can pick up the oxygen humans need and then pump it to the rest of the body where it is needed.

Activity C— Sponge Filter-feeding

1. Show students a slide show of several species of sponges. Ask students to identify where they believe the water is entering the sponge and where it is exiting the sponge. Refer back to the diagrams showing what they observed and to what they remember from the video.

2. Discuss the fact that pores are seen on all sponges in the photos. Water enters through incurrent pores on the outside of the sponge body and then exits through pores in the top. Discuss how we cannot determine exact way the water travels inside the sponge from the tracer dye and the video. There are only certain things that can be said from the video. Scientists have to conduct further research to determine the pathway of the water inside the sponge and/or other things like what might be being removed from the water.

3. Introduce students to cross-sections of sponges that show the pathways of water, and the network of canals that run through the sponge. Explain that scientists have collected and studied sponge anatomy, which has helped to understand sponges better. Show dried specimens of sponges or models, if available.

4. Give each student a clear plastic cup with a straw, which represents the channels in the sponge, with the incurrent pore at one end (in water/glass) and the excurrent (exit) pore at

the other (in student mouth). Have everyone draw water through the sponge and drink it. As a class, discuss how the suction is created that draws the water through the straw. They can also add food coloring to their water, watch it diffuse and then move it around in the glass by blowing through the straw into the water.

5. Discuss what scientists know about how the sponge draws seawater into its body and how it is somewhat different from drawing water through a straw. Explain that the collar cells that line the inner channels of the sponge have flagella that work together to create a current that draws water through the channel and out the exit pores on the top of the sponge. Show diagrams of cross sections of sponges that show the flagella/cells. Have students read background material at this time.

Activity D—Field Experiments—Volume and Pumping Rate

1. Have students take turns reading background material in small groups. Discuss the major concepts and terms with the class.

2. Have students pour the same volume of water into three different containers to show that the volume occupied is the same, but the shape and size of the water can vary, depending upon the container. *You could also expand this exercise to have students learn how to take volume readings from graduated cylinders.*

3. In another exercise, have the students fill a beaker (or plastic cup) half full with water and mark (or read and record) the water level on the beaker with a wax pencil. Place a solid object (heavier than water) into the beaker and then mark the new level with the wax pencil. The difference between the first mark and the second is a measure of the volume that solid object occupies.

Optional Volume/Rate Word Problems

1. Based on the measurements take on living sponges using tracer dyes, scientists have determined that a particular sponge pumps 75 liters/gallons of water per hour through its body. What is its pumping rate in liters per hour?

2. If a certain area of reef (1 hectare/acre) contained 100 individual sponges, each of which pumped 100 gallons per hour, how many gallons of water are being pumped through sponges in this area during 1 hour? How many gallons during one 24-hour period?

The "ME" Connection

Scientists are studying sponges because they may contain substances that could be important as medicines. For more information, visit:

Science Daily Article 2005
Science Daily Article 2000
News Article 3

Evaluation

Have students write an essay describing how sponges feed and using diagrams to illustrate the process. Students can also describe the characteristics of sponges (Phylum Porifera).

Extensions

1. Have students research and diagram the life cycle of a typical sponge, coral and/or seaweed. Make comparisons between the life cycles of these organisms.

2. Have students investigate the medicinal uses of sponges, corals, and seaweeds. Conduct class discussion about this topic. (Some links about sponges are contained in the "Me" connection section.

Resources

The Aquarius Web site contains information on a 2003 mission to study the role of sponges on coral reefs in the Florida Keys.

The Oceanic Research Group Web site contains basic information on sponge biology, including a diagram that shows sponge anatomy.

National Science Education Standards

Content Standard C: Life Science

- Structure and Function of Living Systems
- Regulation and Behavior
- Populations and Ecosystems

For More Information

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Credit