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Islands in the Stream 2002: Exploring Underwater Oases

Drifting Downward

Focus
Plankton in the ocean

Grade Level
9-12 (Biology)

Focus question
Will the design of a planktonic organism's appendages increase its chance for survival in its environment?

Learning Objectives
Students will describe the characteristics of plankton.

Students will develop abilities necessary to do scientific inquiry.

Students will test the effects of different salinity and temperature on the vertical movement of a model of a planktonic organism.

Students will calculate the velocity of the plankton model.

Additional Information for Teachers of Deaf Students
In addition to the words listed as Key Words, the following words should be part of the vocabulary list.
Current
Turbulence
Holoplankton
Mecroplankton
Metamorphose

The words listed as key words are integral to the unit. There are no formal signs in American Sign Language for any of these words and many are difficult to lipread. Having the vocabulary list on the board as a reference during the lesson will be extremely helpful.

You should cover the Background Information with the students before moving on to the Learning Procedure. Optional Steps #16-18 are fantastic, however they will require additional time to complete.

Materials
- ❒ 1 box of aluminum foil
- ❒ 5 or 6 large culture dishes or clear plastic containers, gallon size
- ❒ 1 large glass or clear aquarium (20 to 30-gallon low tank works best)
- ❒ (Optional for density difference) 1 box of salt or sea salt
- ❒ (Optional to calculate velocity) 1 to 4 stopwatches
- ❒ (Optional for temperature measurements) 1 aquarium thermometer
- ❒ Pictures of various types of plankton using http://www.imagequest3d.com/catalogue/larvalforms/ or pictures from other sources listed under Resources section of this activity

Audio/Visual Materials
None

Teaching Time
One or two 90-minute class periods, depending on the discussion time at the end

Seating Arrangement

Individuals and small groups of 4 to 6

Maximum Number of Students

25

Key Words

Phytoplankton
Zooplankton
Drag
Resistance
Appendage
Photic zone
Pelagic zone
Nectonic
Benthic
Velocity
Limiting factors

Background Information

Plankton are tiny organisms that float in the ocean and are at the mercy of the currents. *Planktos* comes from the Greek word meaning "wandering." These tiny organisms drift or swim weakly by the millions and are the basis of the ocean food web. Plankton comes in all shapes and sizes. Unlike pelagic fishes that swim in the open ocean, plankton are adapted to maximize turbulence and drag in the water column. It is beneficial for phytoplankton (*phyton*—meaning, "plant") to stay in the top of the photic zone where there is sufficient light to carry on photosynthesis. The benefit for the zooplankton (*zoion*—meaning "animal") to stay in the photic zone is that there is a sufficient food supply. In order to stay afloat, planktonic organisms have become very "creative" in their adaptation of appendages. The zooplankton that spend their whole life in the plankton are called holoplankton (*holos*—meaning "entirely"). There are other planktonic organisms that are larval stages of fishes, like the reef fishes being studied in the Islands in the Stream 2002 Expedition. In fact, most of the animal groups of the ocean are represented in this temporary life stage called meroplankton (*meros*—meaning mixed). The reef fishes spawn in the ocean and when the larva (tiny fish) hatches out of the egg and begins to metamorphose, it is important that it finds its way to a food supply. Although most planktonic organisms are at the mercy of the currents, some actually migrate down in the water column at night where there is an abundance of smaller organisms, some of which may be food, drifting there.

Learning Procedure

This inquiry activity will allow students to design different shapes of foil to simulate drifting planktonic organisms.

1. Provide each student with a 10cm x 10cm square piece of aluminum foil. This allows for three equal-sized squares from each tear of the sheets from a standard aluminum foil box. One standard 250 square-foot box of aluminum foil should provide enough squares for six classes.

2. Instruct students to design a model of a planktonic organism using the 10cm x 10cm square of aluminum foil. Do not instruct the students how to design their model of a planktonic organism as this should be learned through trial and error. Students are only allowed to use one piece of foil per planktonic organism or per trial. This allows for control of material and makes the students aware of different shapes necessary to cause drag and resist sinking rapidly.

3. Fill a small culture dish (approximately 25 cm in diameter) full of water. Place one dish in the middle of four to six students in order for them to practice "sinking" the plankton designs.

4. Place the large aquarium in the back of the room or in a central location where several students can get around all sides. Fill the tank almost to the top with tap water. Measure the height of the water in cm. This will be used to calculate the velocity.

5. Students may cut or tear the foil, build air pockets, etc. Their job is to design a shape that will sink slowly. The design must sink in order to be considered for competition and the slowest sinker is the winner.

6. Each student is to construct a design using one piece of foil and then place the foil on the surface of the water. In order for the design to be considered for competition, the model must sink within 90 seconds. Any designs that are still floating after 90 seconds will be disqualified.

7. Students may practice with their design in a separate culture dish or small dish pan of water as many times as necessary.

8. Six to ten students may compete with their designs all at once using a large glass aquarium. This enables all participants to make observations on different designs.

9. Each student will hold their model plankton design no more than six inches above the water and on the teachers command, students will drop their plankton onto the water's surface.

10. When the teacher says "go," a stopwatch is started and when the last design reaches the bottom of the aquarium, the stopwatch is stopped. The time is kept in order to compare the velocity of sinking with that of the next group of competing students.

11. Each student will then retrieve their model planktonic organism and another group will compete.

12. Each student is allowed to return to their desk to make improvements on their design.

13. Each student should be allowed to participate at least three times in the group competition.

14. Times should be recorded on a data chart on the board.

15. Direct the students to several pictures of planktonic organisms at (http://www.imagequest3d.com/catalogue/larvalforms/ or from other sources listed under Resources section of this activity. Discuss the design of their appendages and how these designs might cause the plankton to be suspended in the water column. What is the advantage of staying near the surface?

16. (Optional) – After the top ten winners are determined, each of the winning planktonic organism designs should be placed in a saltwater aquarium and observed. Begin a classroom discussion on the properties of water molecules and the interaction of such molecules with sodium chloride. Why do hydrogen and oxygen form covalent bonds? What effects do the different densities of water have on their planktonic organism designs?

17. (Optional) – Repeat Step #14 and heat the water so that is 20 degrees warmer (degrees Fahrenheit). Begin another classroom discussion on the properties of temperature effects on water and planktonic organisms. Since heat consists of random motion and the vibrations of atoms, molecules, and ions (the higher the temperature, the greater the atomic or molecular motion) will this effect the movement of the plankton?

18. (Optional) – Repeat Step #14 and add a small amount of soap and notice if breaking the surface tension has an effect on the plankton design. Why is water cohesive?

19. (Optional) – Students will use a stopwatch and ruler to calculate the time and distance the planktonic organism models travels in the aquarium.

The BRIDGE Connection

www.vims.edu/bridge/biology.html

The "Me" Connection

Lead a discussion on the following: If plankton is removed from the food web in the ocean, would it ultimately destroy our food supply as humans? How would this effect our environment on Earth?

Connection to Other Subjects

English/Language Arts, Geography, Mathematics, Physics and Biological Sciences

Evaluation

Design a rubric for a performance assessment.

Extensions

Have students research marine animals that live part of their life cycle in the plankton.

Have students research areas of the world ocean that are reported to have an abundance of plankton and then hypothesize why these areas are different from areas of the ocean that do not have an abundance of plankton.

Resources

http://oceanexplorer.noaa.gov to keep up to date with the plankton tows aboard the South Atlantic Bight Expedition.

http://www.sciencegems.com/earth2html

http://www.sci.lib.uci.edu/HSG/Ref.html

http://www.soes.soton.ac.uk/staff/tt/eh/index.html

http://www.earthwindow.com/zoo.html

http://lifesci.ucsb.edu/~haddock/plankton

http://state-of-coast.noaa.gov/bulletins/html/hab_14/hab.html

http://thalassa.gso.uri.edu/flora/arranged.htm

http://www.geocities.com/planktonguy/

http://www.des.ucdavis.edu/esp151/LecturePics.htm

Field Guide to the Atlantic Seashore, Kenneth Gosner. 1978. Houghton Mifflin, NY

The Seaside Naturalist, Deborah Coulombe. 1984. Simon and Schuster, NY

Marine Biology Coloring Book, Thomas Niesen. 1982. Harper and Row, NY.

National Science Education Standards

Content Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard B: Physical Science

- Motion and forces
- Transfer of energy
- Conservation of energy and the increase in disorder

Content Standard C: Life Science

- Populations and ecosystems
- Diversity and adaptations of organisms
- Structure and function in living things
- Interdependence of organisms
- Behavior of organisms

Content Standard D: Earth and Space Science

- Structure of the Earth system

Content Standard E: Science and Technology

- Develop abilities of technical design
- Develop understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- Population growth

For More Information

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Acknowledgements

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