Hudson Canyon Expedition

What's Bright Red and Invisible?

Focus
The diversity and predominance of red deep sea organisms

Grade Level
5 - 6

Focus Question
Why are so many red animals found in the deep sea?

Learning Objectives
Students will learn that very little sunlight penetrates the ocean below depths of 200 meters.

Students will learn that no light penetrates the ocean below depths of 1000 meters.

Students will learn that the quality of light changes as depth increases in the ocean.

Students will learn that red organisms are camouflaged in the deep sea.

Students will learn that since being red aids in survival in the deep sea, many different types of organisms have a red body color as an adaptation.

Materials
For the teacher:
- ❒ Prism
- ❒ Flashlight
- ❒ Movie screen or white wall
- ❒ One pair of scissors
- ❒ 36 blue report covers
- ❒ Paper cutter
- ❒ Stapler
- ❒ Staples

Per student pair:
- ❒ One pair of "deep sea glasses" (see Teacher Prep section under Learning Procedure)
- ❒ One red, orange, yellow, green, blue and black (dark brown) M&Ms OR one small red, orange, yellow, green, blue and black circle created using a hole punch
- ❒ One piece of black construction paper

Audio/Visual Equipment
Internet access for students

Teaching Time
One hour

Seating Arrangement
In pairs of two

Maximum Number of Students
36

Key Words
Twilight zone
Midnight zone
Camouflage
Diversity

Background Information

When providing background information to students, the learning objectives above list the key information teachers should convey to students during the lesson. Fifth and sixth grade students do not need to know the physics behind light quality in the ocean. However, detailed background information is provided to increase or augment teacher understanding of the concept.

If you were able to combine all of the world's ocean basins and stir them together with a spoon, the average temperature of the water would be 4°C, the average depth would be about 14,000 feet, and the average light level would be zero. The bulk of our ocean is comprised of deep sea habitats that exist in very little to no light.

The ocean has been broken into three zones based on depth and light level. The specific depths of these zone will vary based on a number of physical parameters, but the following three divisions can be used when teaching about levels in ocean waters. The upper 200 meters of the ocean is termed the photic zone. This zone is penetrated by sunlight and plants thrive. The zone between 200 meters and 1000 meters has been coined the "twilight" zone; in this zone the intensity of light dissipates as depth increases and at the lower depths, light penetration becomes minimal. The aphotic zone, or "midnight" zone, exists in depths below 1000 meters. Sunlight does not penetrate to these depths and the zone is bathed in darkness.

As you travel from surface waters to deeper waters, the quantity of light changes; it decreases with depth. The quality of light also varies with depth. Sunlight contains all of the colors of the visible spectrum (red, orange, yellow, green, blue and violet). These colors combined together appear white. Red light has the longest wavelength and, therefore, the least amount of energy in the visible spectrum. Violet light has the shortest wavelength and, therefore, the highest amount of energy in the visible spectrum. The wavelength decreases and the energy increases as you move from red to violet light across the spectrum in the following order: red, orange, yellow, green, blue and violet; the energy of the light is inversely proportional to the wavelength. Middle school students do not need to know the formula below, but it has been included for teacher reference.

E = hc/wavelength
where E = energy (in Joules),
h = Planck's constant (6.6260755 X 10 –34 Joules/second),
c = the speed of light (2.99792458 X 108 meters/second) and wavelength is in meters

Red light is quickly filtered from water as depth increases. As the wavelength of light increases from red light to blue light, so does the ability to penetrate water; blue light penetrates best. Green light is second, yellow light is third followed by orange light and red light. The exception to the rule is violet light. Although it has the shortest wavelength and the highest energy, violet light is also quickly filtered from water; the small wavelength of light is easily scatted by particles in the water.

All objects that are not transparent or translucent either absorb or reflect nearly all of the light that strikes them. When struck by white light (containing all colors), a red fish reflects red light and absorbs all other colors. Likewise, grass reflects green light and absorbs all other colors. White objects appear white because they reflect all colors of light in the visible spectrum. Black objects appear black because they absorb all colors of light. On a hot sunny, summer day do you stay cooler wearing a white shirt or a black one? The answer is a white shirt! A white shirt reflects all wavelengths of light, while a black shirt absorbs them. Now consider that red fish. If a red fish is swimming at the surface of the ocean, it appears red because it reflects red light. Can you see a red fish swimming at 100 meters? At this depth, the red fish is difficult, if not impossible to see, and appears blackish because there is no red light to reflect at that depth and the fish absorbs all other wavelengths of color.

In the twilight zone, there are numerous animals that are black or red. At depth, these fishes are not visible. The black animals absorb all colors of light available and the red animals appear black as well; there is no red light to reflect and their bodies absorb all other available wavelengths of light. Thus red and black animals predominate. Since the color blue penetrates best in water, there simply are not that many blue animals in the midwater regions of the ocean; their entire bodies would reflect the blue light and they would be highly visible to predators.

During the upcoming Exploration of the Hudson Shelf Valley and Canyon System, scientists will be studying the diversity of life in the deep sea. Exploratory surveys will also be conducted to a depth of 1000 meters to assess the distribution of a particular crab. Can you guess the name and color of the crab the scientists will be looking for? They will be searching for a crab called the red crab and, yes, they are bright red!

Learning Procedure

Teacher Prep:

- Place prism in beam of flashlight and practice rotating prism to best project the colors of the spectrum on the movie screen or white wall.
- Cut each blue report cover lengthwise into four strips of roughly two-inches thickness. Because the report covers have a front and a back, you will end up with eight strips total.
- Staple the eight strips together, using two staples, along the short edge. Each set of eight strips will serve as student "deep sea dive goggles".
- Separate M&Ms by colors so that each student pair will have one of each of the following colors: black (dark brown), red, orange, yellow, green and blue to create an "M&M" set. Students love to play with candy, but you can also use a hole puncher to cut out dots from construction paper of each of the colors listed above for each student pair (use bright blue paper for the color blue).

The day of the lesson:

1. Begin with a discussion of what your students know about light.
2. Discuss the key elements presented in the Background Information section.
3. Explain that a slide projector, like the sun, is a source of white light.
4. Explain that a prism breaks white light into all of the colors that comprise white light.
5. Dim the lights in the classroom.
6. Using the slide projector and prism, show students the colors of the visible spectrum.
7. Have students write down the colors they see in the order in which they observe them.
8. Tape a small piece of a blue report cover over the light source.
9. Ask students to note what color is projected (blue).
10. Ensure that students understand that the blue report cover blocks part of the spectrum by absorbing some of the colors of light.
11. Turn off slide projector.
12. Pass out one piece of black construction paper, one set of deep sea diving goggles and one "M&M set" to each pair of students.
13. Explain that the black piece of paper represents the darkness of the deep sea.
14. Ask students to spread their M&Ms out over the black piece of paper.
15. Have students place one of the eight layers of blue report covers over their eyes and while looking through the blue layer, observe which colors of M&Ms are readily visible. Allow enough time for each student in the pair to observe.
16. Have students add an additional report cover layer (total of two layers) and repeat their observations.
17. Continue to add layers and observe colors until all eight layers have been used.

Note: Using the blue report covers allows students to see how colors appear in deeper water. The blue covers filter out other colors of the spectrum with increasing efficiency as additional layers are used. Water, likewise, with increasing depth, selectively filters out all other colors of the spectrum but blue. Students should observe that the color black disappears first, followed by red, then orange, and yellow.

18. Ask students to write down why they think there are so many red animals living in the twilight zone.
19. Over the next week, have students conduct independent research on any of the red deep sea animals found in the table on Page 5. Ask students to note what type of animal it is (Is it a fish, a crab, a shrimp, etc.?):

The BRIDGE Connection

Go to the BRIDGE website at http://www.vims.edu/bridge/ Under the Navigation side bar click on Human Activities to learn more about the technology used to study deep sea environments.

The "ME" Connection

If you were to become a SCUBA diver, what color wetsuit would you wear to become less visible to fish (like sharks)? Your wetsuit choices include yellow, orange, red, green and blue.

Connections to Other Subjects

Language Arts

Ask students to read either of the following books to learn more about deep sea diversity:

Creatures that Glow. Ganeri, Anita and Peter Herring. 1995. Harry N. Abrams, Inc. ISBN 0-8109-4027-2

Sea-Fari Deep. Woodman, Nancy. 1999. National Geographic Society. ISBN 0-7922-7340-0

Evaluation

At the close of the activity detailed above, students are asked to record their answer to the following question: Why are there so many red animals living in the deep sea? Use student responses to gauge student understanding.

For exceptional students: Tell students that there

Red Deep Sea Animals for Students to Research

Name	Type of animal
*Bloodbelly comb jelly (*Lampocteis* sp.)	A cnidarian; a jellyfish relative
*Giant ostracod (*Giganocypris agassizii*)	A crustacean; a crab relative
*Giant red mysid (*Gnathophausia ingens*)	A crustacean; a crab relative
*Johnson's sea cucumber (*Parastichopus johnsoni*)	An echinoderm; a sea star relative
*Red sea fan (*Swiftia kofoidi*)	An echinoderm; a sea star relative
*Rockfish (*Sebastes* sp.)	Fish
*Spiny king crab (*Paralithodes rathbuni*)	A crustacean; a crab
Sergestid shrimp (*Sergestes* sp.)	A crustacean; a crab relative
Vampire squid (*Vampyroteuthis infernalis*)	A mollusk; a snail relative
Deep sea amphipod	A crustacean; a crab relative
Deep water jelly (*Periphylla periphylla*)	A cnidarian; a jelly
Krill (*Euphausia* sp.)	A crustacean; a crab relative

*Note: Descriptions of these animals can be found on the Monterey Bay Aquarium's website http://www.mbayaq.org/efc/living_species/. Although this site provides distribution of animals in the Pacific, students can access great photographs and some good, basic information.

are some jellyfish that have clear bodies yet their stomachs are red. Ask students to explain why this might be so. Answer: Jellies have clear bodies so that they are transparent in water and cannot be seen. However, if a jelly eats something that is NOT transparent, having a red stomach helps to hide the jelly's last meal! If the stomach were transparent like the rest of the animal, other animals might be able to see the stomach contents. Pretty cool trick!

Extensions

Ask scientists participating in the Hudson Shelf Valley and Hudson Canyon Cruise what types of red animals they have observed and where they have observed them.

Resources

Websites for student research

http://www.mbayaq.org/efc/living_species/
http://www.mbari.org/
http://www.biolum.org
http://www.bioscience-explained.org/EN1.1/features.html
http://www.pbs.org/wgbh/nova/abyss/
http://oceanlink.island.net/oinfo/deepsea/deepsea.html
http://people.whitman.edu
http://www.seasky.org/monsters
http://www.divediscover.whoi.edu
http://www.nationalgeographic.com
http://www.marine.whoi.edu/ships/alvin/alvin.htm
http://www.ocean.udel.edu/deepsea
http://www.pbs.org/wgbh/nova/abyss/life/extremes.html
http://www.whoi.edu/WHOI/VideoGallery/vent.html

National Science Education Standards

Content Standard A: Science as Inquiry

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

Content Standard C: Life Science

- Structure and function in living systems
- Diversity and adaptations of organisms

Content Standard D: Earth and Space Science

- Structure of the Earth system

For More Information

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