



Bioluminescent Bewilderment!

Summary:

In this lesson students take a look at organisms that ‘glow’ and figure out why and how this happens.

Background Information:

Bioluminescence is the emission of light by living organisms. In Wisconsin, we can see this in fireflies during the summer. In Puerto Rico, there are bioluminescent bays off the coast of Vieques. Bioluminescence is not uncommon. In fact, most of the world’s oceans contain organisms from just about every kingdom that ‘glow’. In this lesson we are going to be looking at dinoflagellates, in particular *Pyrodinium* from kingdom protista, and fireflies from the animal kingdom.

Habitat:

Adult fireflies are found in the same general habitats as their larvae. Generally speaking, the highest number of firefly species are found in warm, humid areas of the world. Some species, however, are found in very arid regions of the world. In these arid regions, larvae and adults can be readily found following rains. The greatest number of firefly species (highest species diversity) are found in tropical Asia and Central and South America. But, as we know, we find lit-up beetles right in our back yards!

Many firefly species tend to be found around water such as ponds, streams, marshes or even depressions, ditches, etc., that may retain moisture longer than surrounding areas. However, fireflies are also found in very dry regions of the world as well (Ref 2.) *Pyrodinium* are found in water known as bioluminescent bays. These bays share several physical features. They are relatively small in size. The bay with the highest density of *Pyrodinium* in Puerto Rico is in Vieques and is called Puerto Mosquito. It’s only 160 acres. Also each bay is relatively shallow, no deeper than about 14 feet, and has narrow openings to the sea making it more saline than the rest of the ocean water. But most importantly, all of these bays are bordered by mangrove forests.

Dinoflagellates need the vitamin B12 in order to survive. This vitamin is synthesized by scavenger bacteria, which play a role in breaking down mangrove roots and leaves in the natural process of decay. So if there are no mangroves, there are no bacteria.

Grade Level: 9th grade

Goal: For students to learn about bioluminescence and understand the function of this adaptation.

Key Concepts: properties of bioluminescent bays and how they work

Objectives:

- 1) Students will identify bioluminescent organisms from different parts of the world
- 2) Students will describe how these organisms emit light
- 3) Students will write about the impact that environment has on these organisms.

Teaching Location:

In the classroom, library

Lesson Time:

- 1 ½ 50min. periods for activity 1
- 2 50 min. periods for activity 2

Subject Areas for Infusion:

Biology, Environmental Science

Standards:

Science:

C.12.6

A.12.1

Environmental Education

A.12.3

A.8.1

If the opening from the bay to the sea was not narrow, these vitamins would be flushed out. And if the bay were not shallow, the population of these microscopic creatures may not be dense enough for the bioluminescent phenomenon.

Why emit light?

Some fireflies use light as a signal to attract a mate. In most species of North American fireflies, during a certain time of night, males fly about flashing their species specific flash pattern. Females of the same species tend to be perched on vegetation, usually near the ground. If a flashing male catches a female's fancy, she will respond at a fixed time delay after the last male's flash. A short flash dialogue may ensue between the male and female as the male locates her position and descends to mate. Pyrodinium only light up when they are disturbed so is it apparent that this glow is for a defense function. It's also possible that the light may be used as a means of communication. The blue-green color provides a wavelength easily transmitted through seawater and is also easily detected by other organisms.

What causes bioluminescence?

Although lightning bugs and Pyrodinium are very different, we can answer this question the same for both. These organisms use food as an energy source directed at molecules called luciferins. This light-producing chemical process occurs without heat, unlike electrical lighting. This is because of regulating enzymes, called luciferases, which are proteins that lower the amount of energy necessary to trigger the bioluminescent reaction.

Biobay Fight for survival:

The rarity of the physical and biological conditions that allow bioluminescent bays to exist also make them very much an endangered species. Several in the Caribbean have disappeared because of industrial and boat pollution, cutting mangroves for charcoal, overgrazing of surrounding fields, etc. These factors are not only destroying organisms with bioluminescence but it also lowers the population of fish.

Because of these issues, Vieques Conservation and Historical Trust have dedicated themselves to the preservation of the Puerto Mosquito. The Puerto Rican Department of Natural Resources has recognized the importance of the Trust's efforts. In fact, the DNR-Puerto Rico said that Puerto Mosquito and its surroundings will soon be designated as a "Natural Reserve".

Vocabulary

bioluminescent: emission of light by living organisms

dinoflagelletes : microscopic organisms, that are classified as protists , and posses 2 flagella that function for movement

firefly: Any of various nocturnal beetles of the family Lampyridae, characteristically having luminescent chemicals in the posterior tip of the abdomen that produce a flashing light. Also called lightning bug.

mangrove forest: Any of several tropical evergreen trees or shrubs of the genus *Rhizophora*, having stilt like roots and stems and forming dense thickets along tidal shores

Materials:

- Large pieces of paper for posters
- Markers

- Internet access/library

Set-Up:

If a resource library is not available, get some articles together on fireflies and bioluminescent dinoflagellates.

Procedure:**Introduction.**

Write the word bioluminescent on the board and break it down (bio and luminescent) to see if the students can figure out on their own what it means.

Ask students to list some bioluminescent creatures they know.

Add Pyrodinium to the list and tell them that it is a type of dinoflagellate that emits light.

Discuss Puerto Rico, one of the places it's found, and the Biobay experience.

Activity 1.

Ask students to find a partner or assign partners. With their partner, students will be asked to make a graphic organizer that shows similarities and differences between fireflies and pyrodinium.

Assignment:

1. On the poster paper, ask each pair of students to create a graphic organizer, such as a chart, ven diagram, etc., that shows the comparisons of these 2 organisms.
2. We will be going to the library so that you can research both organisms. Some topics to research are reasons for emitting light, habitat, endangerment, how light is emitted....
3. Your grade will be based on point distribution shown in the rubric given (see assessment)
4. These posters will be displayed in the room and each group will have to point out one similarity and one difference to the class.

Activity 2.

1. After a discussion of 3 factors contributing to the biobay as the habitat for pyrodinium, the teacher should lead into discussion of why these areas are becoming endangered. The class should also talk about some things that might be put in place to save these areas.
2. Students will be responsible for writing a paper on mangrove forests. They can write about them in general or pick black, white or red mangrove to write about. The paper should include the following topics as well as a bibliography:

What is a mangrove forest?

What is their lifecycle?

What is the habitat of mangrove forest, where in the world are they located?

What role does mangrove forest play in the habitat of pyrodinium?

How are these areas being destroyed?

3. Students are given at least one period to begin their research.

Conclusion.

Students will reassess why bioluminescent bays are threatened, and what solutions can help alleviate those problems. Have a brief follow-up class discussion about what they learned.

Assessment.

Assessment 1 Rubric:

	Possible Points
The chart was easy to read, organized	5
There were 5 or more comparisons	5
There were 5 or more contrasts	5
A sketch or drawing of each organism was included	5
One of similarity and one difference was shared with the class	5
Total Possible points	25

Assessment 2:

Each student turns in their paper as a homework assignment to be graded by the teacher using the list of questions as a guide to the grade.

References:

1. Bernache-Baker, B., The Bioluminescent Bays of Vieques, June 1995.
2. The Firefly Files : University of Ohio
<http://iris.biosci.ohio-state.edu/projects/FFiles/frfact.html>