TIEE
Teaching Issues and Experiments in Ecology - Volume 1, January 2004

ISSUES – FIGURE SET

What's Killing the Coral Reefs and Seagrasses?

Charlene D'Avanzo [1] and Susan Musante [2]

1 - School of Natural Sciences, Hampshire College, Amherst, MA, 01002 cdavanzo@hampshire.edu

2 - Education and Outreach Program Manager, The American Institute of Biological Sciences, Washington, D.C. 20005, smusante@aibs.org

Bleaching in coastal Florida
©- Reef Relief, www.reefrelief.org)

Figure Set 3: How Shading Affects Photosynthetic/Respiratory Balance in Corals

Purpose: Students figure out that corals contain algae (zooxanthellae) and therefore are photosynthesizing organisms. With this knowledge, they can deduce what happens when corals bleach.
Teaching Approach: "Turn to Your Neighbor"
Cognitive Skills: (see Bloom's Taxonomy) — knowledge, comprehension, interpretation, application
Student Assessment: design an experiment

BACKGROUND

Coral bleaching is a serious problem in coral reefs worldwide. Bleaching occurs when coral eject their symbiotic zooxanthellae and turn from tan to white. Increased water temperature, likely due to global warming in some areas, is correlated to bleaching. There are now global reef watches documenting coral bleaching events and other problems such as diseases.

One explanation for coral die-off in the Florida Keys area is that increased turbidity of the water column (perhaps due to increased nutrients and phytoplantkon growth) results in less light reaching corals. Coral bleaching has been observed there and corals do eject their zooxanthellae under low light conditions. To understand the process of coral bleaching students must understand that the coral animal contains photosynthetic algae. This activity will help them figure that out.

In this set of experiments, the researcher measured metabolism (changes in oxygen concentrations) by placing a clear tunnel over a 4x2m section of coral and measuring oxygen at the upstream and downstream ends. This is a modification of the upstream-downstream approach for measuring system metabolism in streams. Her goal was to assess effects of shading on coral metabolism because water column turbidity from increased sedimentation and eutrophication is a problem in some reefs.

For coral bleaching images see

http://www.reefbase.org/threats/thr_bleaching.asp, http://www.gbrmpa.gov.au/corp_site/info_services/science/bleaching/, and http://www.marine.uq.edu.au/OHG/news/.

STUDENT INSTRUCTIONS

Questions for Thought

1) Turn to your neighbor and take 5 minutes to first describe and then interpret the data in Figure 3A (note: einsteins is a measure of light energy). Be prepared to volunteer or be called on during our discussion.
2) Turn to your neighbor and take 5 minutes to first describe and then interpret the data in Figure 3B. Note that the researcher measured coral metabolism in a control (B) and a channel that she shaded with black plastic for a month (A). Using what you now know, interpret the data. If the corals in channel A were shaded for a very long time, what do you think might happen to them and why?
3) Coral bleaching is a phenomenon that takes place when corals are stressed, such as when water temperature is too high for them. Corals are normally light tan in color and after "bleaching" they are white. Using the information you learned from the coral metabolism study, why do you think this is?

FIGURES

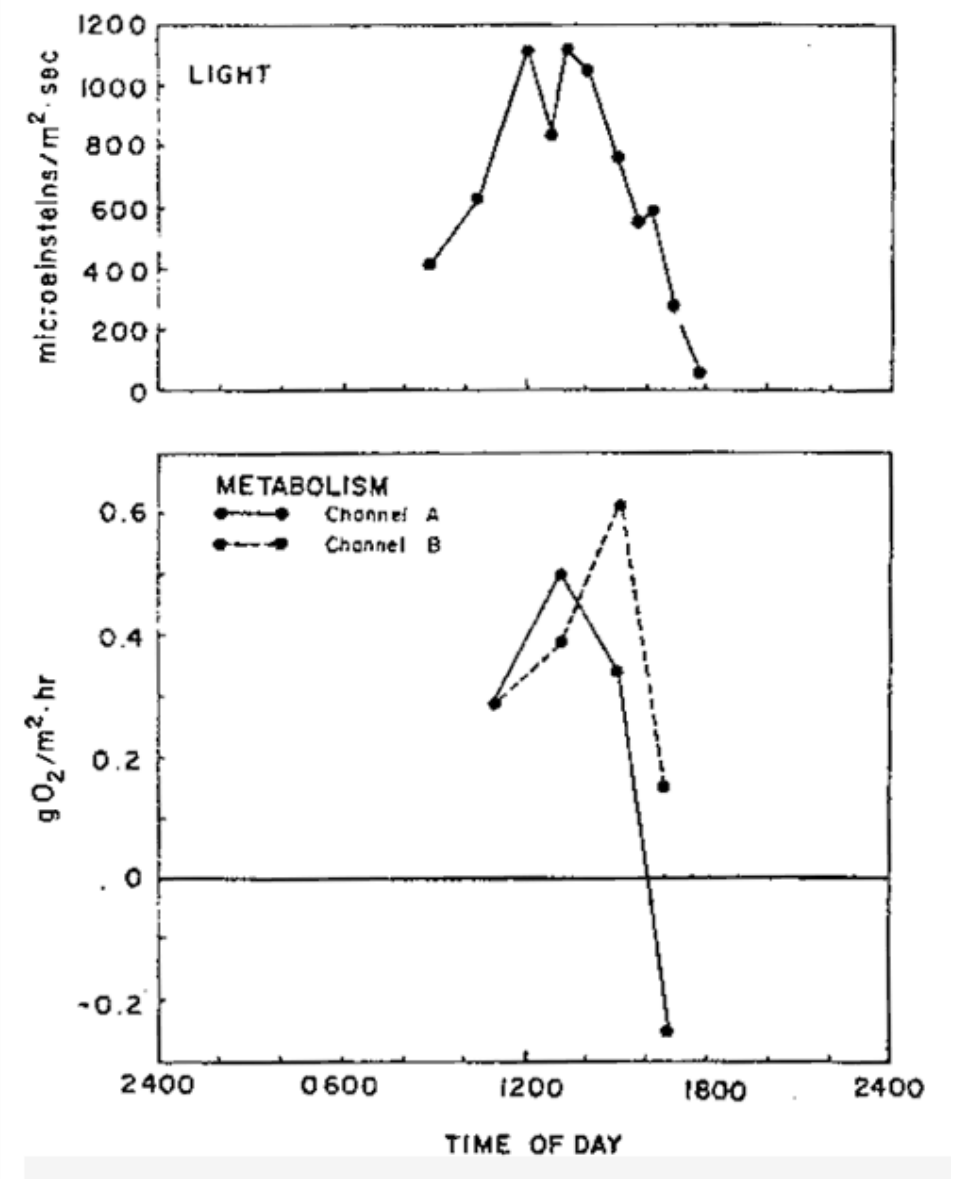

Figure 3A. Light intensity (microeinsteins per square meter per second) and metabolism (grams of oxygen per square meter per hour) of corals in 2 channels over a day (0600 = 6 AM; 1200 = 12 noon; 1800 = 6 PM). (From Rogers, C. S. 1979. The effect of shading on coral reef structure and function. Journal of Experimental Marine Biology and Ecology 41: 269-288).

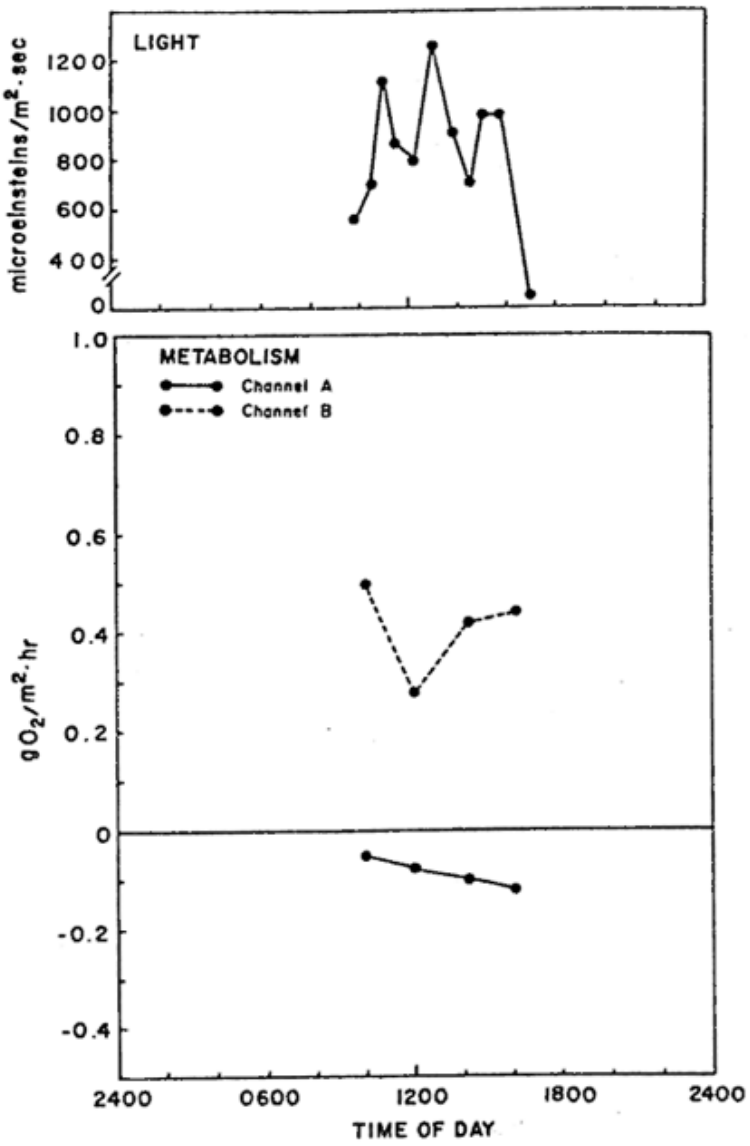

Figure 3B. Metabolism of control channel B and shaded channel 28 days after shading of channel A began. Units are the same as in 3A. (From Rogers, C. S. 1979. The effect of shading on coral reef structure and function. Journal of Experimental Marine Biology and Ecology 41: 269-288).

NOTES TO FACULTY

Your students will likely be impressed by the pretty dramatic visual change in corals when they are undergo bleaching. Many environmental stresses are not so obvious of course. There are many images of coral bleaching on the internet that you can show in class. Three coral bleaching websites with good images are listed in the Background section of this Figure Set.

Just prior to beginning the "Turn to Your Neighbor" activity (1) to understand Figure 3A, you should briefly explain the author's methods and that the unit "einsteins" is a measure of light energy.

During the subsequent discussion, good observations are that the pattern of oxygen change is similar in the two channels and corresponds to the daily change in irradiance. In addition, in channel A there is a net decrease in oxygen change at 1700 but the rest of the values are positive.

If none of the students has explained that positive rates indicate photosynthesis, ask a series of questions, such as:

*** Why do the rates of oxygen change go up at midday and why are they positive in each channel at 1100 and 1300?

*** What is the difference between a rate of change of oxygen and the concentration of oxygen?

*** How could you obtain a rate of change in a setup like this?

*** What would you predict would happen in you removed the corals, put marine plants in the channels, and repeated the experiment?

*** What if you took out the plants and put in marine animals?

*** So, why is the rate change negative in the coral experiment at 1700 in channel A?

*** On the "Turn to Your Neighbor" activity (2) - Note that the researcher measured coral metabolism in a control (B) and a channel that she shaded with black plastic for a month (A). Using what you now know, interpret the data. If the corals in channel A were shaded for a very long time, what do you think might happen to them and why?

*** Coral bleaching is a phenomenon that takes place when corals are stressed, such as when water temperature is too high for them. Corals are normally light tan in color and after “bleaching” they are white. Using the information you learned from the coral metabolism study, why do you think this is?
Ans - When corals ejects their zooxanthellae they turn white; the algae contain brown pigments.

Student Assessment: Design an experiment.

Many corals support symbiotic zooxanthellae which photosynthesize. Design an experiment to demonstrate this symbiosis to students in a lab. Be sure to clearly state the question that the experiment addresses.

Evaluating an Issue: How do you know whether it is working?

On-going (also called formative) evaluation of the approaches your are using is critical to the success of student-active teaching. Why try out new ideas if you don't know whether or not they are working? This is a brief overview of formative evaluation. For more information, go to the Formative Evaluation essay in the Teaching Section.

Course Goals:

Formative evaluation only works if you have clearly described your course goals - because the purpose of the evaluation is to assess whether a particular technique is helping students reach these goals. For instance, most of us have "learn important ecological concepts and information" as a course goal. If I reviewed the nitrogen cycle in a class, for evaluation I might ask students to sketch out a nitrogen cycle for a particular habitat or system. Each student could work alone in class. Alternatively, I might ask students to work in groups of 3 and give each group a different situation (e.g. a pond receiving nitrate from septic systems, an organic agricultural field, an agricultural field receiving synthetic fertilizer). The students could draw their flows on a large sheet of paper (or an overhead transparency) and present this to the rest of the class.

The Minute Paper:

Minute papers are very useful evaluative tools. If done well they give you good feedback quickly. Minute papers are done at the end of a class. The students are asked to respond anonymously to a short question that you ask. They take a minute or so to write their response in a 3x5 card or a piece of paper. You collect these and learn from common themes. In the next class it is important that you refer to one or two of these points so that students recognize that their input matters to you. The UW - FLAG site (www.wcer.wisc.edu/nise/cl1/flag/) gives a good deal of information about using minute papers including their limitations, how to phrase your question, step-by-step instructions, modifications, and the theory and research behind their use.