



To Shell or not to Shell: Impacts of Ocean Acidification

National Science Standards: A, B, C, D, E, F, G

Ocean Literacy Principles and Concepts: 1, 3, 4, 5, 6

Education in the Environment Initiative Principles and Concepts: Ib, c, IIa, c, IIIa, c, IVa, c

Background

Shells serve as a protective structure for both marine and terrestrial organisms. Marine ecosystems that depend upon calcium-carbonate to make shells, such as coral reefs or oyster beds, can be impacted by changes in ocean pH due to increased carbon dioxide. In experimental conditions under very high levels of CO₂, shells of clams, oysters, corals, snails and urchin shells dissolve. If these organisms are unable to build or repair shells, with increased acidification caused by industrial emissions, deforestation and other human activities, they will likely cease to exist in these environments. These results do not occur for all organisms. In experimental conditions, extreme increases in carbon dioxide result in crabs, lobsters, temperate sea urchins, limpets, and calcifying algae all building thicker shells with the more acidic conditions. Some organisms are able to adapt more rapidly than others and some will leave an environment if they cannot adapt. Nutrient levels, water temperature, food availability and habitat changes all have an impact and efforts to reduce that impact have the greatest chance of preserving some of these habitats.

Materials

- pieces of empty clean chicken eggshell (these are abundant, calcified shells and serve as a proxy for marine shells)
- lemon juice, vinegar, cola, ammonia, water, soap and other household solutions
- pH test strip, pH probe, or red cabbage juice indicator
- a small dish for each sample
- medicine dropper or plastic pipette
- scale if you choose to measure the changes
- magnifying lens

Procedure

1. Predict the effect of the solutions on the pieces of shell. *What will happen if I put a piece of egg shell in cola, water, soap, etc? Which solution will have the greatest effect on the shell?*
2. Put a separate piece of shell into each small dish. Keep one piece in a dish on its own as a control. *Weigh the shell in advance if you will be measuring the change in the shell.*
3. Use the dropper to place a few drops of selected liquid on the shell piece. Use a different piece of shell for each liquid. Label the dish with the type of liquid you used.
4. Watch what happens. What do you observe? Which liquids react with the shell first?
5. From your observation on the eggshell, what might be some consequences of



ocean acidification for animals with shells? How might you test this hypothesis?

Extensions:

1. Allow the pieces to sit, checking back on them through the day. If the liquid is safe to touch. Touch the pieces of shell at the end of the experiment.
2. Dry and weigh the sample at the end and compare the weight before and after exposure to the solution(s).

Explanation

This activity allows you to see firsthand the effects ocean acidification can have on calcifying organisms. When exposed to vinegar, which is an acid, the calcified eggshell produces CO₂ bubbles as it dissolves. The shells and skeletons of live calcifying organisms can be similarly affected as the ocean acidifies. If shell-building organisms are affected then all of the organisms that depend on them will also be impacted.

Additional references:

Doney, S.C. 2006. The dangers of ocean acidification. *Scientific American* March: 58-65.

Special Issue: Ocean Acidification-from Ecological Impacts to Policy Opportunities. 2009. *Current: The Journal of Marine Education* 25(1): 1-45.

Acid Test: The Global Challenge of Ocean Acidification (20 minute movie on ocean acidification): <http://www.nrdc.org/oceans/acidification/aboutthefilm.asp>

Animation showing shell formation www.whoi.edu/oceanus/viewArticle.do?id=52990
The Ocean in a High CO₂ World: <http://www.ocean-acidification.net/>