

MINICOSMS HELP BUILD A BIGGER PICTURE OF OCEAN ACIDIFICATION

Ocean acidification is a newly recognised threat to marine life caused by increased levels of atmospheric carbon dioxide (CO₂) dissolving in the sea.

The threat is particularly acute in the Southern Ocean because the solubility of CO₂ in sea water increases in cold water. By 2100, concentrations of CO₂ in the Southern Ocean are predicted to increase three-fold, possibly jeopardising the existence of key plankton species¹.

Increased acidity affects the physiology of plankton, the availability of nutrients, and the ability of some species to form calcium carbonate shells. Consequences at the microbial community level are difficult to predict because they involve complex responses of many species in dynamic competition. In an earlier article (*Australian Antarctic Magazine* 10: 26-27), we outlined the scope of the problem. We now have some preliminary results from two major experiments investigating the effects of acidification on microbial communities.

The experiments were conducted during the recent *Sub-Antarctic Zone Sensitivity to Environmental Change* voyage, in ship-board 'minicosm' tanks (which aim to replicate the ecosystem on a small scale). Experiments were performed on microbial communities at two sites: one in the northern sub-Antarctic region (46°19' S, 140° 40' E), and one in the polar frontal region (54° 29' S, 147° 17' E). The acidity of the

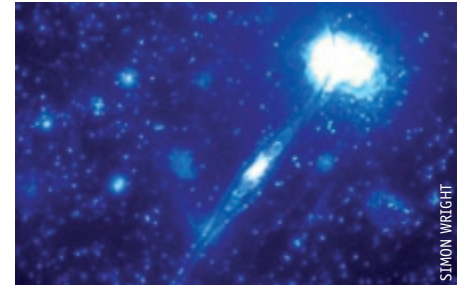
minicosms was manipulated to simulate 1, 2, 3 and 4 times current atmospheric concentrations of CO₂ (380 to 1440 ppm). The experiments had three main objectives:

- to determine pH-induced changes in the composition of microbial communities (phytoplankton, protozoa, bacteria, and viruses);
- to quantify pH-induced changes in microbial processes, including rates of production, respiration, grazing, viral infection, CO₂ uptake, oxygen evolution, and calcification;
- to identify species that are 'winners' or 'losers' under conditions of high acidity/CO₂, which can be used as markers of pH-induced changes in the composition of natural communities in the Southern Ocean. Such species will be cultured to determine the physiological traits that cause plankton to be sensitive to or tolerant of high acidity.

The resulting information should allow better predictions of the effect of increased acidity on natural communities of marine microbes in the Southern Ocean.

Complete analysis of the samples and data will take up to a year, but preliminary results showed:

- Phytoplankton photosynthesis removed up to 25% of the CO₂ during the experiment. In the open ocean, this would be quickly replaced from the atmosphere. Due to the reduced buffering capacity of the ocean at elevated CO₂ concentrations, it suggests that phytoplankton production will contribute to future variability of ocean acidification.
- Phytoplankton concentrations were higher in acidified treatments than in controls. Whether



Under ultraviolet light a sample from a minicosm reveals a galaxy of bacteria (small dots) and a larger algal cell (*Cylindrotheca closterium*). The cells were treated with a DNA stain that fluoresces under ultraviolet light.

this was due to improved phytoplankton growth, or to reduced grazing losses due to the inhibition of protozoa, should become clear after further analysis of the experiments.

Analysis is proceeding on the rates of processes that limit the composition and abundance of microbial communities (photosynthetic fitness, grazing and growth) and mediate atmospheric concentrations of greenhouse gases (photosynthesis, respiration, sinking of organic matter).

We plan to follow up the voyage experiments with further minicosm-based studies of ocean acidification at the Australian Antarctic Division. These will use communities of marine microbes obtained off Tasmania or returned on the *Aurora Australis*, and at an Antarctic continental station during 2008-09.

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¹ Raven J et al. (2005). Ocean acidification due to increasing atmospheric carbon dioxide. The Royal Society, London 57 pp. Download at www.royalsoc.ac.uk/document.asp?id=3249



Suellen Cook measures the oxygen concentration of samples from the minicosm tanks and the ocean.



The 650 L gas-tight minicosm tanks use intravenous feeding bags (courtesy of the Polar Medicine Unit) to deliver acid slowly to each tank. Tanks have temperature control, gentle stirring, filtered artificial light, and several sampling points.



Dr Imojen Pearce investigated the grazing activity of protozoa on phytoplankton through a series of dilutions.