

RESEARCH SUMMARY:

Effects of elevated atmospheric CO₂ on the physiology of the purple sea urchin

Christopher J Osovitz
University of California, Santa Barbara

Central aim: The central aim of this project is to employ emerging molecular tools to strengthen our understanding of the biological consequences of ocean acidification on California's reef system by investigating the physiology of an important biological member of California's coastal ecosystem, the purple sea urchin, in response to elevated levels of CO₂.

Background: The current trajectory of global climate change has generated an urgent need to understand the ecological consequences of such change. In particular, marine systems face the threat of ocean acidification due to increasing atmospheric CO₂ levels. The most recent Intergovernmental Panel on Climate Change (IPCC) report projects global CO₂ levels to reach 540 – 970 parts per million (ppm) by the year 2100, up from the current level of 370 ppm (IPCC 2007). This increase in CO₂ could in turn decrease ocean pH (currently 8.0-8.3) as much as 0.3 pH units (Haugan and Drange 1996), a degree which has already been shown to slow the rate of calcification in the skeletons of calcareous marine organisms (e.g. Orr et al. 2005). However, the impact of such changes on the physiological ecology of California reef species remains unclear.

Approach: In order to assess the physiological effects of ocean acidification, skeletal growth and hardness and gene expression will be measured in the calcareous purple sea urchin, *Strongylocentrotus purpuratus* in response to artificially elevated levels of CO₂ under laboratory conditions.

Methods: Several hundred recently settled juvenile purple sea urchins will be collected from the Santa Barbara Channel and held in three tanks in the laboratory for 120 days. The seawater of each tank will be infused with air comprised of one of three differing concentrations of CO₂: ambient, 540 ppm, or 970 ppm, bracketing the range of IPCC projections for 2100. Following the laboratory rearing period, skeletal growth and hardness and gene expression of each sea urchin will be investigated. While measurements of skeletal growth and hardness will directly assess the purple sea urchin's ability to overcome the anti-calcifying effects of an acidified environment (e.g. Shirayama and Thornton 2005), gene expression analysis will allow for investigation of finer scale physiological consequences of living in lower pH. Changes in gene expression are thought to be a chief mechanism through which species adjust to environmental fluctuation (Schulte 2001) and here will be examined using cDNA microarrays, a powerful new genomic tool that enables the simultaneous study of the expression of thousands of genes. Microarray techniques are an excellent fit for this study, as ocean acidification could impact several aspects of skeletal growth and calcification and the genes involved in mediating acidified environments have yet to be fully identified.

Conclusion: Complementing organismal approaches with emerging molecular techniques, like the cDNA microarray, should produce a more holistic understanding of biological responses to environmental change and more accurate predictions regarding possible ecological consequences of climate change, like ocean acidification.