FAST BREAKING PAPERS - 2009

April 2009

M. Debora Iglesias-Rodriguez talks with *ScienceWatch.com* and answers a few questions about this month's Fast Breaking Paper in the field of Geosciences. The author has also sent along images of her work.

Article Title: Phytoplankton calcification in a high-CO2 world
Authors: Iglesias-Rodriguez, MD;Halloran, PR;Rickaby, REM;Hall, IR; Colmenero-Hidalgo, E;Gittins, JR;Green, DRH;Tyrrell, T;Gibbs, SJ;von Dassow, P;Rehm, E;Armbrust, EV;Boessenkool, KP
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(addresses have been truncated)

SW: Why do you think your paper is highly cited?

Because recent debate about the long-term fate of increasing carbon dioxide (CO_2) in the oceans and its effect: ocean acidification has prompted questions about how marine organisms, particularly those that calcify, will adapt to these changes.

While most studies have dealt with either laboratory observations or the geological record, my work combines both laboratory analysis of the effect of ocean acidification on calcium carbonate-producing phytoplankton with analysis of their geological record over the past 220 years, during the Anthropocene epoch—the period of anthropogenic CO_2 release.

The model organisms that I investigate, coccolithophores (single-celled algae, protists, and phytoplankton), are responsible for most of the open-ocean calcification and thus, information on how these adapt to climate change is extremely important in order to predict any alteration in the marine carbon cycle.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

Yes, my paper describes a new finding and synthesizes information spanning from cellular responses to long-term trends in the geological record.

SW: Would you summarize the significance of your paper in layman's

terms?

Increased CO_2 in the Earth's atmosphere is causing some microscopic ocean plants to produce greater amounts of calcium carbonate—with potentially wide-ranging implications for predicting the cycling of carbon in the oceans and global climate modeling.

This work shows that calcification by phytoplankton could increase along with the increasing levels of CO_2. This is important because the majority of ocean calcification is carried out by coccolithophores.

When coccolithophores make plates of calcium carbonate they also release CO_2. But because these organisms photosynthesize they also consume CO_2. It is the balance between calcification—which produces carbon dioxide—and the consumption of CO_2 by photosynthesis that will determine whether coccolithophores act as a "sink" (absorbing CO_2) or as a source of CO_2 to the atmosphere.

Our results, based on experiments that directly replicate how the oceans take up carbon dioxide, show that the rise in CO_2 produced by increased calcification is mitigated by its removal through increased photosynthesis, with a net effect that is unlikely to either contribute greatly or significantly reduce the rise in atmospheric CO_2.

Our research has also revealed that, over the past 220 years, coccolithophores have increased the mass of calcium carbonate they each produce by around 40%. These results are in agreement with previous observations that coccolithophores are abundant throughout past periods of ocean acidification, such as that which occurred roughly 55 million years ago—the Palaeocene Eocene Thermal Maximum.

Figure 1: +details

Figure 2:

Figure 3:

SW: How did you become involved in this research, and were there any problems along the way?

I was testing whether different varieties of *Emiliania huxleyi*, the model coccolithophore species used in my study, responded differently to varying CO_2 levels. At the time when I found my exciting results, I also met Paul Halloran (Oxford University) who was working on the geological record of calcifying phytoplankton. When I realized their observations in the geological record showed that coccolithores have adapted to decreasing pH we started a collaboration that resulted in the *Science* paper.

SW: Where do you see your research leading in the future?

My research will continue to contribute to the understanding of the evolution of coccolithophores by answering fundamental questions in cellular biology. A central question is why do coccolithophores calcify? Without knowing the answer to this question we will not be able to make much progress in our understanding of the environmental regulation of calcification. Because understanding these controls is central to predicting changes in the carbon cycle, I plan to work together with modellers to further our understanding of calcification in the present-day ocean and to make more robust predictions for the future.

SW: Do you foresee any social or political implications for your research?

Most definitely. Ocean acidification has a potentially dramatic impact on ecosystems, from single-cell organisms to large predators. This could have societal implications at different levels with potential effects on tourism, food availability, and the economy. However, these questions are still facing the community of scientists (from molecular biologists to population ecologists and carbon cycle modellers), who, for the first time, are working together to find solutions. My work represents a contribution toward whatever future scenarios could be like for organisms which are central to the ocean carbon pump.

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Figures and descriptions:

Figure 1:

Figure 1:
My work has taken me to the most remote locations in the world such as Elephant Island, in the South Atlantic.

Figure 2:

Figure 2:
The next step after the laboratory incubations is to field test the results observed using cultures." Here, I'm setting up deck incubation experiments aboard RV Discovery in the summer of 2007.

Figure 3:

Figure 3:
In this image, I am conducting laboratory incubation experiments at different carbon dioxide levels, from pre-industrial to projections to the year 2100.

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