SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY

Press Release

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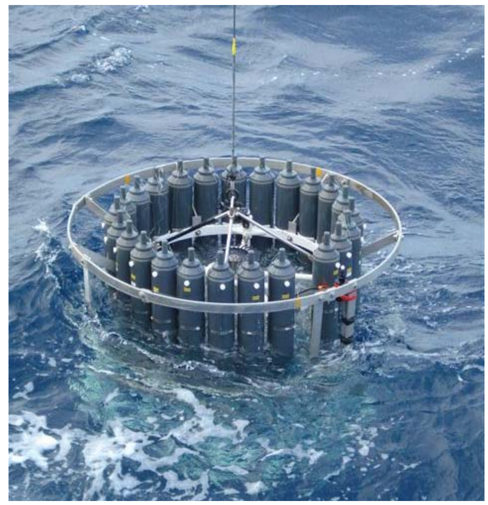
A New View of Oceanic Phytoplankton

Phytoplankton comprise the forests of the sea, and are responsible for providing nearly half of the oxygen that sustains life on Earth including our own. However, unlike their counterparts on land, the marine plants are nearly exclusively microscopic in size, and mostly out of human sight. Consequently, we are still in a very early stage of understanding even the most basic aspects of phytoplankton biology and ecology.



A CTD (Conductivity, Temperature, Depth) rosette is deployed. Photo by Lance A. Fujieki

In a new paper published in Nature, an international team of scientists, including two University of Hawaii at Manoa (UHM) microbial oceanographers, describe a novel strategy for phytoplankton growth in the vast nutrient-poor habitats of tropical and subtropical seas. The research team was led by Benjamin Van Mooy of the Woods Hole Oceanographic Institution on Cape Cod, MA, with key contributions by UHM scientists Michael Rappé and David Karl of the School of Ocean and Earth Science and Technology (SOEST) and UH's new Center for Microbial Oceanography (C-MORE).

Until now, it was thought that all cells are surrounded by membranes containing molecules called phospholipids – oily compounds that contain phosphorus, as well as other basic elements including carbon and nitrogen. These phospholipids are fundamental to the structure and function of the cell and for this reason had been thought to be an indispensable component of life. Phospholipids are one of several classes of molecules that contain the element phosphorus, which has been shown to be in very short supply in many marine ecosystems. The deep sea contains ample phosphorus but delivery to the surface waters where photosynthesis occurs is limited by temperature-induced stratification and the inability to mix the ocean to depths where phosphorus is available. Indeed, research conducted at Station ALOHA near Hawaii during the past two decades has shown that phosphorus is rapidly becoming less abundant in the stratified regions of the North Pacific Ocean, possibly a result of changes in the marine habitat due to greenhouse gas warming.

Van Mooy and colleagues discovered that phytoplankton in the open ocean may be adapting to the low levels of phosphorus by making a fundamental change to their cell structure. Rather than synthesizing the phosphorus-requiring phospholipids for use in their membranes, the plants appear to be using non-phosphorus containing "substitute lipids" that use the nearly unlimited element sulfur also found in seawater instead of phosphorus. These substitute sulfolipids apparently allow the plants to continue to grow and survive under conditions of phosphorus stress, a unique strategy for life in the sea.

To test the generality of this biochemical strategy, the authors compared the response of the phytoplankton communities in different ocean basins that experience varying levels of phosphorus stress. In regions where phosphorus stress is extreme, such as the area dubbed the Sargasso Sea in the central North Atlantic Ocean, phospholipids were nearly nonexistent. By comparison, in the South Pacific Ocean, where sufficient phosphorus exists, there were large amounts of phospholipids. The region around Hawaii was intermediate, which is consistent with the long-term data sets from the Hawaii Ocean Time-series program showing that phosphorus is still measurable but is disappearing from the surface waters at an alarming rate. One prediction from this initial study is that the phytoplankton in Hawaiian waters are likely to become more like those in the Sargasso Sea over time as phosphorus supplies dwindle further. To date, the ability to synthesize substitute lipids appears to be restricted to the phytoplankton; heterotrophic bacteria and other organisms must have a different strategy for survival, or none at all. This has implications for the future structure, biodiversity and function of Hawaiian marine ecosystems, including fish production and long-term carbon dioxide sequestration.

This research will continue as part of C-MORE's stated mission to understand life in the marine environment from "genomes to biomes" (http://cmore.soest.hawaii.edu).

Please also see the Woods Hole Oceanographic Institution's press release on this topic http://www.whoi.edu/page.do?pid=7545&tid=282&cid=54586&ct=162

Paper Information: "Phytoplankton in the ocean use non-phosphorus lipids in response to phosphorus scarcity". Benjamin A. S. Van Mooy, Helen F. Fredricks, Byron E. Pedler, Sonya T. Dyhrman, David M. Karl, Michal Koblíek, Michael W. Lomas, Tracy J. Mincer, Lisa R. Moore, Thierry Moutin, Michael S. Rappé & Eric A. Webb
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