The Vitamin B_{12} Claw

Scientists have revealed a key cog in the biochemical machinery that allows algae at the base of the ocean food chain to thrive. They discovered a previously unknown protein in algae that grabs vitamin B_{12}, an essential but scarce nutrient, out of seawater.

Many algae, as well as humans and other animals, require B_{12}, but they can't make it and must either acquire it from the environment or eat food that contains B_{12}. Only certain single-celled bacteria and archaea have the ability to synthesize B_{12}, which is also known as cobalamin.

Studying algal cultures and seawater samples from the Southern Ocean off Antarctica, a team of researchers from Woods Hole Oceanographic Institution (WHOI) and the J. Craig Venter Institute found a protein they call "the B_{12} claw." Stationed on the outside of algal cells, the protein appears to operate by binding B_{12} in the ocean and helping to bring it into the cell. When B_{12} supplies are scarce, algae compensate by producing more of the protein, officially known as cobalamin acquisition protein 1, or CBA1. The researchers reported their findings May 31, 2012, in *Proceedings of the National Academy of Sciences.*

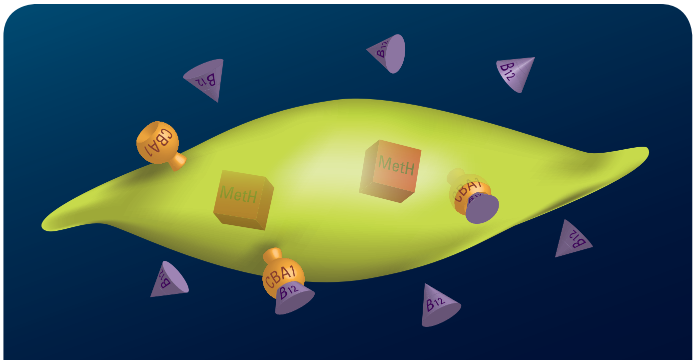
Discovery of CBA1 illuminates a small but vital piece of the fundamental metabolic machinery that allows marine algae to grow. The algae, in turn, have critical impacts on the ocean's food web and on Earth's climate. Via photosynthesis, marine algae remove huge amounts of carbon dioxide, a greenhouse gas, from the air, incorporating organic carbon into their cells and providing food up the food chain. When they die or are eaten, some of the carbon ends up sinking to the ocean depths, where it does not re-enter the atmosphere.

The discovery also opens the door for industrial or therapeutic applications. Since CBA1 is essential for algal growth, it could provide clues on how to promote the growth of algae used to manufacture biofuels. Learning to manipulate the B_{12} biochemical pathways of beneficial or detrimental microbes could eventually lead to antibiotic or antifungal medicines.

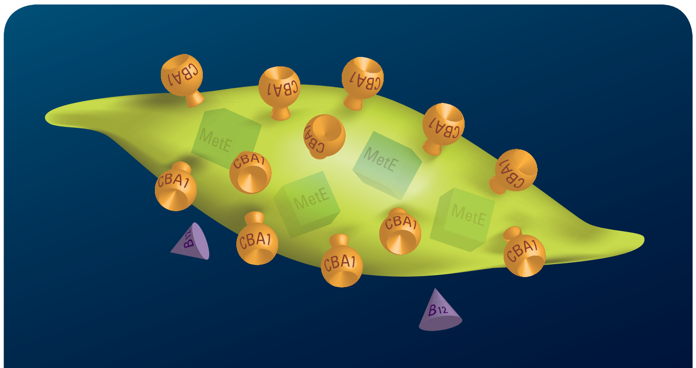
To discover CBA1, WHOI biogeochemists Erin Bertrand and Mak Saito used an approach now common in biomedical research but only recently applied to marine science: proteomics, the study of the proteins organisms make to function in their environment and respond to changing conditions. They discovered the novel CBA1 protein—among thousands of other proteins in the algae—when they starved the algae of vitamin B_{12}. In response, the algae produced CBA1 in abundance. The WHOI scientists worked with Venter Institute colleagues to demonstrate CBA1's presence and function in the ocean.

Bertrand, the study's lead author, earned a Ph.D. from the MIT/WHOI Joint Program in Oceanography in September 2011 and is now a postdoctoral scientist at the Venter Institute. Co-authors of the papers are Andrew Allen, Christopher Dupont, Trina Norden-Krichmar, Jing Bai and Ruben Valas of the Venter Institute, and Saito, Bertrand's Ph.D. advisor at WHOI.

—*Lonny Lippsett*



Scientists hypothesize that cobalamin acquisition protein 1 (CBA1) binds vitamin B_{12} in the ocean and helps bring it into algal cells. The vitamin is needed to activate methionine synthase (MetH), an enzyme essential for growth.



When B_{12} supplies are scarce, algae produce more CBA1 to try to obtain more B_{12}. As a backup, some algae resort to creating another enzyme, MetE, which can replace MetH but is far less efficient.

Illustrations by Amy Caracappa-Qubeck, WHOI

Watch the Audio Slideshow:
www.whoi.edu/oceanus/article/invisible-realm

This research was funded by the National Science Foundation and the Gordon and Betty Moore Foundation's Marine Microbiology Initiative.

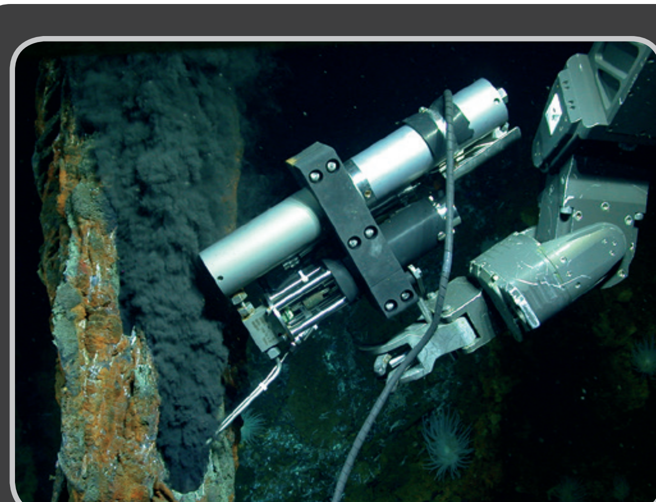


Photo courtesy of Chris German, WHOI