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W. Bryce Penta
penta.2@nd.edu
321-505-3088

Understanding the limiting effects of nutrients on phytoplankton

Effects of vitamin B_{12} on the photosynthetic efficiency and growth of phytoplankton

Just as terrestrial plants form the basis of land-based ecosystems, phytoplankton form the basis of the aquatic ecosystems. These microscopic organisms exist in both freshwater and marine environments. Shifts in ecosystem health and functioning affect phytoplankton through changes in available nutrients and other parameters necessary for growth. In the face of climate change, understanding how marine environments adapt or suffer from changing conditions is crucial. According to Dr. Peter Lee, a College of Charleston biogeochemist, "although it may not seem evident, the vastness of the ocean makes it as important to the Earth's biosphere in terms of productivity as any tropical rain forest. As a consequence, understanding the factors that control phytoplankton growth in the oceans is critical to understanding how the oceans will respond to changing climate and impact the Earth.

Field experiment at sea with mixed phytoplankton samples and added nutrients. Photo credit: Nicole Schanke

Phytoplankton growth depends on limiting factors such as nitrate or trace elements that dictate the proper functioning of photosynthesis; however, one nutrient, vitamin B_{12} lacks thorough understanding. Various studies have shown the biological necessity of vitamin B_{12}, and as a metabolic intermediary little remains known about this vitamin. Many species rely on vitamin B_{12} to aid in the production of a precursor chemical for cloud formation. This chemical, dimethylsulfoniopropionate, leads to products that increase the cloud coverage of the planet, which acts as a cooling mechanism.

Bryce Penta, a rising senior at the University of Notre Dame and a summer intern at the College of Charleston, worked with Dr. Lee lab to better understand the effects of vitamin B_{12} on photosynthetic efficiency and growth of phytoplankton. Under the mentorship of Dr. Lee, Penta looked at the effect of both increase and decrease of the nutrient in natural field samples and laboratory cultures. Penta is one of ten selected students participating in the National Science Foundation (NSF) Research Experience for Undergraduates (REU) through a partnership with College of Charleston.

Using a measurement called F_V/F_M, Penta measured the phytoplankton's ability to photosynthesize at given time periods after alteration of nutrient availabilities. F_V/F_M, or photosynthetic efficiency refers to the functional ability of the phytoplankton to properly use electrons for energy. Acting as a proxy for biomass, chlorophyll *a* levels were also

measured using a fluorometer. The extracted chlorophyll *a* measurements give an approximation of growth as increased phytoplankton densities produce higher levels of chlorophyll *a.*

The research showed that B_{12} did not exhibit an effect on the photosynthetic efficiency and growth; however, this lack of response may be attributed to the increased importance of a separate metabolic pathway that does not rely on vitamin B_{12} and can be turned on when phytoplankton cannot obtain vitamin B_{12}. While these experiments lacked support for a phytoplankton response to B_{12} there is always room for additional experiments with other species that might show a significant effect without the alternate metabolic route. Furthermore, this information can be included in global climate models to improve forecasts and predictions related to climate change.

To learn more about his research and the CofC REU program visit the blog: http://www.blogreu.wordpress.com/ and CofC Web site: http://reu.cofc.edu/.

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W. Bryce Penta
University of Notre Dame
Penta.2@nd.edu

Peter Lee
College of Charleston
Hollings Marine Laboratory
leep@cofc.com