Cruise Report EN538
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Phytoplankton utilization of nitrogen in the surface ocean
Ward Lab: http://www.princeton.edu/nitrogen

This cruise in the subarctic North Atlantic was part of an NSF funded project "Dimensions of Biodiversity: Functional Diversity of Marine Eukaryotic Phytoplankton" (PIs Ward and Sigman from Princeton and Allen from JCVI). The goal of the project is to investigate the *taxonomic, genetic and functional diversity* of eukaryotic phytoplankton and link diversity and assemblage composition to the carbon and nitrogen biogeochemistry of the surface ocean. *Taxonomic* diversity will be investigated by identifying the components of the phytoplankton assemblages using molecular, chemical and microscope methods. *Genetic* diversity will be explored at several levels, including direct sequencing of clone libraries of key functional genes and metatranscriptomic sequencing and microarray analysis of size fractionated/flow cytometrically-sorted phytoplankton assemblages. Using natural abundance and tracer stable isotope methods, we will link *genetic* and *taxonomic diversity* to *functional* diversity in C and N assimilation in size- fractionated and taxon-sorted populations.

In our previous work using similar methods in the Sargasso Sea, we found that small eukaryotic phytoplankton and prokaryotic picoplankton could be distinguished by their nitrogen stable isotope signatures, implying that the two groups rely on different sources of nitrogen. The eukaryotes were disproportionately important in the assimilation of nitrate, sometimes relying almost entirely on nitrate for their nitrogen needs, even when nitrate is present in the surface water at vanishingly low concentrations.

The project involves four cruises, two in the Sargasso Sea (completed in 2012) and two in the subarctic North Atlantic, two environments where the contributions of eukaryotic and prokaryotic phytoplankton are expected to be quite different. The current cruise departed from Narragansett, RI on 29 April, 2014 on a transect towards Iceland. A daily dawn station provided samples for nutrients, isotopic analysis and primary production measurements. While underway, we sampled the underway seawater system at 6 h intervals for nutrients, pigments and isotope samples. At two process stations around 58N 20W and 59°50N 21°35W, differential N utilization was investigated using natural abundance and tracer N isotope methods. Near real time measurements of low level dissolved inorganic nutrient concentrations were made on board and provided crucial information necessary for the incubations, which were the primary experimental basis of the project. We received daily satellite data from a colleague back at Princeton to inform our sampling and provide temporal and spatial context for the experiments. Cloud cover prevented good satellite coverage, but the data we did receive was useful in planning the location of the process stations.

After the process stations, the cruise ended in the Iceland. This expedition was a repeat cruise, on which we carried out essentially the same program as a previous cruise in August-September 2013. We expect to find major ecological contrasts in

process rates and phytoplankton community composition between the August and May seasons, likely reflecting differences in the major N utilization pathways and fates of primary production.

We used the shiptime to collect samples and conduct experiments, which will require months to years to fully analyze using mass spectrometry and molecular biological approaches. So the only preliminary results we have at the end of the cruise are the nutrient measurements and the CTD data. There were few surprises in these measurements. The biomass (estimated from chlorophyll fluorescence and filtration times, as well as the underway fluorometry) was variable and patchy, suggesting that different patches of water were in different stages of the early spring bloom. Nutrient, especially nitrate, concentrations were high in the surface waters, again indicative of the early stages of the bloom. Heavy weather throughout the cruise indicated that the water column was somewhat stirred up, providing high nutrients, but not enough stability to enable a strong bloom. Thus we expect to find a spectrum of stable isotope values in the particulate nitrogen and dissolved nitrate, indicative of differential N utilization and response of different phytoplankton groups to the nutrient availability at different stages of the bloom.

Cruise participants include:
-- Bess Ward (Chief Scientist)
-- Nicolas van Oostende (Ward post doc): primary production, on board flow cytometric analysis, algal pigments, DNA/RNA collection, 15N tracer experiments.
-- Sarah Fawcett (Sigman/Ward post doc): natural abundance particle analysis, 15N tracer experiments, post cruise flow cytometric sorting analysis
-- Jessica Lueders Dumont (Ward/Sigman grad student): Primary production, 15N tracer experiments
-- Andrew Babbin (Ward grad student): nutrient analysis
-- Aimee Babbin (Ward visitor): nutrient analysis
-- Keiran Swart (Sigman grad student): Carbon isotopes, particle collections
-- Dario Marconi (Sigman grad student): Particle collections, nitrate isotopes
-- Jeff Hoffmann (CJVI scientist): metagenomics

R2R data: http://www.rvdata.us/catalog/EN538