Synechococcus cell silica uptake from cultures with added nutrients from laboratory experiments at the Dauphin Island Sea Lab between 2013 and 2015 (Si_in_Syn project)

Website: https://www.bco-dmo.org/dataset/674277
Data Type: experimental
Version:
Version Date: 2017-12-04

Project
» Understanding the Role of Picocyanobacteria in the Marine Silicate Cycle (Si_in_Syn)

Contributors	Affiliation	Role
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Coverage

Spatial Extent: **Lat**:41.19 **Lon**:-73.06

Dataset Description

The effect of nutrients other than Si on the rate of Si accumulation was examined to better understand the factors controlling cellular Si content in *Synechococcus*. This dataset contains Synechococcus cyanobacteria silica uptake rates from cultures grown in Sargasso Sea water with no additions or additions of all f/2 media nutrients, f/2 media vitamins and trace metals, phosphate, nitrate, or silicic acid. Experiments took place at the Krause Lab at Dauphin Island Sea Laboratory (30.2501,-88.0788) between March 2013 to August 2015.

These results are also presented in the following paper:

Brzezinski, M. A., Krause, J. W., Baines, S. B., Collier, J. L., Ohnemus, D. C. and Twining, B. S. (2017), Patterns and regulation of silicon accumulation in Synechococcus spp.. J. Phycol., 53: 746–761. doi:10.1111/jpy.12545

Methods & Sampling

Monocultures of Synechococcus clone 1333 were used to examine variation and controls on Si quotas and rates of Si accumulation. The culture was procured from the National Center for Marine Algae and Microbiota (NCMA) at the Bigelow Laboratory for Ocean Sciences in Boothbay Harbor, Maine. This clone are also available

in other culture collections and has various strain names. Here it is referred to by its NCMA strain number 1333 (a.k.a. CCMP number).

Cells were preconditioned in f/2 Sargasso seawater medium with 120 uM silicic acid. Inocula for experimental cultures were prepared by centrifuging and resuspending aliquots of culture into unamended surface Sargasso seawater (two centrifuge/resuspension cycles) to dilute the medium silicic acid. The carry-over of dissolved silicic acid with the cell inoculum was variable resulting in increases in [Si(OH)4] ranging from 1 - 3 uM when cells were added to experimental culture vessels. The specific centrifuging time and g-force were shown not to affect growth rate in cells relative to those added to fresh media without being concentrated (data not shown).

Cells were incubated at 21C with low light 65 microeinsteins per second per square meter (uE/m2/s) without bubbling. A 12 h light:12 h dark photocycle was used. Additions of individual components of the f/2 media were made: +NO_3, +PO_4, +vitamins & trace metals, +Si, +All constituents, and a control consisting of only aged Sargasso Sea water with triplicate measurements per treatment. Cells were incubated for an additional four hours after incubation.

Each incubation was terminated by filtration and processed for measurement of 32Si activity following Krause et al. (2011). Briefly, Synechococcus cells were filtered onto 0.2 µm polycarbonate membrane filters, the filters mounted on nylon disc planchettes, air dried, covered with mylar film and secured to the planchettes with nylon rings. After aging for 120 days, secular equilibrium between 32Si and its daughter 32P was achieved and 32Si activity was determined using gas-flow proportional counting using GM 25-5 multicounters (Risø National Laboratory, Technical University of Denmark).

Full details of culturing and experimental methods are described in Brzezinski et al. (in review). (as of 05 Jan 2017)

Data Processing Description

BCO-DMO Data Manager Processing Notes:
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions
* blank values replaced with no data value 'nd'
* latitude and longitude of Dauphin Island Sea Lab added to dataset
* uptake rate limited to five decimal places

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Data Files

File	
Culture_Media_Composition.csv	(Comma Separated Values (.csv), 885 bytes) MD5:f2de5c8fbbd5a9a9d266575a3cdc8167
Primary data file for dataset ID 674277	

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Related Publications

Brzezinski, M. A., Krause, J. W., Baines, S. B., Collier, J. L., Ohnemus, D. C., & Twining, B. S. (2017). Patterns and regulation of silicon accumulation in Synechococcus spp. Journal of Phycology, 53(4), 746–761. doi:10.1111/jpy.12545
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Krause, J. W., Brzezinski, M. A., & Jones, J. L. (2011). Application of low-level beta counting of 32Si for the measurement of silica production rates in aquatic environments. Marine Chemistry, 127(1-4), 40–47.

doi:10.1016/j.marchem.2011.07.001
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Parameters

Parameter	Description	Units
clone_id	Synechococcus clone identifier (NCMA strain and CCMP number)	unitless
clone_lat	Latitude of the clone collection site	decimal degrees
clone_lon	Longitude of the clone collection site	decimal degrees
treatment	Shorthand code for additions to culture medium (e.g. N means added nitrate)	unitless
treatment_descrip	Description of what additions were made to culture medium	untiless
uptake_rate	Silica uptake rate	reciprocal hours (h-1)

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Instruments

Dataset-specific Instrument Name	GM 25-5 multicounter
Generic Instrument Name	GM multicounter
Dataset-specific Description	GM 25-5 multicounters (Risø National Laboratory, Technical University of Denmark).
Generic Instrument Description	A gas flow multicounter (GM multicounter) is used for counting low-level beta doses. GM multicounters can be used for gas proportional counting of 32Si to 32P. For more information about GM multicounter usage see Krause et. al. 2011.

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Deployments

Krause_DISL_2013-2015

Website	https://www.bco-dmo.org/deployment/674230
Platform	lab Dauphin_Island_Sea_Lab
Start Date	2013-03-01
End Date	2015-08-31
Description	Laboratory experiments conducted at Dauphin Island sea lab. Clone collection locations included in deployment coordinates.

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Project Information

Understanding the Role of Picocyanobacteria in the Marine Silicate Cycle (Si_in_Syn)

Coverage: Samples collected in western North Atlantic Ocean between Puerto Rico, Bermuda, and Gulf of Maine.

Extracted from the NSF award abstract:

INTELECTUAL MERIT: The investigators will follow-up on their discovery of significant accumulation of silicon by marine picocyanobacteria of the genus Synechococcus to assess the contribution of these organisms to the cycling of biogenic silica in the ocean. Oceanographers have long assumed that diatoms are the dominant marine organisms controlling the cycling of silica in the ocean. Recently, however, single-cell analyses of picocyanobacterial cells from field samples surprisingly revealed the presence of substantial amounts of silicon within Synechococcus. The contribution of Synechococcus to biogenic silica often rivaled that of living diatoms in the two systems examined. Moreover, size fractionation of biogenic silica indicates that up to 25% of biogenic silica can exist in the picoplanktonic size fraction. Given that picocyanobacteria dominate phytoplankton biomass and primary production over much of the world's ocean, these findings raise significant questions about the factors controlling the marine silica cycle globally, as well as the proper interpretation of biogenic silica measurements, Si:N ratios in particulate matter, and ratios of silicate and nitrate depletion. It also suggests that picocyanobacterial populations may be subject to previously unknown constraints on their productivity.

The project will have both laboratory and field components. Because cellular Si varies substantially among the field-collected samples and laboratory strains so far analyzed, the laboratory component will document variability in Si uptake and cellular Si concentrations, while determining what role physiological and phylogenetic factors play in this variability. The investigators will use strains of Synechococcus for which there are already genome sequences. Laboratory experiments will 1) use 32Si radiotracer uptake experiments to assess the degree of variability in Si content and Si uptake kinetics among strains of Synechococcus acclimated to different levels of silicate, 2) characterize the intracellular distribution and chemistry of silicon within cells using fractionation techniques, density centrifugation, electron microscopy and x-ray absorption spectroscopy, and 3) use bioinformatic analyses of published genomes to determine whether uptake of Si can be predicted based on phylogenetic relationships, to identify candidate genes involved in cyanobacterial Si metabolism, and to develop probes for community structure that can be related to cellular Si content. Field work at the Bermuda Atlantic Time Series (BATS) site will assess the contribution of Synechococcus and diatoms to total biogenic silica in surface waters at times of the year when the former are typically dominant. Field measurements will include size fractionation of biogenic silica biomass and Si uptake, and synchrotron-based x-ray fluorescence microscopy, and the phylogenetic composition of the Synechococcus assemblage.

BROADER IMPACTS: This project has the potential to drive a major paradigm shift in our understanding of the marine silicon cycle. In addition, one PhD student will be trained at Stony Brook. Each PI will provide research experience to a number of undergraduates working on original research projects for credit, as a part of an REU program or as the basis for undergraduate theses. Stony Brook research programs for undergraduates are supported with summer research money from the Undergraduate Research and Creative Activities (URECA) program, and draw on its very diverse student body. The investigators will also engage promising high school level students through several residential programs that the PIs have been a part of in the past. These include the BLOOM program at Bigelow and the Simons Summer Research Fellowship Program at Stony

Brook. The PI has continuing relationship with a regional high school (Brentwood) with a high proportion of underrepresented minorities. PI Twining is involved in the Café Scientifique program at Bigelow. Baines will engage in similar outreach through the Center for Science and Mathematics Education (CESAME) sponsored Open Science Nights. Finally, PI Baines will cooperate with CESAMEs teacher education programs, with the aim of incorporating biological oceanography into K-12 curricula. PIs Krause and Brzezinski will incorporate aspects of phytoplankton ecology into UCSB's Oceans to Classroom Program that brings marine research at UCSB to life for over 18,000 K-12 students each year.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1335012

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