Growth rate of Synechococcus cells grown in different silicic acid concentrations from laboratory experiments at the Dauphin Island Sea Lab between 2013 and 2015 (Si_in_Syn project)

Website: https://www.bco-dmo.org/dataset/674268
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
Krause, Jeffrey W.	Dauphin Island Sea Lab (DISL)	Principal Investigator, Contact
Brzezinski, Mark A.	University of California-Santa Barbara (UCSB)	Co-Principal Investigator
York, Amber D.	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Table of Contents

Coverage

Spatial Extent: **N**:41.19 **E**:-65.6 **S**:22.495 **W**:-124.1668

Dataset Description

This dataset contains *Synechococcus* cyanobacteria growth rates from cultures grown in Sargasso Sea water with three different dissolved silicic acid (Si(OH)4) concentrations. 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

Culturing of Synechococcus clones:

Monocultures of six clones of Synechococcus were used to examine variation and controls on Si quotas and rates of Si accumulation. Cultures were procured from the National Center for Marine Algae and Microbiota (NCMA) at the Bigelow Laboratory for Ocean Sciences in Boothbay Harbor, Maine. Many of these clones are also available in other culture collections and have various strain names; here we will refer to each by their NCMA strain number (a.k.a. CCMP number).

All clones were maintained in aged surface Sargasso Sea water with f/2 media constituents with 10 – 100 uM Si depending on the experiment as detailed below. The temperature was 21C with low light 65 microeinsteins per second per square meter (uE/m2/s) on a 12 h light : 12 h dark photocycle. pH was regulated in all cultures by bubbling with humidified ambient air which was sterilized by passage through a bacterial filter prior to entering each culture vessel. Unless otherwise specified, all experiments were conducted under these temperature and light conditions. pH was monitored daily and remained below 8.5 in all experiments.

Influence of [Si(OH)4] on growth rate:

The three silicic acid levels were used: 1 uM (ambient Sargasso Sea water concentration), 60 uM and 120 uM with f/2 levels of all other medium constituents (macronutrients, trace metals, vitamins). Prior to harvest clones were maintained in exponential growth in batch culture for at least 10 generations within each treatment. Growth rates in these cultures were determined by measuring Cell fluorescence (f) to monitored changes in biomass using a TD-700 fluorometer (Turner Designs, Inc.) with a chlorophyll fluorescence filter set. Cells were transferred to fresh media while still in exponential growth. Growth rate at each concentration was determined from the slope of linear regressions of ln(f) versus time over four to six transfers to fresh culture medium. A 1-mL sample was preserved with glutaraldehyde for determining cell abundance using a Beckman Coulter Multisizer 3 coulter counter with a 20 um aperture (part 8320515, range 0.4 - 12 um).

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 clone collection site added to dataset
* growth rate limited to three decimal places

[table of contents | back to top]

Data Files

File
Growth_rate.csv (Comma Separated Values (.csv), 585 bytes) MD5:ac7dccfe8482053f7b6065262117ab10 Primary data file for dataset ID 674268

[table of contents | back to top]

Parameters

Parameter	Description	Units
clone_lat	Latitude of the clone collection site.	decimal degrees
clone_lon	Longitude of the clone collection site.	decimal degrees
clone_id	Synechococcus clone identifier (NCMA strain and CCMP number)	unitless
silicic_acid	Silicic acid concentration [Si(OH)4]	micromolar (uM)
growth_rate	Synechococcus cell growth rate	reciprocal days (d-1)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Beckman Coulter Multisizer 3
Generic Instrument Name	Coulter Counter
Dataset-specific Description	Beckman Coulter Multisizer 3 coulter counter with a 20 um aperture (part 8320515, range 0.4 - 12 um)
Generic Instrument Description	An apparatus for counting and sizing particles suspended in electrolytes. It is used for cells, bacteria, prokaryotic cells and virus particles. A typical Coulter counter has one or more microchannels that separate two chambers containing electrolyte solutions. from https://en.wikipedia.org/wiki/Coulter_counter

Dataset-specific Instrument Name	TD-700 Fluorometer
Generic Instrument Name	Turner Designs 700 Laboratory Fluorometer
Generic Instrument Description	The TD-700 Laboratory Fluorometer is a benchtop fluorometer designed to detect fluorescence over the UV to red range. The instrument can measure concentrations of a variety of compounds, including chlorophyll-a and fluorescent dyes, and is thus suitable for a range of applications, including chlorophyll, water quality monitoring and fluorescent tracer studies. Data can be output as concentrations or raw fluorescence measurements.

[table of contents | back to top]

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.

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

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

[table of contents | back to top]