Growth rates across temperatures for 11 new isolates of marine Synechococcus from Narragansett Bay, July 2017

Website: https://www.bco-dmo.org/dataset/782314
Data Type: experimental
Version: 1
Version Date: 2019-11-20

Project
» Dimensions: Collaborative Research: Genetic, functional and phylogenetic diversity determines marine phytoplankton community responses to changing temperature and nutrients (Phytoplankton Community Responses)

Program
» Dimensions of Biodiversity (Dimensions of Biodiversity)

Contributors	Affiliation	Role
Hutchins, David A.	University of Southern California (USC)	Principal Investigator
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Abstract
Growth rates across temperatures for 11 new isolates of marine Synechococcus from Narragansett Bay, July 2017.

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Coverage

Spatial Extent: **N**:41.7129 **E**:-71.2674 **S**:41.4471 **W**:-71.4007
Temporal Extent: 2017-01-01 - 2018-10-31

Dataset Description

Growth rates across temperatures for 11 new isolates of marine Synechococcus from Narragansett Bay, July 2017.

Methods & Sampling

Natural seawater was enriched for photoautotrophs and split into multiple temperatures for two weeks. After the enrichment period, Synechococcus was isolated from each temperature. Each isolate's thermal niche was measured through a series of lab experiments and sequenced.

Methods: Thermal niches were calculated by measuring each strain’s thermal performance curve. This was

done by acclimating aliquots of each culture for two weeks to a broad range of temperatures between 9° and 33°. Temperatures >33° were added as needed for strains able to grow at these levels. This temperature range was chosen because it exceeds the current summer high and low temperatures in Narragansett Bay, and encompasses the projected warmer temperatures expected in coming decades. Strains were grown at each temperature in triplicate 8 ml borosilicate vials containing 5ml of F/2 medium. Biomass was recorded every two days using in vivo chlorophyll a fluorescence measured on a Turner AU-10 fluorometer (Turner Designs Inc., Sunnyvale, CA, USA), and growth rates and Eppley-Norberg thermal performance curves (Norberg 2004) were calculated in R (Team 2019) using the package growthTools (DOI:10.5281/zenodo.3634918). Rare cultures containing contaminants (verified using fluorescence microscopy) were excluded from the dataset. In two strains for low temperature treatments, LA20 and LA27, after two weeks of acclimation no Synechococcus cells were observed in the culture, so the growth rate was set to zero for these cultures. The results of these thermal performance curves are hereafter referred to as a strain's phenotype.

Data Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions (replaced spaces with underscores)
- changed Sample_Code to Isolate to match other datasets

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Data Files

File	
Syn_growth_rates.csv	(Comma Separated Values (.csv), 3.37 KB) MD5:af760610918e9af8fa2708d044366387
Primary data file for dataset ID 782314	

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Related Publications

Norberg, J. (2004). Biodiversity and ecosystem functioning: A complex adaptive systems approach. Limnology and Oceanography, 49(4,part2), 1269–1277. doi:10.4319/lo.2004.49.4_part_2.1269
Methods

R Core Team (2016) R: A language and environment for statistical computing. R Foundation for Statistical Computing. Vienna, Austria. https://www.r-project.org
Software

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Parameters

Parameter	Description	Units
Isolate	sample identifier; renamed from Sample_Code	unitless
Temp	temperature during growth rates experiments	degrees Celsius
growth_rate_mean	mean growth rate	cells/day
growth_rate_StDev	standard deviation of growth rates	cells/day

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Instruments

Dataset-specific Instrument Name	Turner 10-AU Fluorometer (Turner Designs, CA)
Generic Instrument Name	Turner Designs Fluorometer 10-AU
Dataset-specific Description	Used to measure fluorescence for growth rate calculations.
Generic Instrument Description	The Turner Designs 10-AU Field Fluorometer is used to measure Chlorophyll fluorescence. The 10AU Fluorometer can be set up for continuous-flow monitoring or discrete sample analyses. A variety of compounds can be measured using application-specific optical filters available from the manufacturer. (read more from Turner Designs, turnerdesigns.com, Sunnyvale, CA, USA)

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Project Information

Dimensions: Collaborative Research: Genetic, functional and phylogenetic diversity determines marine phytoplankton community responses to changing temperature and nutrients (Phytoplankton Community Responses)

Coverage: Narragansett Bay, RI and Bermuda, Bermuda Atlantic Time-series Study (BATS)

NSF Award Abstract:
Photosynthetic marine microbes, phytoplankton, contribute half of global primary production, form the base of most aquatic food webs and are major players in global biogeochemical cycles. Understanding their community composition is important because it affects higher trophic levels, the cycling of energy and elements and is sensitive to global environmental change. This project will investigate how phytoplankton communities respond to two major global change stressors in aquatic systems: warming and changes in nutrient availability. The researchers will work in two marine systems with a long history of environmental monitoring, the temperate Narragansett Bay estuary in Rhode Island and a subtropical North Atlantic site near Bermuda. They will use field sampling and laboratory experiments with multiple species and varieties of phytoplankton to assess the diversity in their responses to different temperatures under high and low nutrient concentrations. If the diversity of responses is high within species, then that species may have a better chance to adapt to rising temperatures and persist in the future. Some species may already be able to grow at high temperatures; consequently, they may become more abundant as the ocean warms. The researchers will incorporate this response information in mathematical models to predict how phytoplankton assemblages would reorganize under future climate scenarios. Graduate students and postdoctoral associates will be trained in diverse scientific approaches and techniques such as shipboard sampling, laboratory experiments, genomic analyses and mathematical modeling. The results of the project will be incorporated into K-12 teaching, including an advanced placement environmental science class for underrepresented minorities in Los Angeles, data exercises for rural schools in Michigan and disseminated to the public through an environmental journalism institute based in Rhode Island.

Predicting how ecological communities will respond to a changing environment requires knowledge of genetic, phylogenetic and functional diversity within and across species. This project will investigate how the interaction of phylogenetic, genetic and functional diversity in thermal traits within and across a broad range of species determines the responses of marine phytoplankton communities to rising temperature and changing nutrient regimes. High genetic and functional diversity within a species may allow evolutionary adaptation of that

species to warming. If the phylogenetic and functional diversity is higher across species, species sorting and ecological community reorganization is likely. Different marine sites may have a different balance of genetic and functional diversity within and across species and, thus, different contribution of evolutionary and ecological responses to changing climate. The research will be conducted at two long-term time series sites in the Atlantic Ocean, the Narragansett Bay Long-Term Plankton Time Series and the Bermuda Atlantic Time Series (BATS) station. The goal is to assess intra- and inter-specific genetic and functional diversity in thermal responses at contrasting nutrient concentrations for a representative range of species in communities at the two sites in different seasons, and use this information to parameterize eco-evolutionary models embedded into biogeochemical ocean models to predict responses of phytoplankton communities to projected rising temperatures under realistic nutrient conditions. Model predictions will be informed by and tested with field data, including the long-term data series available for both sites and in community temperature manipulation experiments. This project will provide novel information on existing intraspecific genetic and functional thermal diversity for many ecologically and biogeochemically important phytoplankton species, estimate generation of new genetic and functional diversity in evolution experiments, and develop and parameterize novel eco-evolutionary models interfaced with ocean biogeochemical models to predict future phytoplankton community structure. The project will also characterize the interaction of two major global change stressors, warming and changing nutrient concentrations, as they affect phytoplankton diversity at functional, genetic, and phylogenetic levels. In addition, the project will develop novel modeling methodology that will be broadly applicable to understanding how other types of complex ecological communities may adapt to a rapidly warming world.

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Program Information

Dimensions of Biodiversity (Dimensions of Biodiversity)

Website: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503446

Coverage: global

(adapted from the NSF Synopsis of Program)
Dimensions of Biodiversity is a program solicitation from the NSF Directorate for Biological Sciences. FY 2010 was year one of the program. [MORE from NSF]

The NSF Dimensions of Biodiversity program seeks to characterize biodiversity on Earth by using integrative, innovative approaches to fill rapidly the most substantial gaps in our understanding. The program will take a broad view of biodiversity, and in its initial phase will focus on the integration of genetic, taxonomic, and functional dimensions of biodiversity. Project investigators are encouraged to integrate these three dimensions to understand the interactions and feedbacks among them. While this focus complements several core NSF programs, it differs by requiring that multiple dimensions of biodiversity be addressed simultaneously, to understand the roles of biodiversity in critical ecological and evolutionary processes.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1638804

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