Per-capita growth rates for T. pseudonana selected at low and high temperatures for ~350 generations and assayed at 10 temperatures

Website: https://www.bco-dmo.org/dataset/780192
Data Type: experimental
Version: 1
Version Date: 2019-10-28

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
Litchman, Elena	Michigan State University (MSU)	Principal Investigator
O'Donnell, Daniel R.	Michigan State University (MSU)	Co-Principal Investigator, Contact
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Abstract
Per-capita growth rates for T. pseudonana selected at low and high temperatures for ~350 generations and assayed at 10 temperatures.

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Coverage

Spatial Extent: **Lat**:42.4061 **Lon**:-85.4007
Temporal Extent: 2015-08-06 - 2015-08-15

Dataset Description

Per-capita growth rates for T. pseudonana selected at low and high temperatures for ~350 generations and assayed at 10 temperatures.

These data were published in O'Donnell et al (2018) Global Change Biol. and can also be found in Supporting Information archive gcb14360-sup-0001-SupInfoS1.zip. The filename is ODonnell_etal_2018_temp_gr.rate_data_T.pseudonana_0318.csv. These data can also be seen in Figure 1 of the main text.

Methods & Sampling

We cultured Thalassiosira pseudonana strain NCMA 1335 (formerly 3H) form a single cell (isolated by plating on agar) and sub-cultured 5 replicate populations into 20 ml of L1 marine culture medium in 50 ml tissue culture flasks at 16°C and 5 at 31°C. Per-capita growth rate was ~1 per day at both temperatures. Cultures were agitated daily to maintain cells in suspension, and 1,000,000 cells transferred to fresh L1 marine culture medium every 4 d for 350 generations (~2 y) of experimental temperature selection. Flasks had breathable, sterile caps, allowing for gas exchange. After ~350 generations, we assayed the per-capita population growth rates of all 5 replicate populations from each selection temperature at 10 temperatures, roughly spanning the previously recorded thermal niche of T. pseudonana, acclimating sub-cultured populations at each assay temperature for ~12 generations prior to the assay. Acclimation times ranged from ~10 d at near-optimal temperatures to more than a month at 3°C. We estimated daily change in optical density using a spectrophotometer (see below). Assay times ranged from 4-14 d. We estimated per-capita growth rates by natural log-transforming densities and fitting a linear regression to the exponential portion of the growth curve.

We sampled daily during selection and assays by placing each entire tissue culture flask in a Shimadzu UV-2401PC spectrophotometer (Shimadzu Corporation, Kyoto, Japan) and measuring absorbance at 436 nm (the wavelength corresponding to the absorbance maximum of chlorophyll a. Density data were log-transformed and linear regressions fit using R statistical programming language version 3.3.2.

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

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Data Files

File	
temp-growth_rates.csv	(Comma Separated Values (.csv), 4.68 KB) MD5:a0af4168191637e66d67d3ae2b7fbd14
Primary data file for dataset ID 780192	

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Related Publications

O'Donnell, D. R., Hamman, C. R., Johnson, E. C., Kremer, C. T., Klausmeier, C. A., & Litchman, E. (2018). Rapid thermal adaptation in a marine diatom reveals constraints and trade-offs. Global Change Biology, 24(10), 4554–4565. doi:10.1111/gcb.14360
Results

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Parameters

Parameter	Description	Units
evol_temp	Growth chamber temperature long-term selection experiment	degrees Celsius
assay_temp	Growth chamber temperature during temperature-dependent growth assay	degrees Celsius
gr_rate	Per-capita growth rate of T. pseudonana batch culture	per day
replicate	Replicate population ID during long-term selection experiment	unitless
strain	A second replicate population ID; also indicating selection temperature	unitless

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Instruments

Dataset-specific Instrument Name	Shimadzu UV-2401PC spectrophotometer (Shimadzu Corporation, Kyoto, Japan)
Generic Instrument Name	UV Spectrophotometer-Shimadzu
Dataset-specific Description	Measured Abs436 (the wave- length corresponding to the absorbance maximum of chlorophyll a.)
Generic Instrument Description	The Shimadzu UV Spectrophotometer is manufactured by Shimadzu Scientific Instruments (ssi.shimadzu.com). Shimadzu manufacturers several models of spectrophotometer; refer to dataset for make/model information.

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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-1638958
NSF Division of Ocean Sciences (NSF OCE)	OCE-1638804
NSF Division of Ocean Sciences (NSF OCE)	OCE-1638834

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