Changes in biovolume in three herbivorous protists measured across a temperature gradient ranging from 0 to 22 degrees Celsius for 30 days

Website: https://www.bco-dmo.org/dataset/857328
Data Type: experimental
Version: 1
Version Date: 2021-08-05

Project
» Quantifying Temperature Dependence In Growth & Grazing Rates of Planktonic Herbivores (Planktonic Herbivore Temp Dependence)

Contributors	Affiliation	Role
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Abstract
This dataset reports changes in biovolume in three herbivorous protists measured across a temperature gradient ranging from 0 to 22 degrees Celsius for 30 days. The data provided served for the production of Figure 5 of Franzè and Menden-Deuer, 2020 (doi: 10.3354/meps13200).

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Coverage

Spatial Extent: **Lat**:41.492779 **Lon**:-71.422211
Temporal Extent: 2017-04 - 2017-06

Methods & Sampling

See complete methodology in Franzè and Menden-Deuer, 2020.

Clonal cultures of Oxyrrhis marina (CCMP 3375), Gyrodinium dominans (SPMC 103), and Protoperidinium bipes were established from single-cell isolation. Herbivorous protists were acclimated to each target temperature before growth rates were measured. Due to the wide temperature range tested (0−22°C), cultures were moved from the initial temperature of 15°C through gradual transitions limited to at most 3°C. The experimental Day 0 (D0) was defined as the first day on which acclimated growth rates were measured. To determine predator and prey abundance, samples were preserved in acid Lugol at a 2% final concentration (Menden-Deuer et al. 2001) and enumerated using a Sedgewick-Rafter slide (1 ml volume) and a Nikon Eclipse E800 light microscope equipped with phase contrast. Herbivore biovolume was calculated based on linear

dimensions obtained from ≥35 cells measured at each time point and temperature treatment using an image analysis system consisting of a high-resolution digital camera (Allied Vision, Stingray F45) and ImageJ software (version 1.5i).

Growth rates of the 3 herbivorous species were determined at 7 incubation temperatures: 0, 2, 5, 10, 15, 18, and 22°C. Changes in O. marina, G. dominans, and P. bipes abundance and biomass were determined over 24 h incubations of the triplicate 150 ml bottles and used to calculate growth rates (μ d−1) assuming exponential growth: μ = ln(Nt/N0)/t, where: N0 and Nt are the initial and final cell abundance (or biomass) respectively, and t is the experiment duration in days. Measurements were made at Day 0 and again after 10 and 30 days.

Data Processing Description

Statistical analyses were performed using R (version 1.2.1335) and Prism 7.

BCO-DMO Processing:
- renamed fields to comply with BCO-DMO naming conventions;
- replaced "NM" with "nd" (no data).

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Data Files

File	
temp_dependent_biovolume.csv	(Comma Separated Values (.csv), 4.73 KB) MD5:dcfd55da92fb427d72fd5a0964ce0d2b
Primary data file for dataset ID 857328	

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Related Publications

Franzè, G., & Menden-Deuer, S. (2020). Common temperature-growth dependency and acclimation response in three herbivorous protists. Marine Ecology Progress Series, 634, 1–13. doi:10.3354/meps13200
Methods

Menden-Deuer, S., Lessard, E., & Satterberg, J. (2001). Effect of preservation on dinoflagellate and diatom cell volume, and consequences for carbon biomass predictions. Marine Ecology Progress Series, 222, 41–50. doi:10.3354/meps222041
Methods

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Related Datasets

IsRelatedTo

Franzè, G., Menden-Deuer, S. (2021) **Abundance- and biomass-based growth rates of three heterotrophic protists measured across a temperature gradient ranging from 0 to 22 degrees Celsius for 30 days.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-08-04 doi:10.26008/1912/bco-dmo.857267.1 [view at BCO-DMO]

Franzè, G., Menden-Deuer, S. (2021) **Comparison of abundance-based growth rate predicted following Q10 model, Eppley's equation, and the linear model obtained in Franzè and Menden-Deuer, 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-08-05 doi:10.26008/1912/bco-dmo.857356.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
Event	cell imaged to determine size	unitless
Species	Name of the species used for the experiment	unitless
ESD_um3_0C	Equivalent spherical diameter at incubation temperature of 0 degrees Celsius	cubic micrometer (um^3)
ESD_um3_2C	Equivalent spherical diameter at incubation temperature of 2 degrees Celsius	cubic micrometer (um^3)
ESD_um3_5C	Equivalent spherical diameter at incubation temperature of 5 degrees Celsius	cubic micrometer (um^3)
ESD_um3_10C	Equivalent spherical diameter at incubation temperature of 10 degrees Celsius	cubic micrometer (um^3)
ESD_um3_15C	Equivalent spherical diameter at incubation temperature of 15 degrees Celsius	cubic micrometer (um^3)
ESD_um3_18C	Equivalent spherical diameter at incubation temperature of 18 degrees Celsius	cubic micrometer (um^3)
ESD_um3_22C	Equivalent spherical diameter at incubation temperature of 22 degrees Celsius	cubic micrometer (um^3)

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Instruments

Dataset-specific Instrument Name	Allied Vision, Stingray F45
Generic Instrument Name	Camera
Dataset-specific Description	Cell measurements were performed using a high-resolution digital camera (Allied Vision, Stingray F45) and ImageJ software (version 1.5i).
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

Dataset-specific Instrument Name	I-36LLVL Series, Percival Scientific
Generic Instrument Name	In-situ incubator
Dataset-specific Description	Experiments were conducted using temperature-controlled incubators (I-36LLVL Series, Percival Scientific).
Generic Instrument Description	A device on a ship or in the laboratory that holds water samples under controlled conditions of temperature and possibly illumination.

Dataset-specific Instrument Name	Nikon Eclipse E800 light microscope
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	Microscopy counts were performed with a Nikon Eclipse E800 light microscope.
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

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Project Information

Quantifying Temperature Dependence In Growth & Grazing Rates of Planktonic Herbivores (Planktonic Herbivore Temp Dependence)

Coverage: Narragansett Bay

NSF Award Abstract:
Plankton, single-celled organisms that inhabit the world's oceans are responsible for the generation of oxygen, cycling energy and matter between the atmosphere and the deep ocean and are the basis for virtually all seafood harvested. These life-giving functions critically depend on the relative rates at which plankton grow and get eaten. How temperature influences those rates is essential to understand plankton responses to environmental changes and ocean dynamics. It is well established that plankton grow faster when temperatures are higher however, whether feeding has a similar temperature dependence is unknown. That means oceanographers are missing key data required to build global predictive models. This project will fill essential knowledge gaps and measure physiological rates of singled celled zooplankton across temperature gradients representing the global ocean, from polar to tropical regions and throughout the seasonal cycle. Researchers will combine laboratory experiments with specimens taken from the coastal ocean (Narragansett Bay), which is exemplary in its strong seasonal temperature variations. These data will provide a clear picture of the production capacity and activity of plankton in a global and dynamic ocean. The project supports an early career scientist, as well as graduate and undergraduate students. Scientists will continue communicating their research to the public through large-scale outreach events, education at the high-school level, and engagement through online and other media. Moreover, researchers will continue collaborating with the Metcalf Institute for Marine & Environmental Reporting to support their Annual Science Immersion Workshop for Journalists and their ongoing work to disseminate research findings through web-based seminars.

Grazing is the single largest loss factor of marine primary production and thus affects a key transfer rate between global organic and inorganic matter pools. Remarkably, data for herbivorous protist growth and grazing rates at temperatures representative of the vast polar regions and during winter and spring periods are extremely sparse. By combining laboratory experiments with ground truthing fieldwork, this project alleviates a central knowledge gap in oceanography and delivers the empirical measurements necessary to derive algorithms to incorporate temperature dependence of heterotrophic protist growth and grazing rates into biogeochemical models. The extraordinary seasonal temperature fluctuations in a temperate coastal estuary (Narragansett Bay) are exploited to measure rates of heterotrophic protists isolated from different temperatures and seasons and to quantify the temperature and acclimation responses of these ecotypes. This project delivers data urgently needed to solve the conundrum of whether herbivorous growth and predation is depressed at low temperatures, implying low trophic transfer rates and high carbon export, or if predation proceeds at rates comparable to temperate systems with primary production largely lost to predation. Large temperature gradients in the global ocean mean that cross-biome and biogeochemical models are particularly sensitive to assumptions about the temperature dependence in modeled rate processes. Establishment of the dependence of heterotrophic plankton physiological rates (growth and grazing) to gradients of temperature,

mimicking realistic conditions experienced by plankton in a changing ocean, is a key step towards integrating much needed biological information in biogeochemical modeling efforts. This project makes a significant contribution to linking ecological research with ecosystem models by providing empirically rooted algorithms of the temperature dependence of protistan herbivory and growth rates, key processes in the transformation of organic matter in global biogeochemical cycles and tools critically missing in ecosystem models.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736635

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