Environmental and biological conditions from R/V Porsild characterizing Disko Bay, Greenland in April-May 2011

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Version: 1
Version Date: 2018-07-10

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

Contributors	Affiliation	Role
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Abstract
Environmental and biological conditions from R/V Porsild characterizing Disko Bay, Greenland in April-May 2011.

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Coverage

Spatial Extent: **Lat**:69.183333 **Lon**:-53.2333
Temporal Extent: 2011-04-21 - 2011-05-11

Dataset Description

Environmental and biological conditions characterizing Disko Bay, Greenland in April-May 2011.

Methods & Sampling

Sampling Methodology: Between April 20th and May 11th 2011, 27 dilution experiments were conducted at a 250 m deep coastal site, 1 nautical mile south of Disko Island, Western Greenland (N 69 11, W 53 14); (see Figure 1 in Levinsen et al. 2000a). Source water was collected every 2-3 days. Water column profiles of temperature, salinity, in situ PAR and Chl a fluorescence were acquired with a SBE19plus CTD. Water samples were collected with Niskin bottles from the fluorescence maximum at depths ranging between 15 and 40 m, transferred into to 20L polycarbonate carboys using submerged silicone tubing and stored in the dark for transport to the laboratory.

Experimental design: Phytoplankton growth rates and herbivorous grazer-induced mortality rates were measured using the dilution method (Landry and Hasset, 1982) in a two-point modification using whole seawater (WSW) and a diluted fraction containing 10% WSW. Triplicate 1.8L bottles of both WSW and 10% WSW were incubated for 24 hours in laboratory vans under cool fluorescence light with a 20:4 light-dark cycle. All bottles were placed inside neutral density mesh screen bags to simulate the light level at sampling depth (10-15 µmol photons m-2 s-1) and were manually rotated every 4 hours.
Data treatment for the dilution experiment based rate estimates follow procedures outlined in Morison & Menden-Deuer (2017). Briefly, phytoplankton growth rates measured in the 10% WSW were considered to be a reasonable estimate for the instantaneous growth rates unaffected by grazing. Thus, phytoplankton growth rate (µ,d-1) was calculated as $\mu = 1/t * \ln(Ct/C0)$, with Ct and C0 the final and initial Chlorophyll a concentration respectively and t the time elapsed in days. Herbivorous grazing rate (g, d-1) was calculated as the difference between µ measured in the highly diluted (µ10%) and WSW (µWSW) sample: $g = \mu 10\% - \mu WSW$.
Chlorophyll a was extracted from triplicate subsamples collected when bottles were filled initially and in triplicate from each of the triplicate dilution bottles after 24 hours. In addition, the size structure of the initial phytoplankton community was characterized from triplicate size-fractionated Chl a samples (>0.7 GF/F and >20 µm). The extraction method followed Graff & Rynearson (2011) with the exception of the use of 95% ethanol as a solvent (Jespersen & Christoffersen 1987). The volume filtered ranged from 50 to 200 mL depending on phytoplankton abundance and dilution.

Temperature treatments: Samples were incubated at 3 temperature treatments: in situ (0ºC), +3C and +6C over ambient. Water temperature for the 3 treatments was maintained as follows: the in situ treatment temperature was maintained through addition of snow to the incubation basin and was 0C (±0.0C). The +3C treatment was left to equilibrate with the ambient walk-in incubator air temperature and was 3.9C on average (±0.2C), and the +6C treatment temperature was maintained by a flow through water bath and was 6.0C on average (±0.2C). Incubation bottles were not acclimated to prior temperature. Thus, the transfer from in situ to incubation temperature could have induced a temperature dependent shock-response in the plankton communities and affected the rates measured. Although acclimation could have reduced the potential shock induced by the target temperature, delay in commencement of the experiments would have extended the incubation duration and thus could have altered the species composition and nutrient concentrations. The experimental results from the temperature manipulation treatments should be viewed cautiously in light of the impossibility of acclimating whole communities to rapid changes in environmental conditions in a manner that preserves the integrity of the sampled community and minimizes incubation effects, including nutrient limitation and lack of immigration/emigration (see discussion and Grear et al. 2017).

Data Processing Description

Temperature effects on phytoplankton growth and herbivorous grazing rates were examined using 2-way ANOVA, with incubation temperature and date as factors. Temperature effects on taxon-specific growth rates for a subset of dates were analyzed using a 2-way ANOVA with taxa and temperature as factors. Post-hoc analyses used the Bonferroni approach and examined interaction effects, when significant. Regression analysis used a linear, type-II model (i.e. both variables measured with error). Effects of nutrient addition on phytoplankton growth rates were determined with a paired t-test. Normality of data distributions was assessed with a Lilliefors test. All analyses were assigned statistical significance at $p < 0.05$.

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- appended latitude, longitude coordinates to the data.

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Data Files

File
data_1.csv (Comma Separated Values (.csv), 932 bytes) MD5:2363d36bb7b57ba5de63593b8b78b595 Primary data file for dataset ID 739708

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Related Publications

Graff, J. R., & Rynearson, T. A. (2011). Extraction method influences the recovery of phytoplankton pigments from natural assemblages. Limnology and Oceanography: Methods, 9(4), 129–139. doi:10.4319/lom.2011.9.129
Methods

Grear, J. S., Rynearson, T. A., Montalbano, A. L., Govenar, B., & Menden-Deuer, S. (2017). p CO2 effects on species composition and growth of an estuarine phytoplankton community. Estuarine, Coastal and Shelf Science, 190, 40–49. doi:10.1016/j.ecss.2017.03.016
Methods

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Methods

Jespersen AM, Christoffersen K. 1987. Measurements of Chlorophyll a from phytoplankton using ethanol as a solvent. Archiv Fur Hydrobiologie 109:445–454.
Methods

Landry, M. R., & Hassett, R. P. (1982). Estimating the grazing impact of marine micro-zooplankton. Marine Biology, 67(3), 283–288. doi:10.1007/bf00397668 https://doi.org/10.1007%2FBF00397668
Methods

Levinsen, H., Nielsen, T., & Hansen, B. (2000). Annual succession of marine pelagic protozoans in Disko Bay, West Greenland, with emphasis on winter dynamics. Marine Ecology Progress Series, 206, 119–134. doi:10.3354/meps206119
Methods

Morison, F., & Menden-Deuer, S. (2017). Doing more with less? Balancing sampling resolution and effort in measurements of protistan growth and grazing-rates. Limnology and Oceanography: Methods, 15(9), 794–809. doi:10.1002/lom3.10200
Methods

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Parameters

Parameter	Description	Units
Date	Experimental Date as YYYY-MM-DD	unitless
Depth	Collection depth	meters (m)
Temperature	Surface water temperature	Degree Celsius
Chlorophyll_a	Chlorophyll a concentration	micrograms per liter (ug/L)
Percentage_of_phytoplankton_gt_20um	Contribution of phytoplankton larger then 20um to total chlorophyll concentration	unitless
Phaeocystis_Colony	Number of Phaeocystis colony per ml	colony per milliliter
In_Situ_Growth_rates	Phytoplankton growth rate at in situ temperature	days
In_Situ_Grazing_rate	Herbivorous protists grazing rate at in situ temperature	days
plus3C_Growth_rates	Phytoplankton growth rate at +3ºC from in situ temperature	days
plus3C_Grazing_rate	Herbivorous protists grazing rate at +3ºC from in situ temperature	days
plus6C_Growth_rates	Phytoplankton growth rate at +6ºC from in situ temperature	days
plus6C_Grazing_rate	Herbivorous protists grazing rate at +6ºC from in situ temperature	days
lat	latitude of observation. Negative values are South.	decimal degrees
lon	longitude of observation. negative values are West.	decimal degrees

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Instruments

Dataset-specific Instrument Name	SBE19plus CTD
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	The SBE 19plus V2 SeaCAT measures conductivity, temperature, and pressure at 4 scans/sec (4 Hz) and provides high accuracy and resolution. The 19plus V2 supports numerous auxiliary sensors such as dissolved oxygen, pH, turbidity, fluorescence, oil, PAR, ecc). The SBE 19Plus was integrated with a Carosel water sampler to provide water column characterization during the sampling. Salinity, water temperature, PAR and in situ fluorescence were determined during each sampling deployment.
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

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Deployments

Disko_Bay

Website	https://www.bco-dmo.org/deployment/739730
Platform	R/V Porsild
Start Date	2011-04-21
End Date	2011-05-11

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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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