Phytoplankton growth rates from microzooplankton experiments on the R/V Seward Johnson SJ0516 cruise between Ireland and Iceland during the 2005 North Atlantic Spring Bloom (NASB 2005 project, Antarctic microzooplankton project)

Website: https://www.bco-dmo.org/dataset/3897
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Project
» North Atlantic Spring Bloom 2005 (NASB 2005)
» Rising climatic temperatures impact on antarctic microzooplankton growth and grazing (Antarctic microzooplankton)

Contributors	Affiliation	Role
Rose, Julie	National Oceanic and Atmospheric Administration (NOAA-Milford)	Principal Investigator
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Dataset Description

Experiment Description:
The experiment was conducted onboard the RV Seward Johnson II, from June 20 to July 4, 2005, with water collected at 57° 58' N, 15° 32'W. Four treatments were used with 6 replicates each: (1) 12°C and 390 ppm CO_2 (LTLC), (2) 12°C and 690 ppm CO_2 (LTHC), (3) 16°C and 390 ppm CO_2 (HTLC), and (4) 16°C and 690 ppm CO_2 (HTHC). Sea surface temperature at this location was 12°C at the time of water collection. Experiments were run using a seawater continuous culture system, termed an 'Ecostat' (Hutchins et al. 2003, Hare et al. 2005, 2007). Briefly, whole seawater was collected from 5 to 10 m depth using a trace-metal-clean, towed-intake Teflon pump system (Hutchins et al. 2003), prefiltered through 200 µm Nitex mesh to remove mesozooplankton and incubated in twenty-four 2.7 l trace-metal-clean, clear polycarbonate bottles. Bottles were placed in racks in a temperature-controlled deck incubator with recirculating water and shaded to 30 percent of surface irradiance (I0) using a neutral-density shade screen. Temperatures in the 16°C incubator were gradually increased over a period of 24 h to avoid heat-shocking the plankton. Bottles were bubbled with either air or a commercially prepared air/CO2 mixture with 750 ppm CO2 using an inflow tube through the cap and an airstone to maximize gas transfer to the liquid phase. The gases used for bubbling were filtered through a 0.2 µm HEPA filter to avoid contamination of experimental bottles by trace metals (Hare et al. 2005). The system was run in batch mode for 3 days prior to turning on the pumps, in order to stimulate phytoplankton growth and prevent wash-out of slower growing species. After this batch growth period, whole seawater in each incubation bottle was slowly diluted at a continuous rate using seawater collected at the initial

site. This seawater medium was filtered through a 0.2 µm inline capsule filter initially, then re-filtered through a second 0.2 µm inline capsule filter immediately prior to use as a diluent. The medium was stored in trace-metal-clean, 50 l carboys in the dark. Initial in situ nutrient concentrations were low (0.32 umol nitrate l^{-1}, 0.12 umol phosphate l^{-1}, 0.7 umol silicate l^{-1}), so the medium and the whole water in the incubation bottles were amended with 5 and 0.31 umol l^{-1} (final concentration) of nitrate and phosphate. The dilution rate of 0.5 d^{-1} was controlled in each incubation bottle using a peristaltic pump and calibrated daily to ensure constant flow rate. This flow rate constituted a 50 percent dilution of the experimental bottle volume daily. Incubation bottles were mixed by inverting the rack 120° every 5 to 15 min using a compressed-air-driven system. Diluted seawater flowed out of the incubation bottles at a continuous rate and into 2.7 l polycarbonate bottles stored in the dark, which were used as outflow collection vessels. Seawater carbonate system measurements were performed as described in Feng et al. (2009).

References:
Feng, Y., C.E. Hare, K. Leblanc, G.R. DiTullio, P.A. Lee, S.W. Wilhelm, J. Sun, J.M. Rose, N. Nemcek, I. Benner, and D.A. Hutchins. 2009. The effects of increased pCO2 and temperature on the North Atlantic Spring Bloom: I. The phytoplankton community and biogeochemical response. Marine Ecology Progress Series 388: 13-25.

Hare, C.E., G.R. DiTullio, C.G. Trick, S.W. Wilhelm, K.W. Bruland, E.L. Rue, and D.A. Hutchins. 2005. Phytoplankton community structure changes following simulated upwelled iron inputs in the Peru upwelling region. Aquatic Microbial Ecology 38: 269-282.

Hare, C.E., K. Leblanc, G.R. DiTullio, R.M. Kudela, Y. Zhang, P.A. Lee, S.F. Riseman, and D.A. Hutchins. 2007. Consequences of increased temperature and CO2 for phytoplankton community structure in the Bering Sea. Marine Ecology Progress Series 352: 9-16.

Hutchins, D.A., F. Pustizzi, C.E. Hare, and G.R. DiTullio. 2003. A shipboard natural community continuous culture system for ecologically relevant low-level nutrient enrichment experiments. Limnology and Oceanography: Methods 1: 82-91.

Related files and references:
Rose, J.M., Y. Feng, C.J. Gobler, R. Gutierrez, C.E. Hare, K. Leblanc, and D.A. Hutchins. 2009. The effects of increased pCO2 and temperature on the North Atlantic Spring Bloom. II. Microzooplankton abundance and grazing. Marine Ecology Progress Series 388: 27-40.

Additional parameters measured during these experiments are described in: Feng, Y., C.E. Hare, K. Leblanc, G.R. DiTullio, P.A. Lee, S.W. Wilhelm, J. Sun, J.M. Rose, N. Nemcek, I. Benner, and D.A. Hutchins. 2009. The effects of increased pCO2 and temperature on the North Atlantic Spring Bloom: I. The phytoplankton community and biogeochemical response. Marine Ecology Progress Series 388: 13-25.

Lee, P.A., J.R. Rudisill, A.R. Neeley, D.A. Hutchins, Y. Feng, C.E. Hare, K. Leblanc, J.M. Rose, S.W. Wilhelm, J.M. Rowe, and G.R. DiTullio. 2009. The effects of increased pCO2 and temperature on the North Atlantic Spring Bloom: III. Dimethylsulfoniopropionate. Marine Ecology Progress Series 388: 41-49.

Methods & Sampling

Phytoplankton growth and mortality rates measured using dilution experiments, based on changes in chlorophyll a
Microzooplankton grazing was measured using the modified dilution technique of Landry et al. (1995), without the addition of fluorescently labeled prey. This technique involves the successive dilution of whole seawater to reduce encounter rate between microzooplankton and phytoplankton and thus release grazing pressure on phytoplankton. Phytoplankton growth and mortality rates can then be estimated using the slope and intercept of graphs of apparent growth rate (d-1) versus fraction of whole seawater.

Experiments were conducted on the initial phytoplankton community from the same water used for the experiment and on Day 8 of the Ecostat experiment using outflow water from experimental bottles. Outflow water was collected for approximately 24 h to obtain enough volume to conduct the dilution experiments on T8. Replicate bottles from treatments within the continuous culture system were combined to provide adequate volume for the grazing treatments, so the dilution experiment itself was not replicated. The dilution series was run in 1.2 l polycarbonate bottles that had been soaked in 10% HCl and rinsed thoroughly with Milli-Q water. Each dilution treatment was run in triplicate from the combined experimental treatments. Four dilution

treatments of whole seawater were used in each experiment. Bottles were incubated in the deck incubators housing the seawater continuous culture system for 24 h. Bottles were maintained at the appropriate experimental water temperatures, but were not bubbled during the 24 h incubation. The dilution experiment conducted on the initial phytoplankton community was incubated at ambient water temperatures to avoid the potential for mortality due to thermal stress at the beginning of the experiment. Water for the dilutions also came from the outflow bottles and was filtered through 0.2 um inline capsule filters then used immediately in the experiment. Nutrients were added at the beginning of the dilution experiments to ensure phytoplankton growth in the dilution series was nutrient replete. Nutrient additions consisted of 10 umol nitrate l–1, 10 umol silicate l–1, and 0.63 umol orthophosphate l–1 (all final concentrations). Triplicate bottles of unamended, 100% unfiltered seawater were used as controls to determine phytoplankton growth in unenriched conditions. Samples for total chlorophyll a were removed initially and after 24 h and measured according to (Strickland & Parsons 1972). Samples for total chlorophyll a were filtered onto GF/F filters at low vacuum pressure and extracted in 90% acetone for 24 h in the dark at –20°C. Chlorophyll a samples were read on a Turner 10-AU fluorometer.

Phytoplankton mortality rates (m) were calculated based on the slopes of the regressions of phytoplankton apparent growth rate versus fraction of whole seawater. Phytoplankton growth rates in unamended and nutrient enriched dilution treatments were calculated from the 100% unfiltered seawater bottles. Net phytoplankton growth rates were calculated as the changes in chl a concentration over 24 h in the unamended, whole-seawater control treatment.

References:
Landry, M.R., J. Kirshtein, and J. Constantinou. 1995. A refined dilution technique for measuring the community grazing impact of microzooplankton, with experimental tests in the central equatorial Pacific. *Marine Ecology Progress Series* 120: 53-63.

Strickland, J.D.H., and T.R. Parsons. 1972. A practical handbook of seawater analysis. *Bulletin of the Fisheries Research Board of Canada* 167: 1-310.

Data Processing Description

BCO-DMO Processing Notes:

- File was sorted by treatment
- Added lat,lon values of original water sampling location to file
- Added BCO-DMO header lines
- Parameter names were edited to conform with BCO-DMO convention

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Data Files

File
phyto_growth.csv (Comma Separated Values (.csv), 2.03 KB) MD5:93ce824a68f7d98a536caa1c7c734fc6 Primary data file for dataset ID 3897

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Parameters

Parameter	Description	Units
treatment	Experimental conditions varied in order to observe a variable's effect. Four treatments were used: (1) 12 deg C and 390 ppm CO2 (LTLC), (2) 12 deg C and 690 ppm CO2 (LTHC), (3) 16 deg C and 390 ppm CO2 (HTLC), and (4) 16 deg C and 690 ppm CO2 (HTHC).	dimensionless
day	Sampling day during experiment. The experiment was conducted from June 20 to July 4, 2005.	dimensionless
lat	Latitude component of geographic position where water used for experiment was collected.	decimal degrees
lon	Longitude component of geographic position where water used for experiment was collected. Negative values indicate Western hemisphere.	decimal degrees
water_fraction	Fraction of whole water resulting from successive dilutions.	dimensionless
growth	Phytoplankton growth rates. Rates in unamended and nutrient enriched dilution treatments were calculated from the 100% unfiltered seawater bottles. Net rates were calculated as the change in chl a concentration over 24 h in the unamended, whole-seawater control treatment.	d-1

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Instruments

Dataset-specific Instrument Name	Turner Designs Fluorometer -10-AU
Generic Instrument Name	Turner Designs Fluorometer 10-AU
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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Deployments

SJ0516

Website	https://www.bco-dmo.org/deployment/57981
Platform	R/V Seward Johnson
Start Date	2005-06-03
End Date	2005-07-06
Description	This R/V Seward Johnson cruise, funded by NSF OCE/BIO (OCE-0423418), was conducted as part of the NASB 2005 US/EC Collaboration on Potential Climate Change Impacts on Algal Community Structure and Biogeochemistry During the North Atlantic Spring Bloom. It is uncertain whether a cruise ID was ever assigned. The US State Department designator was SJ-2004-126, possibly reflecting request for approval that began in 2004. The Oceanic Research Ship Schedules database (from the Ocean Information Center maintained by the College of Marine & Earth Studies at the University of Delaware) assigned JOH/05/0063 to leg 2 of this cruise. The BCO-DMO assigned SJ0516 as the unique cruise ID since leg 2 was the sixteenth cruise for R/V Seward Johnson in 2005. Cruise Synopsis adapted from the original text written by NASB 2005 project investigator Matthew Cottrell The R/V Seward Johnson departed from Fort Pierce, FL in June, 2005. The vessel first transited to the Azores (cruise leg 1, Florida to the Azores) where it spent two days before heading north to Iceland (cruise leg 2, Azores to Iceland). The purpose of this cruise was to explore the ecology of heterotrophic and photoheterotrophic bacteria in the North Atlantic. Surface waters were sampled during the transit across the oligotrophic Atlantic, passing Bermuda on the way. Depth profiles were sampled on the leg from the Azores to Iceland. Water was collected for a number of analyses. One of the most important assessed the effect of light on the growth of heterotrophic bacteria using 3H-leucine incorporation and the uptake of other organic compounds. We were especially interested in cyanobacteria, including Prochlorococcus and Synechococcus. Flow cytometery and flow sorting of radiolabeled cells was key to this project. Other analyses included bacterial abundance, bacterial production, bacterial community structure (FISH), community activity (Micro-FISH), chlorophyll a, bacterial chlorophyll a, and the abundance of aerobic anoxigenic phototrophic (AAP) bacteria.

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Project Information

North Atlantic Spring Bloom 2005 (NASB 2005)

Coverage: North Atlantic

Climate-related shifts in phytoplankton assemblages may have profound implications for oceanic feedbacks on the atmosphere, and for human use of marine resources. Particular algal groups are largely responsible for crucial processes like vertical carbon export, biogenic calcification and silicification, production of climatically active gases like dimethylsulfide (DMS), and for sustaining food webs that lead to economically valuable higher trophic levels. The North Atlantic Spring Bloom 2005 (NASB 2005) research program was designed to investigate potential climate change impacts on algal community structure and biogeochemistry during the North Atlantic Spring Bloom, a regime that is ideal for determining how changing ocean conditions may affect both calcareous and siliceous algae.

The research was coordinated with CarboOcean, a major European Union funded activity led by investigators from the Alfred Wegener Institute.

Rising climatic temperatures impact on antarctic microzooplankton growth and grazing (Antarctic microzooplankton)

Coverage: Ross Sea

The investigator will examine to what extent rising climatic temperatures impact antarctic microzooplankton growth and grazing, and to what extent such an impact would modulate top-down control of phytoplankton growth in cold waters. The experimental part of the proposed work would take place in the Ross Sea, a permanently cold ecosystem, and the location of annual large-scale blooms of both diatoms and Phaeocystis antarctica. Changing climate regimes may alter current microzooplankton grazing rates on these blooms either directly through temperature increases or indirectly through algal community shifts. Complementary laboratory experiments on cultures of Antarctic microzooplankton will be conducted to determine the individual and combined effects of temperature and carbon dioxide levels on growth and grazing.

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Funding

Funding Source	Award
NSF Antarctic Sciences (NSF ANT)	PLR-0528715

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