Experimental results: Bloom in Bottle (BIB) experiments: culture studies of the effect of Si and N stress on diatoms of the Santa Barbara Channel (SBDOM project, SBC LTER)

Website: https://www.bco-dmo.org/dataset/518427
Data Type: experimental
Version: 1
Version Date: 2014-07-09

Project
» Mechanisms controlling the production and fate of DOM during diatom blooms (SBDOM)
» Santa Barbara Coastal Long Term Ecological Research site (SBC LTER)

Program
» Long Term Ecological Research network (LTER)

Contributors	Affiliation	Role
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Abstract
Culture studies of diatoms that dominate spring blooms in the Santa Barbara Channel were used to examine the effects of N and Si stress on the magnitude of production and the chemical composition of DOM. Species cultured were: Skeletonema costatum (CCMP 1332), Chaetoceros socialis (CCMP 172), Thalassiosira weissflogii (CCMP 1051), and Odontella aurita (CCMP 595).

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Coverage

Temporal Extent: 2011-03-09 - 2012-08-18

Dataset Description

Culture studies of diatoms that dominate spring blooms in the Santa Barbara Channel were used to examine the effects of N and Si stress on the magnitude of production and the chemical composition of DOM. Species cultured were: *Skeletonema costatum* (CCMP 1332), *Chaetoceros socialis* (CCMP 172), *Thalassiosira weissflogii* (CCMP 1051), and *Odontella aurita* (CCMP 595).

Acquisition Description

Skeletonema costatum:
Duplicate batch cultures of coastal diatom strain *Skeletonema costatum* (CCMP 1332) were grown in clear rectangular 20L polycarbonate carboys under six cool white and two natural s11 type light bulbs providing ~200 umol photons s-1 m-2. The cultures were grown under a 12:10 light:dark cycle and mixed by hand twice per day. Sampling occurred once per day, just before the beginning of the dark period. The media was designed to assess the carbon partitioning response under stress from Si, N, and both Si & N -- however, as this experiment did not proceed as with the other three experiments here (i.e. especially in terms of initial nutrient concentration design, nutrient uptake outcomes, growing time, and parameters measured), nearly all further analyses were not initiated.

Chaetoceros socialis:
Duplicate batch cultures of coastal diatom strain *Chaetoceros socialis* (CCMP 172) were grown in clear rectangular 20L polycarbonate carboys under six cool white and two natural s11 type light bulbs providing ~200 umol photons s-1 m-2. The cultures were grown under a 12:10 light:dark cycle and mixed by hand twice per day. Sampling occurred once per day, just before the beginning of the dark period. The media was designed to assess the carbon partitioning response under stress from Si, N, and both Si & N. To allow better comparison among species and treatments, all experimental flasks were started with a ~40 umol L-1 initial nitrate concentration. In those treatments limited by silicic acid (and therefore replete in N), the Si concentration was adjusted to produce the same number of replete cells as the N-stress

treatments. Phosphorous was added in sufficient quantities to avoid P depletion; vitamins and trace metals were added at f/20 and f/80 concentrations, respectively.

Thalassiosira weissflogii:
Duplicate batch cultures of coastal diatom strain *Thalassiosira weissflogii* (CCMP 1051) were grown in clear rectangular 20L polycarbonate carboys under six cool white and two natural s11 type light bulbs providing ~200 umol photons s-1 m-2. The cultures were grown under a 12:10 light:dark cycle and mixed by hand twice per day. Sampling occurred once per day, just before the beginning of the dark period. The media was designed to assess the carbon partitioning response under stress from Si, N, and both Si & N. To allow better comparison among species and treatments, all experimental flasks were started with a ~40 umol L-1 initial nitrate concentration. In those treatments limited by silicic acid (and therefore replete in N), the Si concentration was adjusted to produce the same number of replete cells as the N-stress treatments. Phosphorous was added in sufficient quantities to remain replete throughout the duration of each experiment; vitamins and trace metals were added at f/20 and f/80 concentrations, respectively.

Odontella aurita:
Duplicate batch cultures of coastal diatom strain *Odontella aurita* (CCMP 595) was grown in clear rectangular 20L polycarbonate carboys under six cool white and two natural s11 type light bulbs providing ~200 umol photons s-1 m-2. The cultures were grown under a 12:10 light:dark cycle and mixed by hand twice per day. Sampling occurred once per day, just before the beginning of the dark period. The media was designed to assess the carbon partitioning response under stress from Si, N, and both Si & N. To allow better comparison among species and treatments, all experimental flasks were started with a ~40 umol L-1 initial nitrate concentration. In those treatments limited by silicic acid (and therefore replete in N), the Si concentration was adjusted to produce the same number of replete cells as the N-stress treatments. Phosphorous was added in sufficient quantities to remain replete throughout the duration of each experiment; vitamins and trace metals were added at f/40 concentration.

Processing Description

BCO-DMO processing notes:
- Changed parameter names to conform to BCO-DMO naming conventions.
- Replaced -999, -999.00, dashes, and blanks with 'nd' to indicate 'no data'.
- Created 'replicate' column and re-arranged data accordingly from columns to rows.
- Assumed that: TEP = Transparent exopolymer particles; and ER = Extracellular release.

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Parameters

Parameter	Description	Units
species	Name of the species.	text
date_start	Date of the start of the experiment.	mm/dd/yyyy
date_end	Date of the end of the experiment.	mm/dd/yyyy
treatment	Treatment condition.	text
time_point	Sampling time point.	alphanumeric
nominal_hrs	Nominal number of hours since start of experiment.	integer
replicate	Replicate number (duplicate batch cultures were grown).	1 or 2
chl	Chlorophyll concentration.	micrograms per Liter (ug L-1)
phyt_abun	Phytoplankton abundance.	cells per milliliter (cells/mL)
phyt_abun_sd	Standard deviation of phyt_abun.	cells per milliliter (cells/mL)
NO3	Nitrate concentration.	micromolar (uM)
Si	Silicate concentration.	micromolar (uM)
Si_bio	Biogenic silica concentration.	micromolar (uM)
prim_prod	Primary production.	micromoles Carbon per Liter per day (uMol C L-1 d-1)
ER	Extracellular release	micromoles Carbon per Liter per day (uMol C L-1 d-1)
POC	Particulate organic carbon.	micromolar (uM)
DOC	Dissolved organic carbon.	micromolar (uM)
DOC_sd	Standard deviation of DOC.	micromolar (uM)
TEP	Transparent exopolymer particles	(uXeq L-1)
TEP_sd	Standard deviation of TEP.	(uXeq L-1)
BP	Bacterial production.	picomoles per Liter per hour (pmol L-1 h-1)
BP_sd	Standard deviation of BP.	picomoles per Liter per hour (pmol L-1 h-1)

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Project Information

Mechanisms controlling the production and fate of DOM during diatom blooms (SBDOM)

Coverage: Pacific California, Santa Barbara Channel

This project is also affiliated with the Plumes and Blooms project. Data: The following data files have been submitted to BCO-DMO but are not yet available online. Data are restricted until June 2016. Please contact the PI for access prior to public availability: -- SBDOM10 and SBDOM11 CTD and Niskin bottle data. The following are available online (see 'Datasets' heading below): -- SBDOM10 and SBDOM11 cruise plans (available online on deployment pages: PS1009, PS1103) -- SBDOM10 and SBDOM11 event logs (available online; see 'Datasets' below) -- Laboratory-based Bloom in a Bottle (BIB) Experiment -- Laboratory-based Remineralization Experiments -- SBDOM10 and SBDOM11 data summaries (including CTD data, nutrients, and bacterial production) Project Description from NSF Award Proposal and Abstract: Diatom blooms are known to produce prodigious quantities of DOM upon entering nutrient stress with a chemical composition that varies with the type of nutrient limitation (Si or N). This variable composition likely influences the nutritional value of DOM to microbes driving species successions towards functional groups of heterotrophic prokaryotes that are best able to metabolize particular forms of DOM. To date each side of this coupled system of production/consumption has been examined independently. A few studies have examined how limitation by different limiting nutrients affects the chemical character of the DOM produced by phytoplankton, while others have focused on the fate of DOM without detailed understanding of the mechanisms influencing its initial chemical composition. We propose to investigate the mechanisms determining the character and fate of DOM produced during temperate diatom blooms. Specifically we will investigate how physiological stress on diatoms induced by different limiting nutrients influences the production, chemical composition of DOM and the microbial community structure that respond to it to better understand the mechanisms driving the accumulation and persistence of DOM in marine systems. The research will involve both laboratory and field experiments. The novel aspects of this work are: 1) We will investigate how limitation by either N or Si impacts the quantity and chemical composition of the DOM released by diatoms. 2) Assess how the differences in the chemical composition of the DOM produced under N or Si limitation affect its lability by examining the productivity, growth efficiency and community structure of heterotrophic bacterioplankton responding to the release of substrates. 3) Predicted DOM dynamics based on (1) and (2) will be tested in the field during diatom blooms in the Santa Barbara Channel, California. While experiments investigating aspects of

either 1 or 2 have been conducted successfully in the past (Lancelot, 1983; Billen and Fontigny, 1987; Goldman et al., 1992; Carlson et al.,1999; Cherrier and Bauer, 2004; Conan et al., 2007) ours will be the first study to combine these approaches in an integrated assessment of the mechanisms governing both the production and fate of DOM produced by diatom blooms experiencing limitation by different nutrients. References: Lancelot, C. (1983). Factors affecting phytoplankton extracellular release in the Southern Bight of the North Sea. Marine Ecology Progress Series 12: 115-121. Billen, G. and A. Fontigny (1987). Dynamics of a Phaeocystis - dominated spring bloom in Belgian coastal waters. II. Bacterioplankton dynamics. Mar. Ecol. Prog. Ser. 37: 249-257. Goldman, J.C., D.A. Hansell and M.R. Dennett (1992). Chemical characterization of three large oceanic diatoms: potential impact on water column chemistry. Marine Ecology Progress Series 88: 257-270. Carlson, C.A., N.R. Bates, H.W. Ducklow and D.A. Hansell (1999). Estimation of bacterial respiration and growth efficiency in the Ross Sea, Antarctica. Aquatic Microbial Ecology 19: 229-244. Cherrier, J. and J.E. Bauer (2004). Bacterial utilization of transient plankton-derived dissolved organic carbon and nitrogen inputs in surface ocean waters. Aquatic Microbial Ecology 35(3): 229-241. Conan, P., M. Sondegaard, T. Kragh, F. Thingstad, M. Pujo-Pay, P.J.l.B. Williams, S. Markager, G. Cauwet, N.H. Borch, D. Evans and B. Rieman (2007). Partitioning of organic production in marine plankton communities: The effects of inorganic nutrient ratios and community composition on new dissolved organic matter. Limnology and Oceanography 52(2): 753-765.

Santa Barbara Coastal Long Term Ecological Research site (SBC LTER)

Website: http://sbc.lternet.edu/

Coverage: Southern California Coastal Zone

From http://www.lternet.edu/sites/sbc The Santa Barbara Coastal LTER is located in the coastal zone of southern California near Santa Barbara. It is bounded by the steep east-west trending Santa Ynez Mountains and coastal plain to the north and the unique Northern Channel Islands archipelago to the south. Santa Barbara Coastal Long-Term Ecological Research (SBC) Project is headquartered at the University of California, Santa Barbara, and is part of the National Science Foundation's (NSF) Long-Term Ecological Research (LTER) Network. The research focus of SBC LTER is on ecological systems at the land-ocean margin. Although there is increasing concern about the impacts of human activities on coastal watersheds and nearshore marine environments, there have been few long-term studies of the linkages among oceanic, reef, sandy beaches, wetland, and upland habitats. SBC LTER is helping to fill this gap by studying the effects of oceanic and coastal watershed influences on kelp forests in the Santa Barbara Channel located off the coast of southern California. The primary research objective of SBC LTER is to investigate the relative importance of land vs.

ocean processes in structuring giant kelp (Macrocystis pyrifera) forest ecosystems for different conditions of land use, climate and ocean influences. SBC LTER Data: The Santa Barbara Coastal (SBC) LTER data are managed by and available directly from the SBC project data site URL shown above. If there are any datasets listed below, they are data sets that were collected at or near the SBC LTER sampling locations, and funded by NSF OCE as ancillary projects related to the SBC LTER core research themes. See the SBC LTER Data Overview page for access to data and information about data management policies.

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Program Information

Long Term Ecological Research network (LTER)

Website: http://www.lternet.edu/

Coverage: United States

adapted from http://www.lternet.edu/ The National Science Foundation established the LTER program in 1980 to support research on long-term ecological phenomena in the United States. The Long Term Ecological Research (LTER) Network is a collaborative effort involving more than 1800 scientists and students investigating ecological processes over long temporal and broad spatial scales. The LTER Network promotes synthesis and comparative research across sites and ecosystems and among other related national and international research programs. The LTER research sites represent diverse ecosystems with emphasis on different research themes, and cross-site communication, network publications, and research-planning activities are coordinated through the LTER Network Office. 2017 LTER research site map obtained from https://lternet.edu/site/lter-network/

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0850857

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