Use of a diatom inhibitor reveals contribution to seagrass ecosystem in experiments conducted using seagrass cores from 1m depth in Grand Bay in 2017.

Website: https://www.bco-dmo.org/dataset/819932
Data Type: experimental
Version: 1
Version Date: 2020-08-10

Project
» The biotic and abiotic controls on the Silicon cycle in the northern Gulf of Mexico (CLASiC)

Contributors	Affiliation	Role
Krause, Jeffrey W.	Dauphin Island Sea Lab (DISL)	Principal Investigator
Cebrian, Just	Mississippi State University (MSU)	Co-Principal Investigator
Cox, Erin	University of New Orleans (UNO)	Contact
Haskins, Christina	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
We report an assessment for determining the contribution by diatoms to community productivity and respiration within a coastal benthic ecosystem with multiple autotrophs. During summer, cores of open sediment and seagrass habitat were collected from a lagoon within the Northern Gulf of Mexico. Cores were maintained in an outdoor mesocosm. Germanic acid, an inhibitor of diatom cell division, was added to half the cores and quantification of production and respiration was done. Inhibition of diatoms reduced benthic productivity within the seagrass habitat. 71 to 83% of production was attributable to diatoms and this contribution moved the benthic system into net autotrophy. Diatom contribution to production in other habitat-community components was more variable (varied from 0 to 86%). Findings underscore the ecological importance of diatoms as producers in seagrass beds, the role of seagrasses in maintaining productivity, and infer that diatoms may have similar contributions in other aquatic vegetated habitats.

Table of Contents

Coverage

Spatial Extent: **Lat**:30.383174 **Lon**:-88.312561
Temporal Extent: 2017-06-28 - 2017-07-31

Methods & Sampling

Three repeated experimental trials were done in summer months. Thirty-two cores (27 cm diameter, 14 cm depth) were collected from 50 m2 area of seagrass bed at 1 m depth on: June 28, July 12 and July 26, 2017 for trials 1-3, respectively. On each date, 16 cores were collected from seagrass habitat in pairs. Another 16 cores were collected from open sediment (OS) habitat. Extracted, paired cores were placed upright into an open-top plastic tub (49 x 33 x 42 cm) to produce eight tubs of each habitat.

Tubs were transported to Dauphin Island Sea Lab (~30-minute drive) filled with seawater (to core depth of 16 cm) pumped from Mobile Bay (20 km, east of site) and arranged in four blocks within an outdoor mesocosm. Each block contained two tubs of each habitat. After two days, a diatom-specific inhibitor (3 µM solution of germanic acid, i.e. Ge treatment) was randomly added to water, i.e. two tubs per block, one of each habitat type. Germanium (Ge) at high Ge/Si ratios (> 0.01) prevents formation of siliceous cell wall (Azam and Chisholm 1976). We added 3 µM solution and allowed two days for Ge incorporation.

Metabolism measurements:

Two days after, we quantified productivity and respiration from changes in oxygen content within 2-3 hour incubations of chambers and bottles following methods in Anton et al. (2009). Oxygen content was measured with a meter (HQ30d, Hach, Loveland, Colorado, USA) and, this was initial oxygen content for both chamber and bottle incubation. After incubation, we measured final oxygen content in bottles and chambers.

To compare rates between treatments, net community production (NCP) and respiration were assessed in mg O2 m–2 h–1 and mg O2 L-1 h-1 for benthic and water-column (WC) communities, respectively. Equations were:

WC NCP = (Fcb – Icb) t-1 (1)

WC respiration = (Fdb – Idb) t-1 (2)

Benthic NCP = [(Fcc – Icc) – (Fcb – Icb)] V t-1 A-1 (3)

Benthic respiration = [(Fdc – Idc) – (Fdb – Idb)] V t-1 A-1 (4)

where capital letters are for initial (I) or final (F) oxygen content (mg L-1) for clear (c) and dark (d) incubations (first letter in subscript) in chambers (c) or bottles (b) (second letter in subscript); t is incubation time (h), V is volume (L) and A is area (m2) of chamber. Gross primary productivity (GPP) was calculated as sum between NCP and absolute respiration for each tub.

To compare GPP between communities, control values were expressed in mg O2 m-2 h-1 after WC metrics of NCP and respiration were integrated over a 1 m depth (x 1000 L). System GPP was obtained by summing WC and benthic GPP.

Environmental measurements:

Salinity and temperature were measured at time of oxygen measurements using the same meter. Surface photosynthetic active radiation (PAR) (from environmental station 30°15.075' N, -88°04.670' E Dauphin Island, Alabama, USA; http://arcos.disl.org) was averaged over incubation duration and integrated over a 48 hour-period prior to incubations (Photosynthetic Photon Flux Density, PPFD). 48 hours reflects a short-term measure of light history.

Statistical analyses:

A series of two-way ANOVAs with trial and treatment as fixed factors were used to test for differences in producer biomass in both habitats and were used to test for differences in rates with and without diatom metabolism. Differences in rates were attributed to diatom metabolism and percent contribution to GPP was calculated based off mean GPP for each trial (n=4) with Ge rate as a proportion of control rate, expressed as a change from 100%.

Data Processing Description

Excel, Sigma Plot

BCO-DMO Data Manager Processing Notes:
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions
* blank values in this dataset are displayed as "nd" for "no data." nd is the default missing data identifier in the

BCO-DMO system. Added ND as a missing data identifier.
* removed all spaces in headers and replaced with underscores
* removed all units from headers
* converted dates to ISO Format yyyy-mm-dd
* set Types for each data column

[table of contents | back to top]

Data Files

File
benthic_gpp.csv (Comma Separated Values (.csv), 21.78 KB) MD5:26b2c9d0d40a5eecf8c7a4d3b79c9501 Primary data file for dataset ID 819932

[table of contents | back to top]

Supplemental Files

File
Cox etal Percent Contribution to GPP filename: Coxetal_pct_contribution_to_GPP.csv (Comma Separated Values (.csv), 306 bytes) MD5:4d6e034a4663e9764a0ad591e97263d0 Percent contribution to gross primary production from lab incubation experiments.
Cox etal Rates Summarized filename: Coxetal_rates_summarized.csv (Comma Separated Values (.csv), 17.66 KB) MD5:9db6620c2decbb6ee615b2020fbb41d9 Summarized Rates from Incubation Experiments.
Cox etal System GPP filename: Coxetal_System_GPP.csv (Comma Separated Values (.csv), 1.11 KB) MD5:5c5152a5c2df5d933a6cee18b75889ff System gross primary production from incubation experiments.

[table of contents | back to top]

Related Publications

Anton, A., J. Cebrian, K. L. H. Jr, and J. Goff. 2009. Low impact of Hurricane Katrina on seagrass community structure and functioning in the Northern Gulf of Mexico. Bull. Mar. Sci. 85: 16
Methods

Azam, F., & Chisholm, S. W. (1976). Silicic acid uptake and incorporation by natural marine phytoplankton populations1. Limnology and Oceanography, 21(3), 427–435. doi:10.4319/lo.1976.21.3.0427
Methods

Dzwonkowski, B., Greer, A. T., Briseño-Avena, C., Krause, J. W., Soto, I. M., Hernandez, F. J., ... Graham, W. M. (2017). Estuarine influence on biogeochemical properties of the Alabama shelf during the fall season. Continental Shelf Research, 140, 96–109. doi:10.1016/j.csr.2017.05.001
Methods

Krause, J. W., Nelson, D. M., & Lomas, M. W. (2009). Biogeochemical responses to late-winter storms in the Sargasso Sea, II: Increased rates of biogenic silica production and export. Deep Sea Research Part I: Oceanographic Research Papers, 56(6), 861–874. doi:10.1016/j.dsr.2009.01.002
Methods

Welschmeyer, N. A. (1994). Fluorometric analysis of chlorophyll a in the presence of chlorophyll b and pheopigments. Limnology and Oceanography, 39(8), 1985–1992. doi:10.4319/lo.1994.39.8.1985
Methods

Parameters

Parameter	Description	Units
Sample_Code	code used to identify samples	unitless
Collection_Date	date the core of seagrass habitat or sediment habitat was collected	yyyy-mm-dd
Ge_Addition_Date	date Ge was added	yyyy-mm-dd
Experimental_Trial_Date	date the incubation trial was done	yyyy-mm-dd
Trial_Number	the number of repeated trials (1-3) that was done	unitless
Paired_core_number	number 1-8 for cores placed in A-D locations (or block) within the outside mesocosm	unitless
Block_A_to_D	the block the core was placed in	unitless
Ge_Control_treatment	identifies whether Ge was added or whether it was a control	unitless
Seagrass_Sediment_habitat	identifies whether the core was from seagrass or sediment habitat	unitless
Light_Dark_Incubation	identifies whether the core was incubated in a clear or dark container	unitless
Seagrass_Above_Ground_Biomass	the dry weight of the above-ground seagrass in the core	g dw
Seagrass_Below_Ground_Biomass	the dry weight of the below-ground seagrass in the core	g dw
Sediment_Chlorophyll	chlorophyll concentration in the sediment	mg/m2
Water_Column_Chlorophyll	chlorophyll concentration in the water	ug/L
Salinity	salinity of the sample at the start of the incubation	psu

Start_Time	start time of the incubation; logged in CST timezone	hh:mm
Temp	temperature of the water at the start of the incubation	degrees Celcius
O2_start	oxygen content at the start of the incubation	mg/L
O2_saturation	oxygen content at the start of the incubation	%
Salinity_2	salinity of the water column within jars at the end of the incubation	psu
JARS_End_Time	time at the end of the incubation of the water column; logged in CST timezone	hh:mm
Temp_2	temperature of the water column within jars at the end of the incubation	degrees Celcius
O2_end_jars	oxygen content at the end of the incubation within jars which enclosed the water column	mg/L
O2_saturation_2	oxygen content at the end of the incubation within jars which enclosed the water column	%
End_Time_jars_minus_Start_Time	length of the incubation of the water column in jars	hh:mm
Decimal_Time	length of the incubation in decimal time of the water column in jars	hours
Water_Column_NCP_and_respiration_Rates	net community production or respiration rates of the water column enclosed in jars	mg L m2 hr-1
Water_Column_NCP_and_respiration_Rates_1m	net community production or respiration rates of the water column enclosed in jars over 1 m depth	mg L m2 hr-1
Water_Column_Gross_Primary_Production	gross primary production of the water column enclosed in jars	mg L m2 hr-1
Salinity_3	salinity of the water within the benthic chambers at the end of the incubation	psu

Chambers_End_Time	the time at the end of the incubation of the benthic chambers; logged in CST timezone	hh:mm
Temp_3	temperature of the water within the benthic chambers at the end of the incubation	degrees Celcius
O2_end_chambers	oxygen content within the benthic chambers at the end of the incubation	mg/L
O2_saturation_3	oxygen content within the benthic chambers at the end of the incubation	%
End_Time_chambers__minus_Start_Time	duration of the incubation of benthic community	hh:mm
Decimal_Time_2	duration of the incubation of benthic community in decimal time	hours
NCP_and_Respiration_Benthic_Rates	net community production or respiration rates of the benthic community	mg L m2 h-1
Benthic_Gross_Primary_Production	gross primary production of the benthic community enclosed in chambers	mg L m2 h-1

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	HQ30d, Hach, Loveland, Colorado, USA
Generic Instrument Name	Multi Parameter Portable Meter
Generic Instrument Description	An analytical instrument that can measure multiple parameters, such as pH, EC, TDS, DO and temperature with one device and is portable or hand-held.

Dataset-specific Instrument Name	Skalar autoanalyzer
Generic Instrument Name	Nutrient Autoanalyzer
Generic Instrument Description	Nutrient Autoanalyzer is a generic term used when specific type, make and model were not specified. In general, a Nutrient Autoanalyzer is an automated flow-thru system for doing nutrient analysis (nitrate, ammonium, orthophosphate, and silicate) on seawater samples.

[table of contents | back to top]

Project Information

The biotic and abiotic controls on the Silicon cycle in the northern Gulf of Mexico (CLASiC)

Coverage: Northern Gulf of Mexico, specifically the Louisiana Shelf region dominated by the discharge of the Mississippi River on the western side of the delta

NSF Award Abstract:
The Louisiana Shelf system in the northern Gulf of Mexico is fed by the Mississippi River and its many tributaries which contribute large quantities of nutrients from agricultural fertilizer to the region. Input of these nutrients, especially nitrogen, has led to eutrophication. Eutrophication is the process wherein a body of water such as the Louisiana Shelf becomes enriched in dissolved nutrients that increase phytoplankton growth which eventually leads to decreased oxygen levels in bottom waters. This has certainly been observed in this area, and diatoms, a phytoplankton which represents the base of the food chain, have shown variable silicon/nitrogen (Si/N) ratios. Because diatoms create their shells from silicon, their growth is controlled not only by nitrogen inputs but the availability of silicon. Lower Si/N ratios are showing that silicon may be playing an increasingly important role in regulating diatom production in the system. For this reason, a scientist from the University of South Alabama will determine the biogeochemical processes controlling changes in Si/N ratios in the Louisiana Shelf system. One graduate student on their way to a doctorate degree and three undergraduate students will be supported and trained as part of this project. Also, four scholarships for low-income, high school students from Title 1 schools will get to participate in a month-long summer Marine Science course at the Dauphin Island Sea Laboratory and be included in the research project. The study has significant societal benefits given this is an area where $2.4 trillion gross domestic product revenue is tied up in coastal resources. Since diatoms are at the base of the food chain that is the biotic control on said coastal resources, the growth of diatoms in response to eutrophication is important to study.

Eutrophication of the Mississippi River and its tributaries has the potential to alter the biological landscape of the Louisiana Shelf system in the northern Gulf of Mexico by influencing the Si/N ratios below those that are optimal for diatom growth. A scientist from the University of South Alabama believes the observed changes in the Si/N ratio may indicate silicon now plays an important role in regulating diatom production in the system. As such, understanding the biotic and abiotic processes controlling the silicon cycle is crucial because diatoms dominate at the base of the food chain in this highly productive region. The study will focus on following issues: (1) the importance of recycled silicon sources on diatom production; (2) can heavily-silicified diatoms adapt to changing Si/N ratios more effectively than lightly-silicified diatoms; and (3) the role of reverse weathering in sequestering silicon thereby reducing diffusive pore-water transport. To attain these goals, a new analytical approach, the PDMPO method (compound 2-(4-pyridyl)-5-((4-(2-dimethylaminoethylamino-carbamoyl)methoxy)phenyl)oxazole) that quantitatively measures taxa-specific silica production would be used.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1558957

[table of contents | back to top]