Photosynthetic pigments from sea ice samples collected on R/V Nathaniel B. Palmer cruise NBP1910 along the Western Antarctic Peninsula from November to December 2019

Website: https://www.bco-dmo.org/dataset/913222
Data Type: Cruise Results
Version: 1
Version Date: 2023-10-17

Project
» Spring Blooms of Sea Ice Algae Along the Western Antarctic Peninsula: Effects of Warming and Freshening on Cell Physiology and Biogeochemical Cycles. (Controls on Sea-Ice Algae (COSA))

Contributors	Affiliation	Role
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Abstract
This dataset includes concentrations of photosynthetic pigments from sea ice samples at various stages of melt collected during the spring melt of November and December 2019 from coastal waters along the Western Antarctic Peninsula. Samples were collected during the R/V Nathaniel B. Palmer cruise NBP1910. Pigments were determined by high-performance liquid chromatography (HPLC).

Table of Contents

Coverage

Spatial Extent: **N**:-64.78 **E**:-64.02 **S**:-67.774 **W**:-68.196
Temporal Extent: 2019-11-08 - 2019-12-05

Methods & Sampling

Field sampling:
Ice samples for primary production measurements were collected mid-morning from 6 stations along the western Antarctic Peninsula in November and December of 2019 on board the R/V Nathaniel B. Palmer along a north-south transect from 64.8°S to 67.8°S. For Stations (Stns) 2 and 3, the ice was "rotten" (sufficiently melted to be disintegrating structurally, present only in small pieces) and collected as an ice-seawater slurry. Small ice chunks were collected directly from the sea surface via a crane-suspended "personnel basket". At the additional 4 stations, sea ice was collected by coring the ice. At Stns 4 and 7, algal samples were collected from internal ice-core layers. Stns 4 and 7 were rafted floes with a flooded internal layer, with Stn 7 > 2500 square meters (m^2) in size. Stns 5 and 6 were on landfast sea ice, where the algae were collected from the bottom 10 centimeters (cm) of the ice. At these 4 stations (Stns 4 through 7), ice cores were taken with a 7.5 cm Kovacs

corer separated by at least 1 m horizontally. Cores were shaded from direct sunlight, while 5 to 10 cm of the visible algal band at the bottom or middle was sectioned with an ethanol-cleaned saw and placed into acid-washed (10% HCl) containers. Each replicate consisted of either a single core (for 10 cm sections) or pools of two cores (for 5 cm sections).

All ice samples were stored in dark, insulated containers for a maximum of 4 hours. On the ship, all ice samples used for primary production measurements were melted in a 3:1 volumetric ratio of melting solution to ice to minimize the effect of the melt on sea-ice communities. The melting solution was a 0.2 micrometer (µm) filtered artificial salt mixture containing three main sea salts plus bicarbonate according to ESAW artificial seawater (3.63×10^{-1} molar (M) NaCl, 4.71×10^{-2} M $MgCl_2.6H_2O$, 2.5×10^{-2} M Na_2SO_4, and 2×10^{-3} M $NaHCO_3^-$, salinity 35). Additional ice cores collected for ancillary biological measurements were melted in a 1:1 volumetric ratio of melting solution to ice. Melts were conducted in the dark at approximately 20° Celsius (C). To speed the melting process, ice samples were further broken into pieces with acid-washed pickaxes with most ice completely melted within 5 hours. Volume and salinity were measured as soon as the ice was completely melted, with sample temperatures remaining below 0°C. All reported volumes were corrected to the original ice volume.

Pigments:
A subsample of 1:1 melt volume was filtered on 25-millimeter (mm) GF/Fs for pigment analysis by high-performance liquid chromatography (HPLC). Filters were promptly flash-frozen in liquid nitrogen and stored at -80°C until analysis. Reverse-phase high-pressure liquid chromatography was conducted at the University of South Carolina after the method detailed by Pinckney et al. (1998). To estimate the relative abundance of diatoms, *Phaeocystis*, and cryptophytes (as contribution to Chl *a* in milligrams per liter (mg L^{-1})), the respective diagnostic pigments of fucoxanthin, 19' hexanoyloxyfucoxanthin, and alloxanthin were used as in Everitt et al. (1990) and Arrigo et al. (2000). Pigment data was qualitatively confirmed via light microscopy.

Data Processing Description

Analysis was carried out at the University of South Carolina Photopigment Analysis Facility. Details of instrumentation and protocols can be found at https://phytoninja.com/lab-protocols/ (see "HPLC Photopigment Analysis Method (technical version)") or in the attached PDF "Long_HPLC_Method.pdf".

BCO-DMO Processing Description

- Imported original file "phspigments.csv" into the BCO-DMO system.
- Converted the Date field to YYYY-MM-DD format.
- Split the Location column into two separate columns for Latitude and Longitude and made the values negative (for South and West directions).
- Renamed fields to comply with BCO-DMO naming conventions.
- Corrected a typo in the description column (replaced '0' with a closing parens ')' symbol in the last 5 rows).
- Saved the final file as "913222_v1_photosynthetic_pigments.csv".

[table of contents | back to top]

Data Files

File	
913222_v1_photosynthetic_pigments.csv	(Comma Separated Values (.csv), 4.84 KB) MD5:8f44a15d4095554c36e2d7d3dc505827
Primary data file for dataset ID 913222, version 1.	

[table of contents | back to top]

Supplemental Files

File		
Long_HPLC_Method.pdf	(Portable Document Format (.pdf), 184.42 KB) MD5:ced361470d4febd1f03a6f0da007594d	
Description of the HPLC methods; originally from https://phytoninja.com/lab-protocols/		

[table of contents | back to top]

Related Publications

Arrigo, K. R., DiTullio, G. R., Dunbar, R. B., Robinson, D. H., VanWoert, M., Worthen, D. L., & Lizotte, M. P. (2000). Phytoplankton taxonomic variability in nutrient utilization and primary production in the Ross Sea. Journal of Geophysical Research: Oceans, 105(C4), 8827–8846. Portico. https://doi.org/10.1029/1998jc000289
Methods

Everitt, D. A., Wright, S. W., Volkman, J. K., Thomas, D. P., & Lindstrom, E. J. (1990). Phytoplankton community compositions in the western equatorial Pacific determined from chlorophyll and carotenoid pigment distributions. Deep Sea Research Part A. Oceanographic Research Papers, 37(6), 975–997. https://doi.org/10.1016/0198-0149(90)90106-6
Methods

Pinckney, J. L., Paerl, H. W., Harrington, M. B., & Howe, K. E. (1998). Annual cycles of phytoplankton community-structure and bloom dynamics in the Neuse River Estuary, North Carolina. Marine Biology, 131(2), 371–381. https://doi.org/10.1007/s002270050330
Methods

Young, Jodi N., Rundell, Susan, Cooper, Zachary S., Dawson, Hannah M., Carpenter, Shelly D., Ryan-Keogh, Thomas, Rowland, Elden, Bertrand, Erin M., Deming, Jody W. (in review) Photosynthetic processes in Antarctic sea ice during the spring melt. Limnology and Oceanography.
Results

[table of contents | back to top]

Parameters

Parameter	Description	Units
Date	date sample was collected	unitless
Latitude	latitude where sample was collected; negative values = South	decimal degrees
Longitude	longitude where sample was collected; negative values = West	decimal degrees
Description	description of sample	unitless
Sample_id	unique identifier of sample	unitless
Replicate	unique replicate	unitless
Chl_c3	concentration of chlorophyll c3	micrograms per liter (ug/L)
Chl_c1c2	concentration of chlorophyll c1 and C2	micrograms per liter (ug/L)
Perid	concentration of peridinin	micrograms per liter (ug/L)
But-fuco	concentration of 19'-butanoyloxyfucoxanthin	micrograms per liter (ug/L)
Fuco	concentration of Fucoxanthin	micrograms per liter (ug/L)
Hex-fuco	concentration of 19'-hexanoyloxyfucoxanthin	micrograms per liter (ug/L)
Neo	concentration of cis-neoxanthin	micrograms per liter (ug/L)
Prasino	concentration of prasinoxanthin	micrograms per liter (ug/L)
Viola	concentration of violaxanthin	micrograms per liter (ug/L)
Diad	concentration of diadinoxanthin	micrograms per liter (ug/L)
Anther	concentration of antheraxanthin	micrograms per liter (ug/L)
Allox	concentration of alloxanthin	micrograms per liter (ug/L)
Diat	concentration of diatoxanthin	micrograms per liter (ug/L)
Lutein	concentration of Lutein	micrograms per liter (ug/L)
Zeax	concentration of Zeaxanthin	micrograms per liter (ug/L)
Gyro	concentration of gryoxanthin-diester	micrograms per liter (ug/L)
Chl_b	concentration of chlorophyll b	micrograms per liter (ug/L)
Chla_Allomer	concentration of chlorophyll a allomer	micrograms per liter (ug/L)
Chl_a	concentration of chlorophyll a + divinyl chlorophyll a	micrograms per liter (ug/L)
Chla_prime	concentration of chlorophyll a'	micrograms per liter (ug/L)
alpha_Carotene	concentration of alpha Carotene	micrograms per liter (ug/L)
beta_Carotene	concentration of beta Carotene	micrograms per liter (ug/L)
Chl_ide_a	concentration of chlorophyllide a	micrograms per liter (ug/L)
Total_Chl_a	concentration of chl a + chl-ide a + divinyl chl a	micrograms per liter (ug/L)
ALL_Chl_a	concentration of chla + chla isomers	micrograms per liter (ug/L)

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	High-Performance Liquid Chromatograph
Generic Instrument Description	A High-performance liquid chromatograph (HPLC) is a type of liquid chromatography used to separate compounds that are dissolved in solution. HPLC instruments consist of a reservoir of the mobile phase, a pump, an injector, a separation column, and a detector. Compounds are separated by high pressure pumping of the sample mixture onto a column packed with microspheres coated with the stationary phase. The different components in the mixture pass through the column at different rates due to differences in their partitioning behavior between the mobile liquid phase and the stationary phase.

Dataset-specific Instrument Name	
Generic Instrument Name	Ice Corer
Generic Instrument Description	An ice corer is used to drill into deep ice and remove long cylinders of ice from which information about the past and present can be inferred. Polar ice cores contain a record of the past atmosphere - temperature, precipitation, gas content, chemical composition, and other properties. This can reveal a broad spectrum of information on past environmental, and particularly climatic, changes. They can also be used to study bacteria and chlorophyll production in the waters from which the ice core was extracted.

Dataset-specific Instrument Name	light microscopy
Generic Instrument Name	Microscope - Optical
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".

[table of contents | back to top]

Deployments

NBP1910

Website	https://www.bco-dmo.org/deployment/913227
Platform	RVIB Nathaniel B. Palmer
Start Date	2019-11-01
End Date	2019-12-15
Description	See more information in R2R: https://www.rvdata.us/search/cruise/NBP1910

[table of contents | back to top]

Project Information

Spring Blooms of Sea Ice Algae Along the Western Antarctic Peninsula: Effects of Warming and Freshening on Cell Physiology and Biogeochemical Cycles. (Controls on Sea-Ice Algae (COSA))

Coverage: Western Antarctic Peninsula

NSF Award Abstract
Rapid changes in the extent and thickness of sea ice during the austral spring subject microorganisms within or attached to the ice to large fluctuations in temperature, salinity, light and nutrients. This project aims to identify cellular responses in sea-ice algae to increasing temperature and decreasing salinity during the spring melt along the western Antarctic Peninsula and to determine how associated changes at the cellular level can potentially affect dynamic, biologically driven processes. Understanding how sea-ice algae cope with, and are adapted to, their environment will not only help predict how polar ecosystems may change as the extent and thickness of sea ice change, but will also provide a better understanding of the widespread success of photosynthetic life on Earth. The scientific context and resulting advances from the research will be communicated to the general public through outreach activities that includes work with Science Communication Fellows and the popular Polar Science Weekend at the Pacific Science Center in Seattle, Washington. The project will provide student training to college students as well as provide for educational experiences for K-12 school children.

There is currently a poor understanding of feedback relationships that exist between the rapidly changing environment in the western Antarctic Peninsula region and sea-ice algal production. The large shifts in temperature and salinity that algae experience during the spring melt affect critical cellular processes, including rates of enzyme-catalyzed reactions involved in photosynthesis and respiration, and the production of stress-protective compounds. These changes in cellular processes are poorly constrained but can be large and may have impacts on local ecosystem productivity and biogeochemical cycles. In particular, this study will focus on the thermal sensitivity of enzymes and the cycling of compatible solutes and exopolymers used for halo- and cryo-protection, and how they influence primary production and the biogeochemical cycling of carbon and nitrogen. Approaches will include field sampling during spring melt, incubation experiments of natural sea-ice communities under variable temperature and salinity conditions, and controlled manipulation of sea-ice algal species in laboratory culture. Employment of a range of techniques, from fast repetition rate fluorometry and gross and net photosynthetic measurements to metabolomics and enzyme kinetics, will tease apart the mechanistic effects of temperature and salinity on cell metabolism and primary production with the goal of quantifying how these changes will impact biogeochemical processes along the western Antarctic Peninsula.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1744645

[table of contents | back to top]