Bioavailability factor of polyphosphate, nucleotides, and methyl phosphonate in bioassay experiments with seawater from R/V Savannah cruise SAV-19-02 in the NW Atlantic Ocean in Spring of 2019

Website: https://www.bco-dmo.org/dataset/864157
Data Type: Cruise Results, experimental
Version: 1
Version Date: 2021-11-02

Project
» Collaborative Research: Assessing the role of compound-specific phosphorus hydrolase transformations in the marine phosphorus cycle (P-hydrolase)

Contributors	Affiliation	Role
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Abstract
Bioavailability factor of polyphosphate, nucleotides (ATM and AMP) and methyl phosphonate (Mepn) in bioassay experiments with seawater collected during R/V Savannah cruise SAV-19-02 from March to April of 2019 in the Northwestern Atlantic from the surface to 50 m depth.

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Coverage

Spatial Extent: **N**:31.7635 **E**:-79.8421 **S**:31.0175 **W**:-80.7965
Temporal Extent: 2019-03-30 - 2019-04-10

Methods & Sampling

Sampling and analytical procedures:

Bioassay experiments were conducted at station 1 and stations 3. At each station, inorganic and organic phosphate amendments were performed on seawater with and without nitrogen enrichment (NH_4Cl, $NaNO_3$). Bioassay Experiments consisted in incubating, over an incubation period of 48h, surface seawater (5m) with inorganic or organic phosphate compounds (20 µM; final concentration of P) including, polyphosphate (polyp), inorganic phosphate (Pi), nucleotides (ATP or AMP) and methylphosphonate (Mepn). In each incubation experiment, a control treatment (surface seawater without amendment) was included.

In bioassay experiments, the bioavailability factor (BF) was determined at T0 for polyphosphate, nucleotides

(ATP or AMP) and methylphosphonate (Mepn). BF is calculated as follows: BF=TE-TN/ TP-TN (Björkman and Karl, 1994), where T_E reflects PO_4^{3-} turnover time in the DOP amended treatment, T_N is the PO_4^{3-} turnover time in the control (no additions) and T_P is the PO_4^{3-} turnover time in the treatment amended with Pi. BF ranges from 0 for an unavailable substrate, to a value of 1 for a DOP model substrate having a bioavailability equal to that of +Pi.

Instrument: Radioactivity was assayed on a Packard Tri-Carb liquid scintillation counter.
Location: Northwestern Atlantic surface waters. Depth: surface-50 m.

Data Processing Description

Data were organized using MATLAB and output as .mat files. Gaps in data were filled with NaN in the .mat files.

BCO-DMO Data Manager Processing Notes:

* Data from source files BioassayExperiments_Datasets.xslx. Sheets: BF_T0_St1, BF_T0_St1_NN, BF_T0_St3 were imported into the BCO-DMO data system and combined into one data table.
* Data columns were added to contain information that was in the Excel sheet names. The original excel sheet name was added as column data_subset_name. Information extracted to additional columns (incubation_hours, station)
* Parameters (column names) renamed to comply with BCO-DMO naming conventions. See https://www.bco-dmo.org/page/bco-dmo-data-processing-conventions
* Missing data values (Blank/Null) values in this dataset are displayed according to the format of data you access. For example, in csv files it will be blank values. In Matlab .mat files it will be NaN values. When viewing data online at BCO-DMO, the missing value will be shown as "nd" meaning "no data."

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Related Publications

Björkman, K., & Karl, D. M. (1994). Bioavailability of inorganic and organic phosphorus compounds to natural assemblages of microorganisms in Hawaiian coastal waters. Marine Ecology Progress Series, 111(3), 265–273. http://www.jstor.org/stable/24849565 https://www.jstor.org/stable/24849565
Methods

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Parameters

Parameter	Description	Units
data_subset_name	Data subset name	unitless
Id_treatments	Labels of dissolved inorganic/organic phosphate amended treatments. Treatments that were amended with Nitrogen (NH4Cl, NaNO3) to avoid nitrogen limitation contain "+NN" in the treatment ID. Acronyms (e.g. Mepn, AMD) are explained in the "Sampling and analytical procedures" section.	unitless
station	Station at which the treatments were conducted	unitless
incubation_hours	Incubation hours. (T=0 is the start of the treatment).	hours
BF	Bioavailability factor (0-1). See methodology for calculations.	unitless

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Instruments

Dataset-specific Instrument Name	Packard Tri-Carb liquid scintillation counter
Generic Instrument Name	Liquid Scintillation Counter
Dataset-specific Description	Radioactivity was assayed on a Packard Tri-Carb liquid scintillation counter.
Generic Instrument Description	Liquid scintillation counting is an analytical technique which is defined by the incorporation of the radiolabeled analyte into uniform distribution with a liquid chemical medium capable of converting the kinetic energy of nuclear emissions into light energy. Although the liquid scintillation counter is a sophisticated laboratory counting system used the quantify the activity of particulate emitting (ß and a) radioactive samples, it can also detect the auger electrons emitted from 51Cr and 125I samples.

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Deployments

SAV-19-02

Website	https://www.bco-dmo.org/deployment/864191
Platform	R/V Savannah
Start Date	2019-03-30
End Date	2019-04-11
Description	Cruise synonym: Zephyr (Zooming in on Enzymatic PhosphoHYdrolysis Reactions)

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Project Information

Collaborative Research: Assessing the role of compound-specific phosphorus hydrolase transformations in the marine phosphorus cycle (P-hydrolase)

NSF Award Abstract:
Phosphorus (P) is an essential building block for life. Because P is in short supply over vast areas of the ocean, P availability may control biological productivity, such as photosynthesis and carbon fixation, which has implications for uptake of the greenhouse gas carbon dioxide and thus climate regulation. Marine microorganisms must satisfy their nutritional requirement for P by obtaining it from seawater, where P is present in a variety of chemical forms, from simple phosphate ions (Pi) to complex dissolved organic phosphorus (DOP) molecules. The concentration of DOP vastly exceeds Pi over most ocean areas, therefore DOP is a critically important source of P for marine microbial nutrition and productivity. However, much remains unknown about the contribution of specific DOP compounds to the P nutrition, productivity, and structure of marine microbial communities. In this project, the investigators will conduct field experiments in the Atlantic Ocean and perform a series of controlled laboratory studies with pure enzymes and microbial cultures to determine how and to what extent different DOP compounds are degraded to Pi in the marine environment. Furthermore, the contribution of these compound-specific DOP molecules to microbial P nutrition, carbon fixation, and community structure will be determined, thus advancing the current state of knowledge regarding the factors that control the activity and distribution of microbial species in the ocean, and the ocean?s role in the climate system. This project will support two female junior investigators, a postdoctoral researcher, and graduate and undergraduate students. The undergraduate students will be recruited from the

Marine Sciences program at Savannah State University, an Historically Black Colleges and Universities. In addition, results will be incorporated into new hands-on K-12 educational tools to teach students about microbial P biogeochemistry, including a digital game and formal lesson plans with hands-on demos. These tools will be validated with K-12 educators and will be widely accessible to the public through various well-known online platforms. These activities will thus reach a broad audience including a significant fraction of underrepresented groups.

P is a vital nutrient for life. Marine microorganisms utilize P-hydrolases, such as alkaline phosphatase (AP), to release and acquire phosphate (Pi) from a wide diversity of dissolved organic P (DOP) compounds, including P-esters (P-O-C bonds), phosphonates (P-C), and polyphosphates (P-O-P). Compound-specific DOP transformations have the potential to exert critical and wide-ranging impacts on marine microbial ecology (e.g. variable DOP bioavailability among species), biogeochemistry (e.g. P geologic sequestration via formation of calcium Pi), and global climate (e.g. aerobic production of the greenhouse gas methane by dephosphorylation of methylphosphonate). However, the mechanisms and comparative magnitude of specific DOP transformations, in addition to their relative contributions to microbial community-level P demand, productivity, and structure, are not completely understood. This study will fill these knowledge gaps by tracking the fate of specific DOP pools in the marine environment. Specifically, this project will test four hypotheses in the laboratory using recombinant enzymes and axenic cultures representative of marine eukaryotic and prokaryotic plankton from high and low nutrient environments, and in the field using observational and experimental approaches along natural Pi gradients in the Atlantic Ocean. In particular, the investigators will reveal potential differences in the hydrolysis and utilization of specific DOP compounds at the community- (bulk enzymatic assays), taxon- (cell sorting of radiolabeled cells in natural samples), species- (axenic cultures) and molecular-levels (pure enzyme kinetic studies and cell-associated proteomes and exoproteomes). Results from our proposed work will provide a robust understanding of the enzymatic basis involved in the transformation of specific forms of DOP and create new knowledge on the relative contribution of these specific P sources to Pi production, marine microbial nutrition, community structure, primary productivity, and thus global carbon cycling and climate. In particular, our refined measurements of the concentration of bioavailable DOP and our unique estimates of DOP remineralization fluxes will provide critical new information to improve models of marine primary production and P cycling.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1736967
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NSF Division of Ocean Sciences (NSF OCE)	OCE-2001212
NSF Division of Ocean Sciences (NSF OCE)	OCE-1948042

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