Polysaccharide hydrolysis rates from bulk water and 3 µm retained fraction (particle-associated) incubations in the Northwest Atlantic aboard the R/V Endeavor cruise EN584 from Jun to Jul 2016

Website: https://www.bco-dmo.org/dataset/986681
Data Type: Cruise Results
Version: 1
Version Date: 2025-11-26

Project
» Latitudinal and depth-related contrasts in enzymatic capabilities of pelagic microbial communities: Predictable patterns in the ocean? (Patterns of activities)

Contributors	Affiliation	Role
Arnosti, Carol	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Principal Investigator
Balmonte, John Paul	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Student
Brown, Sarah Allison	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Student
Lloyd, Chad	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Student
Ghobrial, Sherif	University of North Carolina at Chapel Hill (UNC-Chapel Hill)	Technician
Mickle, Audrey	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
The potential of the seawater microbial community to hydrolyze six high-molecular-weight polysaccharides (arabinogalactan, chondroitin sulfate, fucoidan, laminarin, pullulan, and xylan) was investigated at various sites and depths of the Northwest Atlantic. Nearshore waters close to Cape Hatteras/Cape Lookout, and a transect along ~36° N out to ~58° W were collected during the summer of 2016, aboard the R/V Endeavor cruise EN584. Hydrolysis of high molecular weight substrates to lower molecular weight hydrolysis products was measured using gel permeation chromatography with fluorescence detection, after the method of Arnosti (1996, 2003). This dataset includes polysaccharide hydrolysis rates to measure microbial enzyme activities from bulk water and 3 µm retained fraction (particle-associated) incubations.

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Coverage

Location: NW Atlantic: Atlantic Ocean, nearshore waters close to Cape Hatteras/Cape Lookout, and a transect along ca 36 N out to ca 58 W.
Spatial Extent: **N**:36.015167 **E**:-58.043667 **S**:33.923667 **W**:-76.60145
Temporal Extent: 2016-06-29 - 2016-07-11

Methods & Sampling

Water samples were collected via Niskin bottles mounted on a rosette, equipped with a CTD aboard R/V Endeavor cruise EN584 from Jun to Jul 2016 in the Northwest Atlantic.

Seawater was transferred to 20 L carboys that were rinsed three times with water from the sampling depth and then filled with seawater from a single Niskin bottle, using silicone tubing that had been acid washed then rinsed with distilled water prior to use. From each carboy, water was dispensed into smaller glass containers that were cleaned and pre-rinsed three times with water from the carboy prior to dispensing. This water was used to measure cell counts, bacterial productivity, and the activities of polysaccharide hydrolases, peptidases, and glucosidases. A separate glass Duran bottle was filled with seawater from the carboy and sterilized in an autoclave for 20-30 minutes to serve as a killed control for various measurements.

For each substrate, three 15 mL falcon tubes were filled with bulk seawater and one 15 mL falcon tube was filled with autoclaved seawater to serve as a killed control. Experiments on (operationally defined) particles were carried out by gravity-filtering water through 3 µm pore size filters. 1/12th sections of the 3 µm pore-size filters were submerged in 15 mL artificial seawater. Substrate was added at 3.5 µM monomer-equivalent concentrations, except for fucoidan, which was added at 5 µM concentrations (a higher concentration was necessary for sufficient fluorescence signal). Two 15 mL falcon tubes – one with seawater and one with autoclaved seawater – with no added substrate served as blank controls. Incubations were stored in the dark at as close to in situ temperature as possible.

Subsamples of the incubations were collected at time zero, and at a sequence of subsequent time points. At each time point, 2 mL of seawater was collected from the 15 mL falcon tube using a sterile syringe, filtered through a 0.2 µm pore size syringe filter, and stored frozen until analysis.

Molecular weight distributions were determined by sequential size-exclusion chromatography using a Bio-Rad Econo-Column packed with ~20 cm of Sephadex G-50 resin followed by ~18 cm of Sephadex G-75 resin, and quantified on Shimadzu 10ADvp HPLC systems equipped with Hitachi fluorescence detectors controlled by EZStart software. Hydrolysis rates were calculated based on the change in molecular weight distribution from higher molecular weight initially to lower molecular weight of the substrate over the course of the incubation time, as described in detail in Arnosti (2003).

Data Processing Description

Data was processed using R software. Scripts to calculate hydrolysis rates are available in the associated Github repository (Hoarfrost, 2017).

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Related Publications

Arnosti, C. (1996). A new method for measuring polysaccharide hydrolysis rates in marine environments. Organic Geochemistry, 25(1-2), 105–115. doi:10.1016/s0146-6380(96)00112-x https://doi.org/10.1016/S0146-6380(96)00112-X
Methods

Arnosti, C. (2003). Fluorescent derivatization of polysaccharides and carbohydrate-containing biopolymers for measurement of enzyme activities in complex media. Journal of Chromatography B, 793(1), 181–191. doi:10.1016/s1570-0232(03)00375-1 https://doi.org/10.1016/S1570-0232(03)00375-1
Methods

Hoarfrost, A., Gawarkiewicz, G., & Arnosti, C. (2017, May 15). Ahoarfrost/Shelf1234: Shelf1234 Initial Release. Zenodo. https://doi.org/10.5281/zenodo.580059
Software

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Related Datasets

IsRelatedTo

Arnosti, C. (2017) **Notes on Niskin bottle sampling and use: depth of sample, operator, observations, type of experiments run on the sample, from RV/Endeavor EN556 and EN584, 2015 and 2016 (Patterns of activities project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). Version Date 2017-10-20 http://lod.bco-dmo.org/id/dataset/717427 [view at BCO-DMO]
Relationship Description: Includes notes on Niskin bottle sampling and use on EN584.

Arnosti, C. (2020) **Measurements of polysaccharide hydrolase activities in large volume mesocosm incubations RV/Endeavor EN584, July 2016 (Patterns of activities project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2017-10-20 doi:10.26008/1912/bco-dmo.717495.1 [view at BCO-DMO]
Relationship Description: Includes data from separate experiments performed from the water samples collected on EN584

Arnosti, C. (2022) **Measurements of peptidase and glucosidase activities in large volume mesocosm incubations on RV/Endeavor EN584, July 2016 (Patterns of activities project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2022-12-07 doi:10.26008/1912/bco-dmo.717532.1 [view at BCO-DMO]
Relationship Description: Includes data from separate experiments performed from the water samples collected on EN584

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Parameters

Parameter	Description	Units
Deployment	Cruise ID	unitless
stn	Station number for cruise (9-16, and 12r, r = repeat).	unitless
latitude	Latitude, North is positive	decimal degrees
longitude	Longitude, West is negative	decimal degrees
ISO_DateTime_Local	Time of sample collection, EST/EDT	unitless
ISO_DateTime_UTC	Time of sample collection, UTC	unitless
cast_number	Cast number (refers to cast of CTD/Niskin bottles on cruise)	unitless
depth_sequence	Sequence of depths sampled (1 is surface; higher numbers at greater depths)	unitless
depth_actual	Actual depth at which water was collected	meters
sample_type	Sample from bulk water (Bulk) or Particle Associated (PA) incubation	unitless

amended_unamended	Refers to whether high molecular weight thalassiosira weissflogii extract was added or not. In this dataset all incubations were unamended	unitless
substrate	Polysaccharide used for incubation: arabinogalactan, chondroitin sulfate, fucoidan, laminarin, pullulan, or xylan.	unitless
timepoint	Timepoint_Number of sample collection	unitless
time_elapsed_hr	Incubation time elapsed at sample collection in hours	hours
rep1_rate	Hydrolysis rate of incubation replicate #1 at subsampled timepoint above killed control	nM*hr-1
rep2_rate	Hydrolysis rate of incubation replicate #2 at subsampled timepoint above killed control	nM*hr-1
rep3_rate	Hydrolysis rate of incubation replicate #3 at subsampled timepoint above killed control; Blank = There is no replicate #3 for PA	nM*hr-1
average	Mean hydrolysis rate of incubation replicates at subsampled timepoint above killed control	nM*hr-1
std_dev	Standard deviation of mean hydrolysis rates at subsampled timepoint above killed control; Blank = There is no standard deviation for PA	nM*hr-1

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Instruments

Dataset-specific Instrument Name	CTD
Generic Instrument Name	CTD Sea-Bird SBE 911plus
Dataset-specific Description	A 12 bottle Rosette system using 30 liter Niskin bottles mounted on a frame with a CTD was used for sample collection.
Generic Instrument Description	The Sea-Bird SBE 911 plus is a type of CTD instrument package for continuous measurement of conductivity, temperature and pressure. The SBE 911 plus includes the SBE 9plus Underwater Unit and the SBE 11plus Deck Unit (for real-time readout using conductive wire) for deployment from a vessel. The combination of the SBE 9 plus and SBE 11 plus is called a SBE 911 plus. The SBE 9 plus uses Sea-Bird's standard modular temperature and conductivity sensors (SBE 3 plus and SBE 4). The SBE 9 plus CTD can be configured with up to eight auxiliary sensors to measure other parameters including dissolved oxygen, pH, turbidity, fluorescence, light (PAR), light transmission, etc.). more information from Sea-Bird Electronics

Dataset-specific Instrument Name	Shimadzu 10ADvp HPLC system
Generic Instrument Name	High-Performance Liquid Chromatograph
Dataset-specific Description	Shimadzu 10ADvp HPLC systems coupled with Hitachi fluorescence detectors (L-7485, L-2485, Chromaster - 5440) and controlled by Shimadzu EZstart sofware were used for analysis. A Bio-Rad Econo-Column packed with ~20cm of Sephadex G-50 resin followed by a second ~18cm column packed with Sephadex G-75 resin was used for sequential size exclusion chromatography separation.
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	Niskin bottles
Generic Instrument Name	Niskin bottle
Dataset-specific Description	A 12 bottle Rosette system using 30 liter Niskin bottles mounted on a frame with a CTD was used for sample collection.
Generic Instrument Description	A Niskin bottle (a next generation water sampler based on the Nansen bottle) is a cylindrical, non-metallic water collection device with stoppers at both ends. The bottles can be attached individually on a hydrowire or deployed in 12, 24, or 36 bottle Rosette systems mounted on a frame and combined with a CTD. Niskin bottles are used to collect discrete water samples for a range of measurements including pigments, nutrients, plankton, etc.

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Deployments

EN584

Website	https://www.bco-dmo.org/deployment/717087
Platform	R/V Endeavor
Start Date	2016-06-29
End Date	2016-07-13
Description	Latitudinal and Depth-related Contrasts in Enzymatic Capabilities of Pelagic Microbial Communities. Cruise track obtained from rvdata.us control-point navigation, (http://www.rvdata.us/catalog/EN584)

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Project Information

Latitudinal and depth-related contrasts in enzymatic capabilities of pelagic microbial communities: Predictable patterns in the ocean? (Patterns of activities)

Coverage: Atlantic Ocean, Arctic Ocean, Pacific Ocean, Greenland

NSF Award Abstract:
Heterotrophic microbial communities are key players in the marine carbon cycle, transforming and respiring organic carbon, regenerating nutrients, and acting as the final filter in sediments through which organic matter passes before long-term burial. Microbially-driven carbon cycling in the ocean profoundly affects the global carbon cycle, but key factors determining rates and locations of organic matter remineralization are unclear. In this study, researchers from the University of North Carolina at Chapel Hill will investigate the ability of pelagic microbial communities to initiate the remineralization of polysaccharides and proteins, which together constitute a major pool of organic matter in the ocean. Results from this study will be predictive on a large scale regarding the nature of the microbial response to organic matter input, and will provide a mechanistic framework for interpreting organic matter reactivity in the ocean.

Broader Impacts: This study will provide scientific training for undergraduate and graduate students from underrepresented groups. The project will also involve German colleagues, thus strengthening international scientific collaboration.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1332881

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