Trichodesmium data from R/V Atlantic Explorer cruise AE1409 in the Western Tropical North Atlantic from May 2014 (P Processing by Tricho project)

Website: https://www.bco-dmo.org/dataset/709621
Data Type: Cruise Results
Version: 1
Version Date: 2017-07-20

Project
» Dissolved Phosphorus Processing by Trichodesmium Consortia: Quantitative Partitioning, Role of Microbial Coordination, and Impact on Nitrogen Fixation (P Processing by Tricho)

Contributors	Affiliation	Role
Van Mooy, Benjamin A.S.	Woods Hole Oceanographic Institution (WHOI)	Principal Investigator
Dyhrman, Sonya T.	Lamont-Doherty Earth Observatory (LDEO)	Co-Principal Investigator
Biddle, Mathew	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Trichodesmium data from R/V Atlantic Explorer cruise AE1409 in the Western Tropical North Atlantic from May 2014 (P Processing by Tricho project).

Table of Contents

Coverage

Spatial Extent: **N**:27.8657 **E**:-53.2711 **S**:9.8155 **W**:-64.9907
Temporal Extent: 2014-05-10 - 2014-05-25

Dataset Description

Trichodesmium, nitrogen fixation rates, and P uptake data from cruise AE1409.

Methods & Sampling

All data collected as described in Van Mooy et al (2015).

Sampling - Trichodesmium colonies were collected with surface water net tows along a cruise transect in the western North Atlantic aboard the R/V Atlantic Explorer (AE1409) during May 2014. Sampling occurred at the same time each day (~7:30-8:30 am) using nets with a mesh size of 130 um. Nets were deployed and hauled

through the surface water column 6 times before recovery. Individual Trichodesmium colonies were isolated and washed three times by successive transfer through fresh 0.2 um sterile-filtered local surface seawater. A pooled sample of colonies was isolated and processed from each station. For each sample, an average of ~30 cleaned colonies were transferred onto 47 mm 5 um pore size polycarbonate filters, gently vacuum filtered to remove excess liquid, flash frozen and stored in liquid nitrogen until extraction and sequencing. There were no discernable changes in average colony size from one station to another across the transect. In order to broadly assess the microbiome composition of the North Atlantic Trichodesmium populations, colony composition was sampled to reflect the distribution of Trichodesmium colony morphology found in net tows. At all stations raft type colonies were much more abundant than puff or bowtie variants with approximately 30 rafts to 2 puff/bowtie colonies. As such, the data largely reflect the dominant raft morphology.

Nitrogen Fixation Rates - N2 fixation was measured using the acetylene reduction technique as previously described (Capone, 1993; Paerl, 1994). Briefly, approximately 20 Trichodesmium colonies were placed in a 60 mL polycarbonate bottle containing 60 mL of filtered seawater. A 1 mL aliquot of acetylene was injected into the bottle through a septum cap, the bottle was gently inverted, and allowed to incubate in an on-deck incubator at ambient temperature and light. The headspace of the bottle was analyzed for ethylene approximately every 30 minutes and the rate of ethylene production through acetylene reduction was determined by linear regression. All incubations were conducted in triplicate between approximately local noon and 2 PM.

Phosphate uptake rates - The incubation bottles were carried to a laboratory van that was designated solely for work with radioactive isotopes. Each incubation bottle was spiked with approximately 1.5 uCi of 33P-phosphoric acid. The final concentration of 33P-phosphate in the incubations was approximately 6 pmol L-1, which was likely approximately two orders of magnitude smaller than ambient phosphate concentrations. The bottles were capped and mixed by gently inverting. At each station, three incubations were dedicated to measuring 33P-phosphate uptake and three incubations were dedicated to measuring the chemical reduction of 33P-phosphate to P(III) compounds. The bottles were placed in a flow-through on-deck incubator that was maintained at surface seawater temperatures by continually flushing with the surface seawater from the ship’s pumping system. Temperature in the incubators was occasionally monitored with a waterproof temperature logger (Onset), and found to be within 1C of surface water temperature. The incubators used a combination of neutral density screening and blue transparent film to achieve a light intensity of mimicking PAR at roughly 20m, as confirmed using an underwater spherical quantum sensor (Li-Cor). At three occasions during the cruise (Stations 2, 4, and 9), an additional set of triplicate incubations for each measurement were terminated immediately (i.e. prior to incubation) and processed identically to the experimental incubations; data from these incubations were used to quantify background 33P signals in all of our measurements (i.e. analytical blanks). Background 33P was consistent at all three stations, and was averaged and then subtracted from all of the experimental results; the standard deviation of the background was propagated as analytical error. In all cases the 33P radioactivity recovered from the experimental incubations was three times greater than the background 33P radioactivity. Incubations proceeded for an average of 3.25 h before being terminated by vacuum (approximately 200 mbar) filtration on 25 mm diameter polycarbonate membranes (Millipore); a poresize of 0.2 um was used for whole community incubations and a poresize of 5.0 um was used for the Trichodesmium incubations. The membranes were quickly rinsed three times with freshly filtered (0.2 um poresize polycarbonate membrane) surface seawater. The membranes were then immediately placed in a liquid scintillation vial containing 10 mL of UltimaGold liquid (Perkin Elmer) scintillation cocktail, which was then shaken vigorously. After resting for a few hours, the 33P-radioacitivity in the vials was determined using a liquid scintillation counter (Perkin Elmer). A steady-state phosphate turnover rate was calculated by dividing the total 33P radioactivity retained on the membranes by the total 33P radioactivity added to the incubations and the incubation time. Turnover times (reciprocal of turnover rates) varied from between 15 and 50 hours (not shown), which is much longer than the incubation time and validates the steady-state calculation.

Phosphate concentrations - Phosphate in seawaters samples and incubations was quantified using MAGnesium Induced Coprecipitation (MAGIC) as described by Karl and Tien (1992).

Data Processing Description

BCO-DMO Processing:
Added conventional header with dataset name, PI name, version date.
Modified parameter names to conform with BCO-DMO naming conventions.
Re-formatted date from m/dd/yyyy to yyyymmdd.
Replaced spaces and / with underscores.
Added coordinate information to the data from the station list provided by the PI.

[table of contents | back to top]

Data Files

File
trichodesmium.csv (Comma Separated Values (.csv), 956 bytes) MD5:81eb163fbcb139df72331e98717d0fef Primary data file for dataset ID 709621

[table of contents | back to top]

Related Publications

Capone, D. G. 1993. Determination of nitrogenase activity in aquatic samples using the acetylene reduction procedure, p. 621-631. In P. F. Kemp, B. F. Sherr, E. B. Sherr, and J. J. Cole (ed.), Handbook of methods in aquatic microbial ecology. Lewis Publishers, Boca Raton, Fla.
Methods

Frischkorn, K. R., Rouco, M., Van Mooy, B. A. S., & Dyhrman, S. T. (2017). Epibionts dominate metabolic functional potential of Trichodesmium colonies from the oligotrophic ocean. The ISME Journal, 11(9), 2090–2101. doi:10.1038/ismej.2017.74
General

Karl, D. M., & Tien, G. (1992). MAGIC: A sensitive and precise method for measuring dissolved phosphorus in aquatic environments. Limnology and Oceanography, 37(1), 105–116. doi:10.4319/lo.1992.37.1.0105
Methods

Van Mooy, B. A. S., Krupke, A., Dyhrman, S. T., Fredricks, H. F., Frischkorn, K. R., Ossolinski, J. E., … Sylva, S. P. (2015). Major role of planktonic phosphate reduction in the marine phosphorus redox cycle. Science, 348(6236), 783–785. doi:10.1126/science.aaa8181
Methods

[table of contents | back to top]

Parameters

Parameter	Description	Units
Station	Numeric identifier for the station where the data was collected.	unitless
N2_fix_avg	Average nitrogen fixation rate.	Picomole of nitrogen per colony hour (pmol N/(colony h))
N2_fix_std_dev	Standard deviation of nitrogen fixation rate.	Picomole of nitrogen per colony hour (pmol N/(colony h))
MAGIC_PO4	Phosphate measured using magnesium-induced co-precipitation.	Nanomole per liter (nmol/L)
Alk_phos_avg	Average alkaline phosphatase rates.	Picomole Phosphorus per colony hour (pmol P/(colony h))
Alk_phos_std_dev	Standard deviation of alkaline phosphatase rates.	Picomole Phosphorus per colony hour (pmol P/(colony h))
PO4_uptake_avg	Average phosphate uptake rate.	Picomole Phosphorus per colony hour (pmol P/(colony h))
PO4_uptake_std_dev	Standard deviation of phosphate uptake rate.	Picomole Phosphorus per colony hour (pmol P/(colony h))
Lat	Latitude of sampling. Positive values indicate North.	Decimal Degrees
Long	Longitude of sampling. Negative values indicate West.	Decimal Degrees
Date	Sampling date formatted as YYYYMMDD.	YYYYMMDD

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	on-deck incubator
Generic Instrument Name	In-situ incubator
Dataset-specific Description	A 1 mL aliquot of acetylene was injected into the bottle through a septum cap, the bottle was gently inverted, and allowed to incubate in an on-deck incubator at ambient temperature and light.
Generic Instrument Description	A device on a ship or in the laboratory that holds water samples under controlled conditions of temperature and possibly illumination.

Dataset-specific Instrument Name	underwater spherical quantum sensor (Li-Cor)
Generic Instrument Name	LI-COR Biospherical PAR Sensor
Dataset-specific Description	The incubators used a combination of neutral density screening and blue transparent film to achieve a light intensity of mimicking PAR at roughly 20m, as confirmed using an underwater spherical quantum sensor (Li-Cor).
Generic Instrument Description	The LI-COR Biospherical PAR Sensor is used to measure Photosynthetically Available Radiation (PAR) in the water column. This instrument designation is used when specific make and model are not known.

Dataset-specific Instrument Name	liquid scintillation counter (Perkin Elmer)
Generic Instrument Name	Liquid Scintillation Counter
Dataset-specific Description	After resting for a few hours, the 33P-radioacitivity in the vials was determined using a liquid scintillation counter (Perkin Elmer).
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.

Dataset-specific Instrument Name	net
Generic Instrument Name	Plankton Net
Dataset-specific Description	Trichodesmium colonies were collected with surface water net tows along a cruise transect in the western North Atlantic aboard the R/V Atlantic Explorer (AE1409) during May 2014. Sampling occurred at the same time each day (~7:30-8:30 am) using nets with a mesh size of 130 µm. Nets were deployed and hauled through the surface water column 6 times before recovery.
Generic Instrument Description	A Plankton Net is a generic term for a sampling net that is used to collect plankton. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	temperature logger (Onset)
Generic Instrument Name	Water Temperature Sensor
Dataset-specific Description	Temperature in the incubators was occasionally monitored with a waterproof temperature logger (Onset).
Generic Instrument Description	General term for an instrument that measures the temperature of the water with which it is in contact (thermometer).

[table of contents | back to top]

Deployments

AE1409

Website	https://www.bco-dmo.org/deployment/565190
Platform	R/V Atlantic Explorer
Start Date	2014-05-08
End Date	2014-05-26
Description	May 2014 cruise conducted as part of the "Dissolved Phosphorus Processing by Trichodesmium Consortia: Quantitative Partitioning, Role of Microbial Coordination, and Impact on Nitrogen Fixation" project.

[table of contents | back to top]

Project Information

Dissolved Phosphorus Processing by Trichodesmium Consortia: Quantitative Partitioning, Role of Microbial Coordination, and Impact on Nitrogen Fixation (P Processing by Tricho)

Coverage: Western Tropical North Atlantic

Description from NSF award abstract:
Colonies of the cyanbacterium *Trichodesmium* are responsible for a large fraction of N2 fixation in nutrient-poor, open-ocean ecosystems, ultimately fueling primary production in both *Trichodesmium* and in the broader planktonic community. However, in some parts of the ocean, the scarcity of dissolved phosphorus limits rates of *Trichodesmium* N2 fixation. *Trichodesmium* colonies employ an arsenal of strategies to mitigate the effects of phosphorus limitation, and the consortia of epibiotic bacteria in the colonies may play a significant role in phosphorus acquisition.

In this study, researchers from Woods Hole Oceanographic Institution and Columbia University will use metagenomic and metatranscriptomic sequencing to investigate how phosphorus metabolism is coordinated in *Trichodesmium* consortia, and to discern the role of quorum sensing in phosphorus acquisition and partitioning. Results from this study are expected to expand understanding of *Trichodesmium* from a monospecific colony whose primary function is fixing CO2 and N2 toward a unique planktonic consortium with a diverse, complex, and highly coordinated overall metabolism that exerts profound control over the cycling of inorganic and organic nutrients in the oligotrophic upper ocean.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1332898
NSF Division of Ocean Sciences (NSF OCE)	OCE-1332912

[table of contents | back to top]