Hydrological, biogeochemcial and N2-fixer qPCR-derived abundance data for May 2017 (SP1714) and October (SP1724) SCCS cruises.

Website: https://www.bco-dmo.org/dataset/881028
Data Type: Other Field Results
Version: 1
Version Date: 2024-06-24

Project
» Collaborative Research: Biogeochemical significance of the abundant, uncultivated symbiotic cyanobacteria UCYN-A (BSUCS)

Contributors	Affiliation	Role
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Abstract
Hydrological, biogeochemcial and N2-fixer qPCR-derived abundance data for May 2017 (SP1714) and October (SP1724) SCCS cruises.

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Coverage

Spatial Extent: **N**:33.825 **E**:-114.931 **S**:28.288 **W**:-120.249
Temporal Extent: 2017-05-03 - 2017-10-11

Dataset Description

These data were published in Turk-Kubo et al. (2021). Table 1, Figure 3, Table S1, Table S2

Meaning different No Data values:

UD = undetected
na = not applicable
- - = parameter not measured
DNQ = detected, not quantified
Empty cells = means that the value reported in the average nifH L-1 column is quantified.

Methods & Sampling

Samples were collected using standard oceanographic techniques. A CTD Rosette with 24 10L Niskin bottles was lowered to the maximum sampling depth and then brought back to the surface. Methodology described in depth in Turk-Kubo et al. (2021)

Data Processing Description

Samples for the measurement of nitrate plus nitrite and phosphate (PO43−) concentrations were filtered through precombusted GF/F filters and analyzed using standard techniques on a Lachat QuikChem 8000 Flow Injection Analyzer. Chl *a* samples from each depth were filtered onto GF/F filters, extracted in the dark at 3 °C in 90% acetone for 24 h and measured fluorometrically using a Turner Fluorometer TD-700 as described in Welschmeyer et al.

For DNA collection and extraction, seawater was filtered through SterivexTM filters using gentle peristaltic pumping and flash-frozen in liquid N2. DNA was extracted using the DNeasy Plant Kit (Qiagen, Germantown, MD) using modifications to the manufacturer's guidelines described in detail in Moisander et al. 2007. On-column steps were automated using a QIACube (Qiagen). DNA was quantified using the Picogreen® dsDNA Quantitation kit (Molecular Probes, Eugene, OR).

Gene-based abundance estimates of UCYN-A1, UCYN-A2, *Crocosphaera* (UCYN-B), *Trichodesmium*, *Richelia* associated with *Hemiaulus* (Het-2), and gamma A (γ-24774A11) were determined using Taqman® qPCR assays. Protocols used for all aspects of qPCR analysis, including reaction conditions, the use of linearized plasmids and inhibition reactions, and calculation of unknowns follow those described in detail by Goebel et al. 2010, apart from a 64 °C annealing temperature for the UCYN-A2 assay. The LOD and LOQ for all assays ranged between 25-31 and 200-250 *nifH* copies l−1, respectively. Targets with *nifH* copies >LOD and <LOQ are detected not quantified (DNQ).

Methodology described in depth in Turk-Kubo et al. (2021).

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Data Files

File	
881028_v1_diazoabun.csv	(Comma Separated Values (.csv), 31.33 KB) MD5:eb50de1d2547c069775e366f86751f9e
Primary data file for dataset ID 881028, version 1	

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Related Publications

Turk-Kubo, K. A., Mills, M. M., Arrigo, K. R., van Dijken, G., Henke, B. A., Stewart, B., Wilson, S. T., & Zehr, J. P. (2021). UCYN-A/haptophyte symbioses dominate N2 fixation in the Southern California Current System. ISME Communications, 1(1). https://doi.org/10.1038/s43705-021-00039-7
Results

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Parameters

Parameter	Description	Units

Cruise	Cruise ID	unitless
Station	Station number	unitless
Depth	Sampling depth	meters (m)
latitude	sampling latittude, south is negative	decimal degrees
longitude	sampling longitude, west is negative	decimal degrees
Sample_Date	sampling date	unitless
bottom_depth	bottom depth	meters (m)
mix_layer_depth	mixed layer depth	meters (m)
temperature	temperature	Degrees Celcius (°C)
salinity	salinity	psu
oxygen	oxygen	milliliters per liter (mL L-1)
fluorescence	fluoresence	milligrams per cubic meters (mg m-3)
PAR	Photosynthetically active radiation	unitless
potential_density	potential density. σθ	kilograms per cubic meters (kg m-3)
Nitrate	nitrate	micromoles (µM)
Phosphate	phosphate (PO43-)	micromoles (µM)
P	P* is the amount of dissolved PO43− in the environment relative to what is expected if N and P uptake and remineralization proceed according to Redfield proportions. P* = PO43− − (NO3− + NO2−)/16	unitless
chla_ave	Average chlorophyll a	micrograms per liter (µg L-1)
chla_stdev	Standard deviation chlorophyll a	micrograms per liter (µg L-1)
UCYN_A1_ave	Average of UCYN-A1 gene expression	nitrogenase gene per liter (nifH L-1)
UCYN_A1_stdev	Standard deviation of UCYN-A1 gene expression	nitrogenase gene per liter (nifH L-1)
UCYN_A1_DNQ	UCYN-A1 gene expression detected, not quantified	unitless
UCYN_A2_ave	Average of UCYN-A2 gene expression	nitrogenase gene per liter (nifH L-1)
UCYN_A2_stdev	Standard deviation of UCYN-A2 gene expression	nitrogenase gene per liter (nifH L-1)

UCYN_A2_DNQ	UCYN-A2 gene expression detected, not quantified	unitless
UCYN_B_ave	Average of UCYN-B gene expression	nitrogenase gene per liter (nifH L-1)
UCYN_B_stdev	Standard deviation of UCYN-B gene expression	nitrogenase gene per liter (nifH L-1)
UCYN_B_DNQ	UCYN-B gene expression detected, not quantified	unitless
Tricho_ave	Average of UCYN-A1 gene expression	nitrogenase gene per liter (nifH L-1)
Tricho_stdev	Standard deviation of UCYN-A1 gene expression	nitrogenase gene per liter (nifH L-1)
Tricho_DNQ	UCYN-A1 gene expression detected, not quantified	unitless
Het_2_ave	Average of UCYN-A1 gene expression	nitrogenase gene per liter (nifH L-1)
Het_2_stdev	Standard deviation of UCYN-A1 gene expression	nitrogenase gene per liter (nifH L-1)
Het_2_DNQ	UCYN-A1 gene expression detected, not quantified	unitless
g_24774A11_ave	Average of γ-24774A11 gene expression	nitrogenase gene per liter (nifH L-1)
g_24774A11_stdev	Standard deviation of γ-24774A11 gene expression	nitrogenase gene per liter (nifH L-1)
g_24774A11_DNQ	γ-24774A11 gene expression detected, not quantified	unitless

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Instruments

Dataset-specific Instrument Name	Lachat QuikChem 8000 Flow Injection Analyzer
Generic Instrument Name	Flow Injection Analyzer
Dataset-specific Description	Nutrients were measured on a Lachat QuikChem 8000 Flow Injection Analyzer.
Generic Instrument Description	An instrument that performs flow injection analysis. Flow injection analysis (FIA) is an approach to chemical analysis that is accomplished by injecting a plug of sample into a flowing carrier stream. FIA is an automated method in which a sample is injected into a continuous flow of a carrier solution that mixes with other continuously flowing solutions before reaching a detector. Precision is dramatically increased when FIA is used instead of manual injections and as a result very specific FIA systems have been developed for a wide array of analytical techniques.

Dataset-specific Instrument Name	Turner Fluorometer TD-700
Generic Instrument Name	Turner Designs 700 Laboratory Fluorometer
Dataset-specific Description	Fluorometric analysis of Chl a was measured using a Turner Fluorometer TD-700 (Turner Designs, Inc., San Jose, CA).
Generic Instrument Description	The TD-700 Laboratory Fluorometer is a benchtop fluorometer designed to detect fluorescence over the UV to red range. The instrument can measure concentrations of a variety of compounds, including chlorophyll-a and fluorescent dyes, and is thus suitable for a range of applications, including chlorophyll, water quality monitoring and fluorescent tracer studies. Data can be output as concentrations or raw fluorescence measurements.

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Deployments

SP1714

Website	https://www.bco-dmo.org/deployment/699986
Platform	R/V Robert Gordon Sproul
Start Date	2017-05-03
End Date	2017-05-11
Description	R/V Robert Gordon Sproul Cruise SP1714 May 3 - 11, 2017 Chief Scientist - Matthew Mills (mmmills@stanford.edu) See more cruise information from R2R: https://www.rvdata.us/search/cruise/SP1714

SP1727

Website	https://www.bco-dmo.org/deployment/774496
Platform	R/V Robert Gordon Sproul
Start Date	2017-10-04
End Date	2017-10-11
Description	R/V Robert Gordon Sproul Cruises SP1727 October 4 - 11, 2017 Chief Scientist - Matthew Mills (mmmills@stanford.edu) See more cruise information from R2R: https://www.rvdata.us/search/cruise/SP1727

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Project Information

Collaborative Research: Biogeochemical significance of the abundant, uncultivated symbiotic cyanobacteria UCYN-A (BSUCS)

Coverage: California Current waters off the Southern California shelf

NSF Award Abstract:

Nitrogen is a nutrient whose availability limits growth and productivity of ecosystems. Nitrogen is extremely abundant in the atmosphere in the inert form of gaseous N2, but most organisms cannot reduce N2 into a biologically available form. In all environments, including agricultural soils, there are microorganisms that can make available the N from gaseous N2 by reducing it to the biologically available form, ammonium. In the vast expanses of the open ocean, few organisms are known to have this ability, and recently a unique symbiosis between a single-celled cyanobacterium and a single-celled algae was discovered, which appears to be very widely distributed and likely of global biogeochemical significance. The cyanobacterium in this symbiotic partnership has very unusual metabolism and genomic streamlining. Little is known of the symbiosis because it is not detectable except by modern molecular biological techniques. Recent work has shown this symbiosis to be very widely spread through the oceans, and that there is previously unrecognized diversity in both the cyanobacterial and algal hosts. This research will examine the environmental distributions and the biogeochemical significance of this diversity in coastal US waters. The investigators will engage the public in ocean sciences through internship programs at local high schools and for undergraduate students at Stanford, and by documenting their field research in a 'virtual cruise' blog.

In the marine environment, the contribution of N2 fixation to the fixed nitrogen (N) pool is poorly quantified, in part due to an incomplete understanding on the abundance, activity, and physiology of diazotrophs. The symbiotic unicellular cyanobacteria (UCYN-A) is a poorly characterized, yet globally important, group of marine diazotrophs. UCYN-A is widely distributed in the marine environment, and lives symbiotically with a picoeukaryotic prymnesiophyte alga. We now know that there are multiple ecotypes of UCYN-A, which may be adapted to specific locations in the water-column and different oceanic provinces. Typically N2 fixation was considered unimportant in coastally influenced and non-tropical waters, however recent data shows that multiple subclades of UCYN-A are present. The distribution and rate of N2 fixation by UCYN-A subclades in coastal/nearshore environments is a major unknown in the oceanic N cycle. Its presence in nearshore waters may change the paradigm of the balance between basin N sources (N2 fixation) and sinks (denitrification). Likewise, significant N2 fixation by UCYN-A will need to be considered when determining estimates of new production in coastally influenced waters. This project aims to quantify the significance of different UCYN-A subclades to coastal/nearshore N budgets. It tackles the issue of determining N2 fixation rates by different UCYN-A subclades in coastal waters through rigorous fieldwork off the west coast of North America. The temporal and spatial distribution of UCYN-A subclades, as well as the rates of N2 fixation, will be determined by coupling N2 fixation measurements of bulk communities and individual cells (nanoSIMS) with molecular assays to study these widespread, but dilute, diazotrophic symbionts and their hosts. Additionally the investigators will conduct experiments aimed at constraining the effects of light and nutrient ratios (N/P) on UCYN-A N2 fixation rates, and the prymnesiophyte host's rate of carbon fixation. They will conduct this work through seasonal sampling of a coastal site in the Southern California Bight (Scripps Pier) and on two process cruises in the coastal waters between central California and the Baja Peninsula. The cruise work will provide an opportunity to understand the temporal dynamics of the UCYN-A/prymnesiophyte associations over larger spatial scales. Finally, evidence suggests that unidentified UCYN-A subclades and hosts exist and the investigators have developed a strategy to identify and quantify their temporal and spatial distributions as well as their N2 fixation activities. Data on the coastal distribution, ecology and activity of UCYN-A is critical for obtaining a better understanding of their contribution to fixed N to the marine environment. The group-specific and bulk rates of N2 fixation measured in this study of coastally influenced waters, will provide data for future modeling efforts, which will make an important contribution to constraining oceanic N2 fixation inputs.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1559165
NSF Division of Ocean Sciences (NSF OCE)	OCE-1559152

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