Bulk N2 fixation measurements from UCYN-A symbiosis in the Southern California Current System from May 2017 (SP1714) and October (SP1724) SCCS cruises.

Website: https://www.bco-dmo.org/dataset/881060
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
Bulk N2 fixation measurements from UCYN-A symbiosis in the Southern California Current System from May 2017 (SP1714) and October (SP1724) SCCS cruises.

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Coverage

Spatial Extent: **N**:33.825 **E**:-114.931 **S**:28.289 **W**:-120.249

Dataset Description

These data were published in Turk-Kubo et al. (2021). Table 1, Figure 6, Table S6, Table S7.

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. Seawater was sampled directly from Niskin® bottles into acid-washed 1.2 l polycarbonate bottles through 210 µm Nitex® mesh (Wildco, Yulee, FL) to remove large grazers.

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

Data Processing Description

Incubation bottles received 100 ml of 15N2-enriched seawater. 15N2-enriched seawater was generated and atom% enrichment was measured according to procedures described in detail by Mills et al. 2020. The 15N2-enriched seawater atom% enrichment ranged from 2.0–6.1% for SP1714 and 5.1–24.7% for SP1727. Bottles were incubated (24 h) under simulated in situ light using neutral density screening and maintained at surface seawater temperatures in flow-through on-deck incubators. Samples for atom% 15N of the ambient particulate matter were taken from corresponding depths at T0. At the termination of the incubation, samples for the analysis of 15N enrichment into particulate organic matter (ca. 1000 ml) were processed and measured, and NFRs were calculated. Limits of detection (LOD) and minimum quantifiable rates (MQRs) were calculated as in Gradoville et al. 2017

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

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Data Files

File
881060_v1_bulknfr.csv (Comma Separated Values (.csv), 7.77 KB) MD5:80067ddfbb5f55e0854d780b07b3e998 Primary data file for dataset ID 881060, version 1

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Related Publications

Gradoville, M. R., Bombar, D., Crump, B. C., Letelier, R. M., Zehr, J. P., & White, A. E. (2017). Diversity and activity of nitrogen-fixing communities across ocean basins. Limnology and Oceanography, 62(5), 1895–1909. Portico. https://doi.org/10.1002/lno.10542
Methods

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 identifier	unitless
Station	Station number	unitless
Latitude	Sampling latitude, south is negative	decimal degrees
Longitude	Sampling longitude, west is negative	decinal degrees
Depth	Sample depth	meters (m)
Average_NFR	Average nitrogen fixation rate	nanomoles nitrogen per liter per day (nmol N L-1 d–1)
Stdev_NFR	Standard deviation nitrogen fixation rate	nanomoles nitrogen per liter per day (nmol N L-1 d–1)
LOD	Limit of detection	nanomoles nitrogen per liter per day (nmol N L-1 d–1)
MQR	Minimum quantifiable rate	nanomoles nitrogen per liter per day (nmol N L-1 d–1)
Rep1_NFR	Nitrogen fixation rate, replicate 1	nanomoles nitrogen per liter per day (nmol N L-1 d–1)
Rep2_NFR	Nitrogen fixation rate, replicate 2	nanomoles nitrogen per liter per day (nmol N L-1 d–1)
Rep3_NFR	Nitrogen fixation rate, replicate 3	nanomoles nitrogen per liter per day (nmol N L-1 d–1)
Rep1_T	Incubation time, replicate 1	days
Rep1_APN	Atom percentage nitrogen, replicate 1. T=F (%) [Time=final]	percentage (%)
Rep1_PN	Particulate nitrogen, replicate 1	micromoles nitrogen per liter (µmol N L-1)
Rep2_T	Incubation time, replicate 2	days
Rep2_APN	Atom percentage nitrogen, replicate 1. T=F (%) [Time=final]	percentage (%)
Rep2_PN	Particulate nitrogen, replicate 2	micromoles nitrogen per liter (µmol N L-1)
Rep3_T	Incubation time, replicate 3	days
Rep3_APN	Atom percentage nitrogen, replicate 1. T=F (%) [Time=final]	percentage (%)
Rep3_PN	Particulate nitrogen, replicate 3	micromoles nitrogen per liter (µmol N L-1)
AtomPerc_N2_rep1	atom % enrichment in the 15N2 dissolved seawater	percentage (%)
AtomPerc_PN_rep1	atom % enrichment in the particulate nitrogen	percentage (%)

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Instruments

Dataset-specific Instrument Name	Elemental Combustion System (Costech Analytical Technologies)
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	Samples for bulk PON/POC and N2 fixation and CO2 fixation rates were measured on an Elemental Combustion System (Costech Analytical Technologies) interfaced to a Thermo Finnigan Delta V Advantage isotope ratio mass spectrometer (Thermo Fisher Scientific) at the SOEST Biogeochemical Stable Isotope Facility at the University of Hawai'i, Manoa.
Generic Instrument Description	Instruments that quantify carbon, nitrogen and sometimes other elements by combusting the sample at very high temperature and assaying the resulting gaseous oxides. Usually used for samples including organic material.

Dataset-specific Instrument Name	hermo Finnigan Delta V Advantage isotope ratio mass spectrometer (Thermo Fisher Scientific)
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	Samples for bulk PON/POC and N2 fixation and CO2 fixation rates were measured on an Elemental Combustion System (Costech Analytical Technologies) interfaced to a Thermo Finnigan Delta V Advantage isotope ratio mass spectrometer (Thermo Fisher Scientific) at the SOEST Biogeochemical Stable Isotope Facility at the University of Hawai'i, Manoa.
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

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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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