Nitrogen isotope ratio data for coral tissue and skeleton samples of the scleractinian cold-water coral Balanophyllia elegans collected at Friday Harbor, WA from experiments conducted between 2019 and 2021

Website: https://www.bco-dmo.org/dataset/919958
Data Type: experimental
Version: 1
Version Date: 2024-02-08

Project
» Collaborative Research: Refining the use of scleractinian cold-water coral skeleton-bound d15N as a proxy for marine N cycling (Coral-bound N)

Contributors	Affiliation	Role
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Abstract
This dataset contains nitrogen isotope ratio data for paired coral tissue and skeleton samples of the scleractinian cold-water coral Balanophyllia elegans collected at Friday Harbor, WA. Samples were collected between 2019 to 2021 as detailed in the following study description: Data collected as part of this study include nitrogen isotope ratio data for coral tissue and skeleton of the scleractinian cold-water coral Balanophyllia elegans collected at Friday Harbor, WA. Data was collected between March 2019 and August 2021. These data include paired measurements of the N isotope ratio (d15N) of coral tissue and skeleton. Tissue was measured using and Elemental Analyzer (EA)-coupled Isotope Ratio Mass Spectrometer (IRMS) and skeleton samples were first dissolved and organic nitrogen was oxidized to nitrate with persulfate before being run on a GC-IRMS with the denitrifier method. These data also include the results of two culture experiments with the same species of corals. The corals in the first culture experiment were fed Artemia diets with different known d15N in order to quantify change in the tissue d15N in response to a change in the food source and to determine the offset in d15N between the coral tissue and its diet. The starvation trial culture experiment was conducted to evaluate the effects of starvation on the d15N of coral tissue. For both experiments coral tissue was analyzed using an EA-IRMS. This data also includes the d15N of the respective Artemia diets. Finally, included in this data is hydrological and particulate matter data collect at the site the corals were collected (near Friday Harbor, WA). This data includes nitrate d15N and d18O, suspended particulate organic matter d15N, net tow material d15N, and data collected from a CTD profiler. This data enhances the understanding of cold-water coral diet and trophic position. This data improves the understanding of the relationship between surface nitrate d15N and the d15N recorded in the coral skeleton which is useful for enhancing the resolution of coral d15N paleoproxies.

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- Funding

Coverage

Location: Off the coast of Friday Harbor, WA in the San Juan Islands, 0-45m depth.
Spatial Extent: **N**:48.598 **E**:-122.935 **S**:48.544 **W**:-123.016
Temporal Extent: 2019-03-31 - 2021-08-03

Dataset Description

See "Related Datasets" section on this page to access data and metadata for datasets collected as part of the same study.

Methods & Sampling

This methodology section describes this dataset and other closely related datasets collected as part of this study (see "Related Datasets").

Corals (*Balanophyllia elegans*, LSID=urn:lsid:marinespecies.org:taxname:286920) were collected by divers using blunt-tipped diving knives to remove corals from vertical rock walls at 10-20 m depths. A subset of the corals were immediately frozen for determination of N isotope ratios of tissue and skeleton. Another subset of corals were shipped live overnight to St. Olaf College for the culture experiments.

For the culture experiment, corals were divided into four groups that were each fed *Artemia* (LSID=urn:lsid:marinespecies.org:taxname:480245) nauplii with a different known d15N. The coral tissue was sampled at discrete intervals over the course of the experiment as described below.

For the starvation experiment, corals were split into two group, starved and unstarved. The starved group was fed once every two weeks and the unstarved corals were fed twice a week. The coral tissue was sampled at discrete intervals throughouth the experiment as described below.

Once separated from the skeleton, coral tissue was lyophilized and analyzed using a Costech Elemental Analyzer Isotope Ratio Mass Spectrometer.

Once separated from the coral tissue, the coral skeletons were rinsed and ultrasonicated two times in Milli-Q water, then ultrasonicated in 1% sodium hypochlorite in 20 minute intervals until no tissue remained on the skeleton. The skeletons were then prepared following the methods of Wang et al (2014). The skeleton was ground to a powder using a mortar and pestle, then rinsed with sodium hypochlorite to remove any remaining tissue. The skeletal materials were then dissolved with 4N hydrochloric acid, then oxidized to nitrate by autoclaving in a basic potassium persulfate solution. Skeletal material was oxidized in tandem with standards of glutamine reference material USGS-40 and USGS-41. The samples were then analyzed by Gas Chromatography- Isotope Ratio Mass Spectrometry using the denitrifier method (Sigman et al., 2001). In brief, the denitrifier method uses the denitfrying bacteria *Pseudomonas chlororaphis* f. sp. *aureofaciens* to convert nitrate to nitrous oxide. *P. aureofaciens* was grown in media amended with 10mM nitrate in stoppered glass bottles for 7-10 days before being harvested and resuspended in nitrate free media. Three milliliters of resuspended bacteria was allocated to 20mL headspace vials which were sparged with dinitrogen gas for 6 hours. Nitrate sample solutions were injected into vials (target of 20nmol nitrogen for seawater samples and 7nmol for skeletal matrix samples) and incubated overnight to allow for the complete conversation of nitrate to nitrous oxide. The nitrous oxide was extracted and purified using a Thermo Gas Bench II with a GC Pal autosampler and dual cold traps and analyzed on a Thermo Advantage continuous flow isotope ratio mass spectrometer. Analyzes were referenced to N2O injected from a pure gas cylinder and standardized through comparison potassium nitrate reference materials International Atomic Energy Agency Nitrate (IAEA-N3) and the isotopic nitrate reference material from the United States Geological Survey 34 (USGS-34).

Artemia nauplii samples were stored frozen then lyophilized prior to analysis on the Elemental Analyzer Isotope Ratio Mass Spectrometer.

Nitrate samples were collected with Van-Doren Sampler and filtered with pre-combusted glass fiber filters

(GF/F, 0.7uM nominal pore size). The nitrate concentrations were determined using reduction to nitrous oxide in hot vanadium III solution followed by chemiluminescence detection of nitrous oxide on a Teledyne chemiluminescence NOx analyzer Model T200. The nitrogen and oxygen isotopes of nitrate were analyzed with the denitrifier method on an IRMS (described above).

Suspended particulate organic matter was collected with a Van-Doren Sampler and then collected on pre-combusted GF/F. The filters were lyophilized prior to analysis on an EA-IRMS.

Net tow material was collected with plankton nets with mesh sizes ranging from 80uM, 120uM, and 150uM. The net tow material was filtered and collected on a pre-combusted GF/F which was lyophilized prior to analysis on the EA.

Hydrologic depth profiles were characterized with a CastAway-CTD profiler.

Data Processing Description

Coral tissue and particulate matter was analyzed in tandem with the glutamine standards USGS-40 and USGS-41. These standards were used to correct the data from the EA-IRMS.

Coral skeleton material was oxidized in tandem with USGS-40 and USGS-41 which was used to correct for any oxidation blank. While IAEA-N3 and USGS-34 were used as standard material to correct the nitrate isotope data collected off the IRMS.

Data corrections were performed in Excel. The data reported here is averages of multiple runs when applicable. The uploaded data indicates when these are analytical replicates or sample replicates, all have n ≥ 2.

BCO-DMO Processing Description

* Sheet "skeleton-tissue" of submitted file "BCO-DMO data.xlsx" was imported into the BCO-DMO data system for this dataset. Values "NA" were imported as missing data values.
** Missing data values are displayed differently based on the file format you download. They are blank in csv files, "NaN" in MatLab files, etc.
* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

* Date converted to ISO 8601 format.

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Data Files

File	
919958_v1_skeleton-tissue.csv	(Comma Separated Values (.csv), 891 bytes) MD5:cdc200cfc2476439f49b26d5b8159ca6
Primary data file for dataset ID 919958, version 1	

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Related Publications

Sigman, D. M., Casciotti, K. L., Andreani, M., Barford, C., Galanter, M., & Böhlke, J. K. (2001). A Bacterial Method for the Nitrogen Isotopic Analysis of Nitrate in Seawater and Freshwater. Analytical Chemistry, 73(17), 4145–4153. doi:10.1021/ac010088e
Methods

Wang, X. T., Prokopenko, M. G., Sigman, D. M., Adkins, J. F., Robinson, L. F., Ren, H., Oleynik, S., Williams, B., & Haug, G. H. (2014). Isotopic composition of carbonate-bound organic nitrogen in deep-sea scleractinian corals: A new window into past biogeochemical change. Earth and Planetary Science Letters, 400, 243–250. https://doi.org/10.1016/j.epsl.2014.05.048
Methods

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Related Datasets

IsRelatedTo

Gothmann, A. M., Granger, J., Prokopenko, M. (2024) **CTD data from casts at Friday Harbor, WA in August of 2021 as part of a study of cold-water coral Balanophyllia elegans diet and trophic position.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-02-09 doi:10.26008/1912/bco-dmo.920001.1 [view at BCO-DMO]
Relationship Description: Datasets collected as part of the same study scleractinian cold-water coral Balanophyllia elegans diet and trophic position at Friday Harbor, WA. Data was collected between March 2019 and August 2021.

Gothmann, A. M., Granger, J., Prokopenko, M. (2024) **Data for Artemia fed to corals (Balanophyllia elegans) during a culture experiment conducted to evaluate the relationship between coral diet and tissue nitrogen isotopic ratio from 2019 to 2021.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-02-09 doi:10.26008/1912/bco-dmo.919977.1 [view at BCO-DMO]
Relationship Description: Datasets collected as part of the same study scleractinian cold-water coral Balanophyllia elegans diet and trophic position at Friday Harbor, WA. Data was collected between March 2019 and August 2021.

Gothmann, A. M., Granger, J., Prokopenko, M. (2024) **Experimental data (coral diet and tissue d15N) from a culture experiment with scleractinian cold-water coral Balanophyllia elegans collected at Friday Harbor, WA from experiments conducted between 2019 and 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-02-09 doi:10.26008/1912/bco-dmo.919969.1 [view at BCO-DMO]
Relationship Description: Datasets collected as part of the same study scleractinian cold-water coral Balanophyllia elegans diet and trophic position at Friday Harbor, WA. Data was collected between March 2019 and August 2021.

Gothmann, A. M., Granger, J., Prokopenko, M. (2024) **Experimental data (d15N and d13C) from a starvation experiment with scleractinian cold-water coral Balanophyllia elegans collected at Friday Harbor, WA with experiments conducted between 2020 and 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-02-09 doi:10.26008/1912/bco-dmo.919993.1 [view at BCO-DMO]
Relationship Description: Datasets collected as part of the same study scleractinian cold-water coral Balanophyllia elegans diet and trophic position at Friday Harbor, WA. Data was collected between March 2019 and August 2021.

Gothmann, A. M., Granger, J., Prokopenko, M. (2024) **Particulate data collected near Friday Harbor, WA between 2020 and 2021 as part of a study of cold-water coral Balanophyllia elegans diet and trophic position.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-02-09 doi:10.26008/1912/bco-dmo.919985.1 [view at BCO-DMO]
Relationship Description: Datasets collected as part of the same study scleractinian cold-water coral Balanophyllia elegans diet and trophic position at Friday Harbor, WA. Data was collected between March 2019 and August 2021.

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Parameters

Parameter	Description	Units
Skeleton_Sample_ID	Identifier given to that coral individual skeletal sample	unitless
Tissue_Sample_ID	Identifier given to the coral tissue sample paired with the associated skeletal material	unitless
Average_Skeleton_d15N	Average isotopic ratio of nitrogen (d15N) in sample replicates of an individual coral skeletal material.	permil (0/00)
Skeleton_Standard_Deviation	standard deviation of sample replicates of skeletal material d15N values.	permil (0/00)
Average_Tissue_d15N	Average isotopic ratio of nitrogen (d15N) in analytical replicates of an individual coral's tissue, corresponding to the individuals skeletal material	permil (0/00)
Tissue_Standard_Deviation	standard deviation of sample replicates of tissue material d15N values	permil (0/00)
Date_Collected	Date specimen or samples were collected	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Continuous Flow Interface for Mass Spectrometers
Dataset-specific Description	Thermo Advantage continuous flow isotope ratio mass spectrometer
Generic Instrument Description	A Continuous Flow Interface connects solid and liquid sample preparation devices to instruments that measure isotopic composition. It allows the introduction of the sample and also reference and carrier gases. Examples: Finnigan MATConFlo II, ThermoScientific ConFlo IV, and Picarro Caddy. Note: This is NOT an analyzer

Dataset-specific Instrument Name	Costech Elemental Analyzer Isotope Ratio Mass Spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
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).

Dataset-specific Instrument Name	
Generic Instrument Name	Thermo-Fisher Scientific Gas Bench II
Dataset-specific Description	The nitrous oxide was extracted and purified using a Thermo Gas Bench II with a GC Pal autosampler and dual cold traps and analyzed on a Thermo Advantage continuous flow isotope ratio mass spectrometer
Generic Instrument Description	An on-line gas preparation and introduction system for isotope ratio mass spectrometry that is designed for high precision isotope and molecular ratio determination of headspace samples, including water equilibration, carbonates and atmospheric gases. The instrument allows for the use of a dual viscous flow inlet system of repetitive measurements of sample and standard gas on a continuous flow isotope ratio mass spectrometer (CF-IRMS) system. The sample volume is the sample vial (instead of a metal bellows), and the reference gas volume is a pressurized gas tank. The instrument consists of a user programmable autosampler, a gas sampling system, a maintenance-free water removal system, a loop injection system, an isothermal gas chromatograph (GC), an active open split interface, a reference gas injection system with three reference ports, and one or two optional LN2 traps for cryofocusing. The gas sampling system includes a two port needle which adds a gentle flow of He into the sample vial, diluting and displacing sample gas. Water is removed from the sample gas through diffusion traps. The loop injector aliquots the sample gas onto the GC column, which separates the molecular species. The reference gas injection system allows accurate referencing of each sample aliquot to isotopic standards. The system can be used with several options including a carbonate reaction kit that allows injection of anhydrous phospohric acid into sample vials. Note "Finnigan GasBench-II" is the previous brand name of this instrument.

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Project Information

Collaborative Research: Refining the use of scleractinian cold-water coral skeleton-bound d15N as a proxy for marine N cycling (Coral-bound N)

Coverage: Global ocean

NSF abstract:

Refining the use of scleractinian cold-water coral skeleton-bound d15N as a proxy for marine N cycling

Recent studies show that cold-water corals and their skeletons provide valuable information about the marine nitrogen (N) cycle. This information can shed light on the processes that both drive and respond to changes in Earth’s climate. Cold-water corals are found across the global ocean and can be dated with decadal precision, offering spatial and temporal records of the N cycle in the past. In addition, a single skeleton can be used to

reconstruct both surface and deep ocean composition. Despite the promise of cold-water corals, we don't fully understand how they record changes in the marine N cycle. We must strengthen this understanding before we use cold-water corals to produce reliable records of marine N cycling across space and time, across different coral species, and under different lifestyle and feeding patterns. This project examines how the isotopic composition of organic N trapped in coral skeletons is linked to marine N cycle properties. The study includes a series of lab experiments, measurements of live corals sampled from the natural environment, and measurements of coral skeletal material from different ocean regions and depth horizons archived in museums. The project involves undergraduates at St. Olaf College, Pomona College and Mt. San Antonio College, one of the largest community colleges in Southern California. These students will conduct the research with scientists and peers in collaborating labs. Participation in the project will build student research skills and scientific knowledge for advanced study and prepare students for the scientific workforce. The project will also develop educational materials, including YouTube videos, to promote interest in marine science and awareness of how climate change influences global oceans. These educational materials will be created in collaboration with high school students from underrepresented groups.

The main tool used to investigate marine N cycle history is the isotope composition of particulate organic nitrogen (δ15N-PON) exported from the euphotic zone, which can be accessed using sedimentary archives such as foraminiferal tests, anoxic sediments and soft corals. Recently, the δ15N of organic N trapped within asymbiotic scleractinian cold-water coral (CWC) skeletons has been shown to record the δ15N-PON exported from the surface ocean (Wang et al. 2014; Wang et al. 2017). In order to reliably apply CWC δ15N as a proxy, however, we must explain a ~8.5‰ offset between the δ15N of organic nitrogen within the CWC skeleton and the exported δ15N-PON in regions of coral growth (Wang et al. 2014). The nature of the δ15N offset must be accounted for to be confident that CWC records marine N cycle history consistently across space and time, across different coral species, and for corals with different lifestyle conditions. Through coral culture experiments, measurements of live corals samples from the natural environment, and archives of corals skeletal material from different ocean regions and depth horizons, this research will test whether the offset arises from: (1) a biosynthetic isotope offset between CWC tissue and skeleton, (2) an unusual trophic transfer between CWC tissue and diet, and/or (3) coral feeding on material with elevated δ15N relative to exported δ15N-PON. This work will also provide estimates of N turnover time in CWC, which are scant, and will inform trophic ecology of CWC.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1949119

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