Concentrations of colored dissolved organic matter, dissolved organic carbon, and total phosphorous from experiments conducted at the University of Hawaii, Manoa in 2015 (Coral DOM2)

Website: https://www.bco-dmo.org/dataset/723868
Data Type: experimental
Version: 1
Version Date: 2018-01-17

Project
» Collaborative Research: Dissolved organic matter feedbacks in coral reef resilience: The genomic & geochemical basis for microbial modulation of algal phase shifts (Coral DOM2)

Contributors	Affiliation	Role
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Abstract
Concentrations of colored dissolved organic matter, dissolved organic carbon, and total phosphorous from experiments conducted at the University of Hawaii, Manoa in 2015.

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Coverage

Spatial Extent: **N**:21.435 **E**:-157.7866 **S**:21.4326 **W**:-157.787
Temporal Extent: 2015-10 - 2015-11

Dataset Description

This dataset contains concentrations of colored dissolved organic matter, dissolved organic carbon, and total phosphorous from experiments conducted at the University of Hawaii, Manoa in 2015. Experiment CRANE (Coral Reef Acclimation to Nutrient Enrichment) identifies a monthlong mesocosm incubation study designed to understand the response of the coral reef community to long-term nutrient exposure. This experiment compared the magnitude and composition of exudates from four dominant coral reef benthic primary producer constituents (coral, macroalgae, sand and rubble) factorially under three different inorganic nutrient treatments (ambient, low, and high) over four weeks. This dataset was published in Quinlan et al. (2018) and Silbiger et al. (2018).

Methods & Sampling

The experiments were conducted at the Research Field Station Marine Lab (FSML) Kaneohe Bay, Hawaii, (HIMB; 21.4326 ˚, -157.7866˚).

The following sections contain methodology excerpts from Quinlain et al. (2018) relevant to this dataset.

Collection of major reef constituents:

Three visibly healthy colonies each of Porites compressa and Montipora capitata, two locally abundant hermatypic corals, were collected between 4 and 7 meters depth from fringing reef immediately adjacent to the Hawai'i Institute of Marine Biology in Kāne'ohe Bay, Hawai'i (HIMB; 21.435 ˚, -157.787˚) between 12 and 16 October 2015. Each colony was fragmented into 36 nubbins and one nubbin from each colony was mounted onto each of 36 polystyrene frames (roughly 10 cm2) using epoxy putty. Each frame had 6 nubbins (3 Porites, 3 Montipora); one nubbin from each colony per frame; 24.8 ± 5.23 g dry weight P. compressa, 21.9 ± 5.05 g dry weight of M. capitata. Corals were allowed to acclimate 10 days before the start of the experiment. Rubble of dead skeleton from P. compressa skeleton was haphazardly collected in conjunction with the coral collections, separated into 36 equal portions (78.9 ± 3.42 g dry weight) and contained within polyethylene mesh netting containers. The macroalga Gracilaria sp. (Rhodophyta) was collected from the north point of HIMB (21.4360˚, -157.7881˚); any visible invertebrates and epiphytes within the macroalgae were removed, fronds were separated into 36 equal portions (11.0 ± 0.55 g wet weight) and contained within polyethylene mesh netting mesh containers. Sand was collected from the top 3 cm of aerobic reef sand on the eastern edge of HIMB (21.4350˚, -157.7871˚) using a 7.5 cm diameter core and was left undisturbed in each of the 36 petri dishes in which it was collected.

Aquaria and nutrient enrichment systems:

Square polycarbonate aquaria (n = 36) were affixed with an upper spigot drain to hold water level constant at 6 L, acid washed and soaked for 72 hours in flowing seawater to leach plasticizers prior to the experiment, scrubbed clean, rinsed with freshwater and dried. Each aquarium was filled with 4 benthic constituent units (either four coral frames, four algal or rubble mesh portion containers or four sand dishes) and placed into one of three 1300L flow-through seawater tanks (12 aquaria per tank) as water baths to maintain stable temperature. Each tank thus contained one replicate aquarium of each benthic group maintained at each nutrient level (Figure 1, Quinlain et al. 2018). Source water from Kāne'ohe Bay was filtered through a sand filter followed by a 20 µm polyethylene cartridge pre-filter to exclude large plankton. A concentrated nutrient mix (2 mmol L-1 sodium nitrate and 0.67 mmol L-1 monosodium phosphate, 20L) was prepared every other day by amending seawater with a frozen concentrated stock in a pre-cleaned polycarbonate carboy stored at ambient temperatures in the dark. Both the source water and nutrient mixture were pumped by continuous peristalsis through platinum cured silicone tubes into nutrient mixing aquaria with 90 minute residence times maintained at three concentrations (ambient, low and high; mean and time series concentrations in Figure 1 and Figure S2, respectively, Quinlain et al., 2018) then distributed by peristalsis to the experimental aquaria maintained at a 5-hour residence time. Each week all aquaria were replaced with cleaned and dried aquaria and randomly rearranged spatially within incubation tanks, but maintained in three replicate experimental blocks cycled among 1300 L tanks to account for light and temperature variation; means of 288 ± 354 µmol photon m-2 s-1 and 25.9 ±1.9 ˚C did not differ significantly among water baths and are detailed in a companion manuscript (Silbiger et al., 2018).

Dissolved Organic Matter (DOM) sample collection and analysis:

DOM samples were collected biweekly over a period of four weeks from each aquaria using acid washed and seawater leached treatment-specific, rubber free polyethylene syringes and filtered through a 0.2 µm polyethersulfone filter (25 mm; Sterlitech) in a polypropylene filter holder (Swin-lok; Whatman). Filtrate was collected in acid washed, combusted, triple sample-rinsed amber borosilicate vials with teflon septa lids and stored dark at 4˚C until analysis within 1 month of collection. Dissolved organic carbon (DOC) was measured as non-purgeable organic carbon via acidification, sparging and high temperature platinum catalytic oxidation on a Shimadzu TOC-V (Carlson et al. 2010). Nutrient samples were collected identically, but frozen (-20 °C) in polyethylene centrifuge tubes, thawed to room temperature, mixed thoroughly and analyzed on a Seal Analytical Segmented Flow Injection AutoAnalyzer AA3HR for simultaneous determination of soluble reactive phosphate (PO43-), ammonium (NH4+), nitrate + nitrite (N + N; NO3- + NO2-), silicate (SiO4) and total dissolved nitrogen and phosphorus (TDN, TDP; via in-line persulfate/ultraviolet oxidation). Dissolved organic nitrogen (DON) was calculated as the difference between TDN and the sum of ammonium, nitrate and nitrite.

Samples for fluorescence spectroscopy were measured using an Horiba Aqualog scanning fluorometer following the methods of Nelson et al. (2015) and processed using a Matlab (v2007b) script (see processing

section below). Six PARAFAC components were validated using split half validation and outlier analysis (Figure S1, Quinlain et al., 2018). All PARAFAC components had similar excitation-emission maxima and strong covariation among samples with previously identified fluorophores; thus for subsequent analyses, we examined established fluorescence maxima from the literature (Table S1, Quinlain et al., 2018; Coble ,1996; Stedmon et al., 2003; Lakowicz, 2010).

Data Processing Description

Code used to process the fluorescence spectroscopy data from the Horiba Aqualog scanning fluorometer is available for download in the "Supplemental File" section of this page. The file fDOMmatlab.zip contains the exact code version associated with this dataset version and was originally obtained from the GitHub repository https://github.com/zquinlan/fDOMmatlab/ which may continue to be developed in future.

No data cleaning was performed.

BCO-DMO Data Manager Processing Notes:
* added a conventional header with dataset name, PI name, version date
* modified parameter names to conform with BCO-DMO naming conventions (no spaces, hyphens, special characters)
* forked github code repository https://github.com/zquinlan/fDOMmatlab/ to https://github.com/BCODMO/fDOMmatlab/tree/v1 for curatorial purposes, made a release of the code, and provided a zip download of the contents on this page.
* spatial bounds on this page include the coral collection site and the experimental site.

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Data Files

File
fDOM_DOC_TP.csv (Comma Separated Values (.csv), 16.00 KB) MD5:38d75adc5187c0a0de40249d2ee7b4cb Primary data file for dataset ID 723868

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Supplemental Files

File
fDOMmatlab.zip (Octet Stream, 8.79 KB) MD5:0631e7fb2386e9ee16bf493d36c34271 Code used to process the fluorescence spectroscopy data from the Horiba Aqualog scanning fluorometer. This version of code was used to produce data version 1 of "CRANE: fDOM, DOC, and TP" https://www.bco-dmo.org/dataset/723868. This zip file is also available at the following github release link: https://github.com/BCODMO/fDOMmatlab/releases/tag/v1

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Related Publications

Coble, P. G. (1996). Characterization of marine and terrestrial DOM in seawater using excitation-emission matrix spectroscopy. Marine Chemistry, 51(4), 325–346. doi:10.1016/0304-4203(95)00062-3
Methods

Lakowicz, J. R. (Ed.). (2010). Principles of Fluorescence Spectroscopy. 3. ed., [4. corr. print.] New York, NY: Springer. https://isbnsearch.org/isbn/9780387312781
Methods

Quinlan, Z. A., Remple, K., Fox, M. D., Silbiger, N. J., Oliver, T. A., Putnam, H. M., … Nelson, C. E. (2018). Fluorescent organic exudates of corals and algae in tropical reefs are compositionally distinct and increase with nutrient enrichment. Limnology and Oceanography Letters, 3(4), 331–340. doi:10.1002/lol2.10074
Results

Silbiger, N. J., Nelson, C. E., Remple, K., Sevilla, J. K., Quinlan, Z. A., Putnam, H. M., … Donahue, M. J. (2018). Nutrient pollution disrupts key ecosystem functions on coral reefs. Proceedings of the Royal Society B: Biological Sciences, 285(1880), 20172718. doi:10.1098/rspb.2017.2718
Results

Stedmon, C. A., Markager, S., & Bro, R. (2003). Tracing dissolved organic matter in aquatic environments using a new approach to fluorescence spectroscopy. Marine Chemistry, 82(3-4), 239–254. doi:10.1016/s0304-4203(03)00072-0 https://doi.org/10.1016/S0304-4203(03)00072-0
Methods

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Parameters

Parameter	Description	Units
Major_Benthic_Constituent	Type of organism|substrate in aquaria (coral|macroalgae|sand|rubble)	unitless
Nutrient_Addition	Nominal Level of nutrient addition (ambient|low|high)	unitless
Water_Bath	Experimental Replicate water bath tank (1|2|3)	unitless
Week	Week of continuous nutrient addition (0|2|4)	unitless
Ultra_Violet_Humic_like	Coble Peak A (Ultra Violet Humic-like)	Raman units of water (RU)
Marine_Humic_like	Coble Peak M (Marine Humic-like)	Raman units of water (RU)
Visible_Humic_like	Coble Peak C (Visible Humic-like)	Raman units of water (RU)
Tryptophan_like	Coble Beak T (Tryptophan-like)	Raman units of water (RU)
Tyrosine_like	Coble Peak B (Tyrosine-like)	Raman units of water (RU)
Phenylalanine_like	Coble Peak F (Phenylalanine-like)	Raman units of water (RU)
Proteinaceous_fDOM	Sum of peaks A,M, and C (Proteinaceous fDOM)	Raman units of water (RU)
Humic_like_fDOM	Sum of peaks T,B,and F (Humic-like fDOM)	Raman units of water (RU)
TP_avg	Average Total Phosphorous (TP)	micromoles per liter (µmol L-1)
DOC	Dissolved Organic Carbon (DOC)	micromoles per liter (µmol L-1)

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Instruments

Dataset-specific Instrument Name	Seal Analytical Segmented Flow Injection AutoAnalyzer AA3HR
Generic Instrument Name	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	Horiba Aqualog scanning fluorometer
Generic Instrument Name	Fluorometer
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

Dataset-specific Instrument Name	
Generic Instrument Name	Shimadzu TOC-V Analyzer
Generic Instrument Description	A Shimadzu TOC-V Analyzer measures DOC by high temperature combustion method.

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Project Information

Collaborative Research: Dissolved organic matter feedbacks in coral reef resilience: The genomic & geochemical basis for microbial modulation of algal phase shifts (Coral DOM2)

Coverage: Pacific Coral Reefs

NSF award abstract:
Coral reef degradation, whether driven by overfishing, nutrient pollution, declining water quality, or other anthropogenic factors, is associated with a phase shift towards a reefs dominated by fleshy algae. In many cases managing and ameliorating these stressors does not lead to a return to coral dominance, and reefs languish in an algal-dominated state for years. Nearly a decade of research has demonstrated that trajectories toward increasing algal dominance are restructuring microbial community composition and metabolism; the investigators hypothesize that microbial processes facilitate the maintenance of algal dominance by metabolizing organic compounds released by algae thereby stressing corals through hypoxia and disease. The resilience of reefs to these phase shifts is a critical question in coral reef ecology, and managing reefs undergoing these community shifts requires developing an understanding of the role of microbial interactions in facilitating algal overgrowth and altering reef ecosystem function. The research proposed here will investigate the organics produced by algae, the microbes that metabolize the organics, and the impacts of these processes on coral health and growth. This research has implications for managing reef resilience to

algal phase shifts by testing the differential resistance of coral-associated microbial communities to algae and defining thresholds of algal species cover which alter ecosystem biogeochemistry. This project provides mentoring across multiple career levels, linking underrepresented undergraduates, two graduate students, a postdoctoral researcher, and a beginning and established investigators.

This project will integrate dissolved organic matter (DOM) geochemistry, microbial genomics and ecosystem process measurements at ecologically-relevant spatial and temporal scales to test hypothetical mechanisms by which microbially-mediated feedbacks may facilitate the spread of fleshy algae on Pacific reef ecosystems. A key product of this research will be understanding how the composition of corals and algae on reefs interact synergistically with complex microbial communities to influence reef ecosystem resilience to algal phase shifts. Emerging molecular and biogeochemical methods will be use to investigate mechanisms of microbial-DOM interactions at multiple spatial and temporal scales. This project will leverage the background environmental data, laboratory facilities and field logistical resources of the Mo'orea Coral Reef Long Term Ecological Research Project in French Polynesia and contribute to the mission of that program of investigating coral reef resilience in the face of global change. The investigators will quantify bulk diel patterns of DOM production and characterize the composition of chromophoric components and both free and acid-hydrolyzable neutral monosaccharides and amino acids from varying benthic algae sources. The team will also characterize planktonic and coral-associated microbial community changes in taxonomic composition and gene expression caused by algal DOM amendments in on-site controlled environmental chambers using phylogenetics and metatranscriptomics, including tracking algal exudate utilization by specific microbial lineages. Field-deployed 100 liter tent mesocosms will be used to examine in situ diel patterns of coupled DOM production and consumption, microbial community genomics and ecosystem metabolism over representative benthic communities comprising combinations of algal and coral species. Together these experimental results will guide interpretation of field surveys of centimeter-scale spatial dynamics of planktonic and coral-associated microbial genomics and metabolism at zones of coral-algal interaction, including boundary layer dynamics of oxygen, bacteria and DOM using planar optodes, high-throughput flow cytometry and fluorescence spectroscopy.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1538393

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