Coral and Algal Stable Isotope Data

Website: https://www.bco-dmo.org/dataset/941648
Data Type: Other Field Results
Version: 1
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Project
» The Biophysics of Coral Reef Resilience: hydrodynamic and ecological drivers of coral survival under extreme heat (Biophysics of Coral Reef Resilience)

Contributors	Affiliation	Role
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Abstract
Large-scale oceanographic processes shape the dynamics of coral reef ecosystems and influence their future survival under climate change. In the central Pacific Ocean, high ocean temperatures associated with the strong El Niño event in 2015-16 led to widespread coral bleaching and mortality. This El Niño also altered the flow of major ocean current, which led to anomalously high upwelling on Palmyra Atoll. This corresponded with lower than expected coral mortality given the magnitude of thermal stress and observed levels of bleaching. Here we combined multi-year collections of coral and macroalgae on Palmyra to illustrate how this reef system responded to a major shift in ocean conditions during an El Niño. This data set includes coral and macroalgal stable isotope data collected between 2012 and 2017 on Palmyra Atoll. The coral data include d13C and d15N bulk stable isotope values from Pocillopora meandrina coral host and endosymbiont tissues collected at 10m depth on Palmyra's fore reef slope during 2012, 2014, and 2015. Macroalgal d15N values are provided from Halimeda opuntia from 2012 and 2014-2017.

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Coverage

Location: Palmyra Atoll , US National Wildlife Refuge 5.8885N 162.0787W depth 10m

Methods & Sampling

Sample Collection and Processing

Coral and algal samples were collected at 10m depth on Palmyra's fore reef habitat. Samples were frozen at -20C for transportation. Halimeda samples were decalcified in 5% HCl, dried, ground, and packaged into tin capsules. *Pocillopora meandrina* fragments were air blasted and the host and algal symbiont fractions were separated by centrifugation. Each fraction was loaded onto a pre-combusted GF/F filter (Whatmann), lightly acidified with 5% HCl, and packaged into tin capsules.

Analysis Methods

Bulk δ13C, δ15N, and mass percent Carbon and Nitrogen were measured via EA-IRMS with a Costech

elemental analyzer (Valencia, CA, USA) coupled to a Thermo Scientific Delta XP Plus isotope ratio mass spectrometer (Bremen, Germany). Isotopic data are reported as delta values (δ) and expressed in ‰ relative to the international standards for Carbon (Vienna Hoffman and Rasmussen 2022) and Nitrogen (atmospheric N2). Within-run SD of in-house reference material was <0.2‰ for δ13C and δ15N.

Data Processing Description

Standard preparation methods for bulk tissue stable isotope analysis as described above.

Problem Description

No reported problems or issues from the authors.

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Related Publications

Fox, M. D., Guillaume-Castel, R., Edwards, C. B., Glanz, J., Gove, J. M., Green, J. A. M., Juhlin, E., Smith, J. E., & Williams, G. J. (2023). Ocean currents magnify upwelling and deliver nutritional subsidies to reef-building corals during El Niño heatwaves. Science Advances, 9(24). https://doi.org/10.1126/sciadv.add5032
Results

Hoffman, D. W., & Rasmussen, C. (2022). Absolute Carbon Stable Isotope Ratio in the Vienna Peedee Belemnite Isotope Reference Determined by 1H NMR Spectroscopy. Analytical Chemistry, 94(13), 5240–5247. https://doi.org/10.1021/acs.analchem.1c04565
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	Elemental Analyzer – Isotope Ratio Mass Spectrometry (EA-IRMS) System
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	An EA-IRMS with a Costech elemental analyzer (Valencia, CA, USA) coupled to a Thermo Scientific Delta XP Plus isotope ratio mass spectrometer (Bremen, Germany) was used to measure Bulk δ13C, δ15N, and mass percent Carbon and Nitrogen.
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.

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Project Information

The Biophysics of Coral Reef Resilience: hydrodynamic and ecological drivers of coral survival under extreme heat (Biophysics of Coral Reef Resilience)

Website: http://www2.whoi.edu/site/cohenlab/

Coverage: Central Tropical Pacific

NSF Award Abstract:
Coral reefs are among the most diverse ecosystems on the planet and support the livelihoods of hundreds of millions of people around the world. Ocean warming and intensifying heatwaves are killing coral reefs and there are urgent efforts underway to identify and protect those capable of surviving future warming. Coral reefs in the central equatorial Pacific have experienced three extreme heat events over the last two decades. Initial observational data obtained by the investigators show that coral mortality during each event was spatially variable, implying that some coral communities have developed resilience to thermal stress. In this study, the investigators are examining the role of fine-scale variations in reef temperature and water flow in promoting coral resilience by providing opportunities for genetic adaptation, by protectively cooling corals through upwelling or internal waves, or by enhancing food supply. Results will provide novel insights into the mechanisms by which coral communities survive extreme heat and a new tool that allows scientists and coral reef managers to identify resilient reefs for protection. Additionally, this project is supporting an early-career scientist, graduate and undergraduate research, opportunities for high school students in the United States to participate in research, as well as participation by Kanton high school students. Outreach will be conducted through presentations and a variety of media, including film. The hydrodynamic model output will be made publicly available, and project outcomes will contribute to a universal map of coral thermal thresholds currently under development by the scientific community.

Ocean warming and intensifying heatwaves are devastating coral reefs across the global tropics. Consequently, a coordinated effort is underway to identify and protect coral communities that can survive these changes. This interdisciplinary team of investigators is combining oceanographic observations, 3-dimensional fine-scale hydrodynamic model simulations, benthic surveys, and biological assays to investigate the role of reef hydrodynamics in facilitating coral resilience to thermal stress on Kanton Island in the central equatorial Pacific. The investigators are testing the hypothesis that oceanographic and atmospheric forcing interact with reef bathymetry to induce predictable fine-scale heterogeneity in water temperature and flow across the reef. They are also testing the hypothesis that environmental heterogeneity, in turn, facilitates coral survival of extreme heat by providing opportunities for genetic adaptation, protective cooling, and/or enhanced food supply. Results will provide insights into the biophysical mechanisms underpinning reef resilience and a new tool with which to predict resilience across a broad range of coral reef ecosystems.

This project is supported with funds from the Biological and Physical Oceanography Programs.

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-2049567

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