Carbon and nitrogen stable isotopes of Hawaiian corals collected from August to November 2015

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Project
» Phenotype and genotype of coral adaptation and acclimatization to global change (Coral Adaptation)

Contributors	Affiliation	Role
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Abstract
This dataset contains the carbon and nitrogen stable isotopes of seven coral species (Montipora capitata, Montipora patula, Pocillopora acuta, Pocillopora meandrina, Porites compressa, Porites evermanni, and Porites lobata) from samples collected from 17 August to 13 November 2015 at six sites surrounding the island of O'ahu, Hawai'i. Samples were combusted using a PDZ Europa ANCA-GSL elemental analyzer interfaced to a PDZ Europa 20-20 isotope ratio mass spectrometer at the University of California (UC) Davis Stable Isotope Facility. The carbon isotopic signature of the animal host, algal endosymbiont, and whole coral are reported as the per mil deviation of the stable isotopes 13C:12C relative to Vienna Peedee Belemnite Limestone Standard (v-PDB). The nitrogen isotopic signature of the animal host, algal endosymbiont, and whole coral are reported as the per mil deviation of the stable isotopes 15N:14N relative to air.

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Coverage

Spatial Extent: **N**:21.594193 **E**:-157.683056 **S**:21.286111 **W**:-158.131564
Temporal Extent: 2015-08-17 - 2015-11-13

Methods & Sampling

A complete description of the collection and experimental methods is available in Price et al. (in review). In brief, corals were collected between 17 August and 13 November 2015 from six sites (Electric Beach, Hale'iwa, Hawai'i Institute of Marine Biology [HIMB], Magic Island, Sampan Channel, and Waimanalo) surrounding the island of O'ahu, Hawai'i, USA. Ramets of seven coral species (*Montipora capitata, Montipora patula, Pocillopora acuta, Pocillopora meandrina, Porites compressa, Porites evermanni*, and *Porites lobata*) were collected at a depth of 0.5 to 5 m. A 5 to 10 cm coral ramet (branch or mound) was removed underwater via hammer and chisel from visually healthy parent colonies separated by at least 5 m on the reef to minimize the possibility of selecting corals of the same genet.

Sample Solutions and Standards: All solutions were made with MilliQ water (18 MΩ; Millipore, MA) and

ultrapure reagents unless otherwise noted. All labware was pre-cleaned with 10% v/v HCl and MilliQ water.

Sample Preparation: Methods for the processing and separating coral host tissue and algal endosymbionts tissues for isotopic analyses are described in Price et al. (2020). Briefly, a small subsample (approximately 4 to 6 cm^2) of each collected coral ramet was removed via hammer and a sterile chisel, the bulk coral tissue removed from the skeleton by airbrushing, and the resulting slurry was homogenized. A 0.5 ml sub-sample was removed, dried into silver capsules, and acidified via fumigation with 1N HCl for whole coral isotopic analysis. The remaining slurry was separated into animal host and endosymbiotic algal fractions via centrifugation and filtering steps. Overall, this process resulted in a whole coral sample, a host tissue sample, and an isolated algal endosymbiont sample for each coral collected.

Elemental Analyses*:* All samples were combusted using a PDZ Europa ANCA-GSL elemental analyzer interfaced to a PDZ Europa 20-20 isotope ratio mass spectrometer (Sercon Ltd., Cheshire, UK) at the University of California (UC) Davis Stable Isotope Facility. The carbon isotopic signature of the animal host ($\delta^{13}Ch$), algal endosymbiont ($\delta^{13}Ce$), and whole coral ($\delta^{13}Cw$) are reported as the per mil deviation of the stable isotopes $^{13}C:^{12}C$ relative to Vienna Peedee Belemnite Limestone Standard (v-PDB). Repeated measures of internal standards had a standard deviation of ± 0.2‰ for $\delta^{13}C$. The nitrogen isotopic signature of the animal host ($\delta^{15}Nh$), algal endosymbiont ($\delta^{15}Ne$), and whole coral ($\delta^{15}Nw$) are reported as the per mil deviation of the stable isotopes $^{15}N:^{14}N$ relative to air. Repeated measures of internal standard had a standard deviation of ± 0.2‰ for $\delta^{15}N$. At least 10% of all coral measurements were made in duplicate. The standard deviation of duplicate sample analyses was ± 0.14‰ for $\delta^{13}Ch$, ± 0.26‰ for $\delta^{13}Ce$, ± 0.12‰ for the $\delta^{13}Cw$, ± 0.07‰ for $\delta^{15}Nh$, ± 0.22‰ for $\delta^{15}Ne$, and ± 0.06‰ for the $\delta^{15}Nw$.

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Data Files

File
isotopes.csv (Comma Separated Values (.csv), 51.87 KB) MD5:f509c68cbdf6eee9799e0773999fedcc Primary data file for dataset ID 827587

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Related Publications

Price, J. T., McLachlan, R. H., Jury, C. P., Toonen, R. J., & Grottoli, A. G. (2021). Isotopic approaches to estimating the contribution of heterotrophic sources to Hawaiian corals. Limnology and Oceanography, 66(6), 2393–2407. Portico. https://doi.org/10.1002/lno.11760
Results

Price, J., Smith, A., Dobson, K., & Grottoli, A. (2020). Airbrushed Coral Sample Preparation for Organic Stable Carbon and Nitrogen Isotope Analyses v1 (protocols.io.bgi7juhn). Protocols.io. doi:10.17504/protocols.io.bgi7juhn
Methods

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Parameters

Parameter	Description	Units
Location	Location where samples were collected (State and Country)	unitless
Site	Name of site where samples were collected	unitless
Lat	Site latitude	degrees North
Long	Site longitude	degrees East
Collection_Date	Sample collection date; format: YYYY-MM-DD	unitless
Species	Name of coral species	unitless
Sample_ID	Sample identifier	unitless
d13Ch	The carbon isotopic signature of the animal host reported as the per mil deviation of the stable isotopes 13C:12C relative to Vienna Peedee Belemnite Limestone Standard (v-PDB)	per mil (‰)
d15Nh	The nitrogen isotopic signature of the animal host reported as the per mil deviation of the stable isotopes 15N:14N relative to air	per mil (‰)
d13Ce	The carbon isotopic signature of the algal endosymbiont reported as the per mil deviation of the stable isotopes 13C:12C relative to Vienna Peedee Belemnite Limestone Standard (v-PDB)	per mil (‰)
d15Ne	The nitrogen isotopic signature of the algal endosymbiont reported as the per mil deviation of the stable isotopes 15N:14N relative to air	per mil (‰)
d13Ch_e	The difference of d13Ch and d13Ce	per mil (‰)
d15Nh_e	The difference of d15Nh and d15Ne	per mil (‰)
d13Cw	The carbon isotopic signature of the whole coral reported as the per mil deviation of the stable isotopes 13C:12C relative to Vienna Peedee Belemnite Limestone Standard (v-PDB)	per mil (‰)
d15Nw	The nitrogen isotopic signature of the whole coral reported as the per mil deviation of the stable isotopes 15N:14N relative to air	per mil (‰)

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Instruments

Dataset-specific Instrument Name	PDZ Europa ANCA-GSL elemental analyzer
Generic Instrument Name	Elemental Analyzer
Dataset-specific Description	All samples were combusted using a PDZ Europa ANCA-GSL elemental analyzer interfaced to a PDZ Europa 20-20 isotope ratio mass spectrometer (Sercon Ltd., Cheshire, UK) at the University of California (UC) Davis Stable Isotope Facility
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	PDZ Europa 20-20 isotope ratio mass spectrometer
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	All samples were combusted using a PDZ Europa ANCA-GSL elemental analyzer interfaced to a PDZ Europa 20-20 isotope ratio mass spectrometer (Sercon Ltd., Cheshire, UK) at the University of California (UC) Davis Stable Isotope Facility.
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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Project Information

Phenotype and genotype of coral adaptation and acclimatization to global change (Coral Adaptation)

Coverage: Oahu, HI and Hawaii Institute of Marine Biology

Project Summary:
Overview: This study proposes to evaluate the adaptation and acclimatization capacity of eight species of Hawaiian corals to long-term exposure of elevated temperature and ocean acidification (OA) conditions using a two-part approach: 1) a survey of natural corals found across natural temperature and pCO2 gradients and 2) a two-year long mesocosm study which will expose corals collected in part 1 to a range of temperature and pCO2 conditions expected this century. In both approaches, the phenotypic (i.e., physiological and biogeochemical) responses of corals to future climate change will be measured in conjunction with the already funded genotypic (i.e., genomic and transcriptomic) responses of the same corals by Dr. Rob Toonen. This study will address variation at both the population and species level. It will also be the first study to examine the effects of elevated temperature and pCO2 on corals in replicated mesocosms over a multiannual timeframe with a comprehensive suite of physiological, biogeochemical, and genomic tools.

Intellectual Merit: Coral reefs are among the most diverse ecosystems on the planet, housing an estimated 25% of marine species. Yet, they appear to be especially susceptible to the effects of climate change and ocean acidification. To date, the assumption has been that corals will not be able to adapt because the rates of anthropogenically driven ocean acidification and climate change are too high. But there is little experimental

evidence to evaluate that assumption. Recent models highlight the critical importance of that assumption in determining coral extinction risk, and several recent studies (including a couple of recent ones from Grottoli's group) indicate that previous studies may have underestimated the potential for corals to acclimatize or adapt to global change. Here, quantitative, empirical estimates of the potential for long-term coral acclimatization and adaptation under global change scenarios will be made. The proposed study includes ~97% of the corals in the Hawaiian archipelago, yielding extensive spatial and biological relevance for the study. Lastly, this research brings together the expertise of Grottoli at OSU (coral physiologist and biogeochemist), Toonen at UH (marine molecular biologist), and McCulloch at UWA (geochemist) in a unique collaboration that blends a large suite of genetic, physiological, and biogeochemical tools to build an unprecedentedly comprehensive picture of coral adaptation and acclimation to global change. Thus, this work has the potential to transform our conceptual and empirical understanding of how corals respond to rapid environmental change.

Broader Impacts: Half of the species in the Hawaiian archipelago are endemic, making Hawaiian coral reefs a high priority for biodiversity conservation. Results from the proposed work will be used for adaptive management plans that collaborator Dr. Toonen is involved in with the goal of preserving Hawaiian coral biodiversity in a UNESCO World Heritage Site -- the Papahanaumokuakea Marine National Monument (PMNM). PMNM encompasses the northwestern Hawaiian Islands, is renowned as one of the most pristine and highly protected coral reefs remaining on the planet, is the single largest conservation area under the U.S. flag, and one of the largest marine conservation areas in the world. This project will provide a bridge between short-term, single-species studies and longer-term, multi-species responses to global change in reef community settings. Findings from this work will be communicated at scientific meetings, through peer-reviewed journal publications, and via press releases. Grottoli will also bring her research and enthusiasm for marine science into her classrooms and onto the podium when giving general audience and professional talks. She has an established track record of recruiting and promoting under-represented students and will continue to do so. This project will recruit 3 undergrads and 2 high school students for supported senior thesis/independent research and provide an environment that will foster their passion and skills necessary to pursue career options in STEM disciplines.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1459536

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