Coral energy reserve data from Puerto Morelos, Mexico including calcification, chlorophyll a, stable isotopes, and health metrics

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Data Type: Other Field Results
Version:
Version Date: 2016-10-28

Project
» Physiology and Biogeochemistry of Repeatedly Bleached and Recovering Caribbean Corals (repeat coral bleaching)

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Dataset Description

This dataset includes metrics related to coral energy reserves. Fragments of coral species (*Orbicella faveolata*, *Porites astreoides*, and *Porites divaricata*) were analyzed for concentrations of lipids, proteins, carbohydrates, and chlorophyll a. Carbon isotopic ratios d13C and d15N were measured in both the host and endosymbiont. Health metrics are included which describe bleaching status.

These data were published in:

Schoepf V, Grottoli AG, Levas SJ, Aschaffenburg MD, Baumann J, Matsui Y, Warner ME. (2015) Annual coral bleaching can impair the long-term recovery capacity of corals. Proceedings of the Royal Society B 282: 20151887. http://dx.doi.org/10.1098/rspb.2015.1887.

Methods & Sampling

Experimental Design (text extracted from Grottoli et al., 2014. See publication for figures and full methods description)

In July 2009, 10 coral fragments from nine healthy colonies of Porites divaricata (branching morphology), Porites astreoides (mounding/encrusting morphology), and Orbicella faveolata (formerly Montastraea faveolata (large, mounding morphology) were collected near Puerto Morelos, Mexico (20 deg 500 N, 86 deg 520 W region). Parent colonies were all at least 10m apart and thus assumed to be genotypically different. Fragments were mounted on labeled PVC tiles, and randomly placed in 10 shaded (600 umol photons m(-2) s(-1)) outdoor flow-through seawater tanks, allowed to acclimate for 5 days, and then buoyantly weighed. The temperature in five tanks was gradually raised to 31.5C +- 0.20C (single bleaching treatment) over 7 days then maintained at the elevated temperature, while the other five tanks received ambient reef water (controls; 30.6 C +- 0.24C) . After 15 days, one treatment and one control fragment from each parent colony of each

species were buoyantly weighed and then frozen at 80 C (0 weeks on the reef). The remaining fragments were transplanted back to the reef at 4.9 m depth (20 deg 52.8150 N, 86 deg 50.9890 W). After 6 weeks on the reef, one additional treatment and control fragment from each colony of each species were collected, buoyantly weighed, and frozen at 80C, while the remaining fragments stayed on the reef for a full year at ambient reef temperatures.

Chlorophyll a was determined according to Jeffrey & Humphrey (1975) and standardized to surface area (Marsh 1970). Chlorophyll a values at 0 and 1.5 months on the reef following repeat bleaching are from Schoepf et al. (2011).

Total soluble lipids, animal soluble protein and animal soluble carbohydrate were determined on ground, frozen coral fragments using established methods (Rodrigues & Grottoli 2007; Schoepf et al 2013) and then converted to Joules per gram ash-free dry weight (Gnaiger & Bitterlich 1984)).

Net calcification was determined using the buoyant weight technique (Jokiel et al 1978) and standardized to surface area. Calcification rates at 0 and 1.5 months on the reef following repeat bleaching are from Grottoli et al. (2014).

Tissue C and N isotopic analyses were performed on separated animal host and endosymbiont fractions using established methods (Rodrigues & Grottoli 2006; Hughes et al 2010). The difference between d13Ch and d13Ce (i.e. d13Ch2e) was calculated to determine the relative contribution of photoautotrophic versus heterotrophic carbon to the coral (Rodrigues & Grottoli 2006; Muscatine et al 1989). Repeated measurements of commercial standards (USGS-24, IAEA-N2) had a standard deviation of +- 0.04(permille) for d13C (n = 55) and +-0.11(permille) for d15N (n = 51).

References:

Gnaiger, E., and G. Bitterlich. "Proximate biochemical composition and caloric content calculated from elemental CHN analysis: a stoichiometric concept." *Oecologia* 62.3 (1984): 289-298. http://dx.doi.org/10.1007/BF00384259

Grottoli, Andréa G., et al. "The cumulative impact of annual coral bleaching can turn some coral species winners into losers." *Global change biology* 20.12 (2014): 3823-3833. http://dx.doi.org/10.1111/gcb.12658

Hughes, A. D., et al. "Acquisition and assimilation of carbon in non-bleached and bleached corals." *Marine ecology progress series* 420 (2010): 91-101. http://dx.doi.org/10.3354/meps08866

Jeffrey, SW T., and G. F. Humphrey. "New spectrophotometric equations for determining chlorophylls a, b, c1 and c2 in higher plants, algae and natural phytoplankton." *Biochem Physiol Pflanz BPP* (1975).

Jokiel, P. L., J. E. Maragos, and L. Franzisket. "Coral growth: buoyant weight technique." *Coral reefs: research methods. UNESCO, Paris* (1978): 529-541.

Marsh, James A. "Primary Productivity of Reef-Building Calcareous Red Algae." Ecology 51.2 (1970): 255-263. http://dx.doi.org/10.2307/1933661

Muscatine, L., L. R. McCloskey, and R. E. Marian. "Estimating the daily contribution of carbon from zooxanthellae to coral animal respiration." *Oceanography* 26.4 (1981). http://dx.doi.org/10.4319/lo.1981.26.4.0601

Rodrigues, Lisa J., and Andréa G. Grottoli. "Calcification rate and the stable carbon, oxygen, and nitrogen isotopes in the skeleton, host tissue, and zooxanthellae of bleached and recovering Hawaiian corals." *Geochimica et Cosmochimica Acta* 70.11 (2006): 2781-2789. http://dx.doi.org/10.1016/j.gca.2006.02.014

Rodrigues, Lisa J., and Andréa G. Grottoli. "Energy reserves and metabolism as indicators of coral recovery from bleaching." *Limnology and oceanography*52.5 (2007): 1874-1882. http://doi:10.4319/lo.2007.52.5.1874

Schoepf, Verena, et al. "Short-term coral bleaching is not recorded by skeletal boron isotopes." PloS one 9.11 (2014): e112011. http://dx.doi.org/10.1371/journal.pone.0112011

Schoepf, V., et al. others (2013) "Coral energy reserves and calcification in a high-CO2 world at two temperatures." *PLoS ONE* 8: e75049. http://dx.doi.org/75010.71371/journal.pone.0075049

Data Processing Description

Details of the statistical analysis methods are in Schoepf et al 2015.

BCO-DMO Processing Notes:

- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- replaced blanks with underscores
- added lat and lon of sampling locations based on coordinates in Grottoli et al. 2014.

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Data Files

File
coral_energy.csv (Comma Separated Values (.csv), 26.08 KB) MD5:37cc02b978291d975f4dfd8b837a0698 Primary data file for dataset ID 663524

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Parameters

Parameter	Description	Units
coral_species	Scientific Name of coral	unitless
site_lat	Latitude of sample site	decimal degrees
site_lon	Longitude of sample site; west is negative	decimal degrees
coral_id	Coral identifier	unitless
treatment	Treatment (control=non-bleached; treatment=repeat bleached)	unitless
months_until_rep	Months on the reef following repeat bleaching	unitless
genotype	Parent colony genotype (each species has genotypes 1-9)	unitless
chl_a	Chlorophyll a content of the endosymbiont fraction standardized to surface area of the coral fragment	micrograms per centimeter squared (ug/cm2)
lipid_J_gdw	Lipid concentration of the coral fragment	Joules per g ash-free dry weight (J/gdw)

protein_J_gdw	Protein concentration of the coral fragment	Joules per g ash-free dry weight (J/gdw)
carbohdrate_J_gdw	Carbohydrate concentration of the coral fragment	Joules per g ash-free dry weight (J/gdw)
calcification	The daily calcification rate measured using the buoyant weight	milligrams per day per centimeter squared (mg/day/cm2)
d13C_h	Carbon isotopic ration (13C:12C) of the animal host "h" tissue	per mil (o/oo)
d13C_e	Carbon isotopic ratio (13C:12C) of the endosymbiont "e" tissue	per mil (o/oo)
d13C_h_e	Difference between the carbon isotopic composition of the animal host and that of the endosymbiont	per mil (o/oo)
d15N_h	Nitrogen isotopic composition of the animal host tissue	per mil (o/oo)
d15N_e	Nitrogen isotopic composition of the animal endosymbiont tissue	per mil (o/oo)
lipid_g_gdw	Lipid concentration of the coral fragment	grams per g ash-free dry weight (g/gdw)
protein_g_gdw	Protein concentration of the coral fragment	grams per g ash-free dry weight (g/gdw)
carbohydrate_g_gdw	Carbohydrate concentration of the coral fragment	grams per g ash-free dry weight (g/gdw)
health_0_months	Health status at 0 months (1=non-bleached; 2=partially bleached; 3=bleached; 4=partially dead non-bleached; 5=partially dead bleached; 6=dead)	unitless
health_1_5_months	Health status at 1.5 months (1=non-bleached; 2=partially bleached; 3=bleached; 4=partially dead non-bleached; 5=partially dead bleached; 6=dead)	unitless
health_11_months	Health status at 11 months (1=non-bleached; 2=partially bleached; 3=bleached; 4=partially dead non-bleached; 5=partially dead bleached; 6=dead)	unitless

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Instruments

Dataset-specific Instrument Name	Thermo-Finnigan Delta IV stable isotope mass spectrometer
Generic Instrument Name	Mass Spectrometer
Dataset-specific Description	Costech Elemental Analyzer coupled to a Thermo-Finnigan Delta IV stable isotope mass spectrometer the Grottoli laboratory at Ohio State University.
Generic Instrument Description	General term for instruments used to measure the mass-to-charge ratio of ions; generally used to find the composition of a sample by generating a mass spectrum representing the masses of sample components.

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Deployments

PM_2009_Grottoli

Website	https://www.bco-dmo.org/deployment/663616
Platform	Puerto_Morelos_Reef
Start Date	2009-07-04
End Date	2009-07-09
Description	Sampling sites El Islote, Radio Pirata, The Wall, and Jardines.

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Project Information

Physiology and Biogeochemistry of Repeatedly Bleached and Recovering Caribbean Corals (repeat coral bleaching)

Coverage: Puerto Morelos, Mexico

(Extracted from the NSF award abstract)

The overall stability and health of coral reefs is declining world-wide at an unprecedented rate. Mass coral bleaching, wherein exposure to elevated temperature leads to the loss of significant numbers of endosymbiotic dinoflagellates (Symbiodinium spp., commonly called zooxanthellae) and/or photosynthetic pigments, serves as a primary global example of how fragile this symbiosis is. While we have begun to understand the ecological and physiological impacts of bleaching, there remain key fundamental gaps in knowledge. In particular, it is becoming increasingly clear that a) not all corals either respond to, or recover from, bleaching events the same way, and that b) the impact of annual or repeated bleaching events on corals has not been examined in sufficient detail. Several non-mutually exclusive ecological and physiological pathways could impact how a particular coral species succumbs to or recovers from bleaching. Recent evidence suggests that the following features may play key roles for coral survival in the face of future seawater warming and mass bleaching events: 1) shifts in trophic partitioning (e.g., proportional reliance on autotrophy and heterotrophy) and energy reserve utilization, 2) enhanced thermal tolerance through host and algal-mediated physiological responses, and 3) harboring of different Symbiodinium phylotypes. However, these mechanisms have yet to be investigated in a unified approach that covers the entire coral holobiont system (algae, host tissue, and skeleton), or under scenarios of repeated bleaching.

The overall objectives of this study are as follows: 1) to determine the effect of single and repeated bleaching

on the physiology, biogeochemistry, and recovery of some Caribbean coral species, and 2) to determine which Symbiodinium-type and host-species combinations are more resilient to single and repeated bleaching, what aspects of their physiology and biogeochemistry render them resilient, and to use this information to evaluate the long-term persistence of Caribbean coral reefs. To address these objectives, the following physiological variables will be measured: 1) Symbiodinium type, photochemical function and algal stress physiology, and 2) animal host energy reserves, defense enzyme concentration, skeletal growth, and feeding capacity in the corals Porites porites, Porites astreoides, and Montastraea faveolata. Corals will be examined immediately following thermal stress designed to approximate natural bleaching, and recovery will be monitored over short and long-term time scales. Next, the impact of repeated bleaching will be examined in the subsequent year, followed by examination over the next recovery period. This research is designed to simultaneously evaluate the symbiotic algae, coral host, and skeleton, and to identify patterns of physiological responses and recovery of each Symbiodinium-type and host-species combination that would be indicative of the resilience capacity of Caribbean corals to future more frequent thermal perturbations.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0825413

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