Coral physiology, algal density and type collected from the Reef Field Sites from the Puerto Morelos, Mexico & Kaneohe Bay, Hawaii in 2009 (repeat coral bleaching project)

Website: https://www.bco-dmo.org/dataset/516969
Version: 2015-02-13

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

Contributors	Affiliation	Role
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Dataset Description

Coral metabolism, energy reserves, calcification, algal density and type.

Methods & Sampling

Full details of the experimental design are in:
Grottoli AG, Warner ME, Levas SJ, Aschaffenburg MD, Schopef B, McGinley M, Baumann J, Matsui Y. 2014. Cumulative impact of annual coral bleaching can turn some coral species winners into losers. *Global Change Biology*. doi:10.1111/gcb.12658

A brief description of the analytical methods follows.

Calcification, endosymbiotic algae concentration, total energy reserves, and Symbiodinium identification. Calcification rates were calculated from the buoyant weight data (Jokiel *et al.*, 1978) and standardized to surface area. Endosymbiont cell concentration (Warner *et al.*, 2006), and total soluble lipid, soluble animal protein, and soluble animal carbohydrates (Levas *et al.*, 2013, Rodrigues & Grottoli, 2007) were measured on all frozen fragments. Total energy reserves were calculated as the sum of total lipids, protein, and carbohydrates and reported in Joules (Gnaiger & Bitterlich, 1984) per gram ash free dry weight of coral tissue. Since polyp structure and the coral tissue thickness of each species are different, this normalization facilitates inter-species comparisons (Edmunds & Gates, 2002). Genetic characterizations of *Symbiodinium* were determined by amplification of the internal-transcribed spacer 2 region (ITS2), followed by denaturing gradient gel electrophoresis and cycle-sequencing (Warner *et al.*, 2006). This method reliably identifies the dominant symbiont type in healthy and bleached corals (LaJeunesse *et al.*, 2004, LaJeunesse *et al.*, 2009, Warner *et al.*, 2006) and provides qualitative identification of other background *Symbiodinium*, either within different clades (e.g., endosymbionts A3 vs B1) or at the intra-cladal scale (e.g., endosymbionts A3 and A13) within the same coral fragment. The dominant ITS2-types (intra-cladal designations) are listed for each coral species in the text, while for statistical analyses (described below), the dominant symbiont for each coral fragment treatment-1 was grouped by clade. Specific quantitative PCR for all clades confirmed the accuracy of scoring dominant bands by DGGE analysis (data not shown, McGinley, 2012).

***Photosynthesis, respiration, and feeding*.** Maximal photosynthesis and respiration rates were measured via changes in dissolved oxygen on each individual coral fragment immediately following their respective thermal stress then standardized to ash free dry weight (Rodrigues & Grottoli, 2007). All fragments were placed back on the reef and then feeding rates of each coral fragment were determined using methods in Palardy et al. (2008). Photosynthesis and respiration were used to calculate the percent Contribution of Zooxanthellae (*Symbiodinium* spp.) to Animal Respiration (CZAR) (Muscatine *et al.*, 1981), while respiration and feeding rates were used to calculate the percent Contribution of Heterotrophy to Animal Respiration CHAR (Grottoli *et al.*, 2006, Palardy *et al.*, 2008). The Contribution of the Total acquired fixed carbon relative to Animal Respiration (CTAR) was calculated as the sum of CZAR and CHAR.

Data Processing Description

Three statistical outliers were removed in order to meet assumptions of normality and homogeneity prior to ANOVA analyses. These data are flagged in the excel file and the removed value is included as a comment. Details of the statistical analysis methods are in Grottoli *et al.* (in press).

BCO-DMO Data Processing:
- Added BCO-DMO header info to include brf dscrptn, PI and version
- Edited parameter headers to comply with BCO-DMO convention:

- Total EnRes --> energy_rsrv_total
- 'number endosymbiont cells/cm2' --> count_endosymbiont
- 1o Symbiodinium type --> symbiodinium_primary_type
- 2o Symbiodinium type --> symbiodinium_secondary_type
- 3o Symbiodinium type --> symbiodinium_tertiary_type
- year --> treatment_year
- time --> treatment_recovery_time

- Species was decoded and genus species names were included in data, replacing codes of 1,2,3
- Replaced all "." with "nd"
- Added lat/lon of the collection site of coral fragments (Puerto Morelos 20.8333, 86.8666)
- All precisions were edited to two decimals after consultation with PI.
- Corrected longitude values to negative degrees. (were positive); 13 Feb 2015.

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Data Files

File
coral_physiology.csv (Comma Separated Values (.csv), 19.18 KB) MD5:63d59956d5cc98f1e6d2aa1c84e888d1 Primary data file for dataset ID 516969

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Parameters

Parameter	Description	Units
lat	Latitude component of geographic position where experiments were conducted.	decimal degrees
lon	Longitude component of geographic position where experiments were conducted.	decimal degrees
species	Coral species sampled for use in experiment.	dimensionless
treatment_year	Consecutive bleaching treatments applied to coral samples, where 1 = single bleaching treatment or control conditions in the tanks for 15 days followed by up to a year on the reef, and 2 = repeat bleaching treatment and control conditions for 17 days in the tanks followed by up to a year on the reef. .	dimensionless
status	Status represents treatment conditions applied to coral samples during experiment, where 1=control and 2=treatment conditions.	dimensionless
treatment_recovery_time	Number of years of applied treatment conditions and observation of recovery time on the reef, where: 0 = Year 1, 0 month on the reef 1.5 = Year 1, 6 weeks on the reef 13 = Year 2, 0 months on the reef 14.5 = Year 2, 6 weeks on the reef	dimensionless
genotype	Genotype number represents each parent colony in the study from which all sample fragments were collected, where numbers 1-9 = each parent colony per species used in the experiment.	dimensionless
CZAR	Contribution of Zooxanthellae (Symbiodinium spp.) to Animal Respiration sensu Muscatine et al., (1981).	percent
CHAR	Contribution of Heterotrophy to Animal Respiration sensu Grottoli et al., (2006) and Palardy et al., (2008).	percent
CTAR	Contribution of the Total acquired fixed carbon relative to Animal Respiration (CZAR + CHAR).	percent
energy_rsrv_total	The total coral soluble lipids + animal soluble protein + animal soluble carbohydrates.	joules per gram dry weight
calcification	Calification rate.	milligrams per cm^2 per day
count_endosymbiont	Number of endosymbiont cells unit area.	cells per cm^2
symbiodinium_primary_type	Dominant endosymbiont type.	dimensionless
symbiodinium_secondary_type	Secondary endosymbiont type.	dimensionless
symbiodinium_tertiary_type	Tertiary endosymbiont type.	dimensionless

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Deployments

Coral_physiology_field_exper

Website	https://www.bco-dmo.org/deployment/517699
Platform	Reef Field Sites

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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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