Growth and chlorophyll density of individual fragments of the coral Porites divaricata measured during a reciprocal transplant experiment conducted at three sites in Turneffe Atoll, Belize from February to July 2022

Website: https://www.bco-dmo.org/dataset/927890
Data Type: Other Field Results
Version: 1
Version Date: 2024-05-20

Project
» OCE-PRF: Drivers of phenotypic diversity and adaptation in asexually propagating coral populations (Adaptation in asexual coral populations)

Contributors	Affiliation	Role
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Abstract
We sought to investigate the role of genetic, intra-clonal, and environmental variation in driving variation in fitness-related traits in the Caribbean thin finger coral, Porites divaricata (Taxonomy ID: 262287). We conducted a reciprocal transplant experiment whereby fragments from individual coral colonies of known genetic background were transplanted to three sites from February to July 2022. These sites included two mangrove sites and one reef site at Calabash Caye, Turneffe Atoll, Belize. Prior to and post-transplanting, fragments were measured to determine growth rate over this time. Coral fragments were also photographed to determine red channel intensity, which serves as a proxy for chlorophyll density. This dataset contains the measures of these two coral traits (coral fragment growth and chlorophyll density (red channel intensity)) for each coral individual and also contains metadata about the genotype, origin site, transplanted site, rope at transplanted site, and age. A related dataset contains environmental information about each transplanted site over this time period, based on loggers that recorded temperature and light levels. Data were collected by scientists at the University of Texas at Austin and the University of Belize.

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Coverage

Location: Turneffe Atoll, Belize
Spatial Extent: **N**:17.288681 **E**:-87.81111 **S**:17.28717 **W**:-87.815167
Temporal Extent: 2022-02 - 2022-07

Methods & Sampling

Reciprocal transplant experiment:
In February 2022, 32 colonies (subclone/ramet) of the Caribbean thin finger coral, *Porites divaricata*

(Taxonomy ID: 262287) were identified. 3 to 9 branch fragments were collected from every subclone (colony/ramet). 1 to 3 fragments from each ramet were moved to three designated sites: M1 (mangrove site 1), M2 (mangrove site 2), and R (reef site). 7 to 9 adjacent ropes were deployed at each site (seven ropes at M1 and R, and nine ropes at M2). Following a six-month period (February 2022 - July 2022), two traits were measured for each fragment: length change and red channel intensity, which serves as an inverse indicator of chlorophyll pigment density (Winters, Holzman, Blekhman, Beer, & Loya, 2009).

Trait Measurements:
To measure fragment growth, all fragments were photographed against a scale before and after transplantation, and their lengths were measured from base to apex using ImageJ software. The change in fragment length was determined by dividing the difference between the final and initial lengths by the initial length of the fragment. To measure red channel intensity, all fragments were collected at the end of the experiment and photographed against a laminated DKK color standard (DGK Color Tools) featuring an eleven-step gray scale with true white. Employing the methodology outlined by Winters et al. (2009), these photographs were used to estimate the chlorophyll density of each fragment. Initially, all images were standardized using the gray scale and the MATLAB macro CalibrateImageA. Subsequently, the MATLAB macro AnalyzeIntensity was employed to compute the mean red channel intensity for 20 swatches measuring 25 × 25 pixels for each fragment. Higher values of red channel intensity indicate lower levels of algal photosynthetic pigments (and hence, lower chlorophyll density) (Winters et al., 2009). The MATLAB scripts CalibrateImageA and AnalyzeIntensity are provided in the supplementary files in Winters et al., 2009.

See 'Related Datasets' for the environmental data from the coral transplant sites.

BCO-DMO Processing Description

- Imported original files "GPSCoords_Data.xlsx" (site locations) and "TraitVariation_Data.xlsx" (trait variation data) into the BCO-DMO system.
- Added Latitude and Longitude columns from the site locations list to the trait dataset by matching on Subclone_ID number.
- Moved the comment "could not get value from photo" which was in the R_fin column to a Comment column
- Saved the final file as "927890_v1_coral_trait_variation.csv".

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Data Files

File	
927890_v1_coral_trait_variation.csv	(Comma Separated Values (.csv), 20.30 KB) MD5:fe52a3e09aa6c90a2b3c084129a87a09
Primary data file for dataset ID 927890, version 1	

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Related Publications

Schneider, C. A., Rasband, W. S., ... (n.d.). ImageJ. US National Institutes of Health, Bethesda, MD, USA. Available from https://imagej.nih.gov/ij/
Software

Winters, G., Holzman, R., Blekhman, A., Beer, S., & Loya, Y. (2009). Photographic assessment of coral chlorophyll contents: Implications for ecophysiological studies and coral monitoring. Journal of Experimental Marine Biology and Ecology, 380(1–2), 25–35. https://doi.org/10.1016/j.jembe.2009.09.004
Methods

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Related Datasets

IsRelatedTo

Scavo Lord, K. (2024) **Temperature and light intensity measured at each transplant site during a reciprocal transplant experiment conducted at three sites in Turneffe Atoll, Belize from February to July 2022.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-05-28 doi:10.26008/1912/bco-dmo.927918.1 [view at BCO-DMO]

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Parameters

Parameter	Description	Units
sample	Tag number of transplant	unitless
origin	Site from which sample was collected (originated): M2 = mangrove site 2, M1= mangrove site 1	unitless
clone	Color indicating which genotype the sample belongs to, each color represents a different genotype	unitless
subclone	Character string representing which coral colony (or subclone) each sample belongs to	unitless
sublcone_longitude	Longitude of where coral colony (subclone) was collected; negative values = West	decimal degrees
subclone_latitude	Latitude of where coral colony (subclone) was collected; positive values = North	decimal degrees
trans_site	Site where each sample was transplanted to : M2 = mangrove site 2, M1= mangrove site 1, R = reef	unitless
rope	Rope number that each sample was strung on at the transplanted site	unitless
loc_grtn	Character string indicating whether the colony was transplanted to its home or away site and whether it is an early generation subclone (old) or young generation (young) subclone	unitless
age2	Age of the coral subclone/colony in years	years
grtn	Indicates whether subclone/colony is early generation (old) or late generation (young)	unitless

loc	Indicates whether the sample was transplanted to its home site or away site	unitless
len_in	Initial length of fragment at time of transplanting (start of transplant experiment)	centimeters (cm)
len_fin	Final length of fragment at the end of the transplant experiment. NA indicates that sample did not survive to the end of the fragmentation experiment to be measured.	centimeters (cm)
len_chg	Change of length of fragment over the duration of the transplant experiment. NA indicates that sample did not survive to the end of the fragmentation experiment to be measured.	centimeters (cm)
len_ct	Change of length of fragment over the duration of the transplant experiment divided by the initial length of fragment. NA indicates that sample did not survive to the end of the fragmentation experiment to be measured.	centimeters (cm)
R_fin	Red channel intensity value of sample; measured as intensity of red color in image, 0-255	unitless
Comment	Notes or comments	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Camera
Generic Instrument Description	All types of photographic equipment including stills, video, film and digital systems.

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Project Information

OCE-PRF: Drivers of phenotypic diversity and adaptation in asexually propagating coral populations (Adaptation in asexual coral populations)

Coverage: Caribbean

NSF Award Abstract:
This award is funded in whole or in part under the American Rescue Plan Act of 2021 (Public Law 117-2).

In this era of rapid environmental change and degradation, the survival of marine organisms will depend largely upon their ability to tolerate increasing environmental stress. However, the processes that drive resilience (e.g.,

the relative contribution of genetic versus environmental factors) remain largely a mystery. Corals are a major focus of current studies on organismal resilience because they are undergoing a worldwide decline, and they are so important for both the health of the oceans and the welfare of coastal communities. Corals often occupy and build habitats through asexual reproduction (production of clones), and it is widely assumed that such asexual populations may lack sufficient genetic diversity to respond to diverse environmental stressors. However, few previous studies have quantified the effects of asexual reproduction on the ability of corals to respond to environmental change. This research explores the different mechanisms that contribute to differences in coral stress response among two predominately clonal populations of the Caribbean thin finger coral (*Porites divaricata*) dwelling in distinct habitat types (mangroves vs. reef). This research will illuminate the drivers of organismal resilience, potentially impacting ongoing coral conservation and restoration efforts. It will also broaden the participation of underrepresented groups by encouraging active participation by local community members, students and scientists at the University of Belize, as well as providing unique training opportunities for next-generation scientists at the interface of field marine ecology and genomics. Importantly, these results will be communicated to a wide audience through diverse venues, including technical reports and management recommendations provided for government agencies and non-profit Belizean conservation organizations, popular articles and curricular materials for the community at large, and peer-reviewed manuscripts and presentations targeted to the scientific community.

Among conservation biologists and ecologists, there is an urgent effort underway to understand the causes of diversity in traits impacting organismal survival and reproduction. If we are to understand how natural populations will respond to environmental change, it is critical to understand how genetic, epigenetic, and environmental factors impact resilience. Such studies have advanced significantly in many plant species, but they are only just beginning to be applied to animals like corals. As in many plants, the model species used here - Caribbean thin finger coral (*Porites divaricata*) - reproduces primarily asexually, allowing us to compare the performance of clones in different environments and isolate the effects of genotype, epigenetics (namely DNA methylation), environment, and somatic mutations on variation in stress-related coral traits. Specially, combining fully-crossed reciprocally transplanted coral ramets across mangrove and reef sites with genomic and methylation sequencing data, this research will evaluate 1) the role of intra-genet variation accumulated during asexual reproduction in facilitating adaptation in the mangrove population, relative to roles of between-genet variation and phenotypic plasticity, 2) assess the role of new DNA methylation states, and 3) measure the rate of accumulation of new DNA methylation marks and base-changes during asexual reproduction. Results from this research effort will advance our understanding of the role of mechanisms like DNA methylation and somatic mutations in driving phenotypic variation in critical stress-response traits and how these mutations accumulate over time, provide insight into how such mechanisms are generated and inherited across asexual generations, build upon the sparse understanding of the role of novel habitat types, i.e. mangroves, in coral ecology and evolution; and generate novel molecular resources including the first reference genome assembly for the non-model coral, *P. divaricata*.

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-2126612

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