Coral stereolithography files and sampling information for Acropora palmata, A. cervicornis, and A. prolifera from St. Thomas U.S. Virgin Islands and Belize, 2015

Website: https://www.bco-dmo.org/dataset/752642
Data Type: Other Field Results
Version: 1
Version Date: 2019-01-09

Project
» Collaborative research: Is hybridization among threatened Caribbean coral species the key to their survival or the harbinger of their extinction? (Coral Hybridization)

Contributors	Affiliation	Role
Fogarty, Nicole	Nova Southeastern University	Principal Investigator
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Abstract
Coral specimens collected in the St. Thomas, U.S. Virgin Islands and Belize were 3-dimensionally scanned. This dataset includes metadata on the coral samples such as the collection location and conditions, and the dimensions of the samples. The STL files are available for download in the Supplemental Documentation section below.

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Coverage

Spatial Extent: **N**:18.404256 **E**:-64.902765 **S**:16.917861 **W**:-87.768908
Temporal Extent: 2015-10-27 - 2015-11-09

Dataset Description

Coral specimens collected in the St. Thomas, U.S. Virgin Islands and Belize were 3-dimensionally scanned. This dataset includes metadata on the coral samples such as the collection location and conditions, and the dimensions of the samples. The STL files are available for download in the Supplemental Documentation section below.

Methods & Sampling

Caribbean acroporids (Acropora palmata, A. cervicornis, and A. prolifera) corals were photographed, measured, and collected and transported in coolers of seawater to the laboratory for 3D scans. Corals were kept in a seawater system or under the laboratory dock until scanning commenced. Corals were first photographed, then landmarks (i.e., small balls of modeling clay) were added to the corals to assist with alignments during post-scan analyses, and the coral was scanned.

3D scans of corals were edited in Scan Studio software. Any unnecessary part of the scan was trimmed off, such as the stand that corals were propped on. Multiple scans were aligned using strategically placed markers that were placed on the corals prior to scanning. After aligning the scans, markers were trimmed off, and the image was fused in order to fill any existing holes.

Once .stl files were exported from the scanner software, files were uploaded to Autodesk Meshmixer (Ver. 3.4.35). While in the Meshmixer software, most files had the mesh repaired and filled in using the “make solid” tool in the “edit” tab. In the “Make Solid tool “Sharp Edge Preserve” is to be selected for the “Solid Type” while “Solid Accuracy” is set to 500, and “Mesh Density” is set to 420, all other settings remained the standard. However, prior to making it solid the “Sculpt” tool was used for the dense branched A. prolifera. The “Inflate” brush was used at various strength and sizes to build in sections of branches what were not completely formed during scanning.

Data Processing Description

BCO-DMO Processing Notes:
- added conventional header with dataset name, PI name, version date
- modified parameter names to conform with BCO-DMO naming conventions
- changed format of longitude from degrees-decimal minutes to decimal degrees
- re-formatted date from m/d/yyyy to yyyy-mm-dd
- added column for scan filename

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Data Files

File
3D_scans.csv (Comma Separated Values (.csv), 613 bytes) MD5:1fa0155f5873523429c3c0e5143eb5f8 Primary data file for dataset ID 752642

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Supplemental Files

File
Acropora cervicornis 3D scanner file (.STL) filename: C320_print.stl (Stereolithography File (.stl), 25.46 MB) MD5:cb4eba737b935b44ac8bb6b9faefa53d 3D scanner file of Acropora cervicornis
Acropora palmata 3D scanner file (.STL) filename: P505_print.stl (Stereolithography File (.stl), 43.84 MB) MD5:cc9409eed240460d76a54b1b94a290cd 3D scanner file of Acropora palmata
Acropora prolifera 3D scanner file (.STL) filename: H555_print.stl (Stereolithography File (.stl), 26.14 MB) MD5:4e0f2b5eb39ae1f2e024d4043c1467d3 3D scanner file of A. prolifera

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Parameters

Parameter	Description	Units
Species	taxonomic species name	unitless
Coral_ID	unique identifier given in field	unitless
Genetics_ID	genetic identification identifier	unitless
Location	region where coral was collected	unitless
Site	local site name	unitless
latitude	gps coordinates	decimal degrees
longitude	gps coordinates	decimal degrees
Scan_Date	Date the 3D scan was conducted	unitless
Collection_Depth_ft	depth in ft the coral was collected	feet
Current_Direction_from	direction the prevailing current was coming from	unitless
Wave_Energy	a relative description of wave energy at collection site (low/moderate/high)	unitless
Benthic_Type	brief description of substrate where colony was collected	unitless
Length_cm	size of collected colony	centimeters
Width_cm	size of collected colony	centimeters
Height_cm	size of collected colony	centimeters
Volume	length x width x height	centimeters^3
scan_filename	name of coral 3D scan CAD file	unitless

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Instruments

Dataset-specific Instrument Name	Next Engine Ultra HD 3D Scanner
Generic Instrument Name	3D scanner
Generic Instrument Description	A 3D scan captures digital information about the shape of an object with equipment that uses a laser or light to measure the distance between the scanner and the object.

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Project Information

Collaborative research: Is hybridization among threatened Caribbean coral species the key to their survival or the harbinger of their extinction? (Coral Hybridization)

Coverage: Caribbean and North-West Atlantic

NSF Award Abstract:
Reef-building acroporid corals form the foundation of shallow tropical coral communities throughout the Caribbean. Yet, the once dominant staghorn coral (Acropora cervicornis) and the elkhorn coral (A. palmata) have decreased by more than 90% since the 1980s, primarily from disease. Their continuing decline jeopardizes the ability of coral reefs to provide numerous societal and ecological benefits, including economic revenue from seafood harvesting and tourism and shoreline protection from extreme wave events caused by storms and hurricanes. Despite their protection under the U.S. Endangered Species Act since 2006, threats to the survival of reef-building acroporid corals remain pervasive and include disease and warming ocean temperatures that may lead to further large-scale mortality. However, hybridization among these closely related species is increasing and may provide an avenue for adaptation to a changing environment. While hybrids were rare in the past, they are now thriving in shallow habitats with extreme temperatures and irradiance and are expanding into the parental species habitats. Additional evidence suggests that the hybrid is more disease resistant than at least one of the parental species. Hybridization may therefore have the potential to rescue the threatened parental species from extinction through the transfer of adapted genes via hybrids mating with both parental species, but extensive gene flow may alter the evolutionary trajectory of the parental species and drive one or both to extinction. This collaborative project is to collect genetic and ecological data in order to understand the mechanisms underlying increasing hybrid abundance. The knowledge gained from this research will help facilitate more strategic management of coral populations under current and emerging threats to their survival. This project includes integrated research and educational opportunities for high school, undergraduate and graduate students, and a postdoctoral researcher. Students in the United States Virgin Islands will take part in coral spawning research and resource managers will receive training on acroporid reproduction to apply to coral restoration techniques.

Current models predict the demise of reefs in the next 200 years due to increasing sea surface temperatures and ocean acidification. It is thus essential to identify habitats, taxa and evolutionary mechanisms that will allow some coral species to maintain their role as foundation fauna. Hybridization can provide an avenue for adaptation to changing conditions. Corals hybridize with some frequency and results may range from the introduction of a few alleles into existing parent species via introgression, to the birth of a new, perhaps better adapted genetic lineage. The only widely accepted coral hybrid system consists of the once dominant but now threatened Caribbean species, Acropora cervicornis and A. palmata. In the past, hybrid colonies originating from natural crosses between elkhorn and staghorn corals were rare, and evidence of hybrid reproduction was limited to infrequent matings with the staghorn coral. Recent field observations suggest that the hybrid is increasing and its ecological role is changing throughout the Caribbean. These hybrids appear to be less affected by the disease that led to the mass mortality of their parental species in recent decades. Hybrids are also found thriving in shallow habitats with high temperatures and irradiance suggesting they may be less susceptible to future warming scenarios. At the same time, they are expanding into the deeper parental species habitats. Preliminary genetic data indicate that hybrids are now mating with each other, demonstrating the potential for the formation of a new species. Further, hybrids appear to be capable of mating with both staghorn and elkhorn coral, perhaps leading to gene flow between the parent species via the hybrid. Research is proposed to address how the increase in hybridization and perhaps subsequent introgression will affect the current ecological role and the future evolutionary trajectory of Caribbean acroporids. Specifically, this collaborative project aims to answer the following questions: 1) What is the historic rate, direction, and degree of introgression across species ranges and genomes? Linkage block analysis based on genome-wide SNP genotyping across three replicate hybrid zones will answer this question. 2) What is the current extent and future potential of later generation hybrid formation? Morphometric and genetic analyses combined with in vitro fertilization assays will be used. 3) What mechanisms allow hybrids to thrive in hot, shallow waters? A series of manipulative in situ and ex situ experiments will determine whether biotic or abiotic factors favor hybrid survival in shallow waters. 4) Are hybrids more disease resistant than the parentals species? Disease transmission assays in reciprocal transplant experiments and histological analysis to determine the extent of disease will be conducted. A multidisciplinary approach will be taken that combines traditional and cutting edge technology to provide a detailed analysis of the evolutionary ecology of Caribbean corals.

Note: PI Nicole Fogarty's original award OCE-1538469 was issued while at Nova Southeastern University. This was replaced by OCE-1929979 upon moving to the University of North Carolina Wilmington.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1538469

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