Coral tissue mortality as a function of the presence or absence of sea cucumbers and coral outplant type in cage experiments in lagoonal habitat of Mo'orea, French Polynesia in April and May of 2020

Website: https://www.bco-dmo.org/dataset/920209
Data Type: experimental, Other Field Results
Version: 1
Version Date: 2024-02-12

Project
» Positive Effects of Coral Biodiversity on Coral Performance: Patterns, Processes, and Dynamics (Coral Biodiversity)

Contributors	Affiliation	Role
Clements, Cody	Georgia Institute of Technology (GA Tech)	Principal Investigator, Contact
Newman, Sawyer	Woods Hole Oceanographic Institution (WHOI BCO-DMO)	BCO-DMO Data Manager

Abstract
Coral reefs are in global decline with coral diseases playing a significant role. Coral diseases are commonly sediment-associated and could be exacerbated by overharvest of sediment-feeding sea cucumbers. These data include visual assessments of coral (Acropora pulchra) tissue mortality among corals outplanted in 50 x 50 cm cages in sandy lagoonal areas of Mo'orea, French Polynesia (17.4894° S, 149.8825° W). Zero, one, or two Holothuria atra sea cucumbers were placed into each cage, as well as three treatments of the coral Acropora pulchra (n = 12 cages/treatment): (i) a coral branch with turf algae on the base separating live coral tissue from sediment by ~2.5 cm of turf (hereafter "turf"), ii) a coral with equivalent turf algae on its base but with the turf buried so that sediment contacted the coral's live tissue at the turf-coral juncture (hereafter "buried turf"), or iii) a coral lacking turf on its base and its live tissue in direct contact with benthic sediment (hereafter "no turf"). Percent tissue mortality of each A. pulchra coral was monitored daily for 36 days (April-May 2020) or until tissue mortality of one more corals within a cage was estimated to be ≥50% of the coral's branch height, after which all corals in that cage were collected for sampling and subsequent microbiome analyses. All coral tissue mortality data were collected by Dr. Cody Clements of the Georgia Institute of Technology.

Table of Contents

Coverage

Location: Lagoonal habitat of Mo'orea, French Polynesia (17.4894° S, 149.8825° W); depth 2-3m
Spatial Extent: **N**:-17.4885 **E**:-149.8818 **S**:-17.4886 **W**:-149.8818
Temporal Extent: 2020-04 - 2020-05

Methods & Sampling

In Mo'orea, to assess the impact of sea cucumber removal on sediment- and coral-associated microbiomes, as well as how farmerfish turf on the base of corals might affect disease prevalence, we erected thirty-six 50 cm

x 50 cm x 12 cm tall cages using 1 cm2 grid metal screening to contain or exclude sea cucumbers and prevent access by coral consumers. Cages were situated in an ~85 m2 sand patch within the fringing reef area utilized in our initial experiment described above and were separated from adjacent cages by ≥60 cm, creating a 6 x 6 grid of enclosures. Each cage was stocked with either zero, one, or two *H. atra* (12 cages treatment-1) that were approximately 9-14 cm in length, as is typical for individuals at our site. Density treatments were assigned at random. Cages were inspected daily to ensure that density treatments were maintained (they were), and sea cucumbers outside of cages were removed daily from within about 10 m of the 2 m deep area where cages were situated. All cages were brushed every other day to prevent fouling.

Seven days after applying sea cucumber treatments, sediment samples were taken for microbiome analyses by scraping 30-40 mL of surficial sediment from the top ~5 mm of each caged area into a small Whirl-Pak. Samples were immediately placed on ice and stored in a -80°C freezer upon return to shore. Following sediment sampling, three *A. pulchra* outplants were embedded into the sediment of each cage (108 outplants total) to test the potential effects of (i) sea cucumber density, and (ii) protective effects of farmerfish-cultivated turf algae on coral health and microbiomes (see below). Corals used were approximately 8-10 cm in length and were initially fragmented from numerous *A. pulchra* thickets adjacent to our study area and outplanted using the methods described above.

Of the three outplants included in each cage, two were fragmented from colonies in the field in such a way as to include farmerfish-generated turf algae at their base, while the third was fragmented so that it lacked turf at its base. These three outplants were embedded into the sediment as follows: (i) coral lacking turf planted in direct contact with benthic sediment (hereafter “no turf”), (ii) coral separated from direct contact with sediment by turf algae growing at its base (hereafter “turf”), or (iii) coral with turf on its base, but embedded more deeply into the sediment so that the living coral tissue was in direct contact with the sediment (hereafter “embedded turf”). Percent coral tissue mortality among outplants was visually estimated daily for 36 days. The microbiomes of all corals and the sediment within a cage were sampled when one or more outplants within that cage exhibited ≥50% tissue mortality or when the experiment was terminated on day 36.

Organism identifiers:

Coral: Acropora pulchra, LSID (urn:lsid:marinespecies.org:taxname:207015)

Cucumber: Holothuria atra, LSID (urn:lsid:marinespecies.org:taxname:1672768)

farmerfish: Stegastes spp, LSID (urn:lsid:marinespecies.org:taxname:203822)

BCO-DMO Processing Description

- Converted latitude and longitude values from 17.4894° S to -17.4894 format
- Removed spaces from column names and replaced with underscores ("_")
- Removed units from column names
- Changed date column from m%-d%-%y format to %Y-%m-%d format
- Rounded latitude and longitude values to 6 degrees of precision

[table of contents | back to top]

Data Files

File	
920209_v1_sea_cucumber_enclosure_experiments_moorea.csv	(Comma Separated Values (.csv), 8.09 KB) MD5:99b7f50b1b85e479de58f0d7e9c94a1c
Primary data file for dataset ID 920209, version 1	

[table of contents | back to top]

Related Datasets

IsRelatedTo

Clements, C. (2024) **Coral tissue mortality as a function of the presence or absence of sea cucumbers and coral outplant type in cage experiments in lagoonal habitat of Mo'orea, French Polynesia in April and May of 2020.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-02-12 doi:10.26008/1912/bco-dmo.920209.1 [view at BCO-DMO]

Clements, C. (2024) **Coral tissue mortality in sand patches with vs. without sea cucumber removal in lagoonal habitat of Mo'orea, French Polynesia from June to August of 2021 (Coral Biodiversity project).** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2024-02-12 doi:10.26008/1912/bco-dmo.920201.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
Cage	Cage ID in experiment	unitless
Cage_Replicate	The number assigned to each coral outplant in a given cage	unitless
ID	The unique ID of each coral outplant (Cage and Cage_Replicate)	unitless
Holothuria_atra_Presence	Description of the sea cucumber treatments in the experiment; sea cucumbers (Holothuria atra) were either removed or not removed from sand patches within cages	unitless
Holothuria_atra_Count	The number assigned to each coral outplant in a given cage	unitless
Turf_Treatment	Describes the three turf treatments in the experiment; coral outplants either had turf at their base, turf at their base that was embedded within the sediments, or no turf	unitless
Coral_Tissue_Mortality_Percentage	The percent of tissue mortality of each coral outplant when sampled	unitless
Experiment_Start_Date	Date when experiment began	unitless
Date_Sampled	Date when outplants within a cage were sampled (i.e., when one or more outplants exhibited greater than or equal to 50% tissue mortality)	unitless
Latitude	Latitude of experiment site in decimal degrees; a negative value indicates a Southern coordinate	decimal degrees
Longitude	Longitude of experiment site; a negative value indicates a Western coordinate	decimal degrees

[table of contents | back to top]

Project Information

Positive Effects of Coral Biodiversity on Coral Performance: Patterns, Processes, and Dynamics (Coral Biodiversity)

Coverage: Moorea, French Polynesia, South Pacific Ocean (17º32'S 149º50'W)

NSF Award Abstract:
Coral reefs are extremely diverse, supply critical ecosystem services, and are collapsing at an alarming rate, with 80% coral loss in the Caribbean and >50% in the Pacific in recent decades. Previous studies emphasized

negative interactions (competition, predation) as structuring reef systems, but positive interactions in such species-rich systems could be of equal importance in maintaining ecosystem function. If foundation species like corals depend on positive interactions, then their fitness may decline with the loss of surrounding species, creating a biodiversity meltdown where loss of one coral causes losses of others. This project conducts manipulative field experiments to understand the role of coral biodiversity in facilitating coral growth, survival, resilience, and retention of these foundation species and the critical ecosystem services they provide in shallow tropical seas. This project is committed to: 1) Educating and exciting influential business and civic leaders about conservation and restoration of coastal marine systems before these systems lose ecological function and value. This will involve influential Rotary clubs within North Georgia/Atlanta (the major economic engine of the southeastern US) as an initial focus. 2) Using the Research News and Institute Communications Office at Georgia Tech and well-developed contacts with science writers to produce popular press pieces on important ocean ecology discoveries emerging from these studies. (3) Organizing a public workshop of internationally prominent scientists focused on Maintaining Marine Biodiversity as a Strategy to Sustain Ecosystem Services and Coastal Cultures and Economies. A previous effort like this, organized by the investigators, attracted about 200 attendees and was webcast to numerous high schools in Georgia and to foreign investigators in less developed countries that could not attend. Speakers also conducted in-person video interviews with local high school classes. Due to that success, this model will be repeated. 4) Working with an association of educators and cultural leaders in French Polynesia to produce electronic format presentations on our work and on reef conservation that are appropriate for use by both teachers and leaders within Polynesian culture.

Ecologists have excelled at demonstrating the importance of direct (often negative) interactions among species pairs. However, when these interactions occur in a complex context among thousands of other species in the field, the sum of the many, poorly-known, indirect interactions can counterbalance, or even reverse, the better-known direct interactions, generating diffuse mutualisms instead of agonistic outcomes. In a proof-of-concept initial experiment, coral growth and survivorship were greater in coral polycultures than monocultures, especially during early stages of community development. Processes generating this outcome are unclear but understanding these is of critical importance as diversity and function of reefs decline and as humans need to predict and adapt to changing environments. This interdisciplinary investigation merges expertise in experimental field ecology, chemical ecology, and the ecology of microbiomes to investigate the functional role of biodiversity in coral reef ecosystems. Experiments use a novel coral transplantation method and field manipulations to assess: 1) whether greater coral species diversity enhances coral community performance, as well as growth and survivorship of individual corals, 2) whether greater genotypic diversity enhances coral performance within a species, 3) whether greater diversity of seaweed competitors further suppresses corals and enhances seaweed performance, and 4) the processes driving the patterns documented above, including the roles of disease, intraspecific versus interspecific competition, predators, mutualists, and differential access to, or use of, resources. The research investigates the relationship between biodiversity and ecosystem function across dimensions of coral taxonomic diversity, from species to genotypes, and creates a series of experiments elucidating general principles underlying ecosystem dynamics. Filling these knowledge gaps advances our fundamental understanding of how biodiversity influences ecosystem function at multiple scales and provides insight into the processes promoting coral coexistence in these species-rich ecosystems. Findings will have practical implications for coral management and restoration and may improve predictions regarding coral reef resilience and recovery in the face of changing climate.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1947522

[table of contents | back to top]