Coral (Pocillopora verrucosa) growth and tissue mortality from experimental field plots in Moʻorea, French Polynesia in 2021

Website: https://www.bco-dmo.org/dataset/925751
Data Type: experimental, Other Field Results
Version: 1
Version Date: 2024-04-23

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

Contributors	Affiliation	Role
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Abstract
Hundreds of studies now document positive relationships between biodiversity and critical ecosystem processes, but as ecological communities worldwide shift towards new species configurations, less is known regarding how biodiversity of undesirable species will shape the functioning of ecosystems or foundation species. We manipulated macroalgal species richness in experimental field plots to test whether and how identity and diversity of competing macroalgae affected the growth, survival, and microbiome of a common coral in Moʻorea, French Polynesia. These data include coral (Pocillopora verrucosa) percent growth and tissue mortality among corals outplanted into 25 cm x 21 cm experimental plots in the back reef lagoon on the north coast of Moʻorea, French Polynesia (17°28′37″S 149°50′21″W). We varied the macroalgal community on the upper surface of each plot by outplanting monocultures holding similar masses of: (1) Sargassum pacificum, (2) Turbinaria ornata, or (3) Amansia rhodantha, as well as (4) polycultures containing all three species (12 plots per treatment; Figure 1 of Clements et al., 2024). There were also two additional treatments: (5) plots with plastic algal mimics to control for effects of shading or abrasion unrelated to the biotic properties of live seaweeds and 6) control plots where corals, but not living algae or physical mimics, were present (n = 12 plots/treatment). This dataset includes coral (Pocillopora verrucosa) growth and tissue mortality at 9 weeks for plots with no algae (control), plastic algal mimics, monocultures of Amansia rhodantha, Turbinaria ornata, or Sargassum pacificum, and polycultures containing all three algal species.

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Coverage

Location: Back reef lagoon on the north coast of Moʻorea, French Polynesia
Spatial Extent: **Lat**:-17.476944 **Lon**:-149.839167

Temporal Extent: 2021-05-30 - 2021-08-07

Dataset Description

Additional Funding Description:
U.S. National Science Foundation (grant no. OCE-1947522), the National Geographic Society (grant no. NGS-57078R-19), the Teasley Endowment to the Georgia Institute of Technology, and the Anna and Harry Teasley Gift Fund.

Methods & Sampling

To test the impact of macroalgal species richness on coral performance, we manipulated macroalgal assemblages on the upper surface of 25 cm x 21 cm cement plots that each contained six *Pocillopora verrucosa* coral outplants (6 corals per plot, 72 plots, 432 corals total). Each plot was affixed to the substrate and elevated ~30 cm to prevent scour by sand and rubble. The upper surface of each plot contained a 4 x 3 grid space, with upturned soda bottle caps embedded within each space. To create a standardized coral population, 6–8 cm length branches of *P. verrucosa* were fragmented from colonies *in situ* and individually epoxied (Z-Spar A-788 Splash Zone Epoxy) into the cut-off necks of inverted plastic bottles (following methods of Clements and Hay 2015). Prior to outplanting, all corals and their epoxy/bottle-top base were wet-weighed in the field using an electronic scale (OHAUS Scout Pro) enclosed within a plastic container mounted to a tripod holding it above the water surface. Before weighing, each coral was gently shaken 30 times to remove excess water, and then weighed, immediately placed back into the water, and attached to their designated plot. Six corals that each originated from different *P. verrucosa* colonies were attached to plots by screwing the corals into bottle caps embedded within every other grid space within each plot.

We varied the macroalgal community on the upper surface of each plot by outplanting monocultures holding similar masses of: (1) *Sargassum pacificum*, (2) *Turbinaria ornata*, or (3) *Amansia rhodantha*, as well as (4) polycultures containing all three species (12 plots per treatment; Figure 1 of Clements et al., 2024). There were also two additional treatments: (5) plots with plastic algal mimics to control for effects of shading or abrasion unrelated to the biotic properties of live seaweeds and 6) control plots where corals, but not living algae or physical mimics, were present (n = 12 plots per treatment).

To create six standardized units of macroalgae or algal mimics within every other space of the 4 x 3 grid of each plot, cable ties were first individually epoxied into the cut-off necks of inverted plastic bottles that were screwed into bottle caps embedded within the plots. An additional cable tie was then used to attach either *Sargassum* (two ~6-8 cm thalli), *Turbinaria* (two ~6-8 cm thalli), *Amansia* (two ~6-8 cm thalli), or algal mimics (two ~6 cm plastic aquarium plants) to the cable tie embedded in each soda bottle neck. Standardized units used in control plots only had a cable tie attached to the embedded cable tie. In polycultures, units of *Sargassum*, *Turbinaria*, and *Amansia* (2 units/species/plot) were distributed to ensure that conspecifics were not located adjacent to one another within the grid space of the plot and so that the mass of each species was approximately the same (Figure 1 of Clements et al., 2024). Any macroalgae or algal mimics displaced from their cable tie (e.g., because of wave action or herbivory) were replaced every 1-2 days, and all mimics were replaced weekly to minimize the influence of fouling organisms (e.g., diatoms, cyanobacteria) that might produce chemical or biological interactions confounding the physical effects these biologically inert "controls" are meant to produce. The different treatments were interspersed randomly to prevent confounding spatial effects with treatment effects.

The percentage growth and tissue mortality of individual corals in each plot were assessed at 9 weeks (experiment initiated on 30 May with treatment effects assessed on 7 August 2021). Each coral was visually examined from all sides and the percentage tissue mortality was estimated and assigned in 10% classes (0, 10, 20%, etc., up to 100%). Twenty-four to 48 hours before the second weighing session, each coral's epoxy/bottle-top base was brushed clean of fouling organisms. To assess growth, corals were detached from the substratum, reweighed in the field as previously described to determine the percentage change in mass, and immediately placed back into the water and reattached to their respective bottle cap.

Taxonomic name, LifeSciences Identifier (LSID):
Pocillopora verrucosa, urn:lsid:marinespecies.org:taxname:206954
Sargassum pacificum, urn:lsid:marinespecies.org:taxname:495052
Turbinaria ornata, urn:lsid:marinespecies.org:taxname:221490
Amansia rhodantha, urn:lsid:marinespecies.org:taxname:213667

Data Processing Description

Mass (i.e. growth) and tissue mortality data were recorded in the field on waterproof paper and entered by hand into an Excel spreadsheet upon return to shore.

BCO-DMO Processing Description

* Sheet 1 of submitted file "Clements et al_Macroalgae Diversity Experiment_Coral growth and mortality.xlsx" was imported into the BCO-DMO data system for this dataset.
** Missing data values are displayed differently based on the file format you download. They are blank in csv files, "NaN" in MatLab files, etc.

* Column names adjusted to conform to BCO-DMO naming conventions designed to support broad re-use by a variety of research tools and scripting languages. [Only numbers, letters, and underscores. Can not start with a number]

* Taxonomic names in the methodology were matched to identifiers at the World Register of Marine Species. All names matched currently accepted names as of 2024-04-023.

Problem Description

Not applicable

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Data Files

File	
925751_v1_coral-growth-and-tissue-mortality.csv	(Comma Separated Values (.csv), 15.36 KB) MD5:e7ecee89be767a6eb03421add33c14d3
Primary data file for dataset ID 925751, version 1	

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Related Publications

Clements CS, Pratte ZA, Stewart FJ, Hay ME (2024) Biodiversity of macroalgae does not differentially suppress coral performance: The other side of a biodiversity issue. Ecology, Accepted
Results

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Parameters

Parameter	Description	Units
ID	The unique ID of each coral outplant.	unitless
Treatment	Denotes the experimental macroalgal treatments applied to the upper surface of the plots in our manipulative experiment. These included monocultures of (1) Sargassum pacificum, (2) Turbinaria ornata, or (3) Amansia rhodantha, (4) polycultures containing all three species, (5) plots with plastic algal mimics, and (6) control plots where corals, but not living algae or physical mimics, were present (12 plots per treatment; Figure 1 of Clements et al., 2024).	unitless
Plot	Plot ID in experiment.	unitless
Colony	The colony from which the replicate originated.	unitless
Position	The position of each coral outplant when embedded within the 4 x 3 grid space on the upper surface of their respective plot (Figure 1 of Clements et al., 2024).	unitless
Growth_percent	The percent mass change of each coral outplant at the end of the experiment.	unitless
Mortality_percent	The percent tissue mortality of each coral outplant at the end of the experiment.	unitless

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Instruments

Dataset-specific Instrument Name	Electronic scale (OHAUS Scout Pro)
Generic Instrument Name	scale
Generic Instrument Description	An instrument used to measure weight or mass.

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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.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1947522
National Geographic Soceity (NatGEO)	NGS-57078R-19

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