Percent growth of corals in experimental plots on Fringing reef (Coral Biodiversity project)

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Data Type: Other Field Results, experimental
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Project
» Positive Effects of Coral Biodiversity on Coral Performance: Patterns, Processes, and Dynamics (Coral Biodiversity)

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

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Coverage

Spatial Extent: **Lat**:-17.476944 **Lon**:-149.839167

Methods & Sampling

Methodology:

We conducted a manipulative experiment in the back reef lagoon of Mo´orea, French Polynesia (17°28´37˝S 149°50´21˝W) comparing monocultures of the corals *A. hyacinthus*, *P. rus*, and *P. verrucosa* to polycultures composed of all three species. We constructed 48 40 cm by 40 cm cement slabs affixed to the benthos and elevated on cinder blocks to prevent scour by sand or unconsolidated rubble; this elevation mimics the coral presence on raised bommies around our manipulation site. The upper surface of each slab contained a six by six grid space in which we embedded 18 upturned bottle caps per plot within every other space. Approximately eight-cm length branches of *A. hyacinthus*, *P. rus*, and *P. verrucosa* were fragmented from colonies in situ and epoxied individually into the cutoff neck of soda bottles, which were then attached to plots at randomized locations by screwing the bottle necks into the upturned caps within each plot (18 corals per plot, 864 corals in total). This produced $n = 12$ for each of the three monocultures and the polyculture, with treatments assigned to plots at random to assure interspersion of treatments. At the initiation of the experiment, 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. This provided a wet mass starting value for each individual coral and its base.

Sampling and analytical procedures:

To assess coral growth, corals and their epoxy/bottle-top base were unscrewed from their treatment plot and

wet-weighed in the field as described above. Twenty-four to 48 hours before this second weighing, each coral's epoxy/bottle-top base was brushed clean of fouling organisms. Before all weighings, each coral was gently shaken 30 times to remove excess water, weighed, immediately placed back into the water, and reattached to its respective bottle cap. At the end of the experiment, each coral was separated from its epoxy/bottle-top base, and each coral and base were weighed separately to assess change in mass of the coral alone. Previously, we have used this method to determine, via subtraction, the coral mass and thus the percentage growth throughout the experimental period; however, in many cases, the epoxy/bottle tops used in this experiment did not exhibit clean breaks from their coral outplant. Thus, we decided to calculate the mean weight of all bottle tops and epoxy with visually clean breaks (326 of 864 bottle tops; mean = 21.76 g ± 0.08 g SE) and subtracted this value from each coral replicate to calculate percent coral mass change.

We used permutation-based, linear mixed-effects (LME) models in the R package predictmeans to compare differences in the percentage mass change and tissue mortality of conspecific corals in monocultures versus polyculture, as well as the combined percentage mass change of all species in polycultures with that of all species in monocultures. In each analysis, plot type (monoculture or polyculture) was treated as a fixed factor, and individual replicate plots were treated as a random effect nested within plot type.

Data Processing Description

BCO-DMO Processing Notes:

- Replaced spaces and special character (%) in column names

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Related Publications

Clements, C. S., & Hay, M. E. (2021). Biodiversity has a positive but saturating effect on imperiled coral reefs. Science Advances, 7(42). doi:10.1126/sciadv.abi8592
Results

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Parameters

Parameter	Description	Units
Plot	The unique ID number of the plot.	unitless
ID	The unique ID number of corals within each plot.	unitless
Species	The species present within the plot. Polyculture plots contain all three species (Porites rus, Pocillopora verrucosa, Acropora hyacinthus).	unitless
Treatment	The experimental treatment of the plot.	unitless
Mass_Change_Percentage	The percent change in mass from T0 to T1 during the third month of the experiment.	unitless

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Instruments

Dataset-specific Instrument Name	OHAUS SP-2001 Scout Pro Balance
Generic Instrument Name	scale
Dataset-specific Description	At the end of the experiment, each coral was separated from its epoxy/bottle-top base, and each coral and base were weighed separately to assess change in mass of the coral alone.
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

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