Percent tissue mortality of corals in experimental plots (Coral Biodiversity project)

Website: https://www.bco-dmo.org/dataset/873820
Data Type: experimental, Other Field Results
Version: 1
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Project
» Positive Effects of Coral Biodiversity on Coral Performance: Patterns, Processes, and Dynamics (Coral Biodiversity)

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Methods & Sampling

Methodology:

To evaluate the potential role of intraspecific competition in suppressing *P. verrucosa* growth in monocultures versus interspecific competition in polycultures, we conducted a subsequent experiment at the same backreef location (17°28′37″S 149°50′21″W) using a similar experimental approach to that described above. We assembled 60 plots (six by six grid space, 18 soda bottle caps embedded) that contained one of five treatment configurations (n = 12 plots per treatment, 576 *P. verrucosa* total):

1) six live *P. verrucosa*; 12 bottle tops with epoxy but lacking coral

2) 12 live *P. verrucosa*; six bottle tops with epoxy but lacking coral

3) 18 live *P. verrucosa*

4) six live *P. verrucosa*, six *P. rus*, and six *A. hyacinthus* (hereafter live polyculture)

5) six live *P. verrucosa*; six dead *P. rus* and six dead *A. hyacinthus* (hereafter dead polyculture)

Corals were attached to plots at randomized locations by screwing the corals into the bottle caps embedded within each plot. At two and seven months, we assessed the percentage growth and tissue mortality of individual corals in each plot as described above. At seven months, four plots were excluded from our analyses where corals had been heavily predated by the pin cushion star *Culcita novaeguineae*. We observed this event in the field, it occurred for only four of our 60 plots, and it occurred only on these adjacent plots, so we considered it to be a nontreatment-related disturbance that should be excluded. Colonization of each plot by benthic macroalgae was assessed at two months but not at seven months, due to macroalgae absence

among plots at that time. As above, percent cover of macroalgae was determined via photographs using ImageJ (version 1.8.0_121), coral tissue mortality was estimated visually, and corals and their epoxy/bottle-top base were wet-weighed in the field to determine changes in mass. At the end of the experiment, corals were successfully separated from their respective epoxy/bottle-top base and were used to determine, via subtraction, the percent coral mass change throughout the experimental period.

Sampling and analytical procedures:

We used permutation-based, LME models in the R package predictmeans to compare differences in the percentage mass change and tissue mortality of *P. verrucosa* corals in each treatment. In each analysis, plot type (e.g., 18 live *P. verrucosa*) was treated as a fixed factor, and individual replicate plots were treated as a random effect nested within plot type.

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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
Treatment	The experimental treatment of the plot. Live polycultures contained three species: Pocillopora verrucosa, Acropora hyacinthus, and Porites rus	unitless
Tissue_Mortality_Percentage	The percent tissue mortality of the coral	unknown
Experiment_Month	The number of months into the experiment the observation was made. All observations were made either 2 or 7 months into the experiment.	months

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Instruments

Dataset-specific Instrument Name	OHAUS SSP-2001 Scout Pro Balance
Generic Instrument Name	scale
Dataset-specific Description	Colonization of each plot by benthic macroalgae was assessed at two months but not at seven months, due to macroalgae absence among plots at that time. As above, percent cover of macroalgae was determined via photographs using ImageJ (version 1.8.0_121), coral tissue mortality was estimated visually, and corals and their epoxy/bottle-top base were wet-weighed in the field to determine changes in mass.
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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