Data from the stoney coral fragment survival experiment on the Coral Coast of Viti Levu, Fiji in 2013 (Killer Seaweeds project)

Website: https://www.bco-dmo.org/dataset/564404
Version: 1
Version Date: 2015-08-14

Project
» Killer Seaweeds: Allelopathy against Fijian Corals (Killer Seaweeds)

Contributors	Affiliation	Role
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Abstract
Experiment results testing Janzen-Connell hypothesis in brooding corals: whether juvenile corals experienced distance-dependent mortality near adult conspecifics. This dataset reports survivorship data from the stoney coral fragment survival experiment on the Coral Coast of Viti Levu, Fiji in 2013.

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Coverage

Spatial Extent: **Lat**:-18.215 **Lon**:177.713
Temporal Extent: 2013-08-07 - 2013-10-08

Dataset Description

Experiment testing Janzen-Connell hypothesis in brooding corals - whether juvenile corals experienced distance-dependent mortality near adult conspecifics.

This dataset includes survivorship data for Pocillopora damicornis and Seriatopora hystrix on tiles set out to the east and to the west of each of 10 focal colonies of the two species. Tiles with four coral fragments of the same species as the focal colony were placed at four distances (6, 12, 24, and 182 cm).

Related Datasets:

64 m^2 grid survey
2 m^2 circle survey
survival replacement tiles
array information

Methods & Sampling

Study site characteristics

This study was conducted on reef flats within no-take marine protected areas (MPAs) adjacent to Votua, Vatuo-lailai, and Namada villages along the Coral Coast of Viti Levu, Fiji. These reserves are scattered along 11 km of fringing reef and are separated by ~3-8 km. The reserves have high coral cover (38-56%), low macroalgal cover (1-3%), and a high biomass and diversity of herbivorous fishes (Rasher, Hoey, and Hay 2013; Bonaldo and Hay 2014). The reef flats range from ~1-3 m deep at high tide, extend ~500-600 m from shore to the reef crest, and are typical of exposed reef flats occurring throughout Fjii.

Except during low tides in calm weather, waves push water over the reef front, and water then flows laterally across the reef flats to discharge through channels bisecting the flats. This creates a relatively predictable current direction at most locations.

Survival experiments

To test whether juvenile corals experienced distance-dependent mortality near adult conspecifics, we collected ~5 mm tall fragments of P. damicornis and S. hystrix, selected suitable adult focal colonies (defined below), and attached conspecific fragments 3, 12, 24 and 182 cm up- and down-current from each focal adult. We deployed fragments around focal colonies in Votua village's MPA, which supports a diverse assemblage of corals covering about 50% of hard substrates (Rasher, Hoey, and Hay 2013). We used fragments from older colonies as proxies for ~6 month old juveniles (Sato 1985) because, despite these species reproducing monthly in some locations (Fan et al. 2002; Kuanui et al. 2008), neither species planulated at our site during the months of this study (August through October 2013).

We used pliers to clip 16 fragments of 30-40 polyps each from the tips of each of 24 large P. damicornis and 24 large S. hystrix colonies in the Votua village MPA. The fragments from each of four source colonies for a species were collected in six rounds over two days. Each round was taken to shore and four fragments (one from each source colony) were epoxied (Emerkit epoxy) onto the unglazed side of 16 2.54 x 2.54 cm tiles. Thus, each tile had fragments from four different colonies and sets of 16 tiles had fragments from the same four colonies. After epoxying, tiles were held in a tub of seawater for ~1 h, allowing the epoxy to harden. Tiles were then cable-tied onto metal racks at ~1 m deep in the MPA and allowed to acclimate for two weeks before deployment in the experiment. Survivorship during acclimation was 100%, producing 384 fragments on 96 tiles for each coral species.

Within the MPA, 10 adult P. damicornis and 10 adult S. hystrix colonies served as focal colonies. Focal colonies: i) were >10 cm at their smallest diameter (10 to 35 cm for P. damicornis and 10 to 75 cm for S. hystrix), ii) had no conspecific colonies within 4 m (so as not to confound effects of the focal colony with effects of nearby conspecifics), iii) were 5-40 cm deep at low tide, and iv) had space for 190 cm PVC pipes to be placed roughly east and west (the predominant current direction was west) without disturbing other corals. Focal colonies were photographed from above and their size determined using ImageJ (Rasband 1997).

Twenty mm diameter by 190 cm long PVC pipes served as platforms to which we attached the tiles. Pipes were anchored to the reef by driving steel rebar through pre-drilled holes and cementing the rebar to the pipe. Notches 2.54 cm long allowed us to cable-tie tiles onto the pipes at distances of 3, 12, 24 and 182 cm from focal colonies. This approach secured all pipes and tiles throughout the experiment. These distances and this scale were chosen to match a previous experiment in the Caribbean that had detected distance dependent mortality of newly settled recruits for a broadcast spawning coral (Marhaver et al. 2013).

Tiles were randomly assigned to positions on pipes. Thus, fragments at each distance and around each conspecific focal colony were random with respect to source colony. Unassigned tiles were kept on the rack as spares (64 fragments on 16 tiles for each coral species).

Every 1-2 d after deployment, we examined all fragments, recording survivorship, consumption, overgrowth by algae, bleaching, or other changes in status.

On some P. damicornis tiles, three or four of the fragments disappeared within a 24 h period between checks on their condition, appearing to have been bitten off. To determine the agents of this localized mortality, we replaced tiles whose four fragments had been eaten with spare tiles holding four healthy fragments around three of the focal colonies that had experienced localized mortality and videotaped the tiles (GoPro II HD) from about 1 m away during the following high tides. Cameras were retrieved at the next low tide and the videos watched.

We evaluated survival patterns using mixed-effects Cox proportional hazards survival models (coxme package, Therneau 2012) in R (R Core Team 2013). Distance and direction from focal colony were fixed effects and focal colony and tile nested within focal colony were random effects because fragments were blocked by tile and focal colony. The size of the focal colony and the depth of the tiles were included as random effects.

Data Processing Description

BCO-DMMO Processing:

- added conventional header with dataset name, PI name, version date
- renamed parameters to BCO-DMO standard
- reformatted date from m/d/yyyy to yyyy-mm-dd
- replaced spaces with underscores
- removed trailing blanks
- changed 3 'spare' entries from date format to general: 01/00/00 to 0
- moved comments from date to died (last) column
- replaced #VALUE! with N/A (in 9 cells with N/A in other dates)
- replaced blank cells with N/A

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Data Files

File
survival_expts.csv (Comma Separated Values (.csv), 120.88 KB) MD5:8b7c15313a70654a294f78cb33b8d2dd Primary data file for dataset ID 564404

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Related Publications

Bonaldo, R. M., & Hay, M. E. (2014). Seaweed-Coral Interactions: Variance in Seaweed Allelopathy, Coral Susceptibility, and Potential Effects on Coral Resilience. PLoS ONE, 9(1), e85786. doi:10.1371/journal.pone.0085786
Methods

Marhaver, K. L., Vermeij, M. J. A., Rohwer, F., & Sandin, S. A. (2013). Janzen-Connell effects in a broadcast-spawning Caribbean coral: distance-dependent survival of larvae and settlers. Ecology, 94(1), 146-160. https://www.jstor.org/stable/23435677
Related Research

Rasher, D. B., Hoey, A. S., & Hay, M. E. (2013). Consumer diversity interacts with prey defenses to drive ecosystem function. Ecology, 94(6), 1347–1358. doi:10.1890/12-0389.1
Methods

Sato, M. (1985). Mortality and growth of juvenile coral Pocillopora damicornis (Linnaeus). Coral Reefs, 4(1), 27–33. doi:10.1007/bf00302201 https://doi.org/10.1007/BF00302201
Methods

Schneider, C. A., Rasband, W. S., ... (n.d.). ImageJ. US National Institutes of Health, Bethesda, MD, USA. Available from https://imagej.nih.gov/ij/
Software

Therneau, T. (2012). coxme: mixed effects Cox models. R package version 2.2-3. Vienna, Austria: R Foundation for Statistical Computing.
Software

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Parameters

Parameter	Description	Units
species	Species surveyed	unitless
polyps	Number of polyps	polyps
attachment	Method of attachment to tile	unitless
tile	Tile Identification	unitless
tile_batch	Tile processing batch number	unitless
pipe	Pipe number	unitless
direction	Direction (east or west)	unitless
dist_focal_col	Distance from focal colony (cm)	cm
tile_loc_code	Tile location (Pipe number; direction; distance)	unitless
fragment	Fragment number on tile (clockwise from top left)	unitless
depth	Tile depth (cm)	cm
focal_col_size	Focal colony size (cm)	cm
date_deployed	Date coral deployed around focal colony	yyyy-mm-dd
lat_approx	Approximate latitude; north is positive	decimal degrees
lon_approx	Approximate longitude; east is positive	decimal degrees
date_bleach_decap	Date of fragment's bleaching or partial decapitation	yyyy-mm-dd
days_bleach_decap	Days until fragment's bleaching or partial decapitation after deployment on array	days
bleach_decap	Fragment bleached or partially decapitated	unitless

date_dead	Date of fragment's death; disappearance; or decapitation	yyyy-mm-dd
days_bleach_dead	Days until fragment's death; disappearance; or decapitation after deployment on array	days
days_bleach_dead_1	Days until fragment's death; disappearance; or decapitation + 1	days
date_removal	Date of fragment's removal from reef	yyyy-mm-dd
live	Fragment did not bleach or die	unitless
bleach_live	Fragment bleached without dying	unitless
died_nobleach	Fragment died without bleaching	unitless
died_bleach	Fragment died and bleached	unitless
mass_mort	Fragment died during mass mortality event	unitless
not_mass_mort	Fragment died but not during a mass mortality event	unitless
mass_mort_repl	Fragment died from mass mortality in a replicate with mass mortality	unitless
not_mass_mort_repl	Fragment died in a replicate that did not experience mass mortality. Any fragment that died in a replicate that didn't experience mass mortality. 0= dead or surviving fragment from a mass mortality replicate or a fragment from a non-mass mort replicate that never died; 1=dead in a replicate that never experienced mass mortality	unitless
died	Died	unitless
spare	Spare	unitless
death_type	Type of death	unitless

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Deployments

Fiji_2013

Website	https://www.bco-dmo.org/deployment/564474
Platform	Hay_GaTech
Start Date	2013-08-13
End Date	2013-10-09
Description	Studies of corals and seaweed were conducted on reef flats within no-take marine protected areas (MPAs) adjacent to Votua, Vatuo-lailai, and Namada villages along the Coral Coast of Viti Levu, Fiji in 2013.

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Project Information

Killer Seaweeds: Allelopathy against Fijian Corals (Killer Seaweeds)

Coverage: Viti Levu, Fiji (18º13.049’S, 177º42.968’E)

Extracted from the NSF award abstract:

Coral reefs are in dramatic global decline, with reefs commonly converting from species-rich and topographically-complex communities dominated by corals to species- poor and topographically-simplified communities dominated by seaweeds. These phase-shifts result in fundamental loss of ecosystem function. Despite debate about whether coral-to-algal transitions are commonly a primary cause, or simply a consequence, of coral mortality, rigorous field investigation of seaweed-coral competition has received limited attention. There is limited information on how the outcome of seaweed-coral competition varies among species or the relative importance of different competitive mechanisms in facilitating seaweed dominance. In an effort to address this topic, the PI will conduct field experiments in the tropical South Pacific (Fiji) to determine the effects of seaweeds on corals when in direct contact, which seaweeds are most damaging to corals, the role allelopathic lipids that are transferred via contact in producing these effects, the identity and surface concentrations of these metabolites, and the dynamic nature of seaweed metabolite production and coral response following contact. The herbivorous fishes most responsible for controlling allelopathic seaweeds will be identified, the roles of seaweed metabolites in allelopathy vs herbivore deterrence will be studied, and the potential for better managing and conserving critical reef herbivores so as to slow or reverse conversion of coral reef to seaweed meadows will be examined.

Preliminary results indicate that seaweeds may commonly damage corals via lipid- soluble allelochemicals. Such chemically-mediated interactions could kill or damage adult corals and produce the suppression of coral fecundity and recruitment noted by previous investigators and could precipitate positive feedback mechanisms making reef recovery increasingly unlikely as seaweed abundance increases. Chemically-mediated seaweed-coral competition may play a critical role in the degradation of present-day coral reefs. Increasing information on which seaweeds are most aggressive to corals and which herbivores best limit these seaweeds may prove useful in better managing reefs to facilitate resilience and possible recovery despite threats of global-scale stresses. Fiji is well positioned to rapidly use findings from this project for better management of reef resources because it has already erected >260 MPAs, Fijian villagers have already bought-in to the value of MPAs, and the Fiji Locally-Managed Marine Area (FLMMA) Network is well organized to get information to villagers in a culturally sensitive and useful manner.

The broader impacts of this project are far reaching. The project provides training opportunities for 2-2.5 Ph.D students and 1 undergraduate student each year in the interdisciplinary areas of marine ecology, marine conservation, and marine chemical ecology. Findings from this project will be immediately integrated into classes at Ga Tech and made available throughout Fiji via a foundation and web site that have already set-up to support marine conservation efforts in Fiji and marine education efforts both within Fiji and internationally. Business and community leaders from Atlanta (via Rotary International Service efforts) have been recruited to help organize and fund community service and outreach projects in Fiji -- several of which are likely to involve marine conservation and education based in part on these efforts there. Media outlets (National Geographic, NPR, Animal Planet, Audubon Magazine, etc.) and local Rotary clubs will be used to better disseminate these discoveries to the public.

PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH

Rasher DB, Stout EP, Engel S, Kubanek J, and ME Hay. "Macroalgal terpenes function as allelopathic agents against reef corals", Proceedings of the National Academy of Sciences, v. 108, 2011, p. 17726.

Beattie AJ, ME Hay, B Magnusson, R de Nys, J Smeathers, JFV Vincent. "Ecology and bioprospecting," Austral Ecology, v.36, 2011, p. 341.

Rasher DB and ME Hay. "Seaweed allelopathy degrades the resilience and function of coral reefs," Communicative and Integrative Biology, v.3, 2010.

Hay ME, Rasher DB. "Corals in crisis," The Scientist, v.24, 2010, p. 42.

Hay ME and DB Rasher. "Coral reefs in crisis: reversing the biotic death spiral," Faculty 1000 Biology Reports 2010, v.2, 2010.

Rasher DB and ME Hay. "Chemically rich seaweeds poison corals when not controlled by herbivores", Proceedings of the National Academy of Sciences, v.107, 2010, p. 9683.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-0929119

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