Effect of habitat, origin, and herbivory on the survival and growth of recruit-sized S. polycystum fronds from MPAs and non-MPAs when reciprocally transplanted

Website: https://www.bco-dmo.org/dataset/644035
Data Type: experimental
Version:
Version Date: 2016-05-02

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

Contributors	Affiliation	Role
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Table of Contents

Coverage

Spatial Extent: **Lat**:-18.208 **Lon**:177.7
Temporal Extent: 2013-01-01 - 2015-05-31

Dataset Description

Raw data on the survival of recruit-sized ramets of *Sargassum polycystum* originated from marine protected and non-protected areas (MPAs and non-MPAs, respectively) in Fiji, reciprocally transplanted between these areas in two conditions: protected by closed cages or exposed to grazing in partially open cages. Survival data is the average number of days survived by the four MPA ramets and by the four non-MPA ramets in each of the cages. Details in Dell et al. 2016 Plos One.

Related Datasets:
Sargassum mature growth - figure 2
Sargassum mature growth conspecific - figure 4
Sargassum recruit-sized growth and survival with conspecifics - figures 5 and 6

Methods & Sampling

[Reference cited below are from Dell et al (2016) Plos One.]
Study site and species:
This study was conducted between January and May in 2013 and 2015 on the coral coast of Fiji's main island, Viti Levu, in the villages of Votua and Vatu-o-lailai (18°12'32S, 177°42'00E and 18°12'13S, 177°41'29E respectively; Fig 1). These villages are ~3km apart and each has jurisdiction over their stretch of reef flat; a habitat ranging between ~1.5 and 3m deep at high tide and between ~0 and 1.5m deep at low tide. In 2002,

these villages established small areas (0.8km2 in Votua and 0.5 km2 in Vatu-o-lailai; Fig 1) as no-take MPAs [25]. Though MPA and non-MPA areas were initially similar in coral and macroalgal cover (33-42% macroalgal cover; 3-12% coral cover [25]), MPAs now differ significantly from the adjacent non-MPAs in benthic cover and fish diversity and abundance. MPAs now have ~56% live coral cover on hard substrate, ~2% macroalgal cover, ~8 fold higher biomass of herbivorous fishes, and higher recruitment of both fishes and corals than the non-MPAs [5,22]. Meanwhile the non-MPAs have lower fish biomass, 5-16% live coral cover on hard substrates and 51-92% macroalgal cover, the majority of which is comprised by Phaeophytes (primarily Sargassum polycystum C. Agardh [22]). In the MPAs, macroalgal cover is restricted to the shallowest, most shoreward areas (where access by herbivorous fishes appears limited), whereas macroalgal cover in the non-MPAs extends throughout the habitat. Thus, over distances of only a few hundred metres, there are dramatic differences in community composition that may impact the efficacy of factors controlling macroalgal populations, without the confounding factors of great differences in space or time.

Effect of habitat and origin on the survival and growth of recruit-sized S. polycystum fronds

Small S. polycystum ramets ~1cm long (range between 0.5cm and 1.5cm) were collected from both the MPA and non-MPA using a nail and hammer so that a small piece of bedrock remained attached to each alga's holdfast, allowing four ramets from either the MPA or the non-MPA to be affixed to ~25cm2 tiles by attaching the rock pieces using aquarium glue (Ecotech Marine, USA). The ramets were selected so that the four on each tile were of equal origin and size and were arranged in a square pattern 1cm distance from each other. The tiles were placed in coolers, containing a few centimetres of seawater and left for 12 hours in the shade to allow the glue to set before moving the tiles to the reef. The tiles were paired so the MPA and non-MPA ramets were of equal size and one tile of each was affixed in a cage so they were 30cm from each other.

These cages were either complete, so the ramets would be protected from fish grazing, or open-sided, so the ramets would be exposed to fish grazing. The open cages lacked the 2 walls parallel to the current direction so that fish access was permitted, while cage effects on flow and shading would be as similar as possible between treatments. The base of each cage was 0.75m x 0.75m, the height was 0.75m and the mesh size was 1cm2 thus excluding all but the smallest fishes and invertebrates. Ten replicates of each treatment were distributed in Votua's MPA and 10 in Votua's non-MPA so that the complete and open cages were paired and the cages in each pair were about one metre apart, while the distance between pairs was ≥ two metres. These cages were distributed ~25 to 50m from shore at a depth of ~1 to 1.5m at low tide.

The experiment was established mid- January 2013, ran for 4 months (112 days), and was checked for ramet mortality every 3 days for the first month and then every week. If an alga was missing but the stone remained, this was noted as mortality. If the stone was also missing this could have been due to failure of the glue, dislodgement by turbulence, or some unknown agent, so we recorded these as 'lost' and excluded them from analysis. Only ten ramets (3.1%) were lost which reduced the total number of ramets in the experiment from 320 to 310.

Despite running for four months and being checked at intervals of 3-7 days throughout this period, we could detect no growth in this experiment so we report only mean duration of survival. Duration of survival was calculated as the average number of days survived by the four MPA ramets and by the four non-MPA ramets in each cage, giving n=10 for each treatment in each habitat. Difference scores (mean survival duration for MPA versus non-MPA sub-samples in each replicate) were normally distributed ($p \geq 0.200$; Shapiro-Wilk) so the effect of origin was analysed by paired t-test run separately for each treatment in each location.

Data Processing Description

Comparisons of the two treatments (caged or grazed) were performed by independent samples t-tests as all datasets satisfied the assumptions of normality and homogeneity of variance or were successfully log2 transformed to do so. This analysis was run separately for each origin (MPA and non-MPA) in each habitat. As data were analysed twice, we applied the Bonferroni correction with $\alpha=0.025$ and ran analyses using SPSS version 16.0.

BCO-DMO Processing:

- added conventional header with dataset name, PI name, version date
- renamed parameters to BCO-DMO standard
- sorted according to database best practices, with slowest changing columns leftmost
- corrected longitutude from West to East degrees

[table of contents | back to top]

Data Files

File
recruit_surv.csv(Comma Separated Values (.csv), 3.20 KB) MD5:751c9dc475aa0f130e3ce5d647f8873f Primary data file for dataset ID 644035

[table of contents | back to top]

Parameters

Parameter	Description	Units
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
location	where Sargassum fronds were transplanted to: MPA = marine protected area; NON-MPA = non-protected area	unitless
origin	where Sargassum fronds were collected for the transplant: MPA = marine protected area; NON-MPA = non-protected area	unitless
treatment	herbivory exclusion: Caged = ramets protected by cages; Exposed = ramets exposed to grazing in cages that lacked the lateral walls	unitless
average_days_survived	average number of days survived by the four MPA ramets and by the four non-MPA ramets in each cage	days

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	scale
Generic Instrument Description	An instrument used to measure weight or mass.

[table of contents | back to top]

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.

Fiji_2015

Website	https://www.bco-dmo.org/deployment/643921
Platform	Hay_GaTech
Start Date	2015-01-01
End Date	2015-05-31
Description	A study of seaweeds was conducted on reef flats within no-take marine protected areas (MPAs) and non-MPAs adjacent to Votua, Vatuo-lailai, and Namada villages along the Coral Coast of Viti Levu, Fiji in 2013.

[table of contents | back to top]

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.

[table of contents | back to top]

Funding

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

[table of contents | back to top]