Survival and growth of recruit-sized ramets growing inside or outside Sargassum beds (crowded and isolated conditions, respectively) in the MPA and non-MPA of two villages in Fiji

Website: https://www.bco-dmo.org/dataset/644080
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: **N**:-18.204 **E**:177.7 **S**:-18.208 **W**:177.691
Temporal Extent: 2013-01-01 - 2015-05-31

Dataset Description

Survival and growth of recruit-sized ramets of *Sargassum polycystum* growing inside or outside *Sargassum* beds (crowded and isolated conditions, respectively) in protected and non-protected areas (MPA and non-MPA, respectively) in two villages in Fiji.

Growth was obtained using the initial height measurement from each ramet and subtracting it from its final height, meaning the ramets that died were recorded as negative change. An average final height was calculated from two sub-samples (the two MPA and two non-MPA ramets) on each tile after 3 months of experiment. Survival was the average number of days survived by the two MPA ramets and by the two non-MPA ramets in each tile Details in Dell et al. 2016 Plos One.

Related Reference:
Dell, C., Longo, G.O., Hay, M.E. (2016) Positive feedbacks enhance macroalgal resilience on Degraded Coral Reefs. Plos One.

Related Datasets:
Sargassum mature growth - figure 2
Sargassum recruit-sized survival - figure 3
Sargassum mature growth conspecific - figure 4

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 conspecifics, origin and habitat on survival and growth of recruit-sized ramets

We investigated the effect of conspecifics on the survival and growth of recruit-sized ramets in conjunction with the effect of origin when ramets were not protected from herbivory. Because Sargassum beds in the MPAs only exist near shore and we did not want to confound distance from shore with treatment, we conducted this experiment at a depth of ~0.5m (at low tide) between ~10m to 20m from shore in both Votua and Vatu-o-lailai (Fig 1).

As in the previous experiment that also used recruit-sized ramets, small algal recruits (0.5 to 1.5cm tall) were detached from the substrate so that a small piece of reef substrate remained attached to the alga's holdfast and these rock pieces were affixed to tiles using Ecotech coral glue. Two MPA and two non-MPA ramets were attached onto each tile in a square pattern 1cm distance from each other. As before, the ramets were chosen so that the four on each tile were of equal size and the tiles were arranged so there was similar size representation of ramets in each treatment. In each location, tiles were placed within established Sargassum beds (crowded condition) or placed in open areas (isolated condition) ~2 metres away.

A total of 30 tiles were affixed in the MPA and 30 in the non-MPA within each village, 15 in crowded and 15 in isolated areas. This design ensured there were two origins (MPA or non-MPA) and two density conditions (crowded or isolated) in each of the MPA and non-MPA habitats of both Votua and Vatu-o-lailai.

The tiles were out-planted at the end of February 2013, monitored every 3 days for the first month and then weekly for two subsequent months for mortality and loss. As in the previous tile experiment, if the stone to which the ramet was attached was missing, those individuals were recorded as lost and excluded from subsequent analyses. Of the initial 240 ramets deployed in each village, 16 and 15 individuals were lost (6.7% and 6.2%) from Votua and Vatu-o-lailai, respectively.

Data Processing Description

At the end of three months, change in height and change in mass were recorded for each ramet. The initial measurement from each ramet was subtracted from its final, meaning the ramets that died were recorded as negative change. An average final height and average final mass were calculated from the two sub-samples (the two MPA and two non-MPA ramets) on each tile giving an n=15 for each density (isolated/crowded) in each location. These data were analysed by Permutations Analysis of Variance blocked by tile, with origin and density as main effects plus the interaction between the two. This analysis was run separately for each of the four locations using the package lmperm [33] on R version 2.15.3 with a=0.05. As significant effects were the same for height as for mass data, only results from the height data are shown.

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
growth_surv_recruit_conspec.csv (Comma Separated Values (.csv), 14.65 KB) MD5:e3e63d84594a471723d36d8af54c49f6 Primary data file for dataset ID 644080

[table of contents | back to top]

Parameters

Parameter	Description	Units
origin_location	combination of the factors origin and location respectively	unitless
origin	where Sargassum fronds were collected for the transplant: MPA = marine protected area; NON-MPA = non-protected area	unitless
location	where Sargassum fronds were transplanted to: MPA = marine protected area; NON-MPA = non-protected area	unitless
condition	whether transplanted area was empty or crowded with conspecifics: crowded = transplanted recruit surrounded by conspecifics; isolated = transplanted recruit isolated from conspecifics	unitless
origin_location_condition	combination of the factors origin, location, and condition respectively: MMcrow = origin MPA - location MPA - condition crowded MMiso = origin MPA - location MPA - condition isolated MNcrow = origin MPA - location NON-MPA - condition crowded MNiso = origin MPA - location NON-MPA - condition isolated NMcrow = origin NON-MPA - location MPA - condition crowded NMiso = origin NON-MPA - location MPA - condition isolated NNcrow = origin NON-MPA - location NON-MPA - condition crowded NNiso = origin NON-MPA - location NON-MPA - condition isolated	unitless
village	village name: VLL = Vatu-o-lailai; VOT = Votua	unitless
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
tile	identification of the tile to which the recruit was attached to	integer
mean_height	the initial height measurement from each ramet was subtracted from its final; meaning the ramets that died were recorded as negative change. An average final height was calculated from the two sub-samples (the two MPA and two non-MPA ramets) on each tile after 3 months of experiment.	cm
average_days_survived	average number of days survived by the two MPA ramets and by the two non-MPA ramets in each tile	days

[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]