Growth of mature caged Sargassum polycystum fronds from MPAs and non-MPAs when reciprocally transplanted

Website: https://www.bco-dmo.org/dataset/643915
Data Type: experimental
Version:
Version Date: 2016-04-29

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

Contributors	Affiliation	Role
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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

Raw data on the growth of mature *Sargassum polycystum* fronds originated from marine protected and non-protected areas (MPAs and non-MPAs, respectively) in Fiji, reciprocally transplanted between these areas and protected by cages. Growth was measured as the difference between the final (30 days) and initial frond length, measured from a standard point established using a thread when the experiment was set. 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 recruit-sized survival - figure 3
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 mature S. polycystum fronds

We used Sargassum polycystum as a study organism because it is often the most conspicuous macroalgal species on degraded Pacific reefs and can grow to dominate large areas [22,28-30]. On reefs lacking adequate herbivory, S. polycystum can reach 8.55 kg wet weight per square metre [28] and its odour can suppress both fish and coral recruitment [5], potentially limiting reef recovery. In Fiji, perennial holdfasts start regenerating in December and by the end of its growing season in June, S. polycystum commonly dominates large expanses of the unprotected reef flats [22,29]. Around this time it may reproduce sexually via spores that disperse only one to three metres [31], suggesting the potential for reduced connectivity between even nearby sites. After June, S. polycystum senesces leaving the perennial rhizomes sheltered within the reef structure. Populations in our study area will have undergone about 10 generations since MPA establishment, which has been shown to be adequate time for population differentiation among some species if selection is strong [24,32].

The dearth of S. polycystum in the MPAs and its high abundance in the non-MPAs could be due to differing physical conditions in those locations. To investigate the role of physical conditions and to test whether S. polycystum in these areas was acclimatising to the different local conditions, a reciprocal transplant experiment was performed between the MPAs and non-MPAs at two villages to measure survival and growth of mature S. polycystum as a function of origin (from the MPA or non-MPA) and habitat (placed in the MPA or non-MPA) when the fronds were protected from herbivory in cages.

The uppermost 15 centimetres of a S. polycystum frond was collected from 40 separate holdfasts in the MPA and 40 in the non-MPA of the villages of both Votua and Vatu-o-lailai. To minimise the likelihood of collecting multiple fronds from a single clone, the holdfasts were separated by at least two metres. The lowest five centimetres of each frond were defoliated, the fronds were then blotted dry with paper towels and weighed to the nearest 0.1g. The top of the defoliated section was marked by piercing the thallus with a needle and tying a thread at this 5cm point to set a standard from which to measure growth in length. One strand of S. polycystum from the MPA and one from the non-MPA were affixed 20cm apart in the centre of a 50cm piece of 3-strand rope. The lowest 5cm of each algal stipe was threaded through the rope to anchor the strand in place. Four ropes were affixed in each of five cages (dimensions 1m x 1m x 0.8m constructed of 1cm mesh) by the two 10cm end sections of each rope so that the rope's centre, holding the algae, was raised a few centimetres above the substrate. Five cages were anchored at a depth of ~1.2m at low tide in both each MPA and non-MPA so that cages at each location were separated by a minimum of two metres. After one month, the length (from the threaded point) and mass of each frond were measured to assess growth.

Change in length was measured in centimetres after two and four weeks. As mass measurements required removing the fronds from the water, to minimise stress to the organism, change in mass was measured in grams only after four weeks. Because significant effects were the same in each of these data sets, only results from height change at week four are reported. A mean change in length was calculated separately for the MPA and non-MPA adults in each cage, yielding an n=5 for each location. Within each independent cage, we calculated the mean growth of MPA origin fronds, the mean growth of non-MPA fronds, and used the difference between these values in paired t-tests run separately for each location testing the effect of origin on growth over the four weeks. These difference scores were normally distributed.

Data Processing Description

To investigate the effect of habitat (MPA or non-MPA) on growth, a Mann-Whitney U test compared MPA originated fronds transplanted into both habitats; the same was done for non-MPA originated fronds. All analyses were conducted in SPSS version 16.0 with a adjusted to a =0.025 to account for the multiple contrasts.

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

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Data Files

File
mat_growth.csv(Comma Separated Values (.csv), 1.46 KB) MD5:a31e828c41c323e2c25897c42f4c240c Primary data file for dataset ID 643915

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Parameters

Parameter	Description	Units
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
village	village name: VLL = Vatu-o-lailai; VOT = Votua	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
growth	difference between the final (30 days) and initial frond length; measured from a standard point established when the experiment was set using a thread	cm

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Instruments

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

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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.

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.

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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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