Porites PSII quantum yield after exposure to Galaxaura thalli in the Viti Levu, Fiji from May 2011 (Killer Seaweeds project)

Website: https://www.bco-dmo.org/dataset/488773
Version: 2014-01-22

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

Contributors	Affiliation	Role
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Methods & Sampling

To confirm that induction of allelochemicals by Galaxaura increases coral damage under field conditions, we conducted an 8-day Galaxaura-Porites manipulation as before, but then placed the thalli (instead of extracts) of Galaxaura that had been in contact with Porites ('treatment') into competition with new Porites fragments (6-8 cm branches, planted as above; n = 15) and assessed the impacts of these seaweeds on corals relative to thalli that had been in contact with Porites skeletons ('controls'; n = 15). We evaluated the effects of treatment and control seaweeds on the photophysiology of these new corals after 2, 4 and 12 days. We also deployed Porites without seaweed contact as environmental controls ('environmental control'; n = 15). At each sampling interval, we took a single PAM fluorometry measurement (as above) on each coral at the most damaged location experiencing seaweed contact along the mid-point of the branch (i.e. excluding extremities). Environmental controls were sampled at the most damaged location along the midpoint using identical protocol. We caged the rack to prevent grazing by large herbivores.

We used PAM fluorometry (Diving-PAM, Walz, Germany) to assess changes in the photosystem II (PSII) quantum yield of zooxanthellae living within Porites, following contact with seaweed thalli or extracts. PAM fluorometry is commonly used to assess PSII function within the coral holobiont in response to biotic or abiotic stressors, and to investigate the processes leading to coral bleaching. Measurements of light-adapted corals (i.e. effective quantum yield (Phi_sub.PSII)) theoretically range from 0.0 to approximately 0.83. Empirical studies suggest that measurements of approximately 0.50-0.75 are indicative of a healthy coral and measurements of approximately 0.00-0.25 are indicative of coral bleaching and mortality. Effective quantum yield (Phi_sub.PSII) values are highly correlated with visual assessments of coral bleaching for Porites and other corals at our study site. We wanted to assess coral responses in nature with minimal disturbance of the test corals, so we sampled them in the field between 09.00 and 13.00 h. We interspersed readings for treatments and controls through time to prevent confounding seaweed effects with in situ temporal changes in non-photochemical quenching (i.e. temperature and UV). Coral fragments were (i) collected from colonies adjacent to our experimental rack (i.e. the same depth and local condition), (ii) allowed to acclimate on the rack for 1-24 months prior to experiments and (iii) haphazardly interspersed among treatments and controls to homogenize initial variance in zooxanthellae density and diversity among replicates. We avoided self-shading while sampling.

Relevant References:

* Rasher DB and ME Hay. "Competition induces allelopathy but suppresses growth and anti-herbivore defense in a chemically rich seaweed". Proceedings of the Royal Society: B-Biological Sciences. vol. 281 no. 1777 20132615, 2014 (http://dx.doi.org/10.1098/rspb.2013.2615).

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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Data Files

File
Glax_thalli.csv (Comma Separated Values (.csv), 7.83 KB) MD5:ad79d58cbd7b05525402d45684c0a057 Primary data file for dataset ID 488773

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Parameters

Parameter	Description	Units
lat	latitude; north is positive	decimal degrees
lon	longitude; east is positive	decimal degrees
date	sampling date	mm/dd/yyyy
day	days of seaweed contact	days
Galaxaura_contact	treatment thalli = previous contact with coral; control thalli = previous contact with skeleton; environmental control = no seaweed contact. See Rasher & Hay (2014) for full description	unitless
replicate	replicate identification number	unitless
id	tag identification number	unitless
yield	photosystem II quantum yield of zooxanthellae living within Porites	unitless

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Instruments

Dataset-specific Instrument Name	Fluorometer
Generic Instrument Name	Fluorometer
Dataset-specific Description	Diving-PAM underwater fluorometer, Walz, Germany
Generic Instrument Description	A fluorometer or fluorimeter is a device used to measure parameters of fluorescence: its intensity and wavelength distribution of emission spectrum after excitation by a certain spectrum of light. The instrument is designed to measure the amount of stimulated electromagnetic radiation produced by pulses of electromagnetic radiation emitted into a water sample or in situ.

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Deployments

Fiji_2011

Website	https://www.bco-dmo.org/deployment/480730
Platform	Hay_GaTech
Start Date	2010-11-01
End Date	2012-01-01
Description	Studies for this deployment were conducted: November 2010 through February 2011 and between November 2011 and January 2012 on shallow (~1 m below the surface at low tide, equal or shallower than 2 m at high tide), intertidal fringing reefs platforms in Villages of Votua, Vatu-o-lalai and Namada, Coral Coast Viti Levu, Fiji. May–December 2011 on an approximately1.5-2.5 m deep reef flat within a no-take marine reserve at Votua Village, Viti Levu, Fiji.

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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.

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Funding

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

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