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

Website: https://www.bco-dmo.org/dataset/488758
Version: 2014-01-22

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

Contributors	Affiliation	Role
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Dataset Description

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.

Methods & Sampling

To assess allelochemical induction in Sargassum and Galaxaura after 8 days of competition with coral, we generated hydrophobic extracts from treatment and control thalli and tested their allelopathic effects on new Porites in the field. We previously identified two allelopathic compounds produced by G. filamentosa-both terpenoid loliolide derivatives. Although these two molecules may be involved in the induction of allelopathy in

Galaxaura, monitoring changes in their concentrations pre- versus post-competition to evaluate induction would be insufficient and potentially misleading, because they represent only two of at least six compounds in an allelopathic mixture produced by Galaxaura. The other allelopathic compounds remain unidentified due to their low yield and/or instability following isolation. Given that multiple compounds within Galaxaura act together to produce its allelopathic effect and that most of these compounds cannot be identified and thus quantified, the only rigorous way to evaluate induction was to assess the allelopathic strength of the extract from seaweeds that had competed with corals versus those that had not. We assessed this for hydrophobic crude extracts because previous studies demonstrated that hydrophilic fractions produced no allelopathic effect and the effect of the whole seaweed was reproduced by the hydrophobic extract alone.

For each seaweed species, we created bulk extracts by removing a small portion of thallus from each seaweed and grouping them by treatment or control. We determined the volumetric displacement of the grouped thalli from each species, exhaustively extracted each in 100% methanol, and dried each by rotary evaporation. We then partitioned each extract between water and ethyl acetate, and retained the hydrophobic (ethyl acetate) fraction of each for testing its allelopathic effects on Porites. To test its effects on Porites, hydrophobic extracts from treatment and control thalli were re-suspended in solvent and incorporated at natural volumetric concentration into a series of approximately 1 cm2 Phytagel (Sigma-Aldrich, USA) squares (n = 10 extract^-1 species^-1) hardened on window screen backing [37,38]. We also prepared squares with solvent but no seaweed extract as controls for the effects of the Phytagel, solvent and backing (n = 10; 'Phytagel control'). Phytagel squares with and without seaweed extracts differed in colour and clarity but because the bioactivity of Sargassum extract squares (dark) and Phytagel control squares (light) did not differ (figure 1), nor did several pigmented seaweed extract versus Phytagel control contrasts in previous assays, we assumed that colour did not affect pulse-amplitude-modulated (PAM) readings to a detectable degree and thus avoided the use of dyes (with unknown effects) to standardize colour/clarity.

Phytagel squares were wrapped and cable-tied at mid-height on individual branches of Porites (6-8 cm height, planted as above) and were interspersed on an un-caged rack in the reserve. After 24 h, we assessed the effects of seaweed extracts versus Phytagel controls on coral photophysiology by taking a single PAM fluorometry measurement (fibre-optic diameter = 5.5 mm, distance = 9-10 mm, angle = perpendicular) under the centre of each square (see paper for detailed methods).

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Data Files

File
extract_allelopathy.csv (Comma Separated Values (.csv), 2.65 KB) MD5:783f6521ea946f8ca85737a4f7b23011 Primary data file for dataset ID 488758

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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	mmddyyyy
extract	hydrophobic extracts from treatment and control thalli	unitless
replicate	replicate 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.

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Funding

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

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