Responses of polyps (survival, inoculation time, time to strobilation, time to ephyra production, bud production, ephyra production) to exposure to five different algal symbiont genotypes

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Project
» RUI: Collaborative Research: Genetic variation as a driver of host and symbiont response to increased temperature on coral reefs (Host Symbiont Temp Response)

Contributors	Affiliation	Role
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Abstract
This dataset includes measurements of the responses of polyps (survival, inoculation time, time to strobilation, time to ephyra production, bud production, ephyra production) to exposure to five different algal symbiont genotypes. This work was conducted in laboratory growth chambers in Los Angeles, California, USA.

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Coverage

Temporal Extent: 2019-12 - 2019-12

Methods & Sampling

We inoculated aposymbiotic Cassiopea xamachana clones with one of the five genotypes of *S. microadriaticum* and maintained them at 26°, 30°, and 32°C for 28 days. We also maintained replicates of aposymbiotic polyps at each temperature as a control. For 26 days, we measured the survival of each polyp, as well as asexual reproduction and developmental timing.

After four days of acclimation to temperature (i.e., Day 1), we supplied polyps with access to one of the five genotypes of *S. microadriaticum*, while also maintaining control polyps with no symbionts. Each well was inoculated with 24,000 cells (2,000 cells/mL) from the appropriate stock algal culture. We fed polyps with Artemia nauplii immediately prior to symbiont inoculation because symbiont uptake occurs more readily when polyps are feeding. We inoculated four six-well plates with each of the five algal genotypes, plus a no algae control, at each temperature, resulting in 24 replicate wells for each genotype by temperature combination (N=432 polyps). We inoculated wells on days 1, 4, 11, 17, 20, and 23 using the same density of cells from the

same stock cultures each time. We visually inspected polyps daily under a dissecting microscope to determine survival. When a polyp died, the polyp was removed and the well was emptied. We quantified two strategies of asexual reproduction as the total number of buds and total number of ephyra produced. Buds that were produced during the experiment remained in the well; most buds settled and metamorphosed into polyps, but the experiment was not long enough to allow any newly produced buds to become inoculated and strobilate. We removed all ephyrae that were produced during the experiment the day they detached from the parent polyp. We also measured three developmental timing events: time to inoculation, time to strobilation, and time to ephyra release. Aposymbiotic polyps are white and appear brown once inoculated with algae, so polyps were considered inoculated when a brown tint was observable under the dissecting microscope. Polyps were considered to have begun strobilating when they became disc-shaped rather than cone-shaped. The time to ephyra release was marked as the day that the ephyra detached from the parent bud.

Data Processing Description

Data Processing:
We used multiple general linear mixed effects models to test for the effects of algal genotype, temperature, and their interaction on total bud production and total ephyra production. Bud production data met assumptions of normality and homoscedasticity and ephyra production was square-root transformed to meet assumptions. Because Cassiopea will not produce ephyra without symbionts, we removed the aposymbiotic group for analyses of ephyra production and the developmental timing events below. Because not all polyps reached each developmental stage, we used a hurdle model approach to examine whether algal genotypes, temperature, and their interaction affected (a) development to each development stage (survival, successful inoculation, strobilation, and ephyra production) and (b) the time for successful individuals to reach that stage. To determine the effects of each factor on reaching each developmental stage, we used generalized linear models with a binomial error distribution, removing individuals who did not reach a previous stage when analyzing progress to the next stage. Then we used additional general linear mixed effects models to test the effects of the same factors on the time to reach each stage, again removing individuals that did not reach a particular stage. Data were transformed to meet model assumptions (inoculation and strobilation: log; ephyra: Box-Cox transformation). To account for any variation among replicate plates, in all models we included plate as a random effect, but removed the random effect when it did not increase model fit (determined by AIC). All models were fit using lm or lmer (or glm and glmer for binomial error distributions) in the ‘lme4’ package in R (v. 4.0.3). For mixed models, we tested the significance of fixed effects with Likelihood Ratio Tests; in the absence of random effects, we tested fixed effects using Anova in the ‘car’ package.

BCO-DMO Processing:
- Missing data identifier ‘NA’ replaced with 'nd' (BCO-DMO's default missing data identifier);
- Added a conventional header with dataset name, PI names, version date
- Rounded column "r" to three decimal places

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Data Files

File
polyp_fitness.csv (Comma Separated Values (.csv), 15.37 KB) MD5:c438f406b708ca0b20fb55d941e64d98 Primary data file for dataset ID 874609

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Parameters

Parameter	Description	Units
WellNum	Plate well number	unitless
Genotype	One of five algal genotypes	unitless
Temp	Growth temperature	degrees celisius
Plate	Plate number	unitless
DayDead	Day on which a polyp died	unitless
Survive_to_End	Binary survival (yes or no)	unitless
Days_to_Inoculation	Number of days until inoculation	unitless
Days_to_Strobilation	Number of days until strobilation	unitless
Days_to_Ephyra	Number of days until first ephyra	unitless
TotalBuds	Number of buds produced	unitless
TotalEphyra	Number of ephyrase produced	unitless

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Instruments

Dataset-specific Instrument Name	Leica compound microscope
Generic Instrument Name	Microscope - Optical
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

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Project Information

RUI: Collaborative Research: Genetic variation as a driver of host and symbiont response to increased temperature on coral reefs (Host Symbiont Temp Response)

Coverage: Florida Keys, Caribbean

Description from NSF award abstract:
On coral reefs, mutualisms with single celled algae (Symbiodinium) and reef species literally and figuratively form the foundation of reef ecosystems. Coral reefs are among the most threatened ecosystems under a changing climate and are rapidly declining due to increasing levels of environmental stress, namely increased temperatures. Climate change is resulting in even warmer ocean temperatures that threaten associations between Symbiodinium and their hosts. In this project the investigators examine the genetic diversity of Symbiodinium and the potential for this important species to evolve in response to temperature. The project will also address whether the ecological and evolutionary dynamics of the Symbiodinium population affect the performance of their host. If so, this suggests that the evolution of microscopic organisms with short generation times could confer adaptation to longer-lived host species on ecologically and economically vital coral reefs. Given that diversity is already being lost on many reefs, considering how evolutionary changes in Symbiodinium will affect reef species is crucial for predicting the responses of reefs to future climate change. This project provides training for two graduate students and several undergraduates at a Hispanic-serving

institution. This work includes outreach to the students and the general public through the Aquarium of Niagara, local K-12 schools, and web-based education modules.

The effects of evolution on contemporary ecological processes are at the forefront of research in evolutionary ecology. This project will answer the call for experiments elucidating the effects of genetic variation in Symbiodinium performance and the effect on the response of the holobiont (host and symbiont) to increased temperature. These experiments examine the effects of temperature through both ecological and evolutionary mechanisms and will determine the relative importance of adaptation and acclimatization in replicated experimental populations. The investigators will examine how genetic variation within a species (Symbiodinium antillogorgium) affects symbiont performance in culture and in the host and how this affects the response of the holobiont to increased temperature. Further, the project examines whether holobiont response to increased temperature associated with climate change depends on particular GxG host-symbiont combinations. Moreover, the investigators will examine the effects of symbiont history on mutualist hosts, which have been largely ignored in eco-evolutionary studies. These experiments provide a first step in predicting whether invertebrate hosts on coral reefs will respond to global change via adaptation of their symbionts.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1559105

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