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Shifting Baselines in Coral Bleaching Resilience

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SHIFTING BASELINES IN CORAL BLEACHING RESILIENCE

Background
- Coral bleaching events are increasing in frequency, magnitude and duration.
- Tropical corals live at/near their upper thermal limits.
- Variable thermal reef environments promote increased thermal tolerance.
- These habitats serve as natural laboratories to understand coral stress tolerance.
- Branching corals from a highly variable (HV) pool on Ofu Island, American Samoa, have higher bleaching resistance than corals from a moderately variable (MV) pool, and MV corals increase heat tolerance when moved into the HV pool.
- Can massive coral species from nearby pools also increase thermal tolerance in the HV pool?

Overview
- Coral bleaching resistance is attributed to phenotypic plasticity and adaptation to frequent pulses of sub-lethal water temperatures.
- From 2015-2016, we tested whether populations of two massive coral species could increase stress tolerances after transplantation into a backreef pool known to enhance bleaching resistance.
- We found evidence of local specialization and limited acclimation potential of massive coral species in conjunction with extreme temperature anomalies in the HV backreef pool.

Results

Porites lobata
- Growth in HV corals > MV_HV & LV_HV (HV_MV_TW p < 0.001, HV_LV_HV p < 0.001).
- By July 2016, native > transplant growth (MV_MV-MV_HV p < 0.001).
- Photosynthetic efficiency in native MV corals > native HV & LV (MV_MV-MV_HV p < 0.001).
- Chlorophyll retention in LV corals > HV (p < 0.001).
- No effect of heat treatment on MV corals.
- All corals harbored Cladocopium ITS type C15.

Goniastrea retiformis
- Growth in native MV corals > MV_HV, LV_HV, and LV_LV (HV_MV_HV, p < 0.001).
- By July 2016, native MV > transplant growth (MV_MV-MV_HV p < 0.001).
- Photosynthetic efficiency of MV corals in January > July (p < 0.001).
- All corals harbored Cladocopium ITS type C40, but types C15 and C3 were abundant.

Methods

ORIGIN
- HV n=120/species
- MV n=120/species
- LV n=120/species

TRANSPLANT
- Native (Common Garden)
- 6 Months
- January 2016

- 12 Months
- July 2016

TIME POST TRANSPLANT
- Control 28°C
- Heat 36.5°C

Treatment
- Porites lobata

Temperature
- Daily thermal maximum in HV pool > MV & LV pool (Tukey’s limmeans for MV-MV_HV p = 0.003, HV-LV_HV p = 0.004).
- Daily temperature range in summer > winter (Tukey’s limmeans for DTR: Summer-Winter p = 0.001).
- Sea Surface Temperatures in 2016 > 2011-2012 and 2015 (p < 0.001).
- Degree Heating Weeks from 2015-2016 > 2010-2012 (p < 0.001).

Conclusions
- Coral transplants in the HV pool had reduced growth, decreased photosynthetic efficiency, and greater chlorophyll loss after heat stress.
- Corals are specialized to their native thermal environment.
- HV corals were more susceptible to acute bleaching stress (P. lobata only) than other native backreef corals.
- Illuminates trade-offs between growth (a proxy for fitness) and stress tolerance.
- The HV pool’s thermal regime appeared to exceed massive coral species’ stress tolerance threshold.
- This could be the first demonstration of a shifting baseline from increased to decreased resilience in corals residing in high-frequency variable environments.
- Species in fluctuating variable environments have evolved the highest tolerance limits and could soon become vulnerable to future climate warming.

Ongoing Research
- Full Reciprocal Transplant Experiment between HV and MV P. lobata populations to elucidate mechanisms underlying local specialization to Ofu’s backreef pools.
- Transcriptome-wide sequencing to examine differential gene expression patterns and potential heat-tolerance loci under selection across the three backreef populations of P. lobata.

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