KI Platygyra Manuscript

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## Loading required package: qdapDictionaries
## Loading required package: qdapRegex
## Loading required package: qdapTools
## Loading required package: RColorBrewer
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## Attaching package: 'qdap'
## The following object is masked from 'package:base':
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##     Filter
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1 Summary

Ocean ecosystems worldwide are threatened by climate change-induced increases in seawater temperatures. Pulse warming events such as El Nino amplify these threats, causing massive losses of coral cover (e.g. 17% of coral reefs during the 1997/98 El Nino). The 2015/16 El Nino is currently the worst on record in terms of severity and longevity, yet despite massive coral mortality, some corals show resilience to this extreme event. Coral resilience is related to many factors, including the structure and flexibility of their internal symbiotic communities. Here we show that the ability of a coral to house a diverse suite of symbionts (*Symbiodinium*) is driven by the identity of the dominant *Symbiodinium* type. Additionally we show that, contrary to current opinion, symbionts present in miniscule abundances (<2%) are indeed important for coral recovery, and furthermore, that corals have the ability to regain symbionts during an extended stress event, providing hope for the future of coral resilience.

2 Background *rename using header reqs: The text may contain subheadings (<6 in total) of <40 characters (incl spaces) each.*

El Nino warming is terrible, creating a particularly acute threat to coral reefs, which already live on the edge of their thermal tolerance. El Niño, the positive phase of the ENSO (El Niño Southern Oscillation), is a natural climatic event that occurs when surface waters heat up in the equatorial Pacific, causing catastrophic effects on reef ecosystems by disrupting coral symbioses (i.e. coral bleaching). The 2015-2016 El Niño is the first major global event since 1997-1998, and has been declared the third global coral bleaching event by NOAA (cite Reef article). El Ninos are getting worse, threatening coral reefs and endangering the persistence of vital ecosystem services, threatening the food security and coastline protection of coastal communities worldwide. Kiritimati Atoll (Christmas Island), located in the Central Equatorial Pacific, is at the epicenter of this extreme El Niño event. Thermal anomalies were severe on Kiritimati, reaching an unprecedented (cite o h-g) XX number of DHW over a XX month long bleaching event, demolishing most of the reef (**???**). *as stressors increase worldwide, all reefs (from shit to pristine) will be increasingly threatened as resilience and recovery are limited by overwhelming environmental stress* Kiritimati reefs range from heavily impacted to

nearly pristine, and thus provides an ideal microcosm to investigate how reefs worldwide will respond to increasing environmental stress, and *XX* potential capacity for resilience and recovery.

El nino warming threatens coral reefs by disrupting the dynamic symbiosis between coral and their internal symbiotic algae (Symbiodinium). This symbiosis is the foundation of reef ecosystems, and a critical element of reef resilience (van oppen and gates 2006). Corals host a diverse community of Symbiodinium, ranging along a continuum from 'selfish opportunistic symbionts' (e.g. some clade D Symbiodinium) which are better suited to sustained environmental stress than others, to 'intimately evolved symbionts' which provide exceptional amounts of nutrition to their coral host (1). Thus, although these relationships have developed over evolutionary time, the resilience of the coral symbiome is constantly shaped by dynamic coral-symbiont interactions (2). *We used to think that bleaching might be good - ABH says that corals bleach in order to expel suboptimal Symbiodinium types in exchange for optimal symbionts during the new conditions (3, Baker:2001bf, 4) We do know that corals house background symbionts in low abundances (5, all the recent ngs studies...), but these relationships have been described as unstable (6, more cites?).* Switching and shuffling (7)* *And we do know that some symbio are "better" than others And then we said that bleaching is definitely bad But at least we do know that it allows changes to occur in the Symbiodinium community structure*

Example of when this high-risk ecological opportunity (8) actually pays off...

Regardless it is likely that symbiodinium community composition is important for resilience, corals that host flexible symbioses may be more sensitive to environmental changes (9) Taxa-specific bleaching is a thing When we've seen resilience/recovery before, corals have only been demonstrated to recover if the stress goes away first Previously, corals have been shown to recover from bleaching only after the external stress (e.g. warming) has subsided. *implying that longer and more frequent stressors spell disaster for reefs worldwide*

Here, we tagged and sampled the same corals before, during, and immediately after the el nino event, on Kiritimati (something about Kiritimati). We used Illumina sequencing to evaluate changes in symbiodinium community structure coincident with the 2015-2016 major el nino event. The goal was to understand... why the hell these corals survived 10 months of extreme heat stress, and actually got better in the middle of it.

3 Findings

a concise, focused account of the findings, probably <2,000 words Results Paragraph 1 (different dominant symbionts drive symbiont diversity capacity, also they didn't switch at commencement of bleaching event) *Figure about diversity* Results Paragraph 2 (<2% symbionts are indeed important) - can I calculate some sort of change score for the different types? *Figure of example sequence abundances, superimposed on coral 99 images* Results Paragraph 3 (Corals can regain symbionts during an extended stress event)

4 Discussion

one or two short paragraphs of discussion. Probably around 500 wds Discussion Paragraph 1 (Methods like NGS are really important for understanding these changes in symbiont diversity, as well as for seeing those low aboundance symbionts) Discussion Paragraph 2 (What does their recovery tell us about the future of coral reefs?)... Why are Platys so excellent and what does that tell us about when coral resilience is threatened by extreme climatic events?

Elucidating the mechanisms underlying changes in coral-symbiont interactions is essential to understanding the ability of the coral symbiome to adapt to the multiple stressors they now face.

5 Methods

The Methods section should be written as concisely as possible but should contain all elements necessary to allow interpretation and replication of the results. As a guideline, Methods sections typically do not exceed 3,000 words.

5.1 Field Information

Kiritimati basics - located in the Central Equatorial Pacific, smack dab in the middle of the Nino 3.4 region (used to quantify el nino presence and strength), human disturbance gradient, bleaching event there (cite bleaching paper here) Tagging corals and collecting samples - transects, tagging corals, photoing corals, sampling corals, processing samples, storage in Guanidinium Taxa sampled - platy, favites, favia, etc. ## Pre-processing and sequencing DNA Extraction - extraction protocol ITS2 region - it's annoying, but it's the best we've got right now PCR and Cleanup - Amy's method of PCR and cleanup Library Prep - Amy's method of library prep, include Illumina Sequencing information (barcodes, etc) ## Post Processing Sequence QC - boku, then merge with illumina utils, max mismatch=3 Sequence clustering - denovo clustering using UCLUST in QIIME, then compare to reference database to assign taxonomy Statistical Analysis - alpha diversity of sequence reads, co-occurence?, beta diversity?

6 References

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8. Baker, A. C. Ecosystems: Reef corals bleach to survive change. *Nature* **411,** 765–766 (2001).

9. Putnam, H. M., Stat, M., Pochon, X. & Gates, R. D. Endosymbiotic flexibility associates with environmental sensitivity in scleractinian corals. *Proceedings of the Royal Society B: Biological Sciences* **279,** 4352–4361 (2012).