NSF-funded project (1/1/2111-12/31/2015)

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Title- The effects of ocean acidification on the organismic biology and community ecology of corals, calcified algae, and coral reefs

Project Summary

Introduction. This project is a 4-y effort focused on the effects of Ocean Acidification (OA) on coral reefs at multiple spatial and functional scales. The project focuses on the corals, calcified algae, and coral reefs of Moorea, French Polynesia, establishes baseline community-wide calcification data for the detection of OA effects on a decadal-scale, and builds on the research context and climate change focus of the Moorea Coral Reef LTER which we direct as 2 of the 4 PIs. The project goals will be attained by combining the skills of scientists with expertise in tropical algal ecophysiology (R. Carpenter), and coral ecophysiology (P. Edmunds), and will establish a post-doctoral, graduate, and undergraduate mentoring program to accomplish the field experimentation. *The project addresses one of the most significant contemporary issues in marine science (OA), capitalizes on the research commitment of the NSF LTER program, and will help to ensure that the US maintains a pivotal role in the global effort to understand OA.*

Intellectual Merit. While coral reefs have undergone unprecedented changes in community structure in the past 50 y, they now may be exposed to their gravest threat since the Triassic. This threat is increasing atmospheric CO_2, which equilibrates with seawater and causes OA. In the marine environment, the resulting decline in carbonate saturation state (Ω) makes it energetically less feasible for calcifying taxa to mineralize; this is a major concern for coral reefs. It is possible that the scleractinian architects of reefs will cease to exist as a mineralized taxon within a century, and that calcifying algae will be severely impaired. While there is a rush to understand these effects and make recommendations leading to their mitigation, these efforts are influenced strongly by the notion that the impacts of pCO_2 (which causes Ω to change) on calcifying taxa, and the mechanisms that drive them, are well-known. *It is our assertion that many of the key processes of mineralization on reefs that are potentially affected by OA are only poorly known. Moreover, we assert that current knowledge is inadequate to support the scaling of OA effects to the community level. It is vital to measure organismal-scale calcification of key taxa, elucidate the mechanistic bases of these responses, evaluate community scale calcification, and finally, to conduct focused experiments to describe the functional relationships between these scales of mineralization.*

We propose a hypothesis-driven approach to compare the effects of OA on reef taxa and coral reefs in Moorea. We will utilize microcosms to address the impacts and mechanisms of OA on biological processes, as well as the ecological processes shaping community structure. Additionally, studies of reef-wide metabolism will be used to evaluate the impacts of OA on intact reef ecosystems, to provide a context within which the experimental investigations can be scaled to the real world, and critically, to provide a much needed reference against which future changes can be gauged. ***Importantly, this proposal addresses several of the high priority recommendations of NSF-sponsored workshops and recent reviews of ocean acidification (Kleypas et al. 2006; Doney et al. 2009; Hofmann et al. 2010)***

Significance and Broader Impacts. The significance of this project lies in the current inability of the scientific community to accurately predict the effects of OA on coral reefs. The broader significance and impact of this research is to blend two approaches, a response of organisms to environmental chemistry versus ecological competition and multiple forcing at both organismal and community scales. The data also will provide a baseline for repeated investigations in the coming decades. In addition to conventional broader impacts including the mentoring of postdocs, graduate students, undergraduates, and technicians, CSUN is designated as an

Hispanic-serving institution, which will ensure that the research will reach beyond the traditional demographics dominating scientific disciplines in the US. The labs of the co-PIs are integrated within a framework of K-12 education (including teachers and their students), and a mentoring program that forges interactions among children, university faculty, and graduate students. In the field, the Gump Research Station interacts with the Polynesian community through the At'itia cultural center that provides a locus for educational activities.