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Coralline algae in a naturally acidified ecosystem persist by maintaining control of skeletal mineralogy and size

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To understand the effects of ocean acidification (OA) on marine calcifiers, the trade-offs among different sublethal responses within individual species and the emergent effects of these trade-offs must be determined in an ecosystem setting. Crustose coralline algae (CCA) provide a model to test the ecological consequences of such sublethal effects as they are important in ecosystem functioning, service provision, carbon cycling and use dissolved inorganic carbon to calcify and photosynthesize. Settlement tiles were placed in ambient pH, low pH and extremely low pH conditions for 14 months at a natural CO_2 vent. The size, magnesium (Mg) content and molecular-scale skeletal disorder of CCA patches were assessed at 3.5, 6.5 and 14 months from tile deployment. Despite reductions in their abundance in low pH, the largest CCA from ambient and low pH zones were of similar sizes and had similar Mg content and skeletal disorder. This suggests that the most resilient CCA in low pH did not trade-off skeletal structure to maintain growth. CCA that settled in the extremely low pH, however, were significantly smaller and exhibited altered skeletal mineralogy (high Mg calcite to gypsum (hydrated calcium sulfate)), although at present it is unclear if these mineralogical changes offered any fitness benefits in extreme low pH. This field assessment of biological effects of OA provides endpoint information needed to generate an ecosystem relevant understanding of calcifying system persistence.

1. Background

A primary challenge for global change biology is to better understand the role of the sublethal effects of environmental change on individuals and populations in real world ecosystems. Laboratory experiments provide critical insight into the direct effects of environmental change on individual species, but it is often unclear how such effects will be balanced with other responses, or manifest in more complex ecosystems or naturally variable environments. Thus, a better understanding of the trade-offs among sublethal effects of environmental change, as well as how the sublethal effects reported in laboratory experiments materialize in field environments can improve forecasts of the ecological effects of global change.

Ocean acidification (OA), caused by the absorption of atmospheric carbon dioxide (CO_2) into seawater, is projected to have widespread impacts on marine species and ecosystems in the near future [1]. Corals, coralline algae, foraminifera, sea urchins, molluscs and other marine organisms whose skeletons or shells are composed of calcium carbonate ($CaCO_3$) are projected to be some of the worst affected, as changes in seawater chemistry may increase the energetic costs of building and maintaining $CaCO_3$ structures [2,3]. In general, OA reduces