



# **Climate change impacts on Caribbean coral reefs: reef accretion and scope for acclimation through symbiont genetic diversity**

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## Abstract

Caribbean coral reefs are in crisis. Degradation of living coral and fish assemblages has accelerated during the past half century, with a suite of anthropogenic drivers –from local fishing pressure to unprecedented global scale climate change– implicated. Accompanying these losses is the physical disintegration of the three-dimensional calcium carbonate reef structure. Flattening of reefs, synonymous with loss of ecosystem function and provision of services, is caused by an imbalance in the carbonate budget: a trade-off between carbonate production and consolidation by calcifying organisms (principally coral-algal symbioses) and framework breakdown by bioeroding organisms and storms.

This thesis focuses on expanding our understanding of two functionally critical issues that strongly influence Caribbean coral reef community composition and dynamics, and which look likely to have a key bearing on the future state of reefs in the region: coral photosynthetic endosymbionts, and carbonate budgets. The former exert an important role in the production of the coral carbonate framework, whilst the latter reflect the dynamics of reef carbonate production and erosion. In the first part of the thesis, existing information on rates of carbonate production and erosion on Caribbean reefs is utilised to construct a detailed theoretical carbonate budget model. The model is used to chart historic changes in Caribbean carbonate budgets, tracking reef flattening across time and identifying key ecological drivers of these changes. This “eco-geomorphic” model is then coupled with state-of-the-art climate and ecological models, to project reef processes to the end of the century, asking the question ‘at what point will Caribbean reefs shift to net erosional regimes?’. The models are also used to explore the efficacy of local management and climate mitigation in altering the negative trajectory of reefs under projected warming and ocean acidification.

In the second part of the thesis, 632 corals from across the wider Caribbean are screened, to construct the largest recorded baseline of symbiont biogeography for the region’s key remaining reef framework builder, *Montastraea annularis*. Spatial patterns of symbiont diversity are explored in terms of environmental, geographic and genetic factors, contributing to the growing body of work currently in the early stages of cataloguing symbiont diversity and its ecological significance.

Although carbonate budget models forecast a bleak outlook for the Caribbean, detection of widespread low-level prevalence of thermally-tolerant endosymbionts in *M. annularis* provides a weak ‘nugget of hope’ for potential coral acclimation. Combined local management and aggressive mitigative action on carbon emissions are pre-requisites for maintenance of functioning reefs into the next century. Coral reef conservation efforts can be improved if we fully appreciate the contributions of *all* reef components –not just the enigmatic ones– to healthy reef functioning.

For the beautiful reefs of the Caribbean

And for Duncan

Patience is a virtue, and I'd wait forever

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