

Unlocking how corals have acclimatised to thrive within the temperate waters of Sydney Harbour

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Certificate of Original Authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been appropriately acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This research is supported by an Australian Government Research Training Program Scholarship.

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Samantha Goyen

17/07/2019

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Thesis Summary

Whilst corals are under immense anthropogenic pressure from increasingly altered environments, growing evidence suggests that some coral populations have evolved to thrive within present day marginal environments. Marginal coral populations are therefore significant to understand the adaptive and acclimative capacities required to tolerate future climates. Genetic shifts within the coral microbiome are being increasingly recognised for their importance to holobiont functioning under extremes, and is considered in this thesis in terms of symbiont (Symbiodiniaceae) and bacterial diversity in response to variable environmental conditions. Promising new “omics” approaches are allowing us to create species-specific metabolite profiles and further uncover the complex mechanisms of cell metabolism under environmental stress. When coupled to measurements of coral physiological variables (photosynthesis, respiration and calcification), the molecular regulation of corals under various environmental conditions can be elucidated.

This thesis focuses on two coral species, *Plesiastrea versipora* and *Coscinaraea mneilli* surviving under highly variable environmental conditions in Sydney Harbour. Specifically, coral heat stress tolerance was investigated during the 2016 El Niño event, which led to the first report of coral bleaching in Sydney Harbour, showing that these high-latitude corals bleach in a similar way to tropical corals. Sampling for microbial diversity analysis was conducted ahead of coral bleaching in February, during coral bleaching in April and during coral recovery in August. Parallel measurements of coral metabolic rates (photosynthesis, respiration and calcification) were made in aquaria. Only *P. versipora* showed a bleaching response and a switch towards a heterotrophic nutrient acquisition mode during bleaching highlighting the different bleaching susceptibilities of these two-coral species. Microbial community composition showed clear species-specific associations and shifts in diversity and abundance of key bacterial taxa in response to the thermal anomaly event and over a 2-year study with

seasonal environmental change. Metabolite profiling conducted using GC-MS showed overall between species similarity with lipid compounds dominating the metabolome of both coral species. Under acute heat stress, increases in fatty acid metabolism significantly correlate to holobiont photosynthesis, suggesting a predictive capacity of metabolomic analysis in determining coral performance under heat stress.

The systematic approach implemented in this thesis highlights some of the potential mechanisms of coral persistence in marginal environments. This is relevant as high-latitude regions such as Sydney have been proposed as coral refuge environments with climate change. This research will also open up a new level of biodiversity complexity quantification that is used to designate Sydney Harbour's high conservation value.