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Acclimatory and adaptive responses to climate change in complex life history corals

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Abstract

Coral reefs are often referred to as the rainforests of the sea and provide goods and services to humans that are valued on the 100's of billions of dollars annually. However, 50% of the worlds coral cover has been lost since 1975, due Anthropogenic impacts and primarily to marine heatwaves. Species-specific thermal tolerance and the influence of ontogeny and legacy effects of increasing temperatures have yet to be fully clarified for many corals and across geographic locations, hampering capacity to forecast reef futures under climate change. Our novel documentation of coral gametogenesis and spawning times allowed us to initiate test of thermal legacy on larval development. Gene expression analysis of coral embryos revealed the maternal mRNA complement was dominated by transcriptional activity of development, compared to heavier translational regulation of zygotic gene expression at the swimming larval stage. Development of embryos at 31°C, compared to 28°C, for the first ~48 hours of life resulted in thermal legacy effects on developmental acclimation, with larvae that developed at 31°C showing gene expression enrichment for more advanced development stage processes and differential lipid metabolism, with implications for pelagic larval duration. Nutritionally, larvae shift their dependence on their symbionts with ontogeny and importantly can regulate their symbiont populations to an extent to improve thermal tolerance. Further, our work indicates microRNAs may be regulating the maternal to zygotic development. In juvenile and adult stages we used a Thermal Performance Curve approach to quantify thermal tolerance of multiple Caribbean and Pacific coral taxa at the adult stages. Through this we reveal species specific mechanisms of gene expression and regulation underlying thermal tolerance differences, including alternative splicing and isoform switching. Currently, we are focusing on fine scale studies via Laser Capture Microdissection, single nuclei RNASeq, and spatial transcriptomics to reveal tissue specific gene expression and regulation. Collectively, the work of our lab highlights the importance of studying acclimatization mechanisms across life history stages to better forecast coral performance in a changing climate.