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Plasticity to ocean warming is influenced by transgenerational, reproductive, and developmental exposure in a coral reef fish

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Abstract:

Global warming is expected to drive some ectothermic species beyond their thermal tolerance in upcoming decades. Phenotypic plasticity, via developmental or transgenerational acclimation, is a critical mechanism for compensation in the face of environmental change. Yet, it remains to be determined if the activation of beneficial phenotypes requires direct exposure throughout development, or if compensation can be obtained just through the experience of previous generations. In this study, we exposed three generations of a tropical damselfish to combinations of current-day (Control) and projected future (+1.5°C) water temperatures. Acclimation was evaluated with phenotypic (oxygen consumption, hepatosomatic index, physical condition) and molecular (liver gene expression) measurements of third-generation juveniles. Exposure of grandparents/parents to warm conditions improved the aerobic capacity of fish regardless of thermal conditions experienced afterwards, representing a true transgenerational effect. This coincided with patterns of gene expression related to inflammation and immunity seen in the third generation. Parental effects due to reproductive temperature significantly affected the physical condition and routine metabolic rate (oxygen consumption) of offspring, but had little impact on gene expression of the F3. Developmental temperature of juveniles, and whether they matched conditions during parental reproduction, had the largest influence on the liver transcriptional program. Using a combination of both phenotypic and molecular approaches, this study highlights how the conditions experienced by both previous and current generations can influence plasticity to global warming in upcoming decades.

Keywords: acclimation, aerobic metabolism, climate change, gene expression, phenotypic plasticity