ASSESSING THE IMPACT OF ATMOSPHERIC HEATWAVES ON INTERTIDAL CLAMS

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Heatwaves have become more frequent and intense in the last two decades, resulting in detrimental effects on marine bivalves and the ecosystems they sustain. Intertidal clams inhabit the most physiologically challenging habitats in coastal areas and live already near their thermal tolerance limits. However, whether and to what extent atmospheric heatwaves affect intertidal bivalves remain poorly understood. Here, we investigated the physiological responses of the Manila clam, Ruditapes philippinarum, to heatwaves at air temperature regimes of 40 °C and 50 °C occurring frequently and occasionally at the present day in the Beibu Gulf, South China Sea. With the increasing intensity of heatwaves and following only two days of aerial exposure, Manila clams suffered 100 % mortality at 50 °C, indicating that they succumb to near future heatwaves, although they survived under various scenarios of moderate heatwaves. The latter is couched in energetic terms across levels of biological organization. Specifically, Manila clams acutely exposed to heatwaves enhanced their standard metabolic rate to fuel essential physiological maintenance, such as increasing activities of SOD, CAT, MDA, and AKP and expression of HSP70. These strategies occur likely at the expense of fitness-related functions, as best exemplified by significant depressions in activities of enzymes (NKA, CMA, and T-ATP) and expression levels of genes (PT, KHK, CA, CAS, TYR, TNF-BP, and OSER). When heatwaves occur again, Manila clams can respond and acclimate to thermal stress by implementing a suite of more ATP-efficient and less energy-costly compensatory mechanisms at various levels of biological organization. It is consequently becoming imperative to uncover underlying mechanisms responsible for the such positive response and rapid acclimation to recurrent heatwaves.