Stressed out underground?: Illuminating the genomic response to heat stress in surface and subterranean predaceous diving beetles

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Abstract

Subterranean realms possess high environmental stability with respect to light levels, temperature, and humidity. The transition to a subterranean lifestyle can therefore cause massive shifts in a species' biology. How does the colonisation of these habitats affect the thermal tolerance of an organism? Past studies demonstrate species in extremely stable environments might lose the ability to mount a heat shock response, which involves the expression of heat shock proteins to remediate misfolded or denaturing proteins as a result of heat stress. Such organisms might therefore be at particular risk of decline in the face of climate change. However, similarly robust data are limited for subterranean organisms. To help address this knowledge gap, here we compared the heat-shock response of a surface-dwelling and subterranean species of predaceous diving beetle (Dytiscidae, Hydroporinae), *Paroster nigroadumbratus* and *P. macrosturtensis,* the latter of which is restricted to a single groundwater aquifer in the Yilgarn region of Western Australia. Though *P. macrosturtensis* is able to survive warmer conditions than it encounters in nature based on past survival experiments, it is nonetheless less robust in the face of temperature extremes compared to surface-dwelling relatives; the genomic basis of this difference is unknown. By sequencing transcriptomes of experimentally heat-shocked individuals we demonstrate both species can indeed mount a heat shock response at high temperatures (35°C). However, the genes involved in these responses differ and a far greater number are differentially expressed in the surface species, including those involved in remediating oxidative stress, which might explain its more robust response to heat stress. In contrast, the subterranean species significantly upregulated a heat shock protein gene under conditions it encounters in nature, suggesting it is far more sensitive to ambient stressors. These findings have conservation implications for *P.*

macrosturtensis and contribute to a growing narrative concerning weakened thermal tolerances in obligate subterranean organisms at the molecular level.

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