

Thermal response of mangrove macrobenthos: explaining processes in endangered coastal systems

M. Fusi^{1,2}, F. Giomi³, B. Mostert⁴, F. Porri⁴, C. McQuaid⁴ & S. Cannicci²

¹Università Cattolica del Sacro Cuore, Agricultural and Environmental Chemistry Institute, 29100 Piacenza, Italy.

E-mail: marco.fusi@unimi.it

²Department of Evolutionary Biology, University of Florence, Firenze, Italy.

³Department Integrative Ecophysiology, Alfred-Wegener-Institute for Polar and Marine Research, Bremerhaven, Germany.

⁴Coastal Research Group, Department of Zoology and Entomology, Rhodes University, Grahamstown, South Africa.

Abstract

Rapid climate change has a strong impact on marine ecosystems, through warming, acidification and hypoxia of sea water. Marine ectotherms are mostly affected by changes in temperature, which directly influences oxygen availability and the ability to utilize oxygen affecting their overall fitness. As a consequence, understanding the thermal response of organisms is crucial to forecast the effects of climate change on ecosystem functionality. Here we focus on the thermal tolerance of adult males, females and gravid females, of two mangrove ecosystem engineers inhabiting the East African mangroves, the amphibious crabs *Perisesarma guttatum* (Sesarmidae) and *Uca urvillei* (Ocypodidae). In order to assess their sensitivity to acute temperature fluctuations across a wide latitudinal gradient, we studied the thermal window of Kenyan and South African populations of both species. The metabolic rate, haemolymph oxygen saturation and heart rate were measured in the laboratory along a temperature ramp (17-37 °C) in water and in air. Additionally, we characterized the environmental temperature range which the animals are subjected to and compared this to their relative body temperatures. In order to evaluate the species sensitivity, we fit the environmental data with the thermal model constructed by our experiments. The results show different responses for sex in both species and particularly a stenothermic response in water compared to air, with a pronounced latitudinal effect, with the South African populations better adapted to lower temperatures than the Kenyan ones. Females with eggs show a higher metabolic rate than males and females with no eggs, representing the most vulnerable adult life stage. The results suggest that these subtropical mangrove populations are vulnerable to long-term increases in temperature, particularly because of reduced oxygen content in water as it warms. This is likely to lead to a loss of fitness with serious consequences for the persistence of such populations and the overall mangrove ecosystem functioning.

Keywords

climate change, aerobic scope, ecosystem engineer, ecosystem functionality, mangrove macrobenthos, fitness