MISA snapshot

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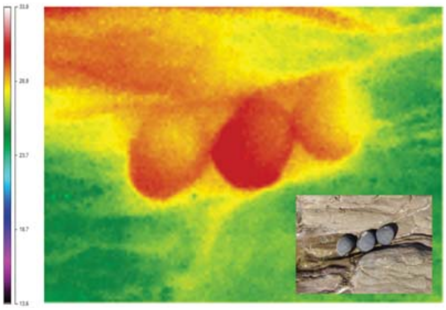
Excellence in marine science inspired through Collaboration

How not to get cooked in the warming climate

Predicted temperatures from climate change models suggest many animals will have to re-locate in order to survive if environmental changes are realised. Researchers are using thermal imaging to identify the drivers of body temperature in ectotherms and their ability to adapt in the harsh intertidal environment to identify variables that can be used to refine climate models providing realistic distribution estimates.

Intertidal habitats are stressful and extreme environments characterised by gradients of environmental conditions, with stressors such as temperature varying dramatically through space and time. Intertidal ectotherms commonly face temperature fluctuations greater than 20°C between high and low tide. Despite their physiological ability to cope with the natural thermal stress, intertidal ectotherms already live at or near to the upper limit of their thermal tolerance making them particularly vulnerable to global warming and the predicted increase in extreme events such as heat waves. Disruptions of ectotherm populations could profoundly impact the structure, dynamic and functioning of the whole marine ecosystem. It is therefore critical to determine whether intertidal ectotherms will be able to keep pace with and adapt to the warming climate.



Nerita atramentosa thermal and digital pictures on south Australian rock shore

The recent development of physiologically-based mechanistic climate models (i.e. heat-budget models) has provided a greater insight into the species thermal window of adaptation and hence future species distribution ranges. However, there are gaps which continue to persist in climate change studies, especially:

(i) air temperature is often incorrectly used as a proxy for animal body temperature;

(ii) small spatial temperature variations in both the environment and animal body have been mostly disregarded due to the limited spatial resolution of climate change models; and

(iii) marine ectotherms' behavioural responses to thermal stress have mostly been overlooked.

Recent studies conducted by Coraline Chapperon (Flinders University) and Prof. Laurent Seuront (SARDI/Flinders University/CNRS), supported by the Australian Research Council's Discovery Projects funding scheme and the Malacological Society of Australasia, have addressed these gaps by using thermal imaging of ectotherms in the intertidal zone. Specifically they investigated:

(i) what factor(s) primarily determine the body temperatures of two snail species, *Nerita atramentosa* on temperate south Australian rocky shores and *Littoraria scabra* on a tropical Fijian mangrove;

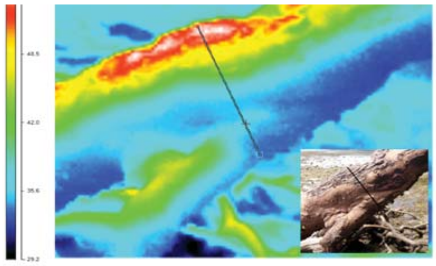
(ii) the temperature variation in both substratum and snail body at a range of spatial (e.g. microhabitat to habitat levels) and temporal (i.e. minutes to seasons) scales; and

(iii) the snail behaviours used to thermoregulate, mainly aggregation and the selection of suitable microhabitats.

Substratum temperature appeared to be the primary driver of body temperature in both *N. atramentosa* and *L. scabrs*. This suggests that it is critical that substratum temperature and others variables such as solar irradiance be integrated in climate change models that use single climatic variables (e.g. air temperature) that are not necessarily correlated to individual body temperatures in nature. In addition, substratum temperature variations observed at the microhabitat level, such as temperature variations greater than 20°C within a mangrove root) reinforces the growing evidence that small spatial scale temperature variations exceed those observed between latitudes.

Both species were able to behaviourally select thermally favourable substratum under high thermal stress in order to thermoregulate, although these behaviours appeared to be species and habitat specific and to vary seasonally. This ability to explore and take advantage of the thermal heterogeneity of the surrounding environment could potentially increase the local survival of mobile ectotherms in a warming world.

This research emphasises the need to integrate the behaviour of intertidal ectotherms and environmental temperature variations in both space and-time into climate change models.



Thermal and digital pictures of a mangrove root (Fiji) highlighting a temperature decrease greater than 20°C from the top to the bottom of the root.

The results from these studies could enhance management and conservation strategies through for instance the identification of thermal refuges for adaptation to global warming.

References

Chapperon C, Seuront L (2011) Space-time variability in environmental thermal properties and snail thermoregulatory behviour. Functional Ecology, DOI:10.1111/j.1365-2435.2011.01859

Chapperon C, Seuront L (2011) Behavioural thermregulation in a tropical gastropod: links to climate change scenarios. Global Change Biology 17:1740-1749.

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