

Adaptive Physiology at a Local Scale: Implications for Species Distributions under Climate Change

Richard Stafford¹, Terence PT Ng², Gray A Williams² and Mark S Davies³
 rstafford@bournemouth.ac.uk

Introduction

- Physical and biological conditions on rocky shores vary over small spatial scales (~100s m)⁴
- For gastropods, it can be difficult to disperse over these distances as adults, but highly likely during their planktonic phase⁵
- Acclimation may occur over the life time of an organism
- Assessing physiological response so different levels of physical and biological stress provide a measure of within lifetime response to local conditions
- Understanding plasticity and adaptability of marine organisms will refine predictions of how they will respond to climate change.

Methods

- Four sites were selected on Hong Kong Island (Figure 1)
- Simple, *in situ* field measurements were taken to determine the physical and biological characteristics of these sites
- These included aspect, crevice and rockpool cover, number of grazers, number of habitat facilitators etc
- These measurements represented physical stress (temperature and desiccation) and biological stress (intra- and interspecific competition) which limpets were exposed to at each site
- Significantly different stress profiles were determined through a bootstrapped PCA process for each site⁶
- To measure physiological adaptation, the detachment temperature of limpets (*Cellana grata*) was measured for limpets collected from each site (in the lab, within 90 mins of collection)

Figure 1. (Right) Locations of four sites on the Shek O peninsula of Hong Kong Island



Figure 2. (Below) *Cellana grata* on a physically stressful shore (site 1)



Results

- Significant differences occurred between stress profiles at different sites (Figure 3).
- Detachment temperatures also differed significantly between different stress profiles (Figure 4).
- Those sites with higher proportions of physical stress had higher detachment temperatures

Discussion

- Cellana grata* appears to adapt to localised conditions during its lifetime
- Uniform physiology across a range is unlikely to occur in many species which inhabit diverse ranges of habitats⁷
- Understanding the interplay between stress levels and localised adaptation will allow predictions of 'refuges' for species under climate change
- Determining areas with the highest levels of physical stress at present may also allow insights into how species can or can not adapt to future levels of stress more generally

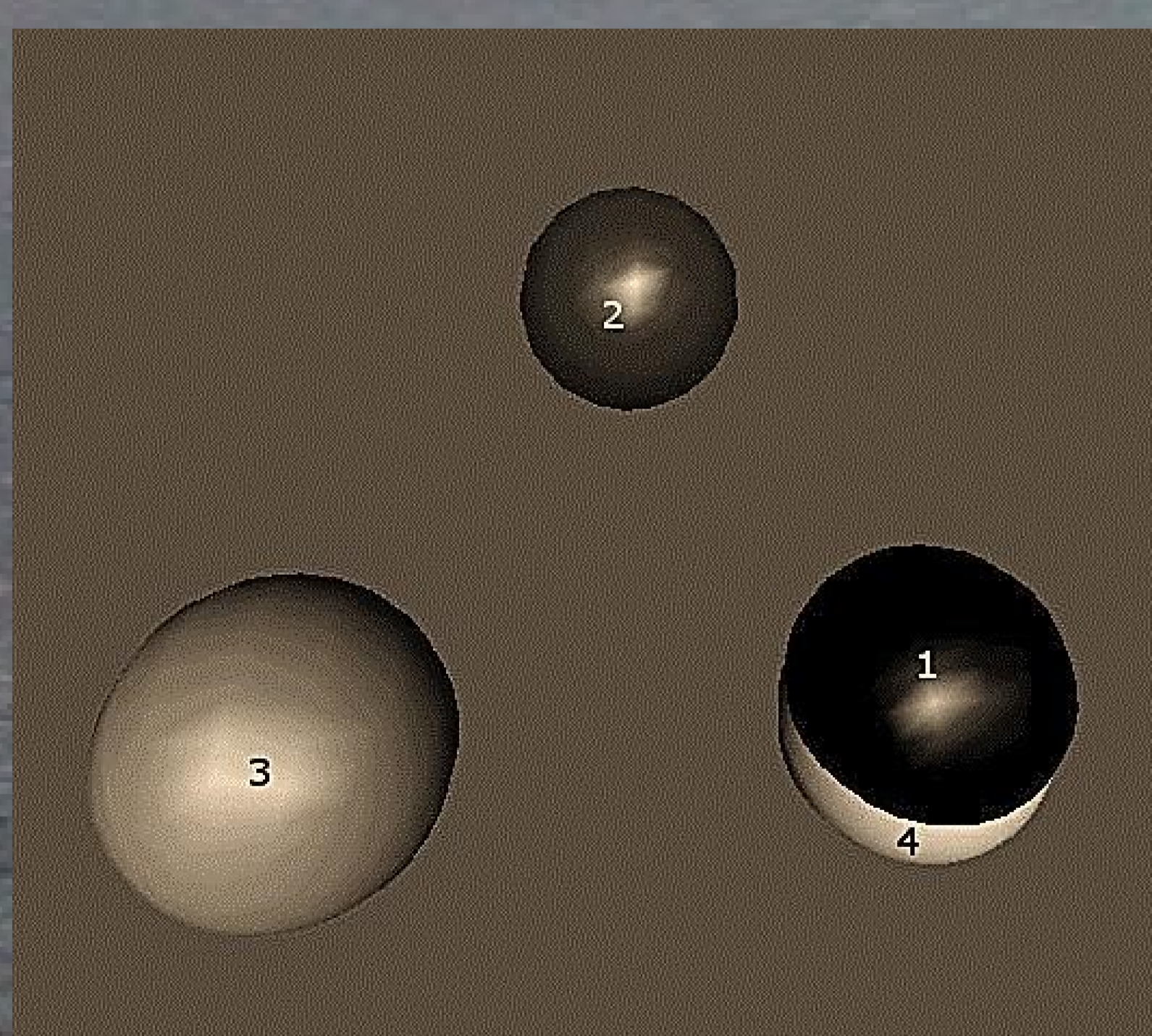
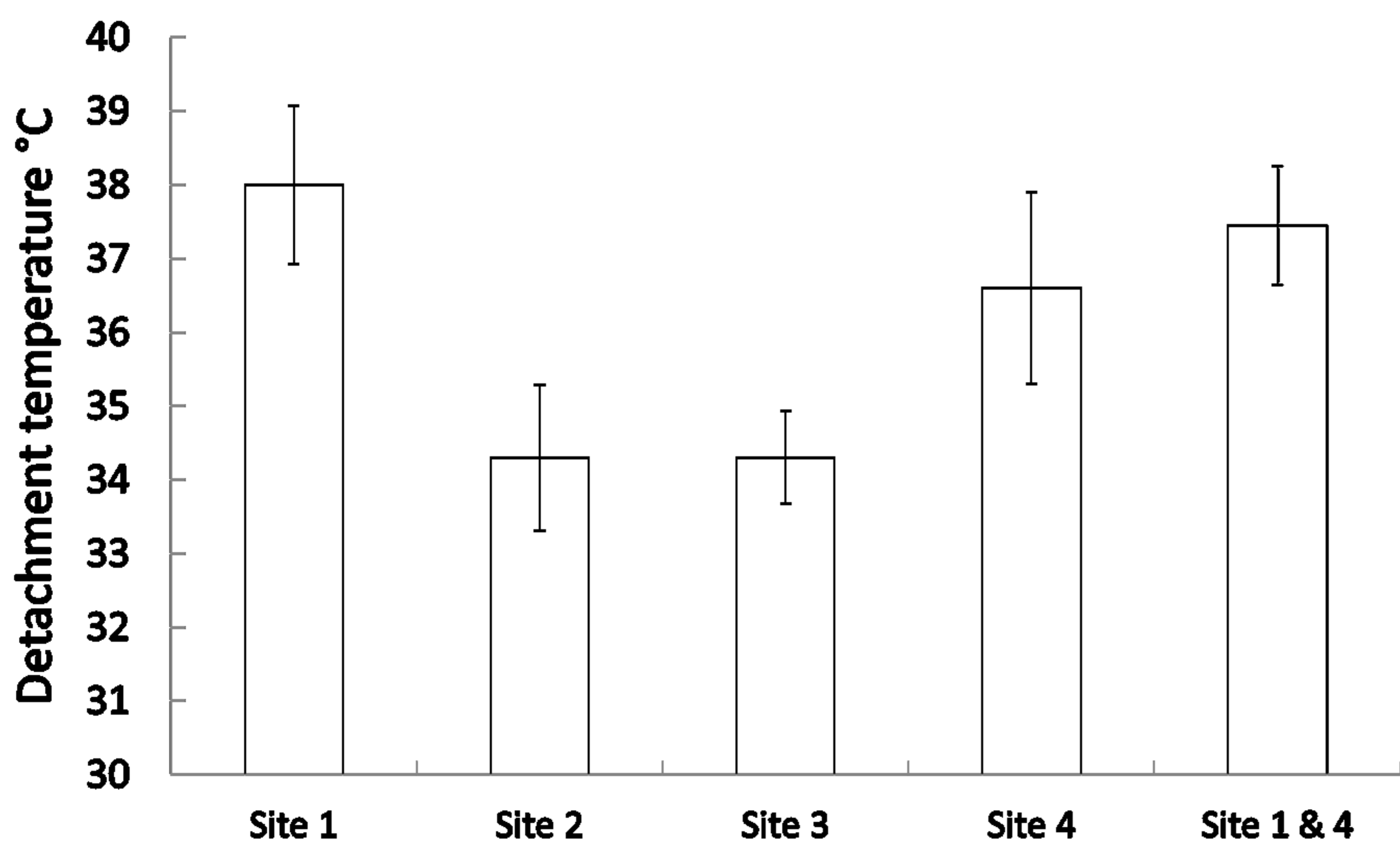


Figure 3 (Left). Bootstrapped PCA of the physical and biological conditions at each of the four sites. Overlap of spheres indicates no significant difference in stress profiles between sites.

Figure 4 (below). Detachment temperature of limpets from each site, and from sites 1 and 4 combined, as no significant difference occurred between these sites



Notes and References

- Centre for Conservation Ecology and Environmental Sciences, Bournemouth University
 - Swire Institute of Marine Science, The University of Hong Kong
 - Faculty of Applied Sciences, University of Sunderland
 - Harley and Helmuth 2003. *Limnol. Oceanogr.* 48: 1498–1508
 - Hoskin 1997. *Mar Biol* 127: 647-656.
 - Stafford et al., 2012. *Anim. Beh.* 83: 563-569.
 - Helmuth 2009. *J. Expt. Biol.* 212: 753-760.
- Background image – view from site 3. North facing with more crevices, lower wave action and higher number of competing grazers than indicated in Figure 2