The ecological functioning of the Antarctic benthos: vulnerability to climate change

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Climate models [1] show that the effects of climate change, e.g. sea surface temperature increase and ocean acidification, will be most intense at the poles. The Antarctic ecosystems are unique, due to both the environmental extremes and the circumpolar current which have biogeograpically isolated the Southern Ocean for ~40 million years [2]. However, the Antarctic ice sheet is rapidly retreating and so are the physical barriers that isolated the Antarctic for millennia [3]. Past geological periods of climate change [1] and present-day ecosystem models [4-6] suggest that marine invasions and extinctions will be very high at the poles: as the habitat available for marine species contract their biogeographic ranges shift towards the poles.

The nearshore shallow Antarctic bottom fauna has been described as being 'Palaeozoic' in nature with high relative abundances of epifaunal suspension feeders and few shell-crushing predators (e.g. crabs and sharks), and so is more similar to the fauna present during the Palaeozoic compared to all the other major oceans today [2]. The Antarctic seafloor has a high degree of endemism e.g. of crinoids, brachiopods, sponges, nematodes, pycnogonids and isopod crustaceans[7]. The fauna also have distinctive physiology with gigantism, high longevity and late maturation being common. The Antarctic ecosystems are therefore functionally unique and are particularly sensitive to invasion by non-native predators, and some evidence suggests this has already begun [7].

For all of the above reasons the Southern Ocean is likely to experience extreme environmental changes in the near future, and these ecosystems are highly vulnerable to such changes. Our overall knowledge of the functionally important Antarctica benthos is somewhat limited, especially in the intertidal zone [8-9]. In this project we will explore how the Antarctic shallow subtidal and intertidal benthic communities will change in the future, and the implications of these difference for Antarctic seafloor functioning.

Existing and new data will be compiled on benthic macroinvertebrate communities across a range of habitat types (e.g. rocky substrates, and different types of soft sediment) at sites on the Antarctic peninsula near British Antarctic Survey stations [10]. The main objectives of this project are:

1. **To determine which taxa are most sensitive to the impending environmental changes and which are functionally important within Antarctic benthic communities**. This information will initially be determined by systematic reviews of the published literature.
2. **To determine the likely effects of climate change on benthic communities.** For example, the direct effects of increasing temperature or the indirect effects of ice retreat reducing the previously regular

intertidal ice scour. The indirect effects will include changes in species interactions as species are lost and/or non-natives arrive.

3. **To assess the impacts of changes in key taxa for the ecological functioning of the benthos.** This will be determined theoretically using biological traits analysis and then experimentally in the lab and field to simulate species loss and invasions and determine the impacts on core ecological functions (e.g. benthic nutrient cycling, or primary production).
4. **To explore the impacts of the most highly anticipated environmental changes on the benthos** further using experimental manipulations (e.g. increased nutrient loading as ice scour lessens).

The project will provide training in: (i) Antarctic fieldwork, (ii) experimental design, (iii) taxonomic identification (iv) biological trait analysis, (v) ecological theory, (vi) statistics and (vii) systematic review. The student will be based in the School of Environmental Sciences at the University of Hull working under the supervision of Dr Bryony Caswell (https://scholar.google.co.uk/citations?user=MPZyfvwAAAAJ&hl=en&oi=ao), and Dr Cath Waller (https://www.hull.ac.uk/faculties/staff-profiles/cath-waller.aspx). The University of Hull has a thriving postgraduate community and the postgraduate training programme provides a full range of courses covering: research techniques, scientific methods, information technology, scientific writing and statistical analyses which are tailored to the needs of each student. Supervision will involve regular meetings between all supervisors and further support of a research support group.

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