



SCAR Fellowship Report



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A macrophysiological framework for assessing the vulnerability of basal animals to climate change



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Introduction

Simple animals such as sponges are predicted to be 'winners' as Antarctic ice shelves collapse because of their rapid recruitment and growth potential [1]. However, this prediction discounts the potential differences or lack of physiological strategies in simple animals, which can dominate the Antarctic seafloor [2]. Our current knowledge of climate change ecophysiology is mostly derived from model animals having metabolic characters such as blood proteins, gills, and 'behaviour' (e.g. fish). Thus, we propose to use standard respirometry experiments to quantify the oxygen regulation strategies among sponges and other simple animals that are common to the SCUBA zone around the Rothera Research Station (RRS) of the British Antarctic Survey (BAS) on the West Antarctic Peninsula.

Project Objectives

Our primary goals were to:

- 1) Use standard respirometry experiments to measure physiological response curves that link oxygen consumption rates (MO_2) to ambient oxygen levels (PO_2).
- 2) Replicate experiments for six to eight different species (n=10 specimens per species).
- 3) Quantify MO_2 - PO_2 physiological curves in sponges.
- 4) Compare results with experiments performed on analogous taxa from the Atlantic Ocean (eight species) completed at my home institute, Memorial University of Newfoundland, Canada (MUN)
- 5) Collate historical physiological response curve data that are representative of the diversity of physiological strategies among water-breathing, marine ectotherms.

Methods, Execution and Results

The primary methods included SCUBA-based collection of animals in waters around RRS and lab-based respirometry experiments using sensors I mobilized from Canada to RRS. A few logistical challenges occurred during my deployment. Chilean customs retained my research equipment during the first week. A miscommunication resulted in no pre-collection of animals prior to my arrival at RRS. Thus, the period required for the animals to recover from sampling stress needed to be factored into my deployment period. Several power outages caused by the ongoing construction work at RRS resulted in a few lost experiments during my time on station. However, we were able to revise and adapt our expectations accordingly as these potential "known unknowns" occurred.

We were able to successfully assess the MO_2 - PO_2 relationship for six species (two sponges, one soft coral, one anemone, one sea star, and one urchin) with n=10 replicates and controls for each. With the comparative data I generated for eight species at MUN, I have the complete dataset needed to assess macrophysiological differences among species and cold-water oceans. By expanding our original project objectives to incorporate historical data, we will be able to broaden the generality of

our results to include eight phyla and 60 additional species. Initial results seem to indicate that regardless of the taxonomic and physiological diversity represented in our data, the shape of the MO_2 - PO_2 is conservative which points to a general response curve among water-breathing ectotherms.

Project Outcomes

The significant outcomes of this project came from successfully achieving the broader research goals of empirically assessing these important metabolic traits of simple animals, including several understudied phyla and from different oceans. By using a simple experimental design, standardized methods, and portable research equipment, we were able to create a future opportunity to expand our work to include additional marine regions that would allow us to test the generality of our findings among other oceans and species.

I achieved several personal goals during this fellowship. My research ideas centred on the ecophysiology of Antarctic sponges were in development since my master's research from over a decade ago. To be able to realize this research was immensely satisfying. By leveraging the Canada-UK memorandum of understanding for field deployment logistics and becoming the first Canadian scientific diver at RRS, this has opened up a novel pathway that others could potentially pursue in the fields of Antarctic macroecology and physiology.

Publications, Presentations and Products

The data from the experiments are currently being processed and analyzed. Two primary publications are planned: (1) one will look at the interspecific and intraspecific variation among basal animals using the data generated from the experiments in the Atlantic and Antarctic oceans, and (2) a review that will look at the historical trends in the MO_2 - PO_2 relationship among the diversity of water-breathing animals that have been studied using standard respirometry experiments.

During my deployment at RRS, I created and submitted a video-presentation for the Ocean Sciences Meeting in San Diego, California that was presented in my absence. As several conferences originally planned for 2020 have been cancelled or delayed as a result of the ongoing COVID-19 pandemic, in-person presentation of results will be rescheduled for 2021 when conferences are replanned.

All data generated from this fellowship will be made available as supplementary materials for the planned primary publications or deposited in open science data portals such as Dryad.

Capacity Building, Education and Outreach Activities

During the pre-deployments training week, I gave an institutional lecture to the academic staff at BAS, Cambridge. While stationed at RRS, I gave a public science lecture to station non-science staff and crew bridging my research in Canada with the collaborative research with BAS. Although brief, I was also able to meet with a BAS PhD candidate (Prem Gill), and gave a brief interview describing my fellowship research at RRS. In addition, I participated in the UK Polar Network Antarctica Flags outreach project for UK school children during my deployment.

During my time at RRS, I was active on Twitter with a personal social media outreach campaign ([#Antarcticaeh](#)). My Twitter posts featured my science imagery and were captioned with behind-the-science content describing my research resulted in >210,000 impressions and >10,000 engagements from January-March 2020. My home institute actively engaged me by retweeting my posts and has arranged for a future sit-down interview and article to be written about my experiences as a SCAR fellow that will be shared through MUN's institution-wide communications network.

Future Plans and Follow-ups

I anticipate a continued, long-term collaboration with Morley and Bates inspired by the results of this work and ideas that stemmed from my visit to RRS. We have plans to expand our macrophysiology experiments to potentially include the Red Sea. The Red Sea represents the complete opposite end of the thermal spectrum relative to Antarctica but hosts comparatively similar, simple taxa. Thus follow-up experiments in this part of the world would test the generality of our findings to the 'warm' end of marine life.

Personal Impact

The SCAR fellowship greatly impacted my personal and professional development. First, my sponge-specific research questions have been in development since I was a graduate student in Canada, a country with no formal ecophysiological research presence in Antarctica. Thus, the SCAR fellowship helped realize a pathway for this novel, international research collaboration to occur. In general, the fellowship expanded my post-doctoral fellowship into an international setting and allowed me to extend my professional network of collaborators. Given I am now the first Canadian marine biologist to have used this pathway for field deployment to do ecophysiological research in Antarctica with BAS, I bring back to Canada a unique polar-research skill set and professional network that will be a foundation I use throughout my career!

Financial Statement

The SCAR fellowship (\$7800 USD = ~\$10,000 CDN before the COVID-19 financial crisis) was used to cover the majority of expenses for: (1) a roundtrip flight to the British Antarctic Survey (Cambridge, UK) for mandatory pre-deployment dive-training week, (2) a roundtrip flight, travel and incidental expenses to the Antarctic Gateway, Punta Arenas Chile, (3) research equipment consumables (sensors, chamber lids, and an ATA Carnet for customs).

| <i>Item</i> | Cost (CDN) |
|--|------------|
| Round-trip 1 – flight, accommodation, & ground transport from St. John's, Canada to the British Antarctic Survey (Cambridge, UK) for pre-deployment training week (Oct 2019) | 1160.43 |
| BAS Dive-training | 1526.69 |
| Round-trip 2 – flight, accommodation, subsistence, and BAS logistics assistance from St. John's, NL, Canada to Antarctic Gateway, Punta Arenas, Chile (Jan-Mar, 2020) | 4537.74 |
| Research equipment | |
| Canada-UK voltage converters | 146.87 |

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|--------------------------|------------------|
| Firesting oxygen sensors | 2225.67 |
| ATA Carnet | 390.00 |
| | |
| TOTAL | \$9987.40 |

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I am immensely grateful to SCAR for creating this opportunity. Thank you Simon Morley for the support during this collaboration. My sincere gratitude to the entire 2020 austral summer staff at the RRS for their professionalism and support. The Science, Dive, and Boat teams in the Bonner lab had integral roles in allowing my field and lab research components to be successful. My field deployment to RRS and the international exchange of knowledge and logistics was also made possible by the memorandum of understanding between the federal governments of Canada and the UK.

References:

- [1] Dayton, P.K. et al. (2013) Recruitment, growth and mortality of an Antarctic hexactinellid sponge, *Anoxycalyx joubini*. *PLoS One* 8: e56939
- [2] McClintock, J.B. et al. (2005) Ecology of Antarctic marine sponges: an overview. *Int. Comp. Biol.* 45: 359-368