PROJECT TITLE: The role of zooplankton (Antarctic krill) in the marine silica cycle at South Georgia

DTP Research Theme(s): Living World, Changing Planet

Lead Institution: British Antarctic Survey (HEI Institution Cardiff University)

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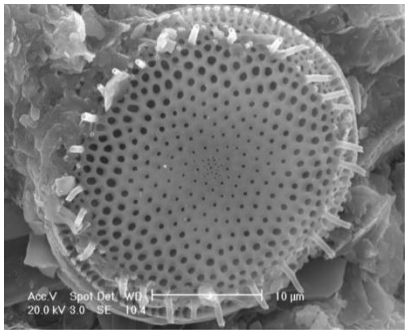
Project keywords: Southern Ocean, marine silica cycle, biological carbon pump, zooplankton, Antarctic krill



The silica frustule of a *Thalassiosira antarctica* resting spore

Antarctic krill *Euphausia superba* (up to 6 cm adult length)

Project Background

The Southern Ocean is generally considered high nitrate low chlorophyll (HNLC), but high primary productivity occurs downstream of Sub-Antarctic islands. At South Georgia this productivity is considered a consequence of the supply of bioavailable silicon and other nutrients from the island shelves and melting glaciers, both in dissolved form and as reactive particles. South Georgia phytoplankton blooms are dominated by diatoms, photosynthetic algae that are responsible for nearly half of the export of carbon from the sea surface to the seafloor and are a sensitive indication of the state of nutrient cycling. Diatoms make their cell walls from silica, and so can deplete silicic acid (dissolved silicon) in South Georgia waters. Zooplankton, particularly Antarctic krill, have a central role in regulating the energy flow through the South Georgia foodweb. Forming dense large swarms, they can exert top-down control on phytoplankton production and play a role in nutrient regeneration in the euphotic zone (Cavan et al. 2019). In addition, their faeces represent an important component of biogenic flux of both organic and siliceous material, contributing up to 100% of the organic carbon flux (Manno et al. 2015).

The response of the silicon cycle to changing environmental conditions is critical for carbon cycling and ecosystem function off South Georgia. However, the physical, chemical and biological drivers of silica cycling remain largely understudied in this region.

The student will use cutting-edge analytical methods to investigate the glacially-derived and biological silica in surface waters, and the flux of silica out of the euphotic zone due to sedimentation and zooplankton grazing as well as the potential role of krill in regulating the silica cycle. They will have access to >10 years of sediment trap and frozen zooplankton samples, allowing a seasonally- and interannually- resolved view of silica cycling in an ecologically important region of the Southern Ocean, which will provide an important view of potential changes in organic matter cycling and marine ecosystems into the future.

Project Aims and Methods

Silicon isotopic compositions can be used to resolve the origin of contributions to the marine silica cycle (biogenic, fresh glacial material or other lithogenic; Pickering et al. 2020). This study will use these novel techniques to analyse seasonal and interannual variability in the isotopic silica proportions in water, krill food and krill faecal material to investigate the role they play in the marine silica cycle. The specific objectives include:

1) Quantify components of the silica cycle on a seasonal and interannual timescale off South Georgia.

2) Identify and isotopically fingerprint the dissolved and particulate (diatom, glacial flour, etc) components in the South Georgia marine silica cycle. Water column and sediment trap samples from the South Georgia shelf will be analysed for silica isotopes.

3) Investigate the intra and interannual variability in contribution of different silica sources to the total silica export from the sea surface to the shelf and downstream sediments. Sediment trap samples will be analysed for carbon:silica ratios and the isotopic proportions used to identify relative contributions of silica sources.

4) Investigate the impact of krill on silica biogeochemical cycling. Krill stomach and krill faecal pellets will be analysed to quantify silica material content and identify the role of krill in regulating the flow of silica through the water column.

There is flexibility within the project to focus on aspects of silica analytical method development, marine silica cycle and sources, diatom taxonomy, and zooplankton distribution and biological carbon pump.

The student will be encouraged to undertake fieldwork as part of a BAS long-term observation programme, to take water samples and collect samples of zooplankton and settling material around South Georgia. However, should this not be possible, the PhD can be completed using water, zooplankton and sediment trap samples already obtained by BAS.

Candidate requirements

The successful candidate will have a Masters or BSc (minimum 2:1) in Earth Sciences, Environmental Sciences, Oceanography, Fisheries Acoustics or a related subject. Experience of laboratory analyses is desirable and/or strong numerical skills and ability to handle complex datasets.

Training

The student will join the Ecosystems group at BAS, there they will get training in Southern Ocean science and zooplankton ecology. If fieldwork is undertaken, this will include at-sea training in sampling zooplankton, handling specimens, manipulating experiments. They will learn fisheries acoustics techniques to analyse moored echosounder data. They will have the opportunity to work with Cardiff and Bristol researchers and train in a number of laboratory skills, including sample preparation, clean laboratory chemistry, isotope mass spectrometry and light and electron microscopy.

Background reading and references

Cavan EL, Belcher A, Atkinson A, Hill SL, Kawaguchi S, McCormack S, Meyer B, Nicol S, Ratnarajah L, Schmidt K, Steingberg DK, Tarling GA & Boyd PW. 2019. The importance of Antarctic krill in biogeochemical cycles. Nature Communications 10; 4742

Manno C, Stowasser G, Enderlein P, **Fielding S,** Tarling GA. 2015. The contribution of zooplankton faecal pellets to deep-carbon transport in the Scotia Sea (Southern Ocean). Biogeosciences 12, 1955–1965.

Pickering RA, Cassarino L, **Hendry KR**, Wang XL, Maiti K, Krause JW. 2020. Using Stable Isotopes to Disentangle Marine Sedimentary Signals in Reactive Silicon Pools. Geophysical Research Letters, 47(15), e2020GL087877

Schmidt K, Schlosser C, Atkinson A, **Fielding S**, Venables HJ, Waluda CM, Achterberg EP. 2016. Zooplankton gut passage mobilizes lithogenic iron for ocean productivity. Current Biology 26: 1-7.

Useful links

How to apply:

In the first instance, contact the Lead Supervisor to discuss the project.

To submit an application, please send your CV, statement of interest, degree transcripts, degree certificates and contact details of two academic referees directly to the Lead Supervisor of the project before **Friday 8th January 2021 at 2359 GMT.**

Should you have any enquiries, please contact Ali Teague at the BAS Student Office

Please visit our website to find out more about BAS and the BAS PhD Student Programme

The application deadline is Friday 8 January 2021 at 2359 GMT. Interviews will take place from 8th to 19th February 2021. For more information about the NERC GW4+ Doctoral Training Partnership please visit https://www.nercgw4plus.ac.uk.