

PROJECT TITLE: *Antarctic Krill – what’s for dinner in the Southern Ocean?*

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

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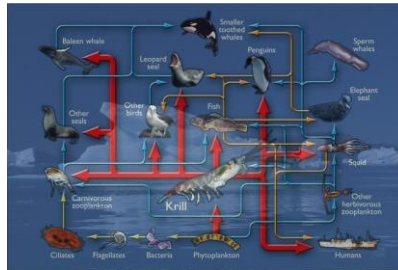
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Project keywords: *Antarctica, Southern Ocean, krill, plankton, ecology, food-web, fishery*



Antarctic krill: key to Southern Ocean food-webs Southern Ocean food-web

Project Background

Antarctic Krill are a keystone species in the Southern Ocean providing a linkage between the planktonic primary producers and the higher trophic levels such as fish, whales, seals and penguins. The composition of marine plankton populations is altering with climate change. However, the full implications of such changes on their consumers and the higher trophic levels remains unknown. To complicate matters, we now know that the plankton food-web itself does not operate as we have previously assumed. Traditionally microplankton have been categorised as either trophic level 1 (primary producers) or level 2 (consumers). However, over the last decade, it has been shown that the, hitherto ignored, mixoplankton (engaging in phototrophy and heterotrophy in the one cell) play a significant and sometimes dominant role in plankton ecosystems. This newly emerging mixoplankton paradigm demands a new interpretation of marine production, including that supporting Antarctic krill. This project seeks to explore the contribution made by mixoplankton to the diet and growth of krill.

Project Aims and Methods

The overarching aim of this project is to identify the trophic levels of krill prey, diatoms and/or the (non-diatom) mixoplankton, and how this affects krill growth dynamics and thence ecosystem functioning. This project will employ integrated observational work and systems dynamics modelling; the work is categorised broadly into 2 work packages (WP) as follows.

WP1, investigation of trophic status of krill diet. This will include exploration of the trophic levels of the protist planktonic food of krill from the Southern Ocean. Microplankton will be fractionated according to their size, buoyancy, phototaxis and motility. Natural abundance stable isotope analysis and lipid/fatty acid analysis will be carried out on these samples to aid in identification of their trophic status and also to determine biochemical signatures for diet tracking into the krill. Captured krill will be dissected and samples from their gut (fore/mid/hind) and body muscle will be subjected to stable isotope and lipid/fatty acid analysis to identify the trophic status of the prey which contribute to krill growth.

Eco-physiological experiments will be conducted in cold-room facilities in Cardiff on Southern Ocean plankton communities with glacially-derived nutrients. This will aid understanding of the impact of meltwater and/or iceberg flux on the Southern Ocean microplankton community and thence krill diet.

WP2, Southern Ocean food-web dynamics. Data obtained from WP1 will be used to configure a plankton food-web model of the Southern Ocean to study the impact of prey quality on krill. This will build from separate simulation modelling studies we have previously conducted on prey-predator interactions and stable isotope signatures. In silico experiments will then be conducted to study the impact of climate change scenarios on the trophic dynamics.

Candidate requirements

This project will suit a student interested in impact of climate change on marine food-webs. Students interested in gaining multidisciplinary skills integrating Antarctic Ocean fieldwork, cold climate laboratory work and ecosystem food-web modelling are particularly encouraged to apply.

Collaborative partner

The student will become familiar in taxonomic analyses of Southern Ocean zooplankton and microplankton and physical oceanography. If fieldwork is possible, and they choose to do so, they will deploy oceanographic equipment, including nets and sensors. They will also carry out light- and electron microscope analyses. Sample preparation for biochemical analyses will be undertaken which will be analysed either by in-house instruments or by other research council facilities.

Training

- Training in plankton sampling, sample analyses and data analysis
- If fieldwork is a viable option, sea-survival training and familiarity with deployment of equipment
- Laboratory training in conducting eco-physiological experiments using state-of-the-art instruments
- Training in systems dynamics modelling to integrate field & laboratory data with ecosystem models

Background reading and references

Fogwill et al (2020) Southern Ocean carbon sink enhanced by sea-ice feedbacks at the Antarctic Cold Reversal. *Nat Geosci* 10.1038/s41561-020-0587-0; **Williams et al (2020)** Algal photophysiology drives darkening and melt of the Greenland Ice Sheet. *PNAS* 10.1073/pnas.1918412117; **Leles et al (2019)** Sampling bias misrepresents biogeographical significance of constitutive mixotrophs across global oceans. *Glob Ecol Biogeog* (10.1111/geb.12853); **Flynn et al. (2018)** Toward a mechanistic understanding of trophic structure: Inferences from simulating stable isotope ratios. *Mar Biol* 10.1007/s00227-018-3405-0; **Schmidt & Atkinson (2016)** Feeding and food processing in Antarctic krill (*Euphausia superba* Dana). In *Biology and Ecology of Antarctic Krill*. Springer, Cham, 2016; **Mitra & Flynn (2007)** Importance of interactions between food quality, quantity, and gut transit time on consumer feeding, growth, and trophic dynamics. *Am Nat* 10.1086/513187; **Murphy (1995)** Spatial structure of the Southern Ocean ecosystem: predator-prey linkages in Southern Ocean food webs. *J Animal Ecol*, pp.333-347.

Useful links

<https://www.cardiff.ac.uk/earth-ocean-sciences>; <https://www.bas.ac.uk/>; <https://www.mixotroph.org/>

“For information on how to apply for postgraduate study at Cardiff University, please follow this link: <https://www.cardiff.ac.uk/study/postgraduate/applying/how-to-apply>”

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>.

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