**Project Title:** Ecological and evolutionary consequences of trait variation in Southern Ocean diatoms

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**Project Background:** Although it is well understood that climate change is rapidly altering polar habitats, the evolutionary responses of cold-adapted, biogeochemically important phytoplankton is essentially unknown, and represents a major knowledge gap that hampers our ability to predict future changes at the base of the marine food web. Diatoms form the base of marine food webs, and understanding the scope for trait evolution in diatom populations is vital to predicting how marine communities will respond to global change. This project will use laboratory experiments to investigate how key functional traits in Southern Ocean diatoms can evolve, and then explore how these potential evolutionary changes can affect marine communities using models. Changes in plankton communities in the Southern Ocean can fundamentally alter the structure and functioning of food webs. Antarctic ecosystem models do not currently include evolutionary processes in predicting responses to change. The project will use models to explore how the inclusion of evolutionary changes in key traits of diatoms affects ecosystem dynamics.

This PhD project will complement an ongoing NSF-NERC project “Southern Ocean diatoms and climate change: quantifying the relative roles of diversity and plasticity in evolution”, and use recently collected Southern Ocean isolates of the diatom genus *Thalassiosira*.

**Key research questions:**
1. How do suites of functional traits vary within the diatom genus *Thalassiosira* in the Southern Ocean?
2. Based on correlations between trait values, what is the scope for trait evolution in *Thalassiosira* in the Southern Ocean?
3. How might trait evolution in Southern Ocean diatoms affect marine food webs in the Antarctic?

**Methodology and timetable:** This PhD project will characterise functional trait diversity in Southern Ocean diatom isolates using standard physiology and growth assays for phytoplankton. Statistical models will then be used to define the trait space available to a genus of diatoms in the Southern Ocean. The student will then use ecosystem models to explore how shifts in diatom functional traits (e.g. growth, cell size, nutrient uptake) could affect Antarctic food webs in the face of warming or other aspects of climate change. The physiology and other laboratory-based work will be done in the first 18 months, data analysis and statistical modelling by the end of year 2. Ecosystem modelling will be done in the final year of the degree. This programme of work leaves some time for the student to follow up on side projects based on their own interest and initial findings during the physiology experiments.
**Training:** A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. This project has a wide range of opportunities to learn about Antarctic microbes and pelagic ecology, laboratory microbiology and microbial physiology techniques, experimental evolution, and ecosystem models. The broader work is a collaboration between the Collins (UoE) and T. Rynearson (University of Rhode Island, USA) groups; modelling will be done in collaboration with N. Levine at University of Southern California (USA) and E. Murphy (British Antarctic Survey, BAS, UK); the student will gain extensive experience in working on a multidisciplinary, collaborative project. The student will spend time with the BAS Ecosystems Team (led by E. Murphy), which undertakes integrated analyses of the structure and functioning of Southern Ocean ecosystems, where they will interact with scientists involved in studying species across multiple trophic levels, from plankton to whales and in analyses of ecosystem responses to change. Through this collaboration there may also be an opportunity for the student to be involved in Southern Ocean fieldwork.

**Requirements:** An undergraduate degree in evolutionary biology, ecology, biological oceanography, or microbiology is required. Other degrees may be considered if the candidate can demonstrate that they have an appropriate background and skill set. Laboratory experience with microbiology is required. Candidates who are familiar with coding or are keen to learn it will be given priority; the particular skills needed for the project will be taught. This project is part of a highly collaborative research programme; the ability to work closely with others, and communicate effectively is necessary.

**Further reading:**
Collins lab website: [http://www.smallbutmighty.bio.ed.ac.uk/](http://www.smallbutmighty.bio.ed.ac.uk/)
BAS Ecosystems website: [www: https://www.bas.ac.uk/team/science-teams/ecosystems/](https://www.bas.ac.uk/team/science-teams/ecosystems/)


**Project summary:** (30 words) To better predict changes to polar food webs under global change, we will make and integrate measures of trait variation in polar diatoms into ecosystem models of the Southern Ocean.