SPITFIRE

NERC SCIENCE OF THE ENVIRONMENT

SPITFIRE Doctoral Training Partnership (DTP)

Research Experience Placement Project 2018

Lead Supervisor:	Gavin Foster
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University/Research Organisation:	UoS
Department:	OES
Project Title:	Opening the black box: the influence of environment on foraminiferal physiology

Total Student Support Costs: £	£2500 (£200 for 10 weeks plus £500 research and training support grant)
Based on a minimum of £200/week full time for a minimum of 8 weeks and maximum of 10 weeks and a £500 Research and Training Support Grant.	

Proposed Start Date: **17th June**	Proposed End Date: **10 weeks later**
Projects should run over the summer vacation and we recommend that projects will have terminated by 21 September 2018.	

Brief Summary – please provide a brief summary (maximum 300 words) of the project.

This should include:

- *Project outline;*
- *Links to staff/School/Centre activity as appropriate;*
- *Supervisory arrangement;*
- *How space/equipment/supporting resource demands will be met;*
- *Elements of the project that will incorporate elements other than computer/modelling e.g. fieldwork and data collection;*
- *How the project will enhance the skills of the appointed student;*
- *Any intellectual property rights concerns that may arise from the work.*

The foraminifera are a group of amoeboid sub-mm sized protists with an extensive fossil record that play an important role in global carbon cycling due to their ability to form calcium carbonate shells (known as tests). The chemical composition of their tests is predominantly determined by: (i) the composition of the seawater they grew in and (ii) a number of environmental factors (e.g. temperature, salinity, and pH). The latter forms the basis of many quantitative reconstructions of climate over the last 140 million years. Such reconstructions inform our understanding of how the climate system works and help to improve our predictions of future climate in the face of anthropogenic climate change. Assessing the reliability and uncertainty of our quantitative reconstructions of past climate using the chemical and isotopic composition of foraminifera is therefore key.

However, rather than being passive recorders of the environment they live in, the composition of the foram tests are heavily influenced by the physiology (i.e. life processes) of the foram and its photosymbionts. Indeed, it is the influence of environment on physiology that often imparts an environmental sensitivity to test composition. This influence comes about predominantly because foraminiferal calcification and respiration and symbiont

photosynthesis modify the pH in the immediate 1 mm or so around the growing foram, such that it is no longer simply growing in seawater but seawater with a composition that is modified by the growth of the foram itself.

This short project will aim to better understand the role of the external environment on the physiology of foraminifera, and hence test composition, by using microelectrodes to make measurements of the pH, [Ca^{2+}], and O_2 in the micro-environment around growing foraminifera under controlled conditions. The student will therefore gain experience in the maintenance and study of foraminifera in laboratory culture and in the development and use of ion-selective microelectrodes to measure pH, Ca and O_2 at micron-scale resolution in biological samples.

Experiments will be performed at the National Oceanography Centre under the guidance of Prof. Gavin Foster, Dr. Tali Babila (OES), Dr Glen Wheeler (MBA), Dr Gerald Langer (MBA). The results of this study will feed into a larger NERC funded project SWEET aimed at reconstructing climate 50 million years ago (http://www.thefosterlab.org/sweet/).

Please give an indicative timescale for the student's work over the length of the project: (maximum 150 words).

This should include:

- *The broad tasks the student will undertake;*
- *An indicative timescale for these tasks.*

The task the student will be to perform the measurement of pH, O_2 and Ca^{2+} gradients in the micro-environment around multiple specimens of two benthic foraminifera species *Ammonia* sp. (non-symbiont bearing) and *Amphistegina* (symbiont bearing). The magnitude of the chemical gradients measured are indicative of the fluxes of ions and molecules in the micro-environment allowing a quantification of the magnitude of calcification, respiration and photosynthesis for each individual. By manipulating the environment the foraminifera are inhabiting, e.g. by changing the temperature, pH and chemical composition of the culture media, we will gain unique insights into how environment influences foram physiology.

An approximate plan is:
Weeks 1-2: ambient conditions
Weeks 2-5: modified temperature
Weeks 5-7: modified pH
Weeks 7-10: modified chemical composition

Proposed procedure for appointing students, including selection criteria:

Please identify specific criteria that should be considered for the selection of placement students e.g. specific quantitative skills that may be required, subject knowledge etc. If a student has been pre-selected, or the research area has been led by the student, please provide the student's contact details, and a summary of their suitability for the SPITFIRE DTP REP programme.

No prior knowledge of foraminiferal biology is required but experience with the use of micro-electrodes and an understanding of how they work is desirable. The candidate should also be numerate and comfortable with data processing.