SPITFIRE Doctoral Training Partnership (DTP)

Research Experience Placement Project 2019

Lead Supervisor:	Thomas Ezard
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University/Research Organisation:	University of Southampton
Department:	Ocean and Earth Science
Project Title: Testing von Baer's Law of Embryologic Divergence in Deep Time	

Total Student Support Costs: £	Student will receive an hourly pay of £8.44 p.h. and is required to work for 30 hours a week over an 8 week period.

Proposed Start Date: 02/07/19	Proposed End Date: 23/08/19
Projects should run over the summer vacation and we recommend that projects will have terminated by 25 September 2019.	

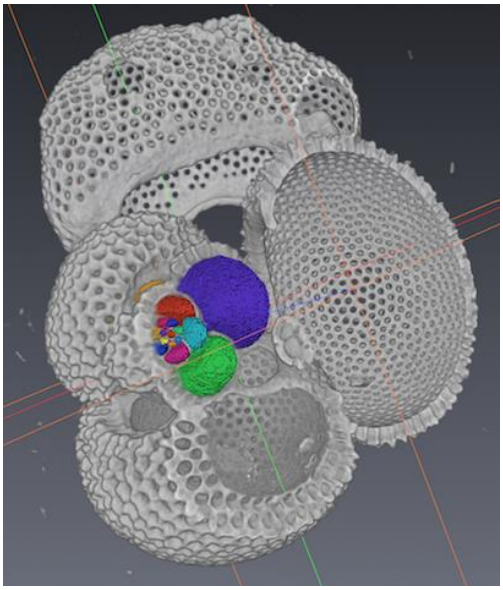
Brief Summary

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.*

All living organisms respond to cues in their environment. This flexibility is a ubiquitous way of adapting to a changing climate, but its role during the emergence of new species is poorly understood. Von Baer's Law of Embryology, translated from 1828, provides a clear hypothesis to test: meaningful divergence between species occurs at the earliest lifestages.

Von Baer's law has not been tested rigorously because of deficient data. X-ray computed tomography (CT), exemplified by the UoS μ-VIS facility, has instigated a digital revolution in the life science data generation. PISTON, an OES-led NERC-funded Large Grant, is developing high-throughput workflows. We have ~600 scanned planktonic foraminifer individuals, which is two orders of magnitude larger than comparable datasets. This REP will apply repeatable analytical protocols (see Figure) to extract quantitative trait data for whether flexible development in the earliest lifestages facilitates speciation.



A planktonic foraminifer (here, a 1mm diameter Trilobatus sacculifer) reconstructed from x-ray computed tomography. Grey denotes the perforated outer shell (test). Each coloured section in the interior is a discrete growth stage of the individual's developmental history.

The labelled scans will provide novel data and contribute to automated computer vision algorithms being developed by Zhang, Nixon and Brostow. Ezard will supervise and co-ordinate cross-disciplinary meetings; day-to-day Avizo Fire supervision will come from Katsamenis and Searle-Barnes. All laboratory costs are covered. The novel data exists as CT scans, but the student will help Brombacher prepare material to gain hands-on experience of the end-to-end research process. Working with engineers, micropaleontologists and computer scientists will expose the student to the interdisciplinary nature of 21st century evolutionary biology. All data will be made available as per PISTON's Data Management plan. As von Baer's Law has not been tested on high-quality data, there is a clear route to peer-reviewed publication.

Please give an indicative timescale for the student's work over the length of the project:
This should include:

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

- Week 1: Training in Avizo Fire software suite for feature extraction and image detection; background reading.
- Weeks 2-6: Processing of earliest stages of life from existing CT scans of planktonic foraminifera across the *Menardellid* divergences. It takes ~60 minutes to process the first 8 developmental stages (including breaks), which means 30 individuals in each of 6 main analytical weeks.
- Weeks 7: Statistical analysis using mixed effect models.
- Week 8: Report to PISTON consortium meeting.

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.

- Training in the use of Avizo Fire will be provided through the PISTON collaboration with μ-VIS collaborators Professor Ian Sinclair and Dr Orestis Katsamenis as well as Project Technician Alex Searle-Barnes. All are PISTON Research Staff or Co-Investigators.
- Background knowledge of scripting methods for statistical analysis will be beneficial for the applicant (e.g., to level taught by Ezard on SOES2036 or BIOL6052).

- Evidence of clear interest in analytical biology – the questions are motivated by one of the oldest biological laws (pre-dating Darwin and Russell by ~40 years), but the tools used to answer them are state-of-the-art.
- Brombacher (PISTON PDRA) will supervise the micropaleontological sample preparation.
- Zhang (PISTON PDRA), Nixon (PISTON Co-I, University of Southampton) and Brostow (PISTON Co-I, University College London) hold weekly meetings with Ezard to discuss progress on feature extraction and computer vision using machine learning tools. The REP student will attend these meetings to discuss their labelled scans, which will refine existing protocols for feature extraction (led by Zhang).