Project Title | Floaters vs. sinkers: How do marine phytoplankton combat the biological pump?
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University (where student will register) | University of Warwick
Which institution will the student be based at? | As above
Theme (Max. 2 selections) | Climate & Environmental Sustainability ☐
| Organisms & Ecosystems ☒
| Dynamic Earth ☐
Supervisory team (including institution & email address) | PI: Dr. Richard Puxty
| Co-I: Prof. David Scanlan

Project Highlights:

- Uncover the “genetic dark matter” responsible for maintaining buoyancy in marine phytoplankton
- Test how abiotic and biotic stress impact buoyancy traits of marine phytoplankton
- Translate discoveries of buoyancy traits into a better understanding of the Earth’s carbon cycle through the biological pump

Overview

Industrialisation has short-circuited the Earth’s carbon cycle; converting ~0.4 trillion tons of organic carbon back to CO₂ from the burning of fossil fuels. The most rapidly cycled pool of carbon is in the Oceans. In the surface oceans, single celled microbes convert CO₂ to particulate organic carbon (POC) through photosynthesis. POC can sink into the ocean interior, through the activity of the biological carbon pump (BCP), effectively storing it for hundreds of years (Figure 1A). Without the BCP, the predicted atmospheric CO₂ concentration would be doubled.

We currently have a poor understanding of the processes that determine the strength of the BCP. However, it is thought that buoyancy traits of surface marine phytoplankton plays a key role [1]. These organisms face a consistent challenge to fight the BCP and maintain themselves in the upper surface ocean, where light can drive photosynthesis. Meanwhile, many biotic and abiotic stresses act upon phytoplankton to force them downward. We have evidence that the propensity to combat the activity of the BCP is genetically encoded (Figure 1B). This project will seek to unravel the genetic mechanisms that phytoplankton employ to fight the BCP and understand how external stresses can overpower these mechanisms. You will combine cutting-edge high-throughput genetics with whole genome sequencing to identify genes required for buoyancy in model marine phytoplankton. You will then validate these genes by standard genetic manipulation and test the effect of a range of abiotic and biotic stressors on these mutants. Your data will have strong implications for our understanding of the Earth’s carbon cycle.
Methodology:

You will use a combination of cutting-edge high-throughput genetics [3] and laboratory evolution experiments [4] to screen for novel buoyancy traits in model phytoplankton. You will then validate these mutants by standard genetic manipulation as established in the supervisor’s laboratories [5]. Characterisation of mutants will involve combinations of transcriptomic and proteomics. Together you will become expert in microbiology, microbial genetics, molecular cloning and next generation sequencing.

Training and skills:

Training will be provided in the above techniques that have been developed in the Puxty and Scanlan labs. Many of these techniques will involve transferable technical skills including use of robotics and genetic manipulation.

Students will be awarded CENTA2 Training Credits (CTCs) for participation in CENTA2-provided and ‘free choice’ external training. One CTC equates to 1/2 day session and students must accrue 100 CTCs across the three years of their PhD.

Partners and collaboration (including CASE):

The supervisors are world-leading experts in marine molecular biology. We frequently publish in high profile interdisciplinary journals (e.g. *Nature Plants, Current Biology, Proc. Natl. Acad. Sci. USA*) and field specific high impact journals (e.g. *The ISME Journal*). You will belong to a larger group of environmental microbiologists in the department of life sciences’ environment theme. ([https://warwick.ac.uk/fac/sci/lifesci/research/envbiosci/](https://warwick.ac.uk/fac/sci/lifesci/research/envbiosci/)). These groups occupy a large shared lab area and as such there is continuous collaborations and opportunities for career development within the theme. Current research in the groups is funded by NERC and generous start-up award to Dr. Puxty.

Dr Puxty’s group: [https://warwick.ac.uk/fac/sci/lifesci/people/rpuxty/](https://warwick.ac.uk/fac/sci/lifesci/people/rpuxty/)

Prof Scanlan’s group [http://www2.warwick.ac.uk/fac/sci/lifesci/people/dscanlan](http://www2.warwick.ac.uk/fac/sci/lifesci/people/dscanlan)
COVID-19 Resilience of the Project:

Should COVID delay lab work, the student will mine already available high throughput genetic screens to identify genetic determinants of buoyancy.

Possible timeline:

Year 1: Perform high-throughput genetic screen to identify gene candidates required for buoyancy in model marine phytoplankton

Year 2: Verify these gene candidates by classical reverse genetics.

Year 3: Test the affects abiotic and biotic stresses on capacity for buoyancy in wild type cells and mutants lacking buoyancy genes

Further reading:


Further details:

Applicants should hold a BSc and/or MSc degree in relevant subjects. Informal enquires can be made to Dr Richard Puxty (*r.puxty@warwick.ac.uk*). Details of how to apply can be found at [https://warwick.ac.uk/fac/sci/lifesci/study/pgr/studentships/nerc-centa/](https://warwick.ac.uk/fac/sci/lifesci/study/pgr/studentships/nerc-centa/)