PROJECT TITLE: Genome evolution of marine cyanobacterial symbionts

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

Lead Institution: University of Bristol

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Project keywords: Genome evolution, genomics, Cyanobacteria, marine symbionts

Project Background
Cyanobacteria have had a huge impact on the biological diversity of the Earth’s ecosystems, in part due to their ability to establish symbiotic relationships with several different hosts (1, 2). One of the most important symbiotic events during Earth’s history is the origin of the chloroplast (3). Studying the early stages of genomic integration at the root of photosynthetic eukaryotes has been obscured by 1.8 billion years of evolution. The great diversity of cyanobacterial symbionts and hosts (e.g., diatoms, sponges) provide ideal systems to understanding how symbioses have evolved. While genome reduction is a trait shared amongst symbionts, the processes that lead to the establishment and integration of symbionts into their hosts are still unclear, as are the genomic consequences.

Project Aims and Methods
This project aims to study the underlying genomic mechanisms driving cyanobacterial symbiosis. Here we will study much more recently evolved symbioses that might hold the key to understanding what sort of interactions occur at the genomic level during early stages of symbioses. Comparisons at the genomic level will tease apart what changes were needed to enslave symbionts under different ecological contexts in marine environments (e.g., open-ocean vs costal settings). This project will implement phylogenomics to reconstruct the evolutionary history and occurrences of symbiosis within cyanobacteria. A Bayesian approach will be implemented to determine age estimates for cyanobacteria symbiotic events. Comparative genomics will enable the identification of genes and gene families that have been lost during the process of symbiosis when involving examples of both nitrogen fixation and photosynthesis. The Ph.D. student funded will have the unique opportunity to work in the lab and develop new phylogenetic/comparative genomic methodologies. This is a great opportunity for students interested in photosynthesis, nitrogen fixation, evolutionary biology, genome evolution, phylogenetic methods, and bioinformatics.
Candidate requirements
At least a 2.1 (Hons) degree or equivalent in a relevant quantitative subject, e.g. microbiology, bioinformatics, marine biology, genetics, genomics, and computer science. For International students, English Language IELTS scores of at least 6.5 (no less than 6.0 in any element). A Masters degree in a relevant subject would be desirable but not essential. Computer programming skills in a relevant language, e.g. C/C++, Python, R or Matlab would be an advantage. We welcome and encourage student applications from under-represented groups. We value a diverse research environment.

Training
By the end of the PhD programme, the student will have learnt comparative genomics, molecular evolution and phylogenetics. The student will be trained in computer programming (Shall Scripting, R Scripting, and either PERL or Python), bioinformatics and phylogenetics. In addition to this core set of skills they will be trained in biogeochemistry. All the skills they will learn are highly transferrable and will be useful to them irrespective of the career path they will choose within the realm of evolutionary biology and microbial genomics more broadly (e.g. bioinformatics and genomics).

Background reading and references

Useful links
http://www.bristol.ac.uk/geography/courses/postgraduate/

NERC GW4+ DTP Website:
For more information about the NERC GW4+ Doctoral Training Partnership please visit https://www.nercgw4plus.ac.uk.

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2021/doctoral/phd-great-western-four-dtp/

How to apply to the University of Bristol:
http://www.bristol.ac.uk/study/postgraduate/apply/

The application deadline is Friday 8 January 2021 at 2359 GMT. Interviews will take place during week commencing 8th February 2021.

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