PROJECT TITLE: Evolutionary assembly of land plants: genomes, development and phenotype

University of Bristol Theme: Net Zero and Climate Change
Research Group(s): Bristol Palaeobiology
Lead Supervisor: Philip Donoghue, University of Bristol, School of Earth Sciences
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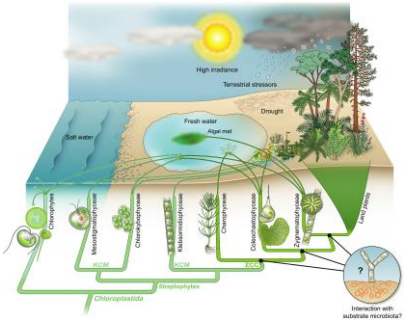
Funder: University of Bristol Scholarship



Many land plant innovations were assembled among their diverse streptophyte 'pond scum' relatives

Project Background

The origin of land plants represents one of the most profound episodes in evolutionary history, transforming the energy budget, albedo, and biogeochemical cycles of our planet. While the fossil record provides a good account of the emergence of living land plants lineages, it is essentially uninformative of the steps in which the land plant bodyplan was first assembled. Consequently, competing hypotheses on the assembly of the land plant bodplan are largely speculative, based in arguments of plausibility. However, recent sequencing efforts have generated a wealth of genome data for the living streptophyte relatives of land plants, providing crucial data for elucidating this key episode in Earth history. It has already demonstrated that the land plant genome was assembled over a protracted period of geologic time and characterised by widespread gene duplication and gene acquisition through transfer from symbionts. This project will exploit these data to go much further, establishing a new highly-resolved and integrative understanding of the evolutionary assembly of land plants by exploiting three methodological advances: (a) using Artificial Intelligence (AI) approaches to inferring the relationship between gene and phenotypic evolution based on their patterns of coevolution within phylogeny; (b) using Bayesian relaxed molecular clock methodology to establish the absolution timing of the gene duplications that characterise the ancestry of land plants, informing on the sequence in which land plant innovations were established; (c) using hierarchical models of trait evolution that are informed by development to establish the nature of the ancestral land plant and its forebears.

Project Aims and Methods

The project will be largely computational and will involve applying phylogenetic, comparative genomic and AI-based methods to datasets of land plant and streptophyte algal genomes that are already available for study. You will use these methods to characterise the sequence in which

genomic and phenotypic traits were acquired within the context of an absolute timescale. This will allow you to identify contributions to the genome from bacteria and eukaryotes like fungi, informing on the timing and sequence in which symbioses were established. The evolutionary and comparative genomic skills developed as part of the project can also be used to address other cutting-edge questions in phylogenetics, developmental biology, comparative genomics and evolution.

Candidate

Applicants should have a background in Plant Science, Evolutionary Biology, Biological Sciences, Genetics, Computer Science or Palaeontology to MSc/MSci level.

Training

Practical training will be provided in phylogenetic methods, plant biology, comparative genomics and AI-based analysis of genomic data. This will be provided as part of the process of undertaking research.

Background reading and references

Bowles, A. M. C., Williamson, C. J., Williams, T. A., Lenton, T. M., and Donoghue, P. C. J., 2022, The origin and early evolution of plants: Trends Plant Sci, v. 28, p. 312-329.

Davín, A. A., Woodcroft, B. J., Soo, R. M., Morel, B., Murali, R., Schrempf, D., Clark, J. W., Álvarez-Carretero, S., Boussau, B., Moody, E. R. R., Szánthó, L. L., Richy, E., Pisani, D., Hemp, J., Fischer, W. W., Donoghue, P. C. J., Spang, A., Hugenholtz, P., Williams, T. A., and Szöllősi, G. J., 2025, A geological timescale for bacterial evolution and oxygen adaptation: Science, v. 388, no. 6742, p. eadp1853.

Donoghue, P. C. J., Harrison, C. J., Paps, J., and Schneider, H., 2021, The evolutionary emergence of land plants: Current Biology, v. 31, p. R1281-R1298.

Useful links

https://donoghue.blogs.bristol.ac.uk/
https://www.bristol.ac.uk/earthsciences/postgraduate/
https://www.bristol.ac.uk/science-engineering/postgraduate-research/pgr-scholarships/
https://www.bristol.ac.uk/directory/visas/student-visa/apply/money

Eligibility

UK and International students are eligible for University of Bristol Postgraduate Research Scholarships. These are funded for 4 years and cover university fees, living expenses at the UKRI standard rate, and an allowance towards research expenses. Scholarships do not cover visa or NHS surcharge costs. See links above for details.

Application

During application select "**University of Bristol Scholarship**" for funding source and "**Geology (PhD)**" for programme. If you are applying this specific project upload this PDF as the "research statement". All studentships must have a September 2026 start date.