

PhD Project Advertisement

Project title: *Multi-omics analysis of nitrogen metabolism by the soil microbial community*

Project No: FBS25-34-Larionov-cr

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Co-supervisors:

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Dr Shamina Pathan, Department of Agrifood and Environmental Science, University of Florence

Industrial co-supervisor: Dr. Bruno Steinkraus, Soilytix CEO (Soilytix GmbH, <https://soilytix.com>)

Project description: This is a bioinformatics project aiming to develop new tools to analyse multi-omics long-reads sequencing data, for a better understanding of nitrogen metabolism in soil.

Nitrogen is an essential nutrient for plants. Application of nitrogen fertilisers into arable soils is essential to sustain crop yields in modern agriculture. However, the excessive use of the fertilisers may result in nitrate leaching and nitrous oxide emission, contributing to eutrophication and climate change. The soil microbial community is a key regulator of the soil nitrogen cycle. Therefore, understanding the biology of the N-cycle in soil is essential for both improving sustainable food production and protecting the environment.

The soil N cycle has been extensively studied. Each reaction in this cycle can be performed by multiple microbial species. However, so far, most studies measured the abundance of N-cycle genes in soli without assessing individual species' contributions. Also, most studies evaluated the genes abundancies at DNA level, without assessment of the genes' expression at RNA level, and how the RNA expression is regulated.

The goal of this project is to leverage on the recent development of long-read sequencing technologies (such as Oxford Nanopore) to develop the new experimental approaches and bioinformatic pipelines to study currently unknown aspects of N-cycling in soil.

Long-reads sequencing can read fragments spanning an entire gene (or multiple genes), and report epigenetic marks at the same time. The differences between homologous genes in different microbial taxa should allow us to distinguish the taxa of origin for each DNA fragment containing an N-metabolising gene. For the same reason, long-read RNA-sequencing will allow us to measure species-specific gene expression. This would not be possible using conventional qPCR or short-read technologies (such as Illumina sequencing).

You will be based in the Cranfield University Bioinformatics Group. The project will start by reviewing currently available bioinformatics resources for N-cycle genes in soil, and the recent developments of long read sequencing technologies relevant to the project. This will allow you to develop bespoke bioinformatics pipelines for detecting species-specific abundance, expression and epigenetic modifications (methylation) of N-cycle genes from long-read DNA- and RNA-sequencing.

The pipelines you develop will be applied to study datasets generated by the project collaborators (University of Reading, University of Florence, and Soilytix GmbH). After being validated, the pipelines and resources you develop could be applied to study nitrogen cycle genes in soil in other contexts too, thus ensuring the project has a wider impact.

Training opportunities: Training in applied bioinformatics (including programming, sequencing data analysis and metagenomics), IT skills (including High Performance Computing cluster), soil science and soil biogeochemistry will be provided by the project supervisors and through participation in selected modules of the courses offered at Cranfield University and in the University of Reading, and by attending other relevant courses available at the time of the project (e.g. the Statistics Summer School in Cranfield, or SysMIC course in UCL). The student will become an early career member of the British Society of Soil Science, enabling them to attend early career conferences and join a community of

soil scientists at a similar career stage. This also allows access to several training opportunities such as the 'Practical Introduction to Soils' and 'Working with Soil' courses, alongside webinars and other events. Additionally, the student will be provided the relevant industrial training during the 3-months placement in Soilytix GmbH.

Project supervision style: The student will be supervised typically through weekly face-to-face meetings with the lead supervisor and no less than monthly online meetings with the wider supervisory team. They will participate in the bi-weekly meetings of the Cranfield Bioinformatics Group and attend monthly meetings within the Cranfield Research Forums. They will join the Soil Biogeochemistry Group online seminar series hosted by TS at the University of Reading. An MS Team will be created for the studentship where drafts of written work will be saved and shared for simultaneous provision of comments and edits by all supervisors. Supervisors will usually be expected to provide feedback on written work within two weeks of the student sharing. All supervisors will review at least one draft of all chapters/manuscripts and other outputs (e.g. posters/presentations) prior to submission/publication/presentation. BS will supervise student's day-to-day activities during the placement in Soilytix GmbH.

Stipend (Salary):

FoodBioSystems DTP students receive an annual tax free stipend (salary) that is paid in instalments throughout the year. For 2024/25 this is £19,237 (£21,237 at Brunel University) and it will increase slightly each year at rate set by UKRI.

Equity Diversity and Inclusion:

The FoodBioSystems DTP is committed to equity, diversity and inclusion (EDI), to building a doctoral researcher(DR) and staff body that reflects the diversity of society, and to encourage applications from under-represented and disadvantaged groups. Our actions to promote diversity and inclusion are detailed on the [FoodBioSystems DTP website](#) and include:

- Offering reasonable adjustments at interview for shortlisted candidates who have disclosed a disability or specific learning difference.
- [Guaranteed interview](#) and [applicant mentoring](#) schemes for applicants, with UK home fees status, from eligible under-represented ethnic groups.

These are opt-in processes.

Our studentships are offered on a part time basis in addition to full time registration. The minimum registration is 50% FT and the studentship end date will be extended to reflect the part-time registration.

For up to date information on funding eligibility, studentship rates and part time registration, please visit the [FoodBioSystems website](#).