PROJECT TITLE: Investigating the impacts of plastic use in agriculture on the soil ecosystem.

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

Lead Institution: University of Bristol

Lead Supervisor: Dr Charlotte Lloyd, University of Bristol, Geographical Sciences/Chemistry

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Project keywords: Plasticulture, soil fauna, ecotoxicology, microbial communities

Project Background

Agriculture’s intimate relationship with plastic began during the 1960’s, as a cheap and flexible alternative for covering glasshouses and mulch films started being used in commercial crop production. Since then, the global use of plastic has increased dramatically, with annual use projected to reach 7.4 million tonnes in 2019, a 69% increase since 2012. The use of plastic (mainly polyethylene) is increasing to meet the growing demand for food due to population increases, and challenges of growing crops in some locations due to climate change. Despite this increase in use, the fate and impact of plastic particles and plastic-derived organic compounds (PDOCs), including additives, on the soil ecosystem remains largely un-investigated. Most research to date has focused on the marine ecosystem, however terrestrial organisms play a fundamental role in maintaining soil health which is key for sustaining ecosystems as well as agricultural practises. Fundamentally, there has been no work carried out on the impact of PDOCs, which include polymer degradation products and plastic additives such as plasticisers (e.g., bisphenol A) and UV stabilisers (e.g. benzophenones and hindered amine derivatives). This project is ideal for somebody who would like to contribute to the first study of the impact of the ingestion of plastic-derived chemicals on terrestrial organisms and evidence generated could inform new environmental policy and governmental regulation.

Project Aims and Methods

The overall aim of the PhD project will be to investigate the impact of PDOCs and particulates on the agricultural soil ecosystem, from microbes through to macro-fauna. The project will have three main objectives: 1. To assess the effect of the presence of agricultural plastic on the native soil microbial community, 2. To investigate the impact of agricultural plastic on soil invertebrates, and 3. To examine the role of the common earthworm (Lumbricus terrestris) in the in-situ processing of agricultural plastic polymer, its degradation products, and additives. The project will involve both laboratory and field-based experiments and use for example a combination of cutting-edge analytical techniques to identify plastic derived contaminants within the soil and metagenomic analysis to assess the impact on the microbial population. Other experiments will be designed to test the toxicity of PDOCs and particles to important soil invertebrate populations, both when exposed singularly and in combination to represent the cocktail of contaminants they would be exposed to under normal environmental conditions. There will also be the opportunity to learn computational skills which will allow the large data sets generated to be explored and
robustly analysed. Moreover, the student will benefit from a truly interdisciplinary supervision team whose expertise spans molecular-scale chemistry, biology and ecotoxicology. The research produced will provide important information regarding the impact of the use of plastic on soil ecological health and will deliver key data to aid the development of new environmental policy.

Candidate requirements
At least a 2.1 (Hons) degree or equivalent in a relevant quantitative subject (e.g., environmental science, environmental chemistry, microbiology, genomics, and ecotoxicology). A Master’s degree in a relevant subject would be desirable but not essential. Computer programming skills would be an advantage. Some relevant field or outdoor experience is desirable for the student to participate in fieldwork. We welcome and encourage student applications from under-represented groups. We value a diverse research environment. Please also note that the supervisors would welcome adaptations to the research plan to suit the successful candidate’s interests.

Training
By the end of the PhD programme the student will have experience of cutting-edge organic geochemistry analytical methods such as gas chromatography and mass spectrometry, in addition to computational genomics and ecotoxicology methodologies. Training will be provided in computer programming (e.g. R, Matlab, Python) to aid data analysis and visualisation. The student will also gain valuable training in the design, preparation and execution of both laboratory and field-based experiments. All of the skills gained will be highly transferrable and will be useful to them irrespective of their chosen future career path.

Background reading and references

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

Bristol NERC GW4+ DTP Prospectus:
http://www.bristol.ac.uk/study/postgraduate/2023/doctoral/phd-great-western-four-dtp/

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

Please note: If you wish to apply for more than one project please contact the Bristol NERC GW4+ DTP Administrator to find out the process for doing this.

The application deadline is Monday 9 January 2023 at 2359 GMT.
Interviews will take place during the period 22 February – 8 March 2023.

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

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