PROJECT TITLE:
Do plants always have to behave that way? Understanding the evolution of root behaviour and its effects on fitness in flowering plants on Mount Etna, Sicily

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

Lead Institution: University of Bristol

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Project keywords: ecological genetics, climate change, plasticity, evolutionary rescue

![Senecio aethnensis at high elevation on Mount Etna](image1)

![Mount Etna, Sicily](image2)

**Project Background**

A fundamental issue in biology is understanding how: (1) organisms behave in different environments to maximise their fitness; (2) how these decisions compromise other aspects of their present and future phenotype (known as “trade-offs”), and; (3) How much genetic variation there is in (1) and (2), and therefore how quickly organisms evolve new life histories in the face of environmental change.

Understanding such trade-offs is crucial because they help to explain why organisms evolve to use particular habitats and habits (presumably because some trade-offs are genetically or ecologically fixed), and why there are limits to the range of environments a single genotype can use (presumably because maintaining flexibility during an organism’s lifetime is costly). We will address these questions using two species of *Senecio* daisies, which grow along an elevational gradient on Mount Etna, Sicily, characterised by predictable changes in soil type and climate, with corresponding changes in key traits such as root behaviour and its relationship to shoot growth, leaf form, and plant physiology, and plasticity.

These project will help us to understand how easily evolutionary trajectories, and the sensitivity of organisms, may change in novel environments. This has important implications for the evolution of ecological communities and their resilience in the face of climate change, and how effective artificial selection of plant crops can slow soil erosion or improve water use efficiency.
Project Aims and Methods
The aims and methods used the project will evolve depending on the student’s interests and choice of research direction, as well as what the data dictates. However, we envisage three main aims:

1. Estimate variation among genotypes, populations, and species in root behaviour in Senecio on Mount Etna, and explore how these trade off against other key aspects of fitness such as water use efficiency, root strength, above ground growth rate, and resistance to fungal pathogens. This will involve use of root pouches to assay root growth rates and behaviour, an approach recently pioneered at Bristol.

2. Test for phenotypic plasticity in these genotypes by assaying key traits and how they change across a range of soil types and temperature regimes typical the different elevations these populations experience on Mount Etna. These data will be used to predict how environmental variation will affect the trait correlations, and the levels of genetic variation (and evolutionary potential) in these populations. These data will test whether trade offs in life histories are constant within genotypes (i.e. across environments), and how much they vary in their strengths across genotypes and populations.

3. Use existing gene expression data for these same genotypes (data sourced from an ongoing NERC project) to understand the genetic basis of this plasticity, and relate variation in gene expression in genes known to affect root development to variation in root behaviour.

Candidate Requirements
We are looking for an enthusiastic student with a deep interest in evolutionary biology, and in understanding how populations evolve in nature. An interest in plant ecology, and experience of working with plants would also be an advantage, although is not necessary. All other training will be provided.

Training
The student would receive training in: (1) population and ecological genetics and evolutionary rescue (Bridle); (2) quantitative genetics and the analysis of genetic variation in life histories (Postma), and (3) plant developmental genetics, especially of root phenotypes (Grierson). They will also benefit from the taught postgraduate courses available at Bristol and Exeter, and from training from other researchers in these groups who analyse phenotypic plasticity, trait correlations, the genomic basis of plasticity, and evolution in natural populations. In addition, the successful student would work with other collaborators on the project, at the Universities of Oxford, Catania, and Napoli.

References / Background reading list


Links:
School URL  http://www.bristol.ac.uk/biology/courses/postgraduate/

NERC GW4+ DTP Website:  http://nercgw4plus.ac.uk/

Bristol NERC GW4+ DTP Prospectus: http://www.bristol.ac.uk/study/postgraduate/2019/doctoral/phd-great-western-four-dtp/

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

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