Evolution of pesticide resistance as a complex trait: understanding genetic architecture to improve global health and sustainable agriculture

Supervisory team:
Main supervisor: Prof Jason Wolf (University of Bath)
Second supervisor: Prof Alastair Wilson (University of Exeter)
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Host institution: University of Bath
CASE partner: Syngenta

Project description:
Can we predict the evolution of complex traits? This fundamental question has important implications for understanding of evolution in both academic and applied contexts. In an applied context, researchers have traditionally focused on developing methods to accelerate evolutionary change in economically valuable traits, like gain and yield. However, we also face the critical problem of pesticide resistance evolving, where the obvious goal is to avoid evolutionary change. Thus, being able to predict the conditions that inhibit the evolutionary emergence of resistance has clear applied importance for sustainable agriculture and public health. To address this problem, this project will integrate genomic approaches to characterise the genetic basis of resistance, theoretical approaches to modelling evolutionary change, and experimental methods to tracking real-world evolutionary change. We will link this work to cutting edge approaches in sustainable agriculture and the control of vector born disease by modelling and ground-truthing the performance of proposed alternative resistance-management strategies.

The cornerstone of the project will be characterising the genetic basis of insecticide resistance in a natural population using a powerful model system: the fly Drosophila melanogaster. To achieve this goal, we will use genomics approaches to identify links between molecular genetic variation and resistance to individual and mixtures of pesticides. The other main component of the project will be development of theory for predicting how anthropogenic selection drives microevolutionary change. These two elements will be combined to predict evolutionary outcomes under different patterns of insecticide-imposed selection, which will be tested through experimental evolution of fly populations. Evolutionary changes in resistance will be tracked along with genome-wide evolutionary responses. Results from experimental evolution will feed back on the models to evaluate their predictive power and inform their further refinement. The ultimate goal will be understanding the efficacy of using multiple insecticides together to delay resistance, which will have important implications for sustainable agriculture and controlling diseases.

The student will benefit from joint supervision by researchers at the University of Bath, University of Exeter, and Syngenta, providing both a strong academic foundation and clear applied links to maximise the impact of the work. By simultaneously making advances through modelling, experimentation, and computation, this project has multiple pathways to achievement for an ambitious student. The student will be supported by a comprehensive training plan that integrates key computational, mathematical, and empirical skills, preparing students from a wide range of backgrounds for successful completion of this project.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.