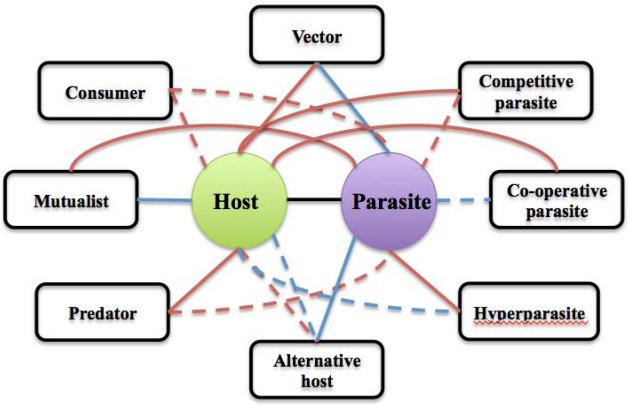
PROJECT TITLE: Host-parasite coevolution in ecological communities

DTP Research Theme(s): Living World

Lead Institution: University of Bath

Lead Supervisor: Dr Ben Ashby, University of Bath, Department of Mathematical Sciences
Co-Supervisor: Prof. Angus Buckling, University of Exeter, Environment and Sustainability Institute

Project Enquiries: b.n.ashby@bath.ac.uk



Understanding how the community affects host-parasite co-evolution. Interactions with the wider ecological community may be beneficial (blue) or detrimental (red) to the fitness of the host or parasite, and the effects can be either direct (solid) or indirect (dashed).

Project Background

Understanding the fundamental processes and mechanisms that underpin host-parasite co-evolution is a major challenge in evolutionary biology and environmental science, with important implications for improving disease management and gaining insights into core biological phenomena. Our knowledge of co-evolution is largely based on single interactions, but hosts and parasites do not exist in isolation; they interact with other harmful and beneficial species in complex communities. Yet precisely how these communities affect host-parasite co-evolution is unknown.

To address this fundamental question in evolutionary biology, this interdisciplinary project brings together expertise in mathematical biology (Bath) to model species interactions, and microbiology (Exeter) to test predictions experimentally. Joining a longstanding research collaboration between Dr Ashby (Bath) and Prof. Buckling (Exeter), the student will use mathematical modelling to explore how the composition and nature of the community affects the outcome of host-parasite co-evolution and will have the opportunity to test key predictions using experimental evolution of microbial communities.

Project Aims and Methods

The central aim of the project is to develop general theory integrating network analysis, community ecology, and evolutionary biology to predict how host-parasite co-evolution unfolds in complex communities. The student will have flexibility to work with the supervisors in project design and research direction. For example, the student may explore how community structure and composition affect co-evolutionary dynamics, or how certain types of communities (e.g. antagonistic or mutualistic) strengthen, weaken, or fundamentally change the co-evolutionary dynamics of a focal host and parasite. The student may also investigate the dynamics of diffuse co-evolution between multiple hosts and parasites (e.g. how do predictions differ when multiple hosts and parasites co-evolve?). The student will apply a wide range of modelling techniques to address these questions, including approaches from population genetics, quantitative genetics, adaptive dynamics, and evolutionary game theory, along with numerical analysis and individual based modelling.

In addition to the core theoretical work, the student will have the opportunity to visit the Buckling laboratory to test predictions through experimental evolution of bacteria and viruses. It is expected in year 1 that the student will make short visits to the Buckling lab to learn biological techniques (if required) and develop projects with the experimental team. Subsequent visits in years 2-4 to carry out experiments may take place over longer periods if necessary.

Candidate Requirements

A suitable candidate will have a strong background in mathematics and a keen interest in modelling biological systems. Prior laboratory experience would be ideal but is not required.

Training

The student will receive training in a range of mathematical modelling and analytic techniques, including methods for numerical analysis and individual based modelling through computer simulations (Ashby). During the laboratory placement, the student will receive training in experimental evolution, general and molecular microbiology and genome resequencing. Specifically, the student will conduct co-evolutionary experiments under a variable community context and determine the phenotypic and genomic consequences (Buckling). Furthermore, the NERC DTP offers scope for substantial training in research and transferable skills, providing an exceptional opportunity to carry out this innovative project.

References / Background reading list

Johnson & Stinchcombe (2007) An emerging synthesis between community ecology and evolutionary biology. *Trends in Ecology and Evolution.* 22:250-257.

Friman & Buckling (2013) Effects of predation on real-time host-parasite coevolutionary dynamics. *Ecology Letters*. 16:39-46.

Useful links

Enquiries relating to the project should be directed to the lead supervisor (see email address above for Project Enquiries). Enquiries relating to the application process should be directed to doctoraladmissions@bath.ac.uk

In order to apply, you should select the relevant University of Bath PhD online application form found here: https://www.bath.ac.uk/study/pg/applications.pl. When completing the form, please state in the 'Finance' section that you wish to be considered for GW4+ DTP funding and quote the project title and lead supervisor's name in the 'Your research interests' section.

Further information about the application process may be found here: http://www.bath.ac.uk/topics/postgraduate-research/

The application deadline is 1600 hours GMT Monday 7 January 2019 and interviews will take place between 4 and 15 February 2019. For more information about the NERC GW4+ DTP, please visit https://nercgw4plus.ac.uk.