

NHM-UCL PhD Studentship

3.5 years from October 2011

Predator control of biodiversity: case studies using microbial microcosms

Supervisors

Dr David Bass (Zoology Department, NHM), Dr David Murrell (Research Department of Genetics, Evolution and Environment, UCL), and Drs Thomas Bell and Owen Lewis (Department of Zoology, University of Oxford)

The project is based at the Natural History Museum, London, with co-supervisors at Oxford and UCL. UCL is the University partner.

Background and project description

Predators play a major role in the evolution and ecology of diverse prey populations. While there have been numerous studies of the effect of single predators, the effect of multiple predators on diverse prey communities remains little studied. Understanding the general ecological principles that determine how predators affect prey biodiversity might be especially important for conservation biology because top predators tend to be most affected by humans. The main aim of this research is to understand the effect of predator diversity in structuring the prey community, and the repercussions for the surrounding ecosystem. Controlled experiments are virtually impossible with large organisms. The strategy that we will employ will be to investigate the effects of predators in model ecological communities composed of bacteria and their predators (protozoa) [1-3]. There will be two components to the research. First, the student would conduct fieldwork within the UK (and potentially further afield). The fieldwork will establish collections of predators and prey for further experiments in the laboratory. Experiments will also be conducted at selected field sites to manipulate the composition and diversity of the predator communities in situ. Second, the project will involve detailed experimental manipulations of predator and prey community structure in microcosms in the laboratory. As a result the student will be able to develop ecological models of maintenance of bacterial biodiversity [4] in the context of predator-prey interactions, and models of protist inter-strain competition dynamics in a comparative phylogenetic context. Further experiments will consider the role of spatial structure, caused by limited dispersal/movement, on predator-prey community dynamics. This will test theoretical predictions that increases in environmental quality can lead to decreases in prey density because prey are harder to drive locally extinct, and are less patchily distributed making them easier to find [5].

Very little work has been carried out to investigate the simultaneous impact of viruses (phages) and protists on bacterial communities. We hypothesise that the ecological effect of these two natural enemies on bacterial densities will be more than additive, because protists tend to feed better when bacteria are not at very high densities: a situation created by phages. Moreover, the presence of both enemies is likely to reduce the effectiveness of the evolutionary response of bacteria: resistance to protist predation results from an increase in bacteria flocking behaviour, but phages prevent flocking.

This project will use existing and newly created cultures of protists, bacteria, and viruses to test these hypotheses and develop models using morphological assessment of microcosm experiments followed by statistical analyses. Molecular techniques (e.g. tRFLP, sequencing) will also be employed where necessary. The project is an excellent example of how fundamental ecological processes can be studied in a relatively simple set of laboratory experiments. The supervisors bring different but highly synergistic expertise to the project: protistology, phylogenetics, and molecular biology (Bass), microcosm experimental expertise (Bass & Bell), ecological statistics, experimental design and modelling (Bell, Lewis, Murrell).

Relevant background reading

1. **Bell T**, M Bonsall, A Buckling, A Whiteley, RI Griffiths (2010) Protists have divergent effects on bacterial diversity along a productivity gradient. *Biology Letters* 6: 639-642. <http://rsbl.royalsocietypublishing.org/content/early/2010/03/05/rsbl.2010.0027.full>
2. Glücksman E, **Bell T**, Griffiths RI, **Bass D** (2010) Closely related protist strains have different grazing impacts on natural bacterial communities. *Environmental Microbiology*: doi:10.1111/j.1462-2920.2010.02283.x
3. **Bass D**, Howe AT, Mylnikov AP, Vickerman K, Chao EE-Y, Edwards Smallbone J, Snell J, Cabral Jr C, Cavalier-Smith T (2009) Phylogeny and classification of Cercomonadida: *Cercomonas*, *Eocercomonas*, *Paracercomonas*, and *Cavernomonas* gen. n. *Protist* 160: 483-521.
4. **Bell T**, JA Newman, BS Silverman, SL Turner, and AK Lilley (2005) The contribution of species richness and composition to bacterial services. *Nature* 436: 1157-1160.
5. **Murrell, D. J.** (2005) Local spatial structure and predator-prey dynamics: counterintuitive effects of prey enrichment. *The American Naturalist*, 166, 354-367.

Training provided by the project

A Development of skills in experimental ecology and evolution

1) At a practical level: laboratory microcosm experiments, microscopy, molecular biology techniques (PCR, gel electrophoresis, tRFLP, Sanger sequencing, etc.). 2) At theoretical and computational levels: analyses of sequence data, phylogenetics, statistics (including tuition in R), experimental design, and modelling.

B Science communication

1) The student's scientific writing skills will be developed for publication of results in international peer-reviewed journals, but also for more general reviews, and articles for the general public. 2) The student will be required to give oral and poster presentations of their work at at least two relevant international conferences. 3) The student will be coached in and expected to devise presentations and materials for interaction with the general public, specifically at the NHM via events such as NatureLive.

For further details please contact David Bass (d.bass@nhm.ac.uk), David Murrell (d.murrell@ucl.ac.uk), or Tom Bell (thomas.bell@zoo.ox.ac.uk).

To apply, send a **full academic CV including two referees and covering letter** to Anna Hutson, Postgraduate Studies Administrator, The Natural History Museum, Department of Botany, Cromwell Road, London SW7 5BD, UK, or electronically to A.Hutson@nhm.ac.uk **by 20 April 2011. Please cc d.bass@nhm.ac.uk when you email your application or notify me by email if you send your application by post.**