Sylva Scholarship 2010

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Research Title:	The consequences of management and climate change for ecosystem function: a case study of cord-forming fungi in English woodlands.
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Summary of research

Two major challenges face UK forestry over the next half century:

- Meeting increased demand for wood and other forest products and services in a sustainable fashion;
- Managing shifts in the species composition of semi-natural stands in response to environmental change without loss of productive or ecosystem functions.

Forests in the UK are currently valued as much for their biodiversity, carbon storage and environmental services as they are for their capacity to produce useable wood. However, the majority of lowland broadleaf woodland is unmanaged and much is neglected. Growing emphasis on reducing carbon emissions through increased use of locally produced timber and biofuel will provide a powerful incentive to make these woods more productive. It is uncertain whether management for production will have positive or negative impacts on biodiversity and other environmental services. It is clear that in order to maintain and enhance production new provenances and species will need to be introduced that are better adapted to novel environmental conditions. A major concern is that such introductions (either through planting or colonisation) may have significant impacts on many important ecosystem processes such as carbon cycling, disease dynamics and trophic webs, and that this may have an impact on sustainability.

In this study we propose to examine whether changes to the management regime and species composition of UK broadleaved woodland are likely to have a significant impact on ecosystem function. We will do this by investigating their effects on an important group of 'ecosystem engineers' – the cord-forming fungi (CFF).

CFF are powerful but very poorly known protagonists in forest ecosystems. They are the main degrading agents of fallen wood and therefore major players in the forest carbon cycle. In some cases they also play a unique role in carbon sequestration by converting wood breakdown products into a non-degradable form thereby contributing to a forest-specific carbon sink. In addition they are also dominant members of the soil/litter communities, inhibiting the growth of other fungi and microbes, many of them pathogens or potential pathogens.

Recent work suggests that the taxonomy diversity of CFF is significantly higher than previously realised and therefore a corresponding functional diversity also exists, but is mostly unknown. Morphology alone is not a good indicator of CFF diversity or occurrence as the organisms are often cryptic and show high levels of

morphological convergence. This studentship will address this important gap in knowledge by analysing spatial and temporal variation in CFF taxa, their interactions with other organisms, and their contribution to forest 'health'.

There are three main objectives:

1. To describe the structure and composition of the CFF in both managed and neglected lowland broadleaved woodland using a combination of molecular and morphological approaches. Key questions will be
    - to determine to what extent CFF taxa are specific to individual tree species and substrate;
    - to examine how the quantity and quality of deadwood affects proliferation in soils.
    - to measure their proliferation in soils, away from their resource islands to see if, like ectomycorrhizal fungi they form a 'wood wide web';
    - to assess the effects of thinning and clear-felling on proliferation.
2. To determine the effect of non-native tree species, particularly invasive species on CFF community composition and structure and the consequences for ecosystem function. We will focus particularly on carbon-cycling and interactions with other potentially pathogenic microbes. We will examine both exotic plantations in ancient woodland sites and woodlands that have been colonised by woody invasive species such as *Acer pseudoplatanus* and *Rhododendron ponticum*.
3. To investigate interactions between CFF and other soil microbes, including known tree pathogens and beneficial partners, e.g. ectomycorrhizal fungi. We will devise microcosm experiments to measure the diversity and strength of interactions. The results of the microcosm experiments can then be tested at field sites by quantitative analyses (Q-PCR) using specific molecular probes to test the strength of exclusive and synergistic relationships in vivo. We may explore whether the cord system acts as a conduit for other organisms. Based on the few studies available there are strong indications that the cord network formed by CFF preferentially harbours other fungi, bacteria, and possibly protists and viruses as symbionts and/or saprotrophs and that such organisms thus co-occur and co-disperse with CFF. Until we know what these 'hitch-hikers' are the significance of this phenomenon is unknown, but it is likely that they will include plant pathogens and organisms moderating the growth and activity of CFF themselves. Again both morphological (culture-based and confocal microscopy) and molecular (clone library analyses) will be used. The spatial relationships of key organisms involved in the cord 'communities' will also be investigated using confocal and fluorescent microscopy.

The student will carry out molecular analyses and microscopy at the Natural History Museum (NHM) (London) with co-supervisor David Bass. Bass's lab is well-equipped and experienced in all of the techniques required for this project, and has good technical support for training and assisting the student. The NHM also has an excellent microscopy unit (http://www.nhm.ac.uk/research-curation/science-facilities/analytical-imaging/imaging/index.html), which will train the student in relevant techniques for describing cord structure and interactions in ways previously unfeasible.