FUNCTIONALBIO

Functional biodiversity in forests: diversity of soil decomposers and predatory and parasitic arthropods

PROJECT TEAM

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BACKGROUND

In forests, growth and decomposition are the two most important ecosystem functions. Plants supply the majority of growth within the ecosystem, while fungi and soil fauna are the main drivers of decomposition. A large amount of research has been carried out on forest plants, therefore this project is designed to study the biodiversity associated with the other important functional aspects of forest ecosystems. The taxa selected were: fungi, soil microarthropods, parasitoid wasps, bugs and nematodes. Mycorrhizal fungi are important within forest ecosystems as they form associations with the roots of many tree species and assist in the assimilation of nutrients. Soil arthropods play a major role in decomposition and nutrient cycling and also help inoculate roots with mycorrhizae. Within the forest system, there is far greater biodiversity below-ground than above-ground, for example there are approximately 1,000 species of soil invertebrates in a single square metre of beech forest.

Apart from soil fauna, some groups of above-ground arthropods are being studied. Ecological theory suggests that arthropod communities with more complex food web structures and high numbers of predatory and parasitic species have greater inherent population stability and are less prone to pest outbreak. Parasitic hymenoptera were studied as a representative above-ground group.

OBJECTIVES

- Compile a literature review of previously conducted biodiversity studies that relate to this work.
- Select forest sites in Ireland where field sampling will be conducted in collaboration with groups from UCC and TCD.
- Compile a macrofungal basidiomycete and ascomycete inventory of selected woodland sites encompassing the functional groups: ectomycorrhizal fungi, saprotrophs, pathogenic wood-decay fungi.
- Obtain information on the abundance of fruiting bodies of edible forest fungi in the selected woodland sites.
- Relate fungal diversity to site and management factors such as native/non-native broadleaf versus plantation conifer canopy, conifer/broadleaf mixtures, second rotation versus first rotation plantation, stand age, soil type, herb layer vegetation.
- Relate the efficiency of fungal biodiversity indicators to other biodiversity indicators in Irish forests.
- Assess additional aspects of biodiversity (Hemiptera, parasitic Hymenoptera, nematodes and soil microarthropods) in forests that have not been covered by the BIOFOREST project (2001-2006).
- Assess the below-ground biodiversity of forests in detail.
- Provide inventories of the biodiversity in the habitats studied.
- Develop methodologies to assess biodiversity in forests.
- Draw up recommendations to enhance biodiversity in plantation forests.

PROGRESS

Lists of mite species recorded from forests have been compiled and reviews of the Collembola, Hemiptera, parasitic Hymenoptera and nematodes are ongoing and being placed in the context of the fauna recorded from other Irish habitats, in particular agricultural grassland, peatland and some coastal habitats. The analysis for the mites is virtually complete and shows that, in Ireland, many species have been exclusively recorded in forests, in particular in habitats such as fungal fruiting bodies. Thus we can conclude that forests add considerably to the biodiversity of mites in the Irish landscape. This work is ongoing and databases are updated as new data become available.

Macrofungal basidiomycete and ascomycete inventory. The third of the three planned annual samplings was completed in November 2009. During the 2009 autumn

period, 28 sites were sampled compared with 26 in 2008. The total number of site visits in 2009 was 83, compared with 55 in 2008. Over the course of three years the project has sampled 910 quadrats covering approximately 18,200 m^2 of forest.

Data acquired from field sampling include a quantitative assessment of each macro fungal found in a site including substrate data.

Site variables were also collected. These include:

- Soil nutrient data measured using the new PRS technology.
- Deadwood quality and volume has been assessed.
- Soil samples have been collected and are being analysed for N, P, K, Ca, Mg, pH, moisture content and carbon content.
- Data on the physical canopy structure of each site have been collected .
- Data on canopy cover has been collected using the canopy scope method.
- A full list of vegetation present at each site has been compiled.

Ectomycorrhizal (EM) fungi. Fifteen sites have so far been sampled (primarily Sitka spruce) by soil coring. A preliminary screening based on morphological criteria has separated EM samples into recognisable types. Samples of all types have been retained in glutaraldehyde for morphological assessment, and at -80ºC for identification by molecular methods. Abundance of different types on tree roots has been scored. Work has commenced on molecular identification.

Significant outcomes to date. In total, 478 fungal species have been identified from fruit bodies taken from the sites. There were 125 new species realised in 2009 compared with 108 new species in 2008 and 247 new species in 2007. Preliminary analysis of the fungal species found that 178 were listed as common on the British checklist of fungi www.basidiochecklist.info/index.htm .

Five forest types were sampled: first and second rotation Sitka spruce, Scots pine, ash and oak. A representative of each of these types was selected in each of five geographical areas of the country.

A very large diversity of mites and Collembola has been recovered in studies where sampling was carried out by climbing trees (Figure 2). The assemblages in the soil and in moss on the tree are different from the assemblages on the bare branches which are made up of a relatively small number of species; however, these species tend to be specific to such bare branch habitats while the many similar species occur in moss on trees and in soil. The species occurring on the broadleaved species (oak and ask) are different to those occurring on conifers (Figure 3). Virtually no differences were detected between first and second rotation Sitka spruce. The sites sampled were blocked into different regions which were seen to differ significantly from one another. In particular the assemblages found in the Clare/Galway/Tipperary, Cork/Kerry and Wicklow/Kildare area were fairly distinct, while those from Laois/Offaly and Sligo/Roscommon were intermediary in structure.

Approximately, 270 genera of parasitic wasps have been identified from the five forest types sampled. Each forest

Figure 1: *Phaeolus schweinitzii* - a common parasite on Sitka spruce.

Figure 2: Tree climbing has proved to be a valuable method of sampling invertebrates in canopy habitats.

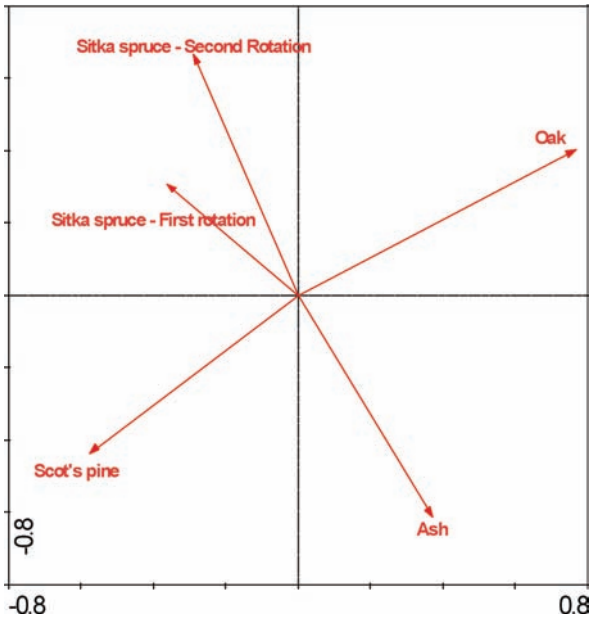

Figure 3: Canonical Correlation Analysis of mites occurring in different forest types. Forest types close together, particularly on the horizontal axis, on the graph are most similar.

type appears to have a unique fauna, with only 18 genera common to all forest types. The broadleaf forests, ash and oak, show the greatest diversity with approximately 180 and 170 genera respectively. Comparatively lower parasitoid diversity was found in the coniferous forests with Scots pine, first rotation and second rotation Sitka spruce forests with 85, 65 and 67 genera respectively. Much of the diversity of the ash forests can be attributed to one site: St John's Wood in Roscommon. To date, only half of the specimens from this site have been identified, but 126 genera have been determined. The ichneumonid, *Pantisarthrus luridus* (Foester), was recorded for the first time in Ireland from an ash site at Donadea Forest Park (Kildare). Many specimens have been sent to the Natural History Museum, London, for verification and it is likely that at least some of these will be new Irish records.

ACTIVITIES PLANNED

- Continue to add to species databases.
- Critical fungal identification will sent to experts for verification.
- The assessment of ectomycorrhizal diversity on roots of each site will be completed in early in 2010 using mophotyping and molecular methods
- Quantitative analysis of macrofungal diversity data will be completed.
- The relationship between fungal diversity and other biodiversity metrics on the forest sites will be evaluated.
- Completion of the identification of the specimens collected. This will now involve collaboration with international experts to ensure proper identification of 'difficult' species.
- Analysis and publication of data.

OUTPUTS

A visiting scholar exchange post was taken at Oregon State University from May 2009 to mid July 2009. A poster was presented on the project at the North American forest ecology workshop NAFEW2009 in Logan Utah in June 2009 www.nafew2009.org.

A presentation on the project entitled *Fungal Diversity in Irish Forest Ecosystems* was given by Richard O'Hanlon at the seminar Forest Fungi in Ireland at Avondale House, Co Wicklow on 28 August 2009.