Lesn. Cas. For. J. 61 (2015) 58–62

Lesnícky časopis - Forestry Journal
http://www.nlcsk.sk/fj/

COST Action FP1305 Biolink: linking belowground biodiversity and ecosystem function in European forests

Overview

European forests are of immense importance to both society and the environment, providing a range of products and ecosystem services many of which are threatened by climate change. Our understanding of the diversity of belowground biota in tree dominated is currently limited and typically spread over distinct trophic levels. Little is known about the redundancy and functional diversity in forest soils. Numerous factors threaten existing belowground biodiversity, the simplification of tree ecosystems in pursuit of higher productivity being one of the prominent ones. There is an urgent need to link up existing scientific expertise at different levels to fully explain the connection and key controlling mechanisms between diversity, stability and function. Concurrently, forest modelling lacks coordinated activity aimed at bringing biodiversity into the fold - current emphasis is on yield and forest gap models which often ignore belowground processes, let alone the biodiversity that powers them. Elsewhere, food web models and ecosystem network models are well developed, but their application to forests is limited.

In general, positive effects of diversity on ecosystem stability and function are known, however there is a growing understanding that looking at diversity at distinct trophic levels is insufficient. To reflect forest ecosystem functioning and to fully understand and explain the connections between diversity, stability and function, we need to link up scientific expertise which is currently concentrated at and invariably focuses on different trophic levels. Knowledge is spread across diverse groups of researches who concentrate their effort at specific types of organisms or functional groups. By bringing together expertise on tree and belowground diversity in tree dominated ecosystems, this COST Action aims to uncover the contribution of diversity within trophic levels to overall ecosystem function and stability. The Action will link the latest understanding of forest biodiversity and ecosystem function from various subject areas. Cutting edge knowledge of the links between biodiversity and ecosystem function exists in fields as diverse as evolutionary ecology, aquatic biology, food web modelling, or indeed forest ecology. Biolink aims to bring top experts from some of these fields in as invited speakers, thus helping our effort to describe the role of belowground biodiversity and functional diversity in ecosystem functioning and stability of forests and tree crops.

Objectives

Biolink works as an open and efficient networking vehicle for researchers, policymakers and end users. It aims to involve not only experts who already work in forestry or tree crop backgrounds, but also researchers from disciplines such as agriculture, microbial ecology, conservation and network modelling, policy experts and members of the business community. The main goal is to create an efficient knowledge exchange platform aimed at establishing belowground diversity as a major determinant of ecosystem productivity and stability. Admittedly, this is a large undertaking, the Action will work on the following objectives in order to paint the bigger picture describing the role of belowground biodiversity:

1) Much of the European area covered by trees has been utilized for many centuries. Current management is designed primarily for productivity and has led to the reduction of tree species diversity. As trees are by far the most dominant primary producer in this type of ecosystem, any manipulation of tree species diversity is likely to be reflected at other trophic levels, particularly belowground. Soil microorganisms such as fungi and bacteria are taxonomically highly diverse and are a key to ecosystem function. An example of the connected nature of these systems is the link between mycorrhizas and forest trees; one of the best understood relationships in forest function. Since tree diversity exerts key influence over the diversity of ectomycorrhizal communities, the potential for feedbacks between mycorrhizal fungal functional diversity and host diversity are considerable. However, the contribution of such interactions to forest ecosystem stability is currently little understood. It is widely accepted that only a small fraction of the microbial species has been described thus far and that a significant fraction of species remains unknown. These are mainly uncultivable bacteria, potentially accounting for a huge fraction of soil microbial diversity. Collecting and integrating data from research employing recent

advances in next generation sequencing (NGS) is one of the tasks of the Action. Any increase in our knowledge of the soil microbiome will widen the window onto the real biodiversity levels occurring in forest and agroecosystems, as well as on their functions and services their activity underpins. Recent methodological developments, both analytical and modelling, allow for an assessment and analysis of functional links within the soil-dwelling community, the task for the Action is to create a clear overview of methods and their potential.

2) Although considerable effort has been made in improving mechanistic modelling of forests at different scales, many are still focused on management-yield relations and consider the soil as a black box. As yet, these models are unable to simulate the consequences of changing biodiversity (incidentally, both above- and below ground) on ecosystem performance and behaviour. Existing (aquatic) food-web models, LCA (Life cycle Analyses) models and agricultural soil models are far better at simulating interaction between tropic levels. The implementation and integration of at least some of the algorithms used in these models can substantially improve existing forest models. The stability and functionality of the soil is of prime importance to ecosystem functioning, improving - or even starting on - the simulation of this component must improve overall model performance. For the modelling community, the opportunity to work directly with experimentalists, end-users and modellers from related fields creates a unique opportunity for advancement of their efforts. This framework will also present an opportunity for young scientists to be trained in ecosystem modelling.

3) Knowledge of the role of soil biological communities in supporting resilience in agroecosystems across Europe is often limited to specific environments, management systems and tree crops such as walnut, chestnut, olives, oak or other perennials. These crops often represent an intensively managed succession to previous forest ecosystems in many parts of Europe and/or form the basis of productive agroecosystems integrated with contiguous forests. The resilience and productivity of these agroecosystems is primarily driven by the stability of the soil component, which in turn is probably generated by soil biodiversity inherited from earlier forests. The 'biodiversity insurance hypothesis' applicable to these simplified ecosystems will be assessed by the Action through a systematic and critical knowledge exchange. The Action aims to find appropriate and innovative recommendations as to the feasibility of harnessing the belowground biodiversity to support productivity. These are currently highly required by the practitioners, managers and policy makers and are likely to form the basis of knowledge-based agroecosystem management strategies.

4) The Action will contribute to the ongoing debate about the economic and social costs of biodiversity loss within, but also outside Europe. EU Biodiversity Strategy to 2020 states that 'The Commission will continue its work to fill key research gaps, including on mapping and assessing ecosystem services in Europe, which will help improve our knowledge of the links between biodiversity and climate change, and the role of soil biodiversity in delivering key ecosystem services'. Biolink COST Action will enhance the collation and synthesis of evidence-based guidance and support relating to belowground biodiversity in European forest ecosystems. Crucially, Biolink adopts a multidisciplinary approach, bringing together experts in biodiversity at different trophic levels within forest ecosystems, ecosystem modellers, tree ecology and management specialists, supplemented with leading experts on biodiversity in other types of ecosystems, thus linking current understanding of belowground functional biodiversity at different scales and trophic levels in European forests in order to provide a basis for the development of prescriptions for tree ecosystem management.

5) A significant effort has been put into biodiversity conservation, both at national and at EU level (Natura 2000, Biodiversity Strategy to 2020, CAP reform). Current science indicates that loss of biodiversity is likely to diminish ecosystem service provision and therefore takes on social and economic dimensions. Whether it is timber or fruit production, carbon sequestration, water filtration or soil protection, it is likely that all these services are dependent on belowground biodiversity, with microbial communities playing a key role. The output of this COST Action will have a direct relevance to these efforts. Soil biodiversity provides numerous essential services, including releasing nutrients, purifying water, contributing to the composition of the atmosphere, and providing a major source of genetic and chemical resources (e.g. antibiotics). The EU Joint Research Centre is working on improving its preliminary assessment and mapping of locations where soil biodiversity is threatened, his COST Action will contribute to this undertaking by providing information about the functional importance of soil dwelling organisms. Further afield, the European Commission is developing a European Innovation Partnership on Agriculture Productivity and Sustainability, with a particular focus on land management. The Action aims to assess how knowledge of biodiversity function can be utilised to strengthen ecosystem resilience and of ecosystem service provision, as well as its utilisation in support of EU climate change adaptation policies

And finally, although not a scientific aim in the strict sense, Biolink creates a learning environment for early--stage scientists. It is imperative that the Action utilises all means available to foster efficient exchange of knowledge and advice between established and early-stage scientists. The Action aims to provide the early-stage scientists with an opportunity to come across the latest developments in the field, but also to be exposed and become aware of the commercial applicability of biodiversity science. Throughout

the four years, the Action will invite leading experts from closely related fields (theoretical, aquatic, agricultural, socio--economic backgrounds) to provide early-stage researchers with an exposure to a wide range of views on biodiversity, its importance and utilisation. The Action has allocated a substantial proportion of its first year budget to supporting study visits by early stage researches and will continue to do so in later years.

Work in progress

The first meeting of Biolink took place at the University of Reading (UK) between 4th and 7th November 2014. One of the main aims of the meeting was to establish a vibrant community of scientists interested in relating the many forms of belowground biodiversity found in European forests and tree plantations to the functioning of the whole ecosystem. The meeting kicked off the scientific work of the Action by focusing on activities based around the following working Groups:

WG 1 Linking belowground biodiversity to ecosystem function.

WG 2 Microbial and faunal functional biodiversity in belowground food-webs.

WG 3 Belowground biodiversity in plantations and tree crops.

WG 4 Functional diversity in forest models.

The two-day programme included a brainstorming session, a series of stimulating invited speaker presentations, a poster session where starting researchers will present their work and sufficient space and time to talk to colleagues old and new. Alongside arranging the working schedule for the immediate future, the meeting aimed at posing fundamental questions such as what is the underlying mechanism connecting soil biodiversity to the myriad of its functions, how do we study its strength and why does soil biodiversity matter.

Biolink is set to continue until 2018 and provide an open platform for anyone interested in soil biodiversity in forests and tree crop plantations, more information about the Action and upcoming events can be found on www.bio-link.eu.

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