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EDITORIAL NOTES

Exploratory workshop on diversity and function in ectomycorrhizal communities

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This special issue of the Annals of Forest Science presents eight articles written by invited speakers at the Exploratory Workshop on Diversity and Function in Ectomycorrhizal Communities held in Nancy (France) on December 7–8, 2009. The workshop was sponsored by the European Science Foundation and co-sponsored by INRA, the Regional Council of Lorraine and the Network of Excellence EVOLTREE of the European Union.

This meeting has been motivated by the growing interest of ecological science for functional biodiversity, especially concerning two complementary challenges. The first one is about the structure–function relationship in species communities; it aims at understanding how the functional traits contribute to the assemblage of species and determine the stability of the community structure, and how the activities of the different species combine in the community and result in processes at ecosystem level. The second challenge, particularly relevant because of the present climate change concerns, is more answerable to applied ecology: how to control and manage the complex network of functional interactions in communities in a changing environment.

The purpose of the exploratory workshop was to apply the general concepts of community ecology and functional biodiversity to these two challenges in the precise case of the ecology and management of European forests, targeting the central compartment of any forest ecosystem: the community of the symbiotic fungi which inhabit the roots.

European forests are presently suffering from increasing stresses of natural and man-made origins which affect not only the tree stands themselves but also the quality and quantity of ecosystem services such as wood production, soil protection, nutrient cycling, carbon sequestration or water quality (see for instance AFS 63 (6), 2006). These forests are dominated by social tree species which form monospecific stands characterized by a particular type of root association with fungi: the ectomycorrhizal (ECM) symbiosis (Smith and Read 2009). ECM communities play a major role in biogeochemical cycles, primary production and ecosystem sustainability. At the same time, they are shaped by silviculture and environmental disturbances (Buée et al. 2005; Mosca et al. 2007; Diedhiou et al. 2009; Rineau and Garbaye 2009; this issue). The complexity of these interactions and the lack of appropriate investigation methods in underground ecology have for long prevented analysing the functional structure of ECM communities and its response to abiotic factors.

However, new techniques have been developed (e.g. molecular fingerprinting of the fungal symbionts (Gardes

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and Bruns 1993), stable isotope tracing (Högberg et al. 1999), transcriptomics (Courty et al. 2009), proteomics and micro-enzymatic assays (Courty et al. 2005; Pritsch, this issue)) to explore in situ the functional diversity of ECM communities. This makes possible, for the first time, deciphering their complex temporal and spatial activity patterns, as well as determining to which extent they contribute to the resilience of the ecosystem when submitted to environmental disturbance. Questions to be addressed are for instance: are the many ECM types in a community functionally complementary or redundant? Is it possible to sort them into functional groups? Do rare types contribute significantly to the overall functioning of the ecosystem? What are the most important functions performed by the ECM community? Do they correspond to specific functional traits? Such basic knowledge is the prerequisite to understanding the contribution of ECM communities to ecological processes of interest for silviculture, soil conservation and landscape management. Figure 1 illustrates the conceptual background of this emerging research activity (from Courty et al. 2010).

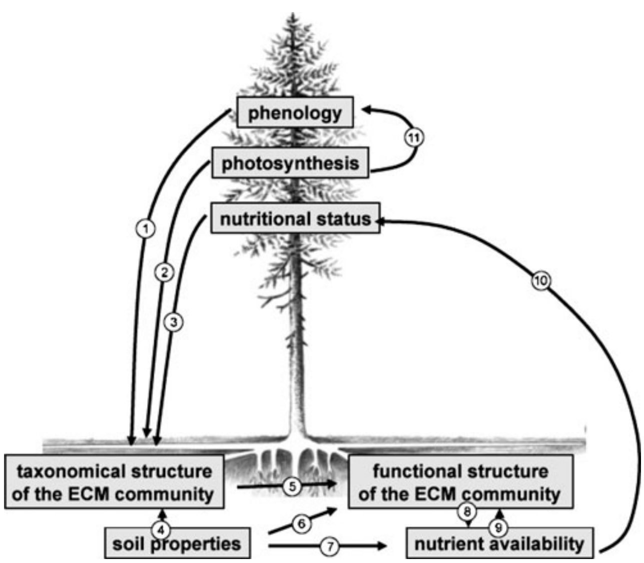

Fig. 1 Synthetic representation of the causal relationships in an ectomycorrhizal forest ecosystem (the *circled numbers* refer to the *bold numbers* in the legend). Because ECM fungi have diverse nutritional and ecological requirements, the taxonomical structure of the ECM community is impacted by tree phenology (*1* seasonal presence or absence of functional leaves, bud break, leaf senescence, periods of shoot elongation, root growth or cambium activity, carbon allocation patterns, developing organs as carbon sink, etc.); photosynthetic efficiency (*2* quantity of available photosynthates); tree nutritional status (*3* water, phosphorus, nitrogen contents of the root tissues); and soil properties (*4* mineral composition and quality of the organic matter). The functional structure of the ECM community first depends on its taxonomical structure (*5*) because the different symbionts display different profiles of potential activities, but also on the physicochemical properties of the soil (*6*) and on the availability of nutrients (*9*), which is in turn determined by the soil properties (*7*) and by the functional structure of the ECM community itself (*8* mineral solubilization, enzymatic degradation of organic matter). Then, the pool of nutrients mobilized by the ECM community directly determines the mineral nutrition of the tree (*10*), which in turn controls the efficiency of photosynthesis (*11*), closing the whole feed back loop (from Courty et al. 2010)

The eight articles presented here review some of these issues and discuss relevant case studies. Rudawska et al. and Colpaert analyse the role of ECM communities in the interaction between industrial soil pollution and tree stands: how does the community structure respond to heavy metal deposition and how do fungal species adapt and protect the roots. Pritsch et al. and Plassard et al. show how ECM fungi efficiently mobilize nutrients from soil organic matter through the activity of extracellular enzymes, with an emphasis on methodological developments, functional diversity and phosphorus tree nutrition. R. Koide discusses how the general concepts of functional ecology help to understand ectomycorrhizal communities. Using two case studies, Richard et al. and Rineau and Courty study how ECM communities respond to environmental disturbance and adapt to the resource in terms of species composition and enzymatic activity profile. Finally, Egli reviews the present knowledge in ECM community ecology and discusses the use of this knowledge to define indicators of forest health and to the management of edible forest mushrooms with high commercial value.

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