Abstract

In forest ecosystems, substantial part of carbon enters soil in the form of plant litter. The decomposition of litter and soil organic matter represents an important process affecting nutrient cycling and carbon balance in soils. Fungi are considered the primary decomposers in terrestrial ecosystems due to the production of wide range of extracellular enzymes that allow them to attack the lignocellulose matrix in litter. Even if fungi represent key players in organic matter decomposition, the information about the structure and diversity of their communities is still limited and the roles of individual fungal taxa in forest soils remain unclear.

This Ph.D. thesis focused on the characterization of fungal communities in forest soils and their potential to decompose plant litter. The method for in-depth analysis of complex microbial communities from environmental samples was established and used. In addition, single eukaryotic functional gene was analysed in soil for the first time at a depth that allowed reliable estimation of diversity.

It was demonstrated that microbial community composition differs among horizons of forest soil profile. Despite similar diversity, significant differences in microbial community composition were observed between the DNA and RNA. Several microbial groups highly abundant in RNA pool showed only low abundance in DNA community indicating that low-abundance species make an important contribution to decomposition processes in soils. During plant litter decomposition, fungal community undergoes rapid succession with dramatic changes in its composition and most of the abundant taxa only temporarily dominate in the substrate. In forest soil, fungal activity, biomass and diversity decrease substantially with depth. The structure of fungal community in forest soil is distinctively influenced by the seasonal effects which are most apparent in the litter horizon. In the litter horizon, saprotrophic genera reached their seasonal maxima in autumn but summer typically saw the highest abundance of ectomycorrhizal taxa. While the composition of the litter community changed over the course of the year, the mineral soil rather showed changes in fungal biomass. Non-basidiomycetous fungi isolated from forest soil differed from saprotrophic basidiomycetes in their ability to decompose biopolymers present in litter and soil. Non-basidiomycetous fungi likely do not play significant role in lignin degradation but are able to produce a range of cellulolytic and chitinolytic enzymes giving the evidence that they are actively engaged in decomposition of lignocellulose and dead fungal biomass. Concerning the effect of chemical composition of litter on its decomposition rate, it was demonstrated that litter nitrogen content positively correlates with litter mass loss while lignin content does not have any effect neither on the litter mass loss nor the activity of ligninolytic enzymes. This result suggests that the activity of ligninolytic enzymes is probably a less suitable indicator of lignin decomposition than expected.