The structure of mycorrhizae and mycorrhizal fungi in forest soil and nurseries

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The humus layer of forest soil is inhabited by a multi-coloured mosaic of fungal mycelium. In addition to saprophytic mycelia, symbiotic ones are very common and mycorrhizal fungi seem to predominate.

The root tips of trees have a density of about 50 per cm^3 of soil. Most of them are mycorrhizal. In fact our trees would not survive without mycorrhizae, pine being the most dependent on them. With a few exceptions, these mycorrhizae are ectotrophic. Ericaceous shrubs, herbs and grasses have endomycorrhizae, which are mainly formed by phycomycetes and ascomycetes, comprising only a few species.

In contrast, the number of ectomycorrhizal fungi is high, probably over 1 000 species. A single tree may have more than a hundred. The root systems are regularly mottled by fungal mantles and one short root may bear many mycorrhizal fungi. On the other hand, clones in which one and the same mycorrhizal fungus predominates are common, sometimes extending for several square metres.

The most important formers of ectomycorrhizae are the basidiomycetes. Important and mainly mycorrhizal genera are *Boletus, Leccinum, Suillus, Lactarius, Russula, Cortinarius, Amanita, Tricholoma* and *Hygrophorus*. There are also important symbionts in the genera *Laccaria, Paxillus, Cantharellus, Gomphidius* and *Hydnum*. In fact, most large-sized mushrooms are symbionts, even obligate symbionts. They are so dependent on tree carbohydrates that they cannot form fruiting bodies without them, being absent, for instance, from clear-cut areas. Other fungi worth mentioning are the basidiomycete *Piloderma*, with its bright yellow mycelium, and the ascomycetes *Elaphomyces* and *Cenococcum*, the latter with a stiff jet-black mycelium (Mikola 1948, 1961, Laiho 1970).

The classification of ectomycorrhizae is primarily based on the fungal partner. However, only a few mycorrhizae are recognizable by the symbiont. The majority have to be distinguished by mantle colour and structure, intensity of infection and the vigour of the short roots.

Nutrient-absorbing tree roots are very superficial, most of them being situated in the humus layer. At its surface the mycorrhizae are young and well developed. At greater depths they are older, sparser and suffer from lack of oxygen.

Mycorrhizae are almost equally common in all our forest soils (Mikola & Laiho 1962), but their structure varies from site to site. On moderately fertile sites, *Vaccinium* type and *Myrtillus* type, they reach their optimum, having a thick mantle and well-developed Hartig net. On the most fertile sites, herb-rich type, the mycorrhizae have a thin mantle and weak Hartig net, and rhizomorphs are lacking because of the active soil fauna and high nutrient level.

When the forest soil is fertilized, the species composition of the mycorrhizal fungi becomes poorer and the structure of the mycorrhizae weaker (Lehto 1984, Laiho et al. 1987). In nurseries, the nutrient level can be so high that mycorrhiza formation is prevented, at least for a while. With lower fertilizer dosages, mycorrhizae are formed, but they are weak in structure and poorly branched, particularly in peat moss substrates. In mineral soil their structure is sturdier.

Nursery mycorrhizae tend to have the same appearance, being tannin brown in colour. The number of fungi involved is evidently small. The ascomycete *Wilcoxina micolae* Yang & Korf. forms almost half of the mycorrhizae in our nurseries (Mikola 1965). It forms ectomycorrhizae with spruce and birch and ectendomycorrhizae with pine. This has caused concern, because the ectendotrophs have traditionally been considered one-sidedly parasitic. In forests, this species is rare and it disappears from forest plantations within a few years, being replaced by indigenous species of the site. At present there are a number of inoculation programs designed to introduce into nurseries fungal partners able to survive in forests.

References

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