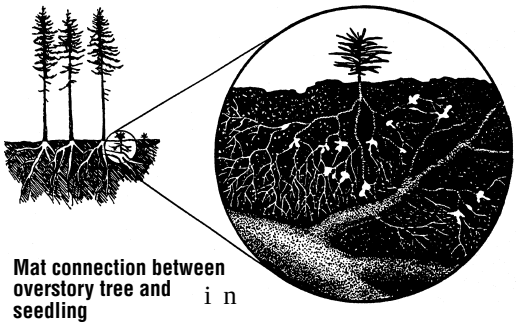
MYCORRHIZAL FUNGAL MATS

ROLE IN FOREST PRODUCTIVITY

background

There is an important class of fungi, called mycorrhizal fungi, that form mutually beneficial relationships with plants. Over 90% of all known plant species form mycorrhizae with these fungi, and in a large percentage of plant species, this relationship is mandatory for plant growth. These fungi benefit plants by (1) growing out of root surfaces thereby extending the effective nutrient-absorbing surface area of the roots, (2) producing enzymes that increase phosphorous and nitrogen availability to plants by decomposing organic matter, (3) protecting plants from root pathogens, and (4) altering roots to make plants more resistant to drought. There is a specialized group of mycorrhizal fungi that form dense mats forest floor litter and mineral soil. These fungal mats are the focus of this research.



Mat connection between overstory tree and seedling

the studies

There have essentially been two types of mycorrhizal mat studies conducted at the H. J. Andrews Experimental Forest: (1) those addressing how mats influence forest soil carbon and nitrogen cycling and (2) those addressing factors influencing mat distribution patterns at different scales. The first set of studies focuses on how mats function so their relative ecological importance can be assessed. The second set of studies allows us to determine how management practices may influence their abundance and reestablishment after timber harvest.

Since fungal biomass of mat-forming mycorrhizal fungi dominate the soils they colonize (up to 50% by weight), much can be learned about the biology, and chemistry of soils by comparing the characteristics of mat soils with adjacent soils with no visible mat material. We have conducted seasonal studies of mat/nonmat soil differences at the H. J. Andrews Experimental Forest as well as sites in the Oregon Coast Ranges and at the northern California coast. This range of sites was studied to determine if similar results would be found in each location. We found the same results regardless of where we looked.

The mat distribution studies have included the following:

- The effects of understory vegetation on mat frequencies.
- The recovery of mats through time after timber harvest.
- The effects of stand edges on mat distribution patterns.
- Factors influencing mat distribution patterns within 2 x 10 meter plots in different aged stands.
- Mat distribution patterns on sites on which mature trees are retained after timber harvest.

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findings to date

- Mats are essentially eliminated by clear-cut harvesting of forests stands. In some cases, it can take over 80 years before pre-harvest concentrations of mats are once again seen in forest soils.
- The chemistry of mat soils is significantly altered by the production of organic acids which greatly increase weathering rates of soil minerals.
- These fungi appear to have the capability of breaking down organic matter so that organic nutrients can be directly cycled from litter to the host tree.
- The composition of soil organisms associated with mat soils is different than that in nonmat soils which may have the net effect of increasing soil biodiverisity.
- Mats are often found in greater abundance at the base of understory vegetation in mature and old-growth forests.
- Mats are responsible for increasing nutrient availability to trees by: (1) increasing the efficiency by which nutrients locked up in nonliving organic matter are recycled, (2) releasing phosphorus and other plant nutrients from mineral soils, and (3) removing inorganic plant nutrients from soil solution.
- Enable relatively shade intolerant conifer seedlings to become established under enclosed canopies.

forest management implications

Because of the role fungal mats play in maintaining optimum forest productivity and their potential role in enhancing forest biodiversity, it is desirable to manage to maintain this important component of forest ecosystems. Although there is much we need to know about factors influencing the ability to maintain mats in disturbed forests, there are a few principles that have come from other studies of forest mycorhhizae that can be used as a guide. Forest soils that have been compacted or physically disturbed generally have a much reduced ability to colonize seedlings than in undisturbed soils. It is likely that intense fire may have the same effect. There is evidence that retaining mature live trees on a site increases the probability of mat reestablishment after harvest. Thus, reducing the frequency and intensity of timber harvest could result in higher densities of fungal mats.

publications

Griffiths, R.P., B.A. Caldwell, K. Cromack, Jr. and R.Y. Morita. 1990. **Douglas-fir forest soils colonized by ectomycorrhizal mats: I. Seasonal variation in nitrogen chemistry and nitrogen cycle transformation rates**. Can. J. For. Res. 20: 211-218.

Griffiths, R. P., M. A. Castellano, and B. A. Caldwell. 1991. **Ectomycorrhizal mats formed by Gautieria monticola and Hysterangium setchellii and their association with Douglas-fir seedlings, a case study**. Plant Soil 134: 255-259.

Aguilera, M.L., R.P. Griffiths, and B.A. Caldwell. 1993. **Soil nitrogen chemistry in different age classes of Pacific Northwest coniferous forests**. Soil Biol. Biochem. 25:1015-1019.

Griffiths, R. P., A. Chadwick, M. Robatzek, K. Schauer, and K. Schaffroth. 1995. **Association of ectomycorrhzial mats with Pacific yew and other understory trees in coniferous forests**. Plant and Soil. 173:343-347.

Griffiths, R. P., Bradshaw, G. A., Marks, B., and G. W. Lienkaemper. 1996. **Spatial distribution of ectomycorrhizal mats in coniferous forests of the Pacific Northwest, USA**. Plant and Soil 180:147-158.

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