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Comparison of Communities of Ectomycorrhizal Fungi in Old-growth and Mature Stands of Douglas-fir on Southern Vancouver Island

Introduction

Fungi that form ectomycorrhizas are essential interfaces between soil and trees, and are thus one of the most ecologically important groups of organisms in forests. Most of the nutrients obtained by the roots of ectomycorrhizal hosts are removed from the soil by ectomycorrhizal fungi and transferred to host cells within ectomycorrhizas. In the upper 10-20 cm of soil of native forests, where nutrient availability is highest, more than 90% of the feeder roots of ectomycorrhizal host plants are usually colonized by ectomycorrhizal fungi (e.g. Meyer 1973, Glenn et al. 1991, Goodman and Trofymow 1998). Genera in the Pinaceae are ectomycorrhizal (Molina et al. 1992), whereas those in the Cupressaceae form arbuscular mycorrhizas (Harley and Smith 1983). Ectomycorrhizal fungi are also of value for their sporocarps, which are recreational, aesthetic, and commercial resources (Pilz and Molina 1996). Hence there is a need to assess the importance of old-growth stands of Douglas-fir (*Pseudotsuga menziesii*) for conservation of ectomycorrhizal fungi. The objective of this study was to determine whether old-growth and 90-year-old stands of Douglas-fir differ significantly in abundance, diversity, and composition of types of ectomycorrhizas.

Methods and Materials

The two sites sampled, Koksilah and Goldstream, are both on southeastern Vancouver Island in the Very Dry Maritime subzone of the Coastal Western Hemlock biogeoclimatic zone (CWHxm) (Green and Klinka 1994), within 40 km of Victoria, British Columbia (BC). At each site an old-growth and a mature stand of Douglas-fir were selected that were well-matched in species composition, soil, slope, aspect, and topography. The old-growth stands were 288 and 441 years old and the mature stands were 87 and 89 years old at Koksilah and Goldstream respectively. All four stands had regenerated following stand-destroying fire. In each stand, samples of soil were taken with a 5 cm diameter corer to a depth of 15 cm from the surface of the forest floor. Roots were extracted from one half of each core, and the other was analyzed for nutrients. The forest floor was processed separately from mineral soil. Soil was gently washed in a 0.5-mm sieve to extract ectomycorrhizas. Ectomycorrhizal types were distinguished using morphology, anatomy, reaction to chemical reagents, and autofluorescence, as described in Goodman et al. (1996). Randomized sampling was stratified according to five broad soil habitat classes: decayed logs, decayed stumps, the forest floor (litter, fragmented litter, and humus, or LFH) over bedrock or gravel, LFH and mineral soil at the base of codominant trees, and LFH and mineral soil elsewhere. At Koksilah, a total of 72 soil cores were taken in May of 1992 and 1993, and November of 1992, and analyzed for numbers and types of ectomycorrhizas. A total of forty-eight cores were taken at Goldstream, 24 in November of 1993 and 24 in May of 1994.

Results

Sixty-nine morphological types of ectomycorrhizas were distinguished and described (Goodman 1995). Nineteen types each accounted for more than 1% of the 17,500 ectomycorrhizal root tips examined. Old-growth and mature stands showed almost no difference in richness (Figure 1), equitability, or diversity of types. *Cenococcum geophilum* was the most common type, followed by ectomycorrhizas formed by a *Piloderma*-like fungus (type 2), a *Rhizopogon* in the section *villosuli* (CDE7) (Goodman et al. 1996), *Lactarius rubrilacteus*, and *Piloderma fallax* (CDE1) (Goodman et al. 1996) (Figure 2). There was no evidence that any types were specific to either mature or old-growth stands. The results of this study have been reported in more detail (Goodman and Trofymow 1998, in press).

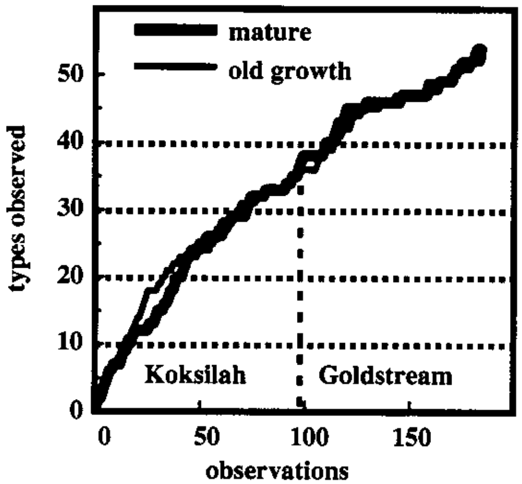

Figure 1. Number of ectomycorrhizal types observed as a function of number of observations in mature and old growth stands of Douglas-fir at both sites. An observation is the occurrence of a type in a core sample of soil.

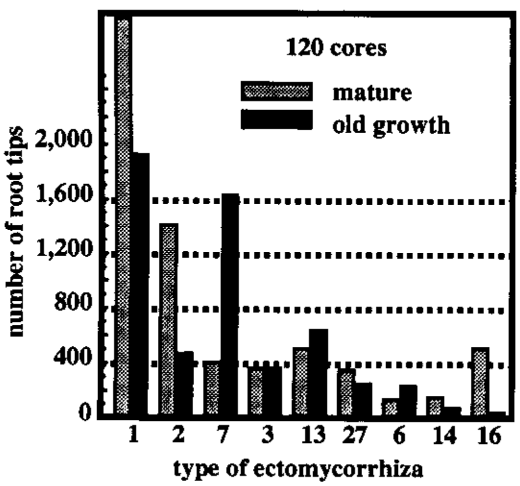

Figure 2. Abundance of the nine most frequent ectomycorrhizal types in old-growth and mature stands at two sites. 1 = *Cenococcum geophilum*, 2 = *Piloderma*-like, 3 = *Piloderma fallax*, 7 = *Rhizopogon*, 13 = *Lactarius rubrilacteus*; types 6, 14, 16, and 27 were not identified.

Discussion

It appears that many ectomycorrhizal fungi do not survive clearcutting and therefore must depend on dispersal from older stands in order to colonize younger stands (Perry et al. 1987). Proximity of old-growth to maturing stands may be especially important for hypogeously fruiting species, which are dispersed mainly by small mammals. It is perhaps not surprising that the ectomycorrhizal communities of the old-growth and mature stands of this study were so similar, considering their proximity and the similarity of their vegetation and soil. Differences in the ectomycorrhizas of mature and old-growth forests are more likely to occur where frequent or severe disturbance, lack of old-growth legacies, or lack of old-growth stands from which fungi can disperse has delayed or redirected ectomycorrhizal succession. We studied only two old-growth/mature stand pairs, leaving future studies to provide more replication. Also, it may be necessary to study the ectomycorrhizas of younger stands to determine if diversity of ectomycorrhizas can be maintained in commercial forests. Future comparisons of old-growth and mature plots might best include intensive sampling of large stumps and logs, which are absent from many mature stands. Much remains to be learned of the diversity and habit of ectomycorrhizal fungi. In the long term (e.g. >4 rotations), soil conditions may gradually change in forests kept at ages <100 years by repeated harvesting, perhaps leading to reduced ectomycorrhizal diversity. The impact of losses of natural stands >250 years (old growth) on ectomycorrhizal diversity is an important concern that remains to be addressed.

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