Forest Sciences

Prince Rupert Forest Region

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The Effects of Timber Harvesting on Mushrooms and Mycorrhizae of the Date Creek Research Forest

Research Issue Groups:

- **Forest Biology**
- **Forest Growth**
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Harvesting of mushrooms, especially pine mushrooms, is an important part of local economies in the Prince Rupert Forest Region and other parts of British Columbia. However, most commercial mushrooms are found in mature forests, where timber harvesting and silvicultural practices such as thinning or fertilizing can affect mushroom production. Many people would like to better understand how forest management can affect alternative forest products such as mushrooms. In this note we will discuss what mushrooms are and their relationship to trees, and secondly, summarize research that examines the effects of timber harvesting on mushrooms and mycorrhizal communities.

Mushrooms and mycorrhizae

Many commerically valuable mushrooms, such as pine mushrooms, chanterelles, and boletes, are mycorrhizal fungi. Mycorrhiza (literally *fungus root*) means that these fungi live in symbiosis (as partners) with trees. Each feeder root of coniferous trees is covered in a dense layer of fungal hyphae, forming a mantle, which penetrates roots to directly connect with root cells (Figure 1). A mycorrhizal fungus extends from a root into the surrounding soil,

Figure 1. Mycorrhizal fungi covering root tips of western hemlock (magnified 10X)

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absorbs nutrients and water, and brings them back to share with the tree. The tree photosynthesizes, producing enough sugars to share with the fungus. The feeder roots and fungal symbiont are found throughout the forest floor and upper mineral soil, creating a very large living biomass in the soil. Mushrooms are the only part of this fungus/tree root symbiosis that we commonly see. Mushrooms are the fruiting stage of mycorrhizal fungi, needed to disperse fungal spores for colonizing other tree roots. Picking a mushroom should not be harmful to mycorrhizae if the forest floor is undisturbed, since the feeder roots and fungal mantle will survive. Raking the forest floor, however, can break off tree roots and kill the fungal symbionts responsible for mushrooms.

There are other mushrooms in forests which are not mycorrhizal. For example, black morels and the common 'supermarket' mushroom are saprophytic (live off dead stuff) and can be found growing in burned or disturbed areas. These fungi live in soils by decomposing organic matter rather than by colonizing root tips.

Timber harvesting effects on mycorrhizae and mushrooms

Its should be clear that removing trees will affect mycorrhizal mushroom fruiting because of the symbiotic connection between fungus and trees. We have been conducting studies at the Date Creek research forest, near Hazelton, to examine the effect of stand openings on mycorrhizal communities and mushroom production. Date Creek has a tremendous community of mycorrhizal fungi. Mushroom surveys during one period in September revealed at least 80 mycorrhizal species, and other species exist that we were unable to identify or that were fruiting at different times of the year (Table 1).

In addition to the mature stands at Date Creek, we searched different sized stand openings (gaps ranging from 28 m^2 to 4526 m^2) for mycorrhizal mushrooms. The smallest gaps, where only a few trees had been removed, still had many mushrooms (Figure 2). The number of species dropped considerably as the gaps grew larger. The production of mushrooms was reduced to a few species fruiting very infrequently at gap sizes greater than approximately 600m^2 (20x30 m). Clearly the removal of enough trees to form large gaps in the stand has stopped mushrooms from growing. However, because mushrooms are only the fruiting part of the fungus, we were not yet certain what effect the gaps had on the mycorrhizal community.

The gaps are filled with young seedlings colonized by mycorrhizae, which we can compare to the mycorrhizal community of the adjacent mature forest. We examined western hemlock seedlings across some large gaps (50-75 m diameter) to determine fungal richness and distribution (Figure 3). Seedlings under the canopy had the most mycorrhizae (38 fungal morphotypes), while seedlings near the edge had 21% less (30 fungal types). Seedlings furthest into the gap openings had 25 ectomycorrhizal types, 34% less than the seedlings in the mature forest. The decrease in fungal richness suggests that not all mycorrhizal fungi persist in soils

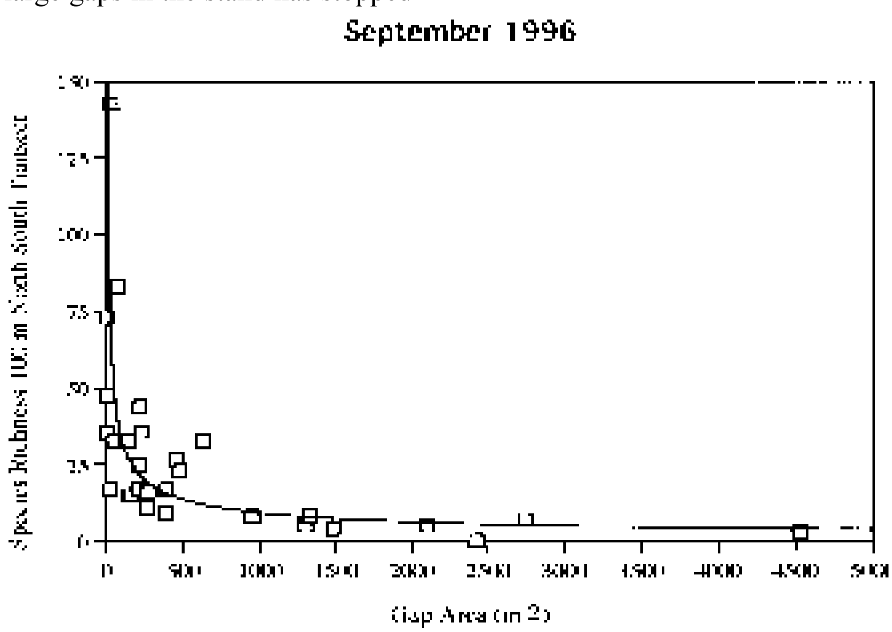

Figure 2. Gap area vs. species richness of mycorrhizal mushrooms per 100 m north/south transect.

after harvesting, to recolonize new seedlings. Instead, some mycorrhizae re-enter the harvested area by slowly spreading from roots of mature trees to roots of seedlings in the openings. Some fungi may also not occur in gaps because they can only grow in the moister, cooler soil conditions found in the mature forest. The decline in fungal richness across the gaps is likely temporary, as we expect the rest of the mycorrhizae community will recolonize the gaps over time. What we noticed, however, was that the mycorrhizae community in the gaps was more diverse than was indicated by the mushrooms found in the gaps.

The reduction in mushroom fruiting in the gaps is therefore not from a lack of mycorrhizal fungi. One possible reason for the reduction in mushrooms is that seedlings are too small to supply fungi with enough energy to grow mushrooms. A second possibility is that warmer and drier (lower relative humidity) soil conditions in gaps are not suitable for stimulating mushroom growth by the mycorrhizal fungi. As trees mature, they will be able to supply sugars needed by fungi and influence the microclimate of soils. Plantations might begin to show more mushroom diversity at about age ten, but full re-establishment of mushroom production might not occur until ages 30 or 40. It is fairly clear that in the short-term, mushroom production will require enough mature trees to support mycorrhizae and to maintain suitable microclimates.

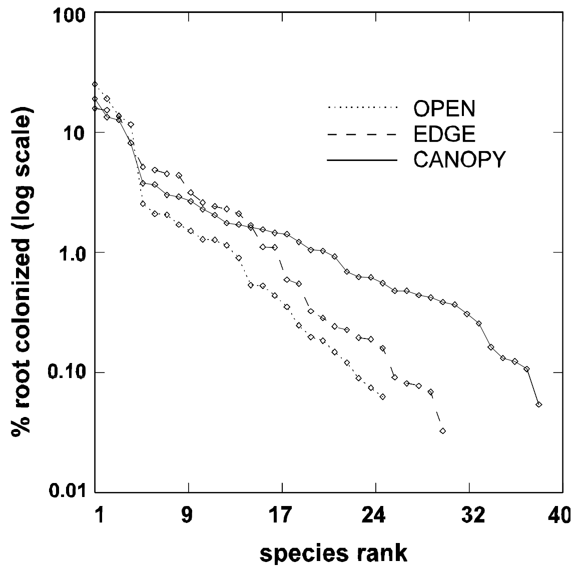

Figure 3. Mycorrhizal communities found on western hemlock across gaps at Date Creek. The fungal types are ranked in order of abundance (% root colonized). 'Canopy' refers to seedlings under mature trees; 'Edge' are seedlings 5 to 10 m into the gap; 'Open' are seedlings 15 to 20 m into the

Future research

Partial cutting is perhaps the best strategy to maintain some level of timber harvesting concurrent with mushroom production. At Date Creek, the light removal treatment has 30% of the forest volume removed through single-tree selection and small gaps. We will begin monitoring parts of the single-tree removal stands for mushroom production. This phase of the research will also look at amounts of mushrooms produced, rather than just diversity, since this is important in assessing the impact to the mushroom industry. The research will also assess a wide range of fungal species to better understand how the mycorrhizal community is affected, rather than just valuable species such as pine mushrooms. This baseline monitoring will also give us more information about other choice edible mushrooms in this region. Many of these species could become more valuable in the future if wild mushrooms continue to grow in popularity.

Mycorrhizae and mushroom research was initiated by **Elaine Wright** in cooperation with **Melanie Jones** and **Dan Durall** (Okanagan College University), **Marty Kranabetter** (Regional soil scientist), **Tara Wylie** and **Paul Kroeger** (consulting biologists).

Table 1. Date Creek mycorrhizal mushroom list, September 1996

Amanita porphyria	*Hydnellum spp.*	*Russula decolorans*
Boletus mirabilis	*Sarcodon imbricatum*	*Russula densifolia*
Cantharellus infundibuliformis	*Hygrophorus bakerensis*	*Russula emetica*
Chroogomphus rutilus	*Hygrophorus cf. erubescens*	*Russula flaviceps*
Chroogomphus tomentosus	*Hygrophorus piceae*	*Russula fragilis*
Clavariadelphus ligula	*Hygrophorus saxatilis*	*Russula cf. gracilis*
Clitocybe spp.	*Hygrophorus tephroleucus v. tephroleucus*	*Russula laurocerasi*
Cortinarius cf. Alboviolaceus (Sericeocybes)	*Hygrophorus spp.*	*Russula occidentalis*
Cortinarius cf. Armeniacus (Telamonia)	*Inocybe geophylla*	*Russula cf. olivacea*
Cortinarius armillatus (Telamonia)	*Inocybe geophylla v. lilacina*	*Russula virescens*
Cortinarius cinnamomea (Dermocybe)	*Inocybe spp.*	*Russula xerampalina*
Cortinarius cf. Cotoneus (Leprocybe)	*Laccaria bicolor*	*Russula spp. (Compactae)*
Cortinarius cf. deceptivus (Telamonia)	*Laccaria laccata*	*Russula spp.*
Cortinarius glaucopus (Phlegmacium)	*Lactarius affinis v. affinis*	*Suillus tomentosus*
Cortinarius mutabilis (Phlegmacium)	*Lactarius deliciosus*	*Thelephora terrestris*
Cortinarius phoeniceus v. occidentalis (Dermocybe)	*Lactarius glyciosmus*	*Tricholoma pardinum*
Cortinarius semisanguineus (Dermocybe)	*Lactarius mucidus var fuscogriseus*	*Tricholoma pessundatum*
Cortinarius cf. Speciosissimus (Leprocybe)	*Lactarius pseudomucidus*	*Tricholoma platyphyllum*
Cortinarius traganus (Sericeocybe)	*Lactarius resimus v. resimus*	*Tricholoma cf. saponaceum*
Cortinarius vanduzerensis (Myxacium)	*Lactarius rufus*	
Cortinarius vibratilis (Myxacium)	*Lactarius scrobiculatus*	
Cortinarius spp. (Bulbopodium)	*Lactarius torminosus v. normandensis*	
Cortinarius (Dermocybe) spp.	*Lactarius uvidus*	
Cortinarius (Phlegmacium) spp.	*Lactarius spp.*	
Cortinarius (Telamonia) spp.	*Leccinum aurantiacum*	
Hydnum repandum	*Leccinum clavatum*	
Entoloma cf. griseus	*Leccinum scabrum*	
Entoloma nidorosum	*Lyophyllum spp.*	
Gomphidius glutinosus	*Paxillus involutus*	
Gymnopilus terrestris	*Ramaria cystidiophora v. maculans*	
Hebeloma mesophaeum	*Rozites caperata*	
Hebeloma sacchariolens	*Russula aeruginea*	
Hebeloma spp.	*Russula claroflava*	

Suggested reading:

Soil Biodiversity - Extension note #13. Forest Sciences, Smithers.

Jones, M. 1994. Diversity of ectomycorrhizal fungi at Date Creek. Progress report, Forest Sciences, Smithers.

Durall, D. and Jones, M. 1995. The effect of gap size on the fungal community at Date Creek: Ectomycorrhizae and sporocarps (Parts I and II). First and second year progress reports, Forest Sciences, Smithers.

Kranabetter, J.M. and T. Wylie. 1997. Ectomycorrhizal community structure across forest openings on naturally-regenerated western hemlock seedlings. Forest Sciences, Smithers.

Managing forest ecosystems to conserve fungus diversity and sustain wild mushroom harvests. Pacific Northwest Research Station GTR-371.