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Ecological description and classification of some pine mushroom habitat in British Columbia

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Abstract

This extension note summarizes the biology, traditional use, harvest method, and habitat of pine mushrooms in British Columbia and briefly discusses how information on habitat can be used to integrate important pine mushroom areas into timber harvest planning.

The pine mushroom (*Tricholoma magnivelare*) is the most economically important species of wild mushroom harvested from the forests of British Columbia. Various factors, including natural variability in annual mushroom productivity and the method of harvest, are thought to influence wild mushroom production, but few benchmark measurements of commercial mushroom productivity are available. Information is needed on the types of stands and ecosystems in which these mushrooms occur.

Soil, vegetation, and forests known to support commercial crops of pine mushrooms across the province are described. Forest subzone, elevation, slope, aspect, and landform all varied between study sites. In general, the soil, vegetation, and forest stand results indicate that submesic site series correlate well with commercial pine mushroom habitat.

The results of this study illustrate that pine mushroom habitat capable of producing commercial crops displays certain characteristics and that pine mushrooms do not grow randomly. We recommend that the information from this study be used to define, expand, and map commercial pine mushroom sites. Forest planners can then use these maps to integrate the harvest of pine mushrooms with timber production objectives. Also, certain forest management techniques may be used to enhance mushroom production while meeting some timber objectives. More research is needed to determine which techniques could be applied to North American forests.

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Introduction

The pine mushroom, *Tricholoma magnivelare* (Peck) Redhead, is the most economically important species of wild mushroom commercially harvested from the forests of British Columbia (deGeus 1995; Wills and Lipsey 1999), the Pacific Northwest (Amaranthus and Pilz 1996; Hosford *et al.* 1997), and Mexico (Bandala *et al.* 1997) (Figure 1). It also occurs in eastern Canada (Redhead 1997). This extension note summarizes the biology, traditional use, harvest method, and habitat of the pine mushroom and briefly describes how information on habitat can be used to integrate important pine mushroom areas into timber harvesting planning.

The pine mushroom, also known as the American matsutake, is closely related to the Japanese matsutake or *Tricholoma matsutake* (Ito & Imai) Sing. The matsutake, endemic to Asia, is a highly sought after edible species that has been harvested and eaten in Japan for centuries. The similarity between the matsutake and the pine mushroom, and recent declines in the production of matsutake in Japanese and Korean forests, have resulted in the high demand for pine mushrooms (Kawai and Ogawa 1981).

Pine mushroom habitat capable of producing commercial crops displays certain characteristics—pine mushrooms do not grow randomly. It is therefore possible to define and map commercial pine mushroom sites.

The reasons for the Asian decline in matsutake production are not completely understood. One possible reason could be die-back of the host red and black pine stands as a result of the spread of pine nematode (Hosford *et al.* 1997). In addition, since World War II, communities in Japan have shifted from using traditional wood and charcoal stoves to burning natural gas. Understorey shrubs and oak trees from the pine forests are no longer being collected to produce charcoal. Consequently, species composition in the pine forests has changed, creating conditions unfavourable for the production of pine mushrooms (Hosford *et al.* 1997).

FIGURE 1. A pine mushroom (*Tricholoma magnivelare*). (Shannon Berch photo)

In North America, increased fire control since the early 20th century and the reduction in the frequency of light to moderately intense "underburn" fires have resulted in increased understorey vegetation and thickening duff layers. These conditions may not be conducive to pine mushroom production (Amaranthus *et al.* 1998). It has also been suggested that the worldwide decline in forest mushroom production, especially in Europe, could be due to increased levels of air and soil pollution (Amaranthus and Pilz 1996; Pilz and Molina 1998). Other factors, such as climate change and natural forest succession, might also affect mushroom productivity.

Extensive timber harvesting and intensive forest management leading to simplified forest ecosystems also have an impact on edible mushroom production (Pilz and Molina 1998). According to Amaranthus *et al.* (1998), "uneven- and even-aged silviculture prescriptions, harvest methods, slash treatments, fertilization, cattle grazing, and natural aging of forest stands all potentially influence wild mushroom productivity." In addition, intensive commercial harvesting of mushrooms may affect future mushroom productivity, forest health and productivity, and the food webs for wildlife species (Amaranthus and Pilz 1996; Pilz and Molina 1998). The Ulkatcho people also believe that excessive foot traffic, which leads to forest floor compaction and damage to the fungal mycelium, can affect mushroom production (B. Chapman, B.C. Ministry of Forests, pers. comm., March 2001).

However, few benchmark measurements of commercial mushroom productivity are available to determine whether mushroom productivity in British Columbia has declined and to compare the effects of these various impacts over time (Amaranthus and Pilz 1998). Natural variability in annual mushroom production due to factors such as the weather also confounds the assessment of these impacts. Long-term monitoring of mushroom productivity is required across a variety of areas to look for trends in productivity and assess the impacts of these various factors. Although several studies have begun to test some of these hypotheses, no results have been published to date.

What are Pine Mushrooms?

The pine mushroom is an ectomycorrhizal fungus that, in British Columbia, grows in association with commercially valuable conifer species. The term *ectomycorrhiza* refers to the symbiotic (mutually beneficial) relationship this fungus has with its host trees. Part of the fungal mycelium, the major underground vegetative component of the fungus, surrounds both individual root cortical cells and the entire feeder root. The mycelium may also act as a significant root extension that increases the tree's effective surface area for absorbing water and nutrients. The fungus benefits by obtaining carbohydrates (sugars) and other growth factors from the tree. When environmental conditions are right, the mycelium produces mushrooms. Because of the mycorrhizal association of this fungus with tree roots, this fungus requires living trees for survival. As a result, it is highly sensitive to timber harvesting.

Some doubt exists about the effectiveness of the pine mushroom as a symbiotic partner. The ectomycorrhiza formed is atypical and some reports and researchers suggest that the fungus may be able to act like a root parasite or even pathogen. Regardless, the fungus clearly requires a living tree host to survive and produce mushrooms.

Traditional Use

Historically, the pine mushroom was one of the important traditional foods of the Nlaka'pamux and Stl'atl'imx native peoples in British Columbia (Turner *et al.* 1987; Freeman 1997; Turner 1997). However, based on available evidence, other First Nations groups in the central Interior of British Columbia, including the Ktunaxa, Tsilhquot'in, Ulkatcho–Carrier (Dakelh), and native peoples of coastal British Columbia, did not generally eat these or other mushrooms (Turner *et al.* 1987; Turner 1997). In the Klamath bioregion of southern Oregon and northern California, the Karuk people have considered the pine mushroom (also known as the tan oak mushroom) to be an important traditional food and have gathered it for generations (Richards and Creasy 1995). As early as the 1930s, Japanese-Americans began collecting pine mushroom in Oregon and Washington (Zeller and Togashi 1934). In the 1940s, Japanese sawmill workers in the Pemberton area of British Columbia collected the pine mushroom and introduced it as an edible, harvestable product to both native and non-native communities (Olivotto Timber 1998). The pine mushroom was also harvested by Japanese-Canadian internees in the Nakusp area during World War II (B. Chapman, B.C. Ministry of Forests, pers. comm., March 2001).

Harvest Methods

The harvesting method is crucial to the value of the harvest. The marketplace demands that pine mushrooms be collected intact—never cut or broken. The method of pine mushroom harvest is also thought to be crucial to future mushroom productivity. Raking up the moss and duff to expose the mushrooms should never be done: it can damage tree roots and the fungal associates that produce the mushrooms (B.C. Ministry of Forests 1997). The fruiting bodies should be sought and removed with minimal excavation and disturbance to the soil, litter, or moss layers, and all soil and moss cover should be replaced. This will help ensure continued production of pine mushrooms for harvest in the following days and in future years. The B.C. Ministry of Forests (n.d.) also recommends that broken, overmature, or wormy mushrooms should be left to spread spores. Excessive foot traffic resulting in forest floor compaction is also thought to affect mushroom productivity (Amaranthus and Pilz 1996; B. Chapman, B.C. Ministry of Forests, pers. comm., March 2001) and this type of disturbance should be minimized.

Pine Mushroom Habitat in British Columbia

Some recent work has described the habitat of pine mushrooms in British Columbia (Trowbridge and Macadam 1998; B.C. Ministry of Forests 1999; Northwest Institute for Bioregional Research 1999; Berch and Wiensczyk 2001). According to these reports, forest stands in British Columbia with known productive pine mushroom habitat occupy a variety of subzones and variants in at least five biogeoclimatic zones: Interior

Cedar–Hemlock (ICH), Sub-Boreal Pine–Spruce (SBPS), Engelmann Spruce–Subalpine Fir (ESSF), Interior Douglas-fir (IDF), and Coastal Western Hemlock (CWH). Elevation, slope, aspect, and landform vary widely; however, soil moisture and nutrient regimes tend to fall within a relatively narrow range. Soil moisture is usually drier than average for the subzone. Soil nutrient regimes fall almost exclusively within the range of poor to medium (B–C). Soils tend to be well or rapidly drained, and are often coarse in texture (sand to loamy sand), with high coarse fragment contents. Forest floors tend to be relatively thin, and humus forms are Hemimors. A common feature of the soils is the presence of an Ae horizon and/or grey-white mycelium that could be mistaken for an Ae horizon (Figure 2). Wildfire is the most common natural disturbance regime.

Canopy closure varied considerably among the stands with productive pine mushroom habitat which have been studied in British Columbia. Western hemlock (*Tsuga heterophylla*) was the most common tree species, occurring in all vegetation layers in some areas, but dominant tree species in the canopy also included lodgepole pine (*Pinus contorta*) and Douglas-fir (*Pseudotsuga menziesii*). The only deciduous tree species encountered was paper birch (*Betula papyrifera*), mainly in the Pemberton study area. Shrub species tend to have relatively low cover values, but include four species (two of them dwarf shrubs) that occurred in over 60% of plots examined: *Chimaphila umbellata*, *Paxistima myrsinites*, *Vaccinium membranaceum*, and *Linnaea borealis*. Generally, these stands have very little herb cover. *Goodyera oblongifolia* is the herb species encountered most frequently and was found in half of the plots studied. Moss cover is highly variable, ranging from 7 to 97%. Three bryophyte species were found in most of the stands studied: *Pleurozium schreberi*, *Hylocomium splendens*, and *Rhytidiopsis robusta*.

These studies were conducted on a limited sample of plots across a wide array of commercial pine mushroom harvest sites. In addition, other areas of the province where pine mushroom is harvested commercially, such as southeastern Vancouver Island, have yet to be described. Clearly, more work is needed to further describe and fully encompass the range of habitat favoured by the pine mushroom.

In general, commercial habitat of pine mushrooms is found on submesic soils. Other factors, such as stand composition and age, density, and health, influence the habitats in which pine mushrooms grow. Pine mushrooms do occur on other site series, such as mesic habitat, but their presence is usually much more sporadic; conditions are therefore not conducive to commercial harvesting opportunities. In addition, submesic habitats that support pine mushrooms are often found within site-series complexes, making them more difficult to recognize.

FIGURE 2. Soil horizon highlighting grey-white mycelial layer. (Rick Trowbridge and Ann Macadam photo)

Recommendations and Management Implications

Pine mushroom habitat capable of producing commercial crops displays certain characteristics—pine mushrooms do not grow randomly. It is therefore possible to define and map commercial pine mushroom sites. These maps can then be used by forest planners to integrate the harvest of pine mushrooms with timber production objectives.

In the Prince Rupert Forest Region, the Northwest Institute for Bioregional Research (1999) evaluated pine mushroom and timber production in the Cranberry Timber Supply Area and the extent of potential pine mushroom habitat in the Kispiox and Kalum Small Business Forest Enterprise Programs. Both the Kalum and Kispiox forest districts are now mapping the extent of submesic ICH areas to pinpoint these sites as potential pine mushroom patches (B.C. Ministry of Forests 1999; Kranabetter *et al.* 2001). In these districts, this ecological information can now be used for planning.

In other forest districts where pine mushroom is important, the information from these studies should be used to begin research and mapping as done in the Prince Rupert Forest Region to verify and expand on local pine mushroom habitat characterization (Figure 3). With reliable regional habitat information for pine mushroom, important site types could be mapped and then integrated into forest planning.

Some of this work is already in progress. The Nlaka'pamux First Nation estimated pine mushroom production in the Nahatlatch watershed (Freeman 1997). The Ulkatcho First Nation and the Cariboo Forest Region Research Section are currently studying in detail the productivity and habitat of pine mushrooms in the Chilcotin Plateau with the objective of integrating pine mushroom and timber harvests (B. Chapman, B.C. Ministry of Forests, pers. comm., March 2001). The Arrow Forest District has also inventoried and described pine mushroom habitat in the Fosthall and Galena Bay operating areas of the Small Business Forest Enterprise Program (Ehlers and Frederickson 2001).

FIGURE 3. A person picking pine mushrooms in the Nass Valley. (Rick Trowbridge photo)

Certain forest management techniques may be used to enhance mushroom production while meeting some timber objectives (Amaranthus and Pilz 1996; B. Chapman, B.C. Ministry of Forests, pers. comm., April 2001). In Japan, silviculture treatments that have been used to enhance matsutake production include altering species composition, thinning overstorey trees, cutting understorey shrub and herb species, and removing organic litter from the forest floor (Hosford *et al.* 1997). However, these techniques should be implemented with extreme caution as they may also damage pine mushroom habitat and reduce productivity. More research is needed to determine how these techniques could be applied to North American forests.

Note

This extension note contains information on the ecology and management of non-timber forest products. In promoting implementation of this information, the user should recognise the equitable sharing of benefits derived from the management and use of this product (Article 8(j) of the United Nations Convention on the Conservation of Biological Diversity). Where possible, the reader should involve the keepers of this knowledge and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with the conservation and sustainable use requirements (Article 10(c)).

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