Ectomycorrhizal Fungus Diversity in Douglas-fir Forests of the Oregon Cascades

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Summary.- Hypogeous (truffle) and epigeous (mushroom) sporocarps of ectomycorrhizal fungi were harvested from 9 Douglas-fir stands representing 3 forest age classes. Presence or absence of *Piloderma bicolor* mycelia in truffle plots was recorded. Stands were sampled in autumn and spring, 1991-94. Analyses are in progress to detect differences in sporocarp production between forest age classes. Preliminary results show that 52% of the truffle species were restricted to a single age class. At least twice as many truffle species restricted to a single age class were unique to the old-growth and young compared to the rotation-age stands. Fewer old-growth plots contained truffle sporocarps compared to the rotation-age and young plots. In contrast to truffle sporocarp frequency, *Piloderma bicolor* occurred in a greater percentage of old-growth plots compared to rotation-age and young-growth plots. Numbers of species for truffles and mushrooms varied significantly between years and between seasons.

Keywords: ectomycorrhizal fungal communities, Douglas-fir stands, forest succession, Pseudotsuga menziesii, Piloderma bicolor

Introduction

Recent interest in maintaining biological diversity has highlighted the need to inventory all forest organisms, including fungi, in the Pacific Northwestern region of North America. This region contains ancient (old-growth) forests, that have experienced little or no human disturbance for centuries, resulting in a late successional or climax stage in forest development (2, 13). Accurate mycological data in human disturbed (harvested) forests and undisturbed (old-growth) forests are needed to understand fungal community dynamics.

Thousands of fungal species form ectomycorrhizae with forest trees of the Pacific Northwest. Despite the importance of ectomycorrhizal fungi to many ecosystem processes, little is known about their community structure and dynamics in natural vegetation. The objective of this study was to determine whether ectomycorrhizal fungal communities vary between successional stages of Douglas-fir (*Pseudotsuga menziesii*) forests.

Data from this study will provide knowledge about species richness, production, community structure, and dynamics based on the fruiting of truffle and mushroom sporocarps and on the occurrence of *Piloderma bicolor* mycelia. Such data are essential to predict impacts of disturbance and management on forest health. Insights gained in this study pertaining to the relationships between forest succession, disturbance, and ectomycorrhizal fungal diversity will provide for comparisons of sporocarp production in forests of the Pacific Northwest (3, 4, 7, 8, 9, 10, 14), the northern Rocky Mountains of the United States (5, 6), and Europe (1, 11, 12, 15).

Materials and Methods

Species diversity and sporocarp production of truffle and mushroom ectomycorrhizal fungi were examined from plots in three replicate stands each of old-growth (>400 year), rotation-age (45-60 year), and young (25-30 year) Douglas-fir forests on and near the H. J. Andrews Experimental Forest in the Western Cascade Range of Oregon.

Stands were sampled once each in the autumn and spring, 1991-94. Sampling both in the spring and autumn was necessary to capture the dichotomy in seasonal fruiting patterns typical of the Pacific Northwest (3, 7, 9, 10). Sporocarp production varies annually so it is necessary to sample stands for several years to average yearly fluctuations. Sporocarp sampling was timed to coincide with the seasonal peak fruiting period.

Ectomycorrhizal mushroom sporocarps were collected from a total area of 700 m^2 per stand from 6 strip plots (2 m x 50 m) and 25 circular plots (4 m^2). Three strip plots were permanently located within each stand. Sporocarps of each ectomycorrhizal mushroom species were collected separately for each square meter of the permanent plots. Three transient mushroom strip plots, placed in the upper, mid- and lower slope strata, were established and relocated with each sampling. Sporocarps of each ectomycorrhizal mushroom species were treated as a single collection for the entire transient plot. Sporocarps were identified, dried, and weighed.

Truffles were collected from a total area of 100 m^2 per stand from the circular plots in which mushrooms were first harvested. Circular plots were placed at 25 m intervals and distributed along three transects (8, 9, 8 plots each) in the upper, mid-, and lower slope strata. In each truffle plot, the percent cover of exposed mineral soil, coarse woody debris by decay class, and *Piloderma bicolor* mycelia, was recorded. Sporocarps were identified, counted, dried, and weighed.

Results and Discussion

Species richness for truffle fungi varied between years and between forest age classes (Tables I and II). A total of 50 truffle species were recorded from all sampling seasons. Fifty-two percent of the truffle species were restricted to a single age class. Old-growth and young stands had twice the number of unique species compared to the rotation-age stands. Four truffle species were unique to autumn 1994 compared to three in spring 1993 and 1992, two in spring 1994 and autumn 1991, and one in autumn 1992. No species were unique to autumn 1993.

Table I. Numbers of truffle species and mushroom taxa by season and year in Douglas-fir stands on and near the H. J. Andrews Experimental Forest, Willamette National Forest, Oregon. Values obtained from 6300 m^2 sampling area per season (3 forest age classes·3 stands·700 m^2 per stand).

Season & year	Total truffle species	Total mushroom taxa
Autumn 91	13	17
Autumn 92	8	85
Autumn 93	15	41
Autumn 94	16	95
Spring 92	19	15
Spring 93	27	10
Spring 94	22	15

Table II. Species richness of truffle fungi in Douglas-fir stands of three age classes on and near the H. J. Andrews Experimental Forest, Willamette National Forest, Oregon. Values for total species obtained from 2100 m^2 sampling area (3 stands·100 m^2 per stand·7 sampling seasons).

Age class	Total truffle species	Numbers of species unique to age class
old-growth	28	10
rotation-age	27	5
young-growth	29	11

Truffles were found in 37% of the 1575 plots. Fewer old-growth plots (27%) contained truffles compared to the rotation-age and young-growth plots (42% each). Forty-two percent of the truffle species were collected only in the spring, 30% in autumn. Twenty-four percent of the truffle species were found in both autumn and spring.

Number of taxa for mushroom fungi varied between years (Table I). A total of 140 mushroom taxa have been identified. Several mushroom species including *Clavariadelphus mucronatus, Hydnum imbricatum, H. repandum* and *Ramaria* spp. occurred only in old-growth plots.

Piloderma bicolor occurred in 55% of the old-growth truffle plots compared to 6% of the rotation age and 2% of the young-growth plots for the three autumn and two spring seasons this data was collected. Mikola (12) observed a close correlation between the occurrence of *Piloderma (Corticium) bicolor* with stand age in spruce forests in Central Finland.

Our results suggest that old-growth forests are critical for maintaining biodiversity of ectomycorrhizal fungi on a regional scale. Given the limited amount of remaining old-growth in the Pacific Northwest, strong conservation measures are needed to protect this regional resource. Our results also show, however, that all age classes of forests contribute to the overall regional fungal diversity so further study of fungal succession is needed. Further analysis of our data will explore correlations between specific habitat conditions (e.g. coarse woody debris) and species occurrence. Such analyses are first steps in determining the environmental and biotic factors that influence fungal succession, and towards developing functional hypotheses of species importance in ecosystem dynamics.

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