# INCIDENCE OF ARMILLARIA ROOT ROT IN BALSAM FIR INFESTED BY BALSAM WOOLLY APHID[1]

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## Abstract

Studies in Newfoundland have shown that the incidence and intensity of armillaria root rot in balsam fir (Abies balsamea) varies directly with the level of damage caused by the balsam woolly aphid (Adelges piceae). This damage appears to predispose trees to infection by Armillaria mellea.

## Introduction

Armillaria root rot, caused by Armillaria mellea (Vahl ex Fr.) Kummer, is an important root disease of a wide variety of tree species in both the temperate and tropical regions of the world. The pathogenicity and degree of parasitism of A. mellea and its role in the decadence of forest trees is not well understood, but the fungus is particularly destructive in plantations and to natural stands already weakened by other factors (3). Day (1) reported that oak trees weakened by drought or by defoliating or stem-boring insects were readily infected by A. mellea. Naumenko (2) and Staley (4) showed that the incidence of the disease in oak increased with the extent of defoliation caused by the gypsy moth, Porthetria dispar (L.), and the leaf roller, Argyrotoxa semipurpurana Kearf.

Armillaria root rot has been recorded in natural stands of native species and in plantations of exotic species in Newfoundland, but little is known about its status in stands of balsam fir, Abies balsamea (L.) Mill,, infested by the balsam woolly aphid, Adelges piceae (Ratz.). The aphid is one of the most destructive forest insects in Newfoundland, where it has infested more than 6000 square miles of balsam fir forest during the last 40 years. The most commonly observed symptoms of aphid attack are inhibited shoot growth, distortion of twigs, or "gout", gradual thinning of the foliage, and dieback of the crown.

A survey of aphid-infested stands in southwestern Newfoundland showed that the disease was more prevalent in trees damaged by the aphid (5). This paper describes the relationship between the incidence of armillaria root rot and damage caused by balsam woolly aphid.

## Materials and methods

Investigations were conducted in five merchantable, 60- to 70-year-old, aphid-damaged balsam fir stands located at Codroy Pond, St. Fintans, Flat Bay Brook, Southwest Brook, and Crabbes River, and in an undamaged stand near Corner Brook.

Damage was stratified into five classes and class limits were arbitrarily assigned within the range of 1 to 7, as follows: undamaged 1, light 1.573.0, medium 3.5–4.5, severe 5–6, and dead 7. Trees were allocated to appropriate damage classes by averaging the numerical indices of visual estimates obtained from the upper and lower halves of the crowns. In damaged stands, 10 trees over 3.5 inches dbh were sampled for each damage class along 20 randomly selected transects. In the undamaged stand, 40 trees were examined. Three primary roots were marked on each tree. The most northerly root was designated as I, and roots II and III were identified clockwise from the first. These roots were exposed and the proximal 3-foot sections were examined for characteristic symptoms and signs of the root rot: discoloration of the bark, resin exudate, and mycelial fans under the bark. The incidence of the disease was expressed as percentage of infected trees. The intensity of the disease was indicated by the percentage of roots infected and by the lineal extent of mycelial fans on the 3-foot sections.

## Results

Armillaria root rot was present in all six stands (Table 1). Infection in undamaged trees averaged 2.5% and in damaged living trees 18.6%. However 36%of living and dead damaged trees were infected. The percentage of infected trees damaged by the aphid was similar irrespective of the location of stands.

The incidence of armillaria root rot increased with the level of aphid damage, averaging 4% in the light, 20% in the medium, 32% in the severe, and 88% in the dead classes (Table 1). The intensity of the disease showed a similar trend as indicated by the lineal extent of mycelial fans (Table 2). The increase in the incidence and intensity of the disease was gradual from the

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light to the severe damage classes and rose sharply from the severe to the dead classes.

Table 1. Percent aphid-damaged and undamaged balsam fir trees* infected by Armillaria mellea in the six stands

| Location of stand | Undamaged | Damage Class | | | | Average |
|---|---|---|---|---|---|---|
| | | Light | Medium | Severe | Dead | |
| Codroy Pond | | 0 | 20 | 30 | 80 | 32.5 |
| St. Fintans | | 0 | 30 | 30 | 100 | 40.0 |
| Crabbes River | | 10 | 30 | 40 | 70 | 37.5 |
| Flat Bay Brook | | 0 | 0 | 30 | 90 | 30.0 |
| Southwest Brook | | 10 | 20 | 30 | 100 | 40.0 |
| Corner Brook (Control) | 1 | | | | | 2.5 |
| Average % | 2.5 | 4 | 20 | 32 | 88 | 30.4 |
| Average % (Light to Dead damage classes) | | | 36 | | | |
| Average % (Light to Severe damage classes) | | | 18.6 | | | |

* The percentage is based on 10 trees in each damage class in a stand except in the control, where the number of trees was 40.

Table 2. Incidence and intensity of Armillaria mellea in balsam fir trees showing aphid damage

| Aphid damage class | No. trees examined | Trees infected (No.) | Trees infected (%) | No. roots examined | Roots infected (No.) | Roots infected (%) | Avg lineal extent of mycelial fans (inches) | Avg lineal extent of mycelial fans (%)* |
|---|---|---|---|---|---|---|---|---|
| Undamaged | 40 | 1 | 2.5 | 120 | 1 | 0.8 | 4.0 | 11.1 |
| Light | 50 | 2 | 4.0 | 150 | 3 | 2.0 | 10.3 | 26.8 |
| Medium | 50 | 10 | 20.0 | 150 | 11 | 7.3 | 13.0 | 36.3 |
| Severe | 50 | 16 | 32.0 | 150 | 22 | 14.6 | 22.9 | 63.7 |
| Dead | 50 | 44 | 88.0 | 150 | 104 | 69.3 | 27.8 | 77.3 |

* Based on 3-ft.-long portions of three roots/tree.

## Conclusions

This study shows that armillaria root rot can affect undamaged as well as aphid-damaged trees, but the incidence of the disease was higher in the latter group. This indicates that aphid damage, including loss of foliage, is a primary factor predisposing trees to infection, but such damage is probably more important in influencing the rate of progress of the disease. Similar observations were made by Day (1), Naumenko (2), and Staley (4) on oak trees damaged by defoliating and stem-boring insects.

Armillaria mellea is common in most forest soils in Newfoundland and may be important in increasing stand decadence and mortality of trees damaged by the balsam woolly aphid. It is becoming more important as aphid infestations spread. The higher incidence of the disease in merchantable stands damaged by the insect shows that high priority must be given to salvaging severely damaged stands. There is also a need for more intensive study on the epidemiology of armillaria root rot in aphid-infested stands in all age classes and on all sites to determine appropriate management practices.

## Literature cited


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