Fomes annosus Root and Butt Rot: A Threat in Managed Stands in Coastal British Columbia

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"Spore infection of coniferous stumps, if not controlled, will probably cause a rapid buildup of F. annosus *in thinned immature stands in coastal British Columbia."*

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Abstract

In coastal British Columbia stands, airborne spores of Fomes annosus *are present throughout most of the year and are particularly numerous during October-November and February-March. Stumps of most commercial conifer species are susceptible to spore infection and the fungus can grow from diseased into healthy roots when in contact. Infection centers in immature stands have originated from mycelium present in stumps of the previous stands. Indications are that* Fomes annosus *root rot will be a significant problem should thinning become a common forest management practice if steps are not taken to control stump infection. Application of borax is recommended to reduce spore infection of stumps.*

Fomes annonsus et ses caries associées, une menace pour la culture des peuplements côtiers de la Colombie-Britannique.

Résumé

Dans la région côtière de la Colombie-Britannique les spores de Fomes annosus causant la Maladie du Rond se dispersent à l'air libre à travers les peuplements, tout le long de l'année avec des maxima durant les mois d'octobre - novembre et en février - mars. Les souches des conifères les plus recherchés sur le marché sont vulnérables à l'infection. Le champignon se propage aux racines saines par simple contact avec les racines contaminées. Certains jeunes peuplements déjà infestés furent contaminés par le mycélium présent dans les souches laissées lors d'exploitations antérieures. En cas d'aménagement intensif de sérieux problèmes surgiront si on ne prévient pas l'infection des souches produites lors des éclaircies par un application de borax soit en poudre, soit en solution.

Annosus root and butt rot caused by **Fomes annosus** (Fr.) Karst., is an important disease in immature coniferous forests in many countries in the temperate zone. Damage is extensive in plantations in eastern and southern United States, and in Europe, where conifer species native to British Columbia have been heavily attacked. Extent of damage caused by **F. annosus** is closely correlated with frequency and intensity of thinnings.

The disease is usually spread from established infection centers by airborne spores. Fresh-cut stumps and wounds are susceptible to spore infection. The fungus colonizes stumps and roots where it can survive for many decades. Spread to adjacent residual trees occurs where diseased and healthy roots are in contact. Damage attributable to **F. annosus** varies among tree species. In the pines, infection results primarily in mortality. In other species, losses occur as butt rot and as windthrow when decay is extensive in the root system. Decay characteristics vary between host species (Wallis and Ginns, 1968).

In British Columbia, **F. annosus** is an important butt-rotting fungus in old-growth trees, particularly western hemlock (**Tsuga heterophylla** (Rfn.) Sarg.) (Buckland **et al.**, 1949; Foster and Foster, 1951). Annosus root rot is present in immature stands but the economic magnitude of the problem is not clearly defined. Intensive forestry practices in young stands have just commenced, therefore conditions which led to widespread infection elsewhere have not been created. This study of **F. annosus** was initiated to predict future losses in thinned stands and if warranted, to recommend control measures to reduce widespread infection. Three factors associated with spread were examined: 1) density and seasonal variation of aerial spore populations; 2) susceptibility of stumps of native coni-

fers to spore infection, and development of decay in stumps following spore infection; 3) passage of the fungus from roots of spore infected stumps in thinned stands to roots of healthy trees. Natural infection from stumps of previous old-growth stands was also observed.

Airborne spores of Fomes annosus

A gross quantitative measure of seasonal populations of airborne spores of **F. annosus** was made at 2-week intervals from March, 1964 to April, 1965, and monthly thereafter to February, 1966, in two stands at Cowichan Lake, Vancouver Island. Discs of western white pine (**Pinus monticola** Dougl.) wood served as spore traps, using the method outlined by Rishbeth and Meredith (1957). A sample comprised 15 discs exposed for 2 hours at midday; 5 control discs were not exposed.

Spores were present in the atmosphere during each sampling period but the quantity had a marked seasonal pattern (Fig. 1). Large populations occurred in October-November, followed by a sharp fall with the onset of freezing temperatures in late December. The population increased again in late January-March and then declined during the summer months.

A close correlation was not evident between spore deposition and temperature or precipitation before or during the time of trapping. When the temperature was below 45 F but above freezing for extended periods, airborne spore populations increased; precipitation, however, was usually high during these cool periods. Spores were deposited on traps in January, 1965 and 1966, even though 30 inches of snow lay on the ground in exposed areas.

Sporophores are frequently found on dead and windthrown western hemlock and occasionally on other conifers and some hardwoods. Spores are discharged throughout most of the year.

Susceptibility of stumps to spore infection

Stumps of 705 western hemlock, 512 Douglas-fir (**Pseudotsuga menziesii** (Mirb.) Franco), 121 western red cedar (**Thuja plicata** Donn), 30 amabilis fir (**Abies amabilis** (Dougl.) Forb.) and 10 Sitka spruce (**Picea sitchensis** (Bong.) Carr.) in 14 localities on Vancouver Island and the south coast of British Columbia, were examined for natural airborne spore infection. In addition, 25 stumps of each of alpine fir (**Abies lasiocarpa** (Hook.) Nutt.), lodgepole pine (**Pinus contorta** Dougl.) and Engelmann spruce (**Picea engelmanni** Parry) and 117 stumps of western red cedar were inoculated with a basidiospore suspension to test their susceptibility to infection. When determining infection in these stumps, discs, one cm thick, were cut from above-ground portions, wrapped in moist paper, and incubated for a week to allow the conidial stage to develop (Rishbeth, 1950). When **F. annosus** decay had been confirmed in the above ground portions of a stump, the roots were excavated to determine the extent of infection.

An average of 19% (range 0-40%) of the western hemlock stumps, and 17% (range 3-37%) of the Douglas fir exhibited decay attributable to natural spore infection at the cut surface (Table 1). Stumps of all the other species tested, except cedar, were also susceptible to spore infection; Sitka spruce — 10%, Engelmann spruce — 88%, alpine fir — 44%, lodgepole pine — 80%. Of the 238 cedar stumps examined, only 6 had the fungus present and infection was confined to one or two small colonies in the sapwood or outer heartwood.

Fomes annosus grew rapidly (up to 30 inches annually) in Douglas-fir and hemlock stumps; decay was well advanced in some roots after two years. However, the decay pattern in a root system tended to be erratic, particularly in Douglas-fir where some roots were extensively rotted while others were not infected. Development of the fungus was much slower in stumps whose roots were grafted to living trees; occasionally infection was still confined to the above-ground portions of the stump even though the fungus had been active for as long as five years.

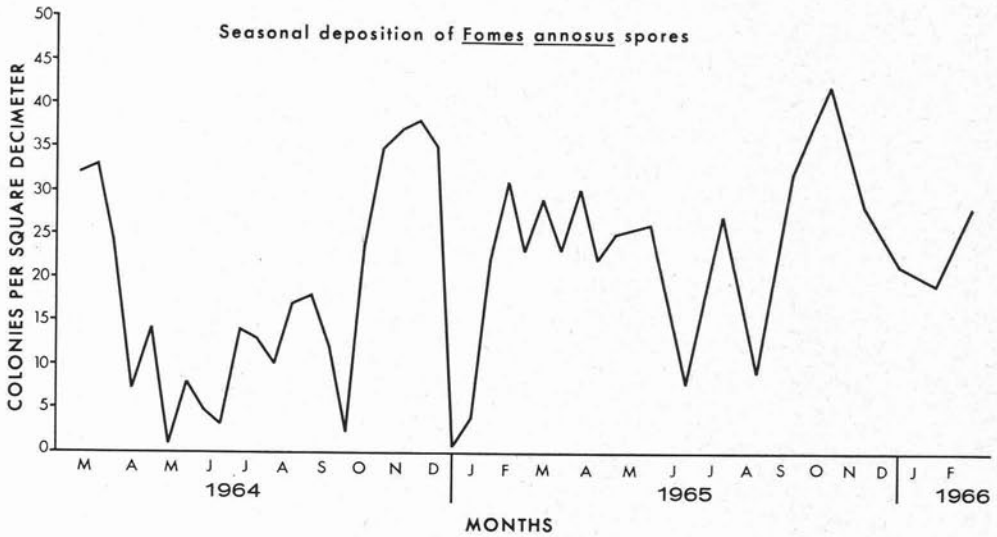

Fig. 1. Seasonal deposition of **Fomes annosus** spores on white pine disc traps.

Table 1. Percentage of stumps in western hemlock and Douglas-fir stands naturally infected with annosus root and butt rot.

Years since thin.	Stand[1] age (yr)	Western hemlock		Douglas fir		Both species	
		no. stumps	% with fomes[2]	no stumps	% with fomes[2]	no. stumps	% with fomes
13	50	3	—	40	5	43	7
12	50	112	28	0	—	112	28
10	30	0	—	30	13	30	13
9	130	5	—	70	14	75	13
7	75	102	19	0	—	102	19
7	25	16	0	0	—	16	0
6	45	4	—	58	3	62	6
6	35	95	18	17	6	112	16
6	75	49	10	9	—	58	9
4	25	22	0	0	—	22	0
4	25	22	4	18	11	40	8
4	40	52	31	0	—	52	31
4	24	0	—	50	14	50	14
3	25	30	40	0	—	30	40
3	25	16	25	84	12	100	14
3	25	146	18	0	—	146	18
2	20	5	—	17	35	22	41
2	20	20	30	42	29	62	29
2	70	0	—	34	37	34	37
1	20	6	—	43	23	49	24
Total		705	19	512	17	1,217	18

[1]Stand age at the time of thinning.
[2]Recorded only when 15 or more stumps were sampled in a stand.

Table 2 Extent of annosus infection in residual tree roots in contact with infected stump roots

Years since thinning	Stand age (yr[3]	Western hemlock roots in contact with the fungus			Douglas-fir roots in contact with the fungus		
		No.	no. infect.	max. extent[1] of infect. (inches)	no.	no. infect.	max. extent[1] of infect. (inches)
13	63	1	1	43	1	1	16
12	62	11	7	85[2]	—	—	—
10	40	—	—	—	2	0	—
7	82	22	11	55[2]	—	—	—
6	51	—	—	—	1	0	—
6	41	7	1	4	—	—	—
4	29	1	1	34[2]	2	1	52
4	44	7	3	12	—	—	—
3	28	3	3	68[2]	8	4	62[2]
2	72	—	—	—	2	0	—
1	26	—	—	—	3	0	—

[1]Extent of infection from point of contact with infected root proximally toward tree.
[2]Present as a butt rot as well as a root rot.
[3]Stand age at date of sampling.

Fomes annosus growth from spore infected stumps in thinned stands to roots of living trees

Stumps in which **F. annosus** decay was extensive were excavated to expose contacts between infected and living roots. All infected living roots were incubated in moist paper to permit the conidial stage to develop as indicated above.

Seventy-five hemlock stumps were excavated, of which 60% had infected roots in contact with 52 roots of adjacent living trees. Over half of these living roots had **F. annosus** decay. The maximum extent of infection in a living tree, 85 inches from the point of contact, was recorded in a 60-year-old stand thinned 12 years prior to sampling (Table 2).

Thirty-eight Douglas-fir stumps were also excavated, half of which had infected roots in contact with 19 living roots of adjacent trees. Six of the living roots had **F. annosus** present, the decay being particularly extensive in young trees (Table 2).

Spread of Fomes annosus from stumps of the previous mature stand

Observations in a thinned 40-year-old hemlock stand on the west side of Vancouver Island, showed that infection centers of 15-20 trees were not uncommon; decay was recorded up to 12 feet from the ground. In a 35-year-old hemlock stand on the east side of the Island, 58% of the butt rot detected was attributed to **F. annosus.** In both areas, the infection had developed from infected stumps of the previous mature stand.

Observations on Douglas-fir indicate that losses will probably be somewhat less than in hemlock, but damage could be significant if large numbers of stumps become infected. For example, a 20-year-old plantation on the west side of Vancouver Island had infection centers of 3-5 trees scattered throughout; decay was recorded up to 6 feet in the lower bole. In this stand, cedar roots in contact with **F.**

annosus in old stumps were also excavated; the heartwood in these roots was extensively rotted and appeared to have little resistance to a rapid invasion by the fungus.

Conclusions

Spore infection of coniferous stumps, if not controlled, will probably cause a rapid buildup of **F. annosus** in thinned immature stands in coastal British Columbia. Passage of the fungus from these infected stumps to residual trees would cause significant losses in western hemlock and Douglas-fir stands thinned 15 or more years before the harvest cut. Some current losses will originate from infected stumps of the previous stand; this mode of infection will probably be greatest in stands cccupying sites which formerly carried western hemlock. Driver and Wood (1968) found 0-57% of the stems in the 20- to 60-year-old hemlock stands, sampled in western Washington, contained annosus butt rot at the time of felling.

No economically feasible control procedure is known to prevent the spread of **F. annosus** once it becomes established in a stand. However, stumps of thinned trees can be treated to reduce spore infection. Preliminary studies indicate that borax, applied liberally to the cut surface as a powder or 10% aqueous solution, can effectively reduce infection by 60-100%. It is the most satisfactory treatment available at present. A dye should be added with the colorless borax to enable checking to see that a complete coverage of the stump surface has been attained.

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