

Root Pathogen Complexes in Pacific Northwest Forests

DONALD J. GOHEEN and GREGORY M. FILIP, Plant Pathologists, Forest Insect and Disease Management, Forest Service, U.S. Department of Agriculture, Portland, OR 97208

ABSTRACT

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Complexes of root pathogens frequently cause tree death within apparently discrete infection centers in Oregon and Washington forests.

Between 1976 and 1978, we surveyed 73 areas with trees dead or dying from root disease in the National Forest, Bureau of Land Management, and Indian reservation lands in Oregon and Washington. At the request of local forest managers, surveys were done to determine which pathogens were causing damage and to obtain information on the location, number, and character of trees affected.

At all infection centers, the root crown of each dead or symptomatic tree and its apparently healthy neighbors was examined. In addition, root systems of dead or symptomatic trees were excavated, and isolations were made from roots, root crowns, and stumps in 22 of the 73 areas. Isolations were made from stained or apparently healthy roots on 2% malt agar and from decayed wood on 2% malt agar amended with 1 ppm benomyl. All were incubated for 6 wk at room temperature, and fungi that developed were identified.

In 12 of the 73 areas (16%), complexes of two or more root pathogens occurred in individual, apparently discrete infection centers (Table 1). The root pathogens colonized roots of adjacent trees or, in some cases, those of the same trees (Figs. 1 and 2). The remaining 61 infection centers each had only one pathogen; *Phellinus weirii* (Murr.) Gilbertson was present in 30 (49%), *Armillaria mellea* (Vahl ex Fr.) Quel. in 16 (26%), *Ceratocystis wageneri* Goheen and Cobb in 14 (23%), and *Fomes annosus* Fr. in 1 (2%).

Infection centers with more than one pathogen were found in Douglas-fir, true fir, and hemlock stands 15 to 100 yr old. All stands had many old stumps from previous clearcutting (on the west side of the Cascade Mountains) or selective harvesting (on the east side of the Cascade Mountains). Many stands also contained substantial numbers of injured trees as a result of disturbance during management activities. Thus, conditions

were extremely favorable for wound-colonizing fungi and for fungi that survive in stumps and spread to new hosts via root contacts.

Root pathogen complexes have been reported from other western forests (1-7; U.S. Forest Service Pacific Southwest Region Pest Detection Inventory, *unpublished*), but origins of complexes as well as interrelationships between and relative roles of the organisms have been studied little. Perhaps such associations are entirely coincidental or perhaps a succession of root disease organisms occur on trees in some stands. The debilitating effects caused by a primary

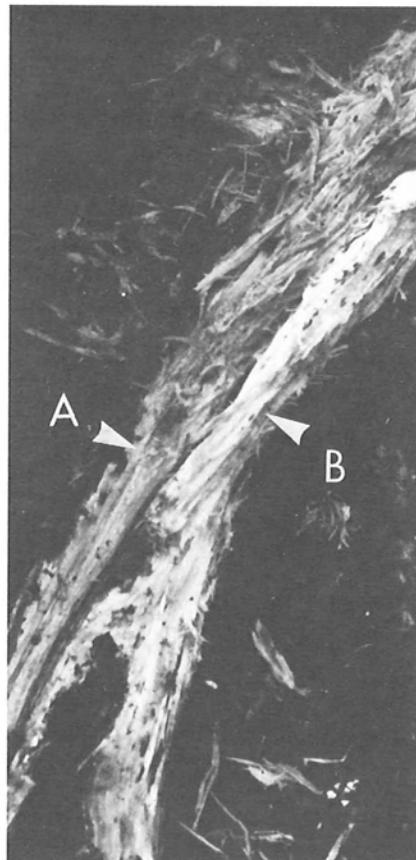


Fig. 1. *Armillaria mellea* (A) and *Fomes annosus* (B) colonizing a western hemlock root, Jefferson County, Washington.

pathogen may favor infection and colonization by secondary pathogens. Root pathogen complexes may have far-reaching significance for forest managers, since control procedures recommended for one pathogen may not be appropriate for or may exacerbate others in the same infection center.



Fig. 2. Douglas-fir exhibiting sapwood stain caused by *Ceratocystis wageneri* (A) and ectotrophic mycelium of *Phellinus weirii* (B), Yamhill County, Oregon.

Table 1. Root pathogen complexes in 12 Pacific Northwest infection centers

Disease center location	Species	Age	Trees (no.)	Percentage of trees infected by:								
				<i>Phellinus weirii</i>	<i>Armillaria mellea</i>	<i>Fomes annosus</i>	<i>Ceratocystis wageneri</i>	<i>A. mellea</i> and			<i>P. weirii</i> and	<i>P. weirii, A. mellea, and</i>
								<i>P. weirii</i>	<i>F. annosus</i>	<i>C. wageneri</i>	<i>C. wageneri</i>	<i>C. wageneri</i>
Washington Forks ¹	<i>Tsuga heterophylla</i>	42	20	0	42	29	0	0	29	0	0	0
Quilcene ²	<i>Pseudotsuga menziesii</i>	15	44	43	57	0	0	0	0	0	0	0
Crystal Mtn. ¹	<i>P. menziesii</i>	15	749	2	85	9	0	0	4	0	0	0
	<i>Abies procera</i>	100	16	62	25	0	0	13	0	0	0	0
Naches ¹	<i>A. grandis</i>	20	418	2	13	0	62	2	0	21	0	0
Wind River ²	<i>P. menziesii</i>											
Oregon Seaside ¹	<i>T. heterophylla</i>	45	20	0	14	57	0	0	29	0	0	0
La Grande ¹	<i>A. grandis</i>	30	66	57	0	43	0	0	0	0	0	0
Ball Bearing Hill ²	<i>P. menziesii</i>	21	525	20	29	0	5	29	0	9	5	3
	<i>A. grandis</i>											
Warm Springs ¹	<i>T. mertensiana</i>	80	42	20	0	5	65	0	0	0	10	0
	<i>P. menziesii</i>	15	648	8	11	0	63	1	0	17	0	0
Oakridge ²	<i>P. menziesii</i>	15	376	0	28	0	44	0	0	28	0	0
Blue River ¹	<i>P. menziesii</i>											
Skeleton Mtn. ²	<i>P. menziesii</i>	70	173	64	33	0	3	0	0	0	0	0
	<i>A. concolor</i>											

¹Pathogen determined by examination of root crowns and cultures isolated from roots, root crown, and/or butt.

²Pathogen determined by root crown examination.

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