

Conifer Mortality Associated with Root Disease and Insects in Colorado

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ABSTRACT

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Surveys were made of conifer mortality in the San Isabel, Rio Grande, San Juan, and Grand Mesa national forests in Colorado. More than 99% of trees examined in apparent mortality centers had root disease, and more than 80% were infested with bark beetles or wood borers. *Fomes annosus* and *Armillaria mellea* were the major root pathogens; both fungi were occasionally found on the same tree. Most root-diseased white fir trees were adjacent to conifer stumps, whereas many affected subalpine fir trees were in uncut stands. A *Verticicladiella* sp. was associated with black stain on Douglas-fir. Major insects associated with mortality included *Scolytus ventralis*, *Dryocoetes confusus*, *Dendroctonus pseudotsugae*, *D. rufipennis*, and wood borers (Buprestidae and Cerambycidae).

Root disease and insects are intimately associated with tree mortality in many forest ecosystems. Cobb et al (2) found that ponderosa pine in California infected with *Ceratocystis wageneri* Goheen and Cobb was prone to infestation by bark beetles and buprestid wood borers. Almost all of the grand firs surveyed in Idaho that were infested with bark beetles also had root disease (5,9). Other associations between bark beetle infestation and root disease have been reported for true fir in Oregon and Washington (8), white fir in California

(3), Douglas-fir, grand fir, and ponderosa pine in Idaho (11), and loblolly pine in the Southeast (1).

Little is known about the causes, distribution, and impact of root disease in the southern Rocky Mountains. This report presents data on the pathogens and insects associated with tree mortality in the San Isabel, Rio Grande, San Juan, and Grand Mesa national forests in Colorado.

MATERIALS AND METHODS

We surveyed along selected roads within mixed-conifer forests and those having spruce and fir trees, where experience indicated that root disease might be important (6,7). Rather than using a statistical sampling scheme, we

selected tree mortality centers (one or several dead or dying trees close together) on the basis of accessibility and location within national forest boundaries.

Recently killed and dying trees more than 1.4 m tall were tallied in each area sampled. Dead trees and live ones with reduced needle complement or chlorotic foliage were examined for typical signs of root disease by uncovering and dissecting the root collar and upper portions of two or three roots. When identification could not be made in the field, root collar wood samples were collected for later pathogen isolation. Surface-sterilized wood samples were cultured for 7-14 days on potato-dextrose agar amended with streptomycin.

Each tree evaluated for root disease was also examined for evidence of insect activity, especially that of bark beetles and wood borers. Insects were identified on the basis of gallery patterns and characteristics of collected adults. Proximity to conifer stumps was also recorded.

RESULTS AND DISCUSSION

Major root pathogens associated with tree mortality in the southern Rocky Mountains were *Fomes annosus* (Fr.) Cke. and *Armillaria mellea* (Vahl. ex Fr.) Karst. *F. annosus* was most common on white fir (*Abies concolor*); however, it

Table 1. Root fungi and insects associated with white fir and subalpine fir mortality in Colorado

Species National forest	Mortality centers (no.)	Trees (no.)		Trees per center (avg. no.)	Trees infested by root fungi (%)			Trees infested with insects (%)			Trees with root fungi and insects (%)	Centers near stumps (%)
		Alive, with symptoms	Dead		<i>Fomes</i> <i>annosus</i>	<i>Armillaria</i> <i>mellea</i>	Both present	Bark beetles		Borers		
						<i>Scolytus</i> <i>ventralis</i>	<i>Dryocoetes</i> <i>confusus</i>					
White fir												
San Isabel	38	12	104	3.0	70.7	24.1	5.2	71.5	0.0	0.8	72.4	89.5
San Juan	24	0	49	2.0	32.6	55.1	12.3	98.0	0.0	2.0	100.0	58.3
Total	62	12	153	2.7	59.4	33.3	7.3	79.4	0.0	1.2	80.6	77.4
Subalpine fir												
San Isabel	6	2	23	4.2	21.7	78.3	0.0	0.0	76.0	0.0	82.6	50.0
San Juan	18	4	28	1.8	0.0	93.8	0.0	0.0	81.3	18.8	100.0	33.3
Rio Grande	28	4	63	2.4	0.0	100.0	0.0	0.0	67.2	8.9	92.5	35.7
Grand Mesa	5	1	36	7.4	0.0	100.0	0.0	5.4	62.2	0.0	67.6	40.0
Total	57	11	150	2.8	3.1	95.6	0.0	1.2	70.2	7.4	86.8	36.8

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Table 2. Root fungi and insects associated with Douglas-fir and Engelmann spruce mortality in Colorado

Species National forest	Mortality centers (no.)	Trees (no.)		Trees per center (avg. no.)	Trees infected by root fungi (%)		Trees infested with insects (%)			Trees with root fungi and insects (%)	Centers near stumps (%)
		Alive, with symptoms	Dead		<i>Armillaria mellea</i>	<i>Verticicladiella sp.</i>	Bark beetles		Borers		
							<i>Dendroctonus pseudotsugae</i>	<i>D. rufipennis</i>			
Douglas-fir											
San Isabel	6	1	14	2.5	100.0	0.0	53.3	0.0	26.7	80.0	66.7
San Juan	1	0	1	1.0	0.0	100.0	100.0	0.0	0.0	100.0	0.0
Total	7	1	15	2.3	93.8	6.2	56.3	0.0	25.0	81.3	57.1
Engelmann spruce											
San Isabel and Rio Grande	2	0	2	1.0	100.0	0.0	0.0	100.0	0.0	100.0	100.0

was also found on subalpine fir (*A. lasiocarpa*) in the San Isabel National Forest (Table 1). *Armillaria mellea* was found on all conifer species. More than 7% of the white fir trees surveyed contained both pathogens. In these trees, *F. annosus* was often found colonizing the root collar, whereas *A. mellea* was located on lateral roots distal to this colonization. Similar associations between these pathogens have been previously noted (4,10).

A black-staining fungus (*Verticicladiella* sp.) was found on Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) infested with the Douglas-fir beetle (*Dendroctonus pseudotsugae* Hopkins). Because pathogenicity tests were not conducted, the role of this fungus in tree mortality is unknown.

Although most white fir trees infected with *F. annosus* were adjacent to conifer stumps, certain *Fomes*-infected white firs and many *Armillaria*-infected subalpine firs were in uncut stands. These pathogens may be common in uncut stands of true fir (J. R. Parmeter, *personal communication*). However, more information is needed on the role of stumps in the presence and buildup of root disease in true fir stands.

Our survey confirmed the close association of root disease with bark

beetles and wood borers. More than 80% of the root-diseased conifers sampled in mortality centers were infested with beetles (Tables 1 and 2). The fir engraver (*Scolytus ventralis* LeConte) was associated most often with root-diseased white fir, and the western balsam bark beetle (*Dryocoetes confusus* Swaine) often infested dying subalpine fir. The Douglas-fir beetle was found on most Douglas-fir, and the spruce beetle (*Dendroctonus rufipennis* (Kirby)) was found on both the Engelmann spruce trees (*Picea engelmannii*) sampled. Wood borers (Buprestidae and Cerambycidae) were occasionally found on all species. Only two beetle-infested trees (both subalpine fir) were free from apparent root disease. Much conifer mortality appeared to be the result of complexes involving both root pathogens and insects.

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