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INCIDENCE OF VERTICICLADIELLA WAGENERII AND PHELLINUS WEIRII
IN DOUGLAS-FIR ADJACENT TO AND AWAY FROM ROADS IN WESTERN OREGON

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ABSTRACT

A survey was conducted comparing the incidence of root disease in Douglas-fir forests in paired 0.1-ha strips adjacent to, and 25 m or more distant from, two roads in western Oregon. Black stain root disease (caused by *Verticicladiella wagnerii*) was found more frequently in roadside strips than in strips at a distance from roads. Distribution of laminated root rot (caused by *Phellinus weirii*) was not influenced by proximity to roads. Black stain was found in 15- to 25-year-old plantations but not in mature timber.

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Additional key words: *Armillaria mellea*, insect vectors, stress.

Douglas-fir forestry in the Pacific Northwest is changing from harvest of old-growth virgin stands to management of young plantations. Accompanying this transition are new disease problems; well-known pathogens are appearing in new roles, and little-known pathogens are gaining prominence.

Verticicladiella wagnerii Kendrick, the cause of black-stain root disease, was first observed in 1938 on pinyon pine and ponderosa pine in the Southwest (8), but was not reported from the Northwest until 1971 (5). Since then it has been reported with increasing frequency from Douglas-fir plantations in Oregon and Washington. Many questions are unanswered about the means of spread of this pathogen. Local infection centers expand tree by tree, but long distance spread apparently requires insect vectors (4).

Information is needed on the distribution of *V. wagnerii* and the damage it causes in order to design and interpret disease surveys and to provide a basis for management of diseased stands. This study was undertaken to test the hypothesis that trees next to roads are more frequently infected than trees away from roadside influence.

While tallying trees infected with *V. wagnerii*, we also recorded incidence of other root pathogens. Most common by far was *Phellinus weirii* (Murr.) Gilbertson, the cause of laminated root rot of many western conifers, including Douglas-fir.

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SURVEY METHOD

The survey was conducted in two areas of western Oregon, one in the Cascade Mountains and one in the Coast Range. Roads were selected for examination because Verticicladiella was known to occur in the vicinity. Stands were sampled along 36.8 km of U.S. Highway 20 from the Willamette National Forest Boundary (300 m elevation) to Tombstone Pass (1300 m elevation). Timber stands near the highway range from 150-year-old Douglas-fir along the first 19.3 km at lower elevations through a series of younger stands and 15- to 20-year-old Douglas-fir plantations at mid-elevation to old-growth Douglas-fir and western hemlock at the pass. The area sampled in the Coast Range was along 3.9 km of Forest Service Road 16007 (about 150 m elevation) on the Mapleton District, Siuslaw National Forest. Douglas-fir plantations from 15 to 25 years old predominate in this stretch, with one stand of 100-year-old Douglas-fir.

The sampling scheme was to pair 0.1-ha strips, one adjacent to the roads, the other 25 m or more distant. Each strip was 10 m by 100 m and was divided into 0.01-ha blocks (10 m x 10 m). Twenty-four pairs of strips were spaced 1.6 km apart along Highway 20, and 19 pairs were spaced 0.3 km apart along both sides of Forest Service Road 16007.

Each strip was examined block by block for dead or dying trees. Verticicladiella was identified by the associated brown-black stain, P. weirii by the characteristic mycelium on root surfaces, and Armillaria mellea by the characteristic mycelium beneath the bark. Infection areas were drawn on a sketch map of each block. The area estimated was the area actually out of production due to root disease as defined by identifiable tree mortality. Data were analyzed by a paired difference test using Student's t-distribution (6).

RESULTS

In the 8.6 ha examined, 275 dead or dying conifers were found. Phellinus weirii was identified on 146 (53%) of these, V. wagnerii on 87 (32%), and A. mellea on 13 (5%). Twenty-nine trees (11%) were dead from unidentified causes. Most of these had been suppressed.

Table 1. Occurrence of Verticicladiella wagnerii and Phellinus weirii in 0.1-ha strips and 0.01-ha blocks adjacent to, and 25 m or more distant from, roads in western Oregon.

Pathogen	Location	
	Roadside	25 m or more distant
<u>V. wagnerii</u>		
Strips (%)	23	14
Blocks (%)	6	3
Trees	66	21
<u>P. weirii</u>		
Strips (%)	44	44
Blocks (%)	10	12
Trees	73	73

Table 2. Occurrence of Verticicladiella wagnerii and Phellinus weirii in plantations and mature stands of Douglas-fir in western Oregon.

Pathogen	Plantation	Mature
<u>V. wagnerii</u>		
Strips (%)	25	0
Trees	80	0
Area (%) ^a	2	0
<u>P. weirii</u>		
Strips (%)	39	60
Trees	35	-
Area (%) ^a	1	11

^aArea out of production because of root disease.

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Verticicladiella occurred significantly more often in roadside strips than in strips away from the road (95% probability level, Table 1). There was no difference in P. weirii occurrence between roadside and distant strips. Because similar results were obtained for Highway 20 and Forest Service Road 16007, the data were combined for analysis.

Verticicladiella was found only in young trees on this survey. Phellinus weirii, on the other hand, was found in both plantations and mature stands (Table 2). Thirty of the 86 strips (35%) were in mature timber. Although P. weirii was encountered in more strips in plantations than V. wagnerii, (39% versus 25%), Verticicladiella had infected more trees (80 versus 35). A tally of the number of trees killed by P. weirii in mature stands was not made because the oldest mortality was no longer identifiable.

DISCUSSION

That roadside trees are more frequently infected by Verticicladiella wagnerii than trees at a distance from roads suggests that stressed trees are especially susceptible to infection. Many infected trees were physically damaged by road construction or maintenance or were growing in disturbed soil on road cuts or fills. Stress has not been reported as a factor in susceptibility of trees to V. wagnerii (3,4,7); however, stressed trees are attractive to root-feeding bark beetles (1) which are thought to be vectors for the fungus (4).

Phellinus weirii spreads vegetatively from root to root; other means of spread have not been demonstrated or hypothesized to be important (2). It is not surprising, therefore, that P. weirii distribution was unaffected by roads.

This survey was not designed for impact information, but results indicate some of the problems associated with damage assessment in stands of different ages and suggest the magnitude of root disease in the areas examined. Recording damage by the number of afflicted trees for a persistent disease such as laminated root rot is misleading in mature stands, because much of the mortality has occurred years before and sites have reverted to brush. An estimate of the area out of production because of infection is more realistic in old stands but is meaningless in young stands before continuous infection centers have formed.

Although it cannot be considered representative of the Douglas-fir region as a whole, the loss of 11% of the area of mature stands sampled in this study from Douglas-fir production certainly represents a major loss. The amount and distribution of mortality in the sampled young stands indicates that they will suffer comparable losses in time.

Verticicladiella has killed more trees in larger infection centers in sampled plantations than P. weirii. Because the sample is not representative, however, we have no grounds to project future losses. The impact of V. wagnerii will be determined by the rate and persistence of spread within infection centers and the frequency of initiation and distribution of new centers. This study provides a basis for a rational survey procedure.

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Patch-occupancy dynamics in fragmented landscapes

Ilkka Hanski

Ecologists are often faced with the dilemma of holding only observational data on patterns, while being hard pressed to say something about the processes that have supposedly produced these patterns. A popular example is the pattern of habitat patch occupancy of species living in fragmented landscapes, and the processes of stochastic population extinction and patch recolonization. Patch-occupancy dynamics is a fashionable^{1–3}, though still controversial^{4,5}, issue in conservation biology, where there is the additional difficulty that experimentation would often be unethical as well as impractical. The purpose of this review is to summarize the kind of pattern data that ecologists interested in 'patch-occupancy dynamics' have accumulated, and to outline a recent approach to modelling of occupancy data for the purpose of answering questions about the dynamics.

Patterns of patch occupancy

It has been said that the increase in species number with increasing (island) area is one of the few valid

Recent work on the dynamics of species living in fragmented landscapes has produced much information on patterns of habitat patch occupancy in a wide range of organisms. Building on an elementary Markov chain model of patch occupancy, a family of incidence–function models can be constructed for particular kinds of metapopulations. These models can be parameterized with field data on patch occupancy, and the models can be used to make quantitative predictions about specific metapopulations. This approach provides a potentially powerful tool for the management of reserve networks and species living in fragmented landscapes.

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generalizations in ecology. The species–area relationship, and the analogous species–isolation relationship (decreasing species number with increasing isolation) were two critical building blocks on which the equilibrium theory of island biogeography⁶ was established. These multi-species patterns tend to emerge from regularities in the occurrence of individual species on true or habitat islands varying in area and isolation. Below, I use the shorthand term '(habitat) patch' for islands and also discrete fragments of a particular kind of habitat.

Patterson^{7,8} has drawn attention to significant 'nestedness' of species occurrences in habitat patches. Theoretically, species might occur as if randomly placed

in patches, with the constraint that smaller patches have a smaller probability of having any one of the species than larger patches. But this is not the pattern typically observed. In reality, each species tends to occur in patches exceeding an apparent threshold value in size. This threshold area varies among the species, which produces the more-or-less regular increase in species number with increasing area. That is, species that are present in a