Rhabdocline Taxa in Pennsylvania

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ABSTRACT

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Both *Rhabdocline pseudotsugae* subsp. *pseudotsugae* and *R. weirii* subsp. *oblonga* occur on Douglas-fir in Pennsylvania and southern New York. *R. pseudotsugae* subsp. *pseudotsugae* was the predominant species in Pennsylvania north of the Pocono Mountains and was the only species found south of the Pocono Mountains. The pattern of epidermal dehiscence over the apothecium was not a reliable means of separating these two species.

Needlecast caused by *Rhabdocline pseudotsugae* Syd. has been known on Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) in the northeastern United States since the early 1930s (1). In 1969, Parker and Reid (5) revised the monotypic genus *Rhabdocline* to include two species and five subspecies. On the basis of herbarium specimens, the fungus in Massachusetts and Rhode Island was identified as *R. weirii* subsp. *oblonga* Parker & Reid (5). Forest pathologists have assumed that this species was involved in the Douglas-fir needlecast that occurred throughout New England and New York and that was reported once from northeastern Pennsylvania (1,6).

In 1979, Rhabdocline needlecast became epidemic in Douglas-fir Christmas tree plantations at scattered locations throughout eastern Pennsylvania (2). Since then, the disease has increased in incidence and severity and now occurs throughout the eastern half of the state, particularly in the northeastern and east central portions. We found both *R. pseudotsugae* Syd. subsp. *pseudotsugae* Parker & Reid (RPP) and *R. weirii* subsp. *oblonga* (RWO) in two plantations but had no measure of the distribution or the relative frequencies of the two species in Pennsylvania Christmas tree plantations (2).

O'Brien and Morton (3,4) reported both RPP and RWO in Christmas tree plantations in northern Michigan. RWO was the predominant species. They reported that the two species could be reliably differentiated by the pattern of epidermal dehiscence over the apothecium; the needle epidermis dehisced laterally above apothecia of RWO and medially above apothecia of RPP (4). Observations in affected plantations in Bradford County, PA, indicated that the relative frequencies of the two species differed from those found in Michigan and that the pattern of epidermal dehiscence was not a reliable indicator of fungus species. The following studies were done to determine the distribution of *Rhabdocline* taxa in Pennsylvania and to determine whether pattern of epidermal dehiscence was a reliable criterion by which to separate the species of the pathogen.

MATERIALS AND METHODS

During late May and early June of 1981–1983, affected Christmas tree plantations were examined in Bradford, Carbon, Monroe, and Schuylkill counties of Pennsylvania. To avoid a possible selective action of the pesticide on the pathogens, areas of these plantations were selected that had not been treated with fungicides. Three to nine infected trees were randomly selected in each plantation, depending on the frequency of unsprayed, infected trees. From each tree, one twig was removed 0.5 m above ground on the north side of the tree. These twigs were labeled, bagged, and dried until used. Three plantations were sampled in Bradford County, one in Monroe County, and two each in Schuylkill and Carbon counties. All sampled trees were from seed sources in the Lincoln National Forest, NM. In addition, a sample collected in the same manner from a single tree was received from a grower in Wayne County, PA, and a single infected landscape tree was sampled in the Arnot Forest, Schuyler County, NY. The latter sample was taken from the lowest branch, about 2 m from the ground.

Several needles bearing apothecia were selected at random from each twig, soaked in 5% aqueous KOH for 5 min, and rinsed for 5 min in distilled water. Each needle was examined at ×30 and the pattern of epidermal deshiscence above each apothecium noted. A squash mount in Melzer's reagent then was made from each apothecium and examined for the presence (J+) or absence (J−) of an amyloid reaction of the ascal pore apparatus (5). This amyloid reaction is the primary means by which the two species are differentiated (*R. weirii* = J+, *R. pseudotsugae* = J−) (5).

Table 1. Locations of affected plantation and number of *Rhabdocline* apothecia displaying lateral, medial, or indeterminate epidermal dehiscence in relation to the iodine reaction of the asci in these apothecia

	Number of apothecia displaying indicated epidermal dehiscence					
	J+			J−		
County and plantation	Lat[a]	Med	Ind	Lat	Med	Ind
Schuylkill County, PA						
1	0	0	0	94	42	23
2	0	0	0	230	121	43
Carbon County, PA						
1	0	0	0	124	147	32
2	0	0	0	53	39	12
Monroe County, PA	0	0	0	64	65	5
Wayne County, PA	0	0	0	3	3	3
Bradford County, PA						
1	0	0	0	173	126	10
2	50	27	2	39	46	5
3	41	3	0	121	165	13
Schuyler County, NY	40	10	0	2	5	0
Subtotal	131	40	2	903	759	146
Percent of total[b]	75.7	23.1	1.2	50.0	41.9	8.1

[a] Lat = lateral, Med = medial, and Ind = indeterminate (lateral + medial).
[b] Totals: J+ = 173, J− = 1,808.

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RESULTS AND DISCUSSION

The results of examining 1,981 apothecia on 913 needles from 52 trees from 10 locations are summarized in Table 1. Plantations 2 and 3 in Bradford County, PA, had mixed infections of RWO and RPP, predominantly RPP. The single tree sampled in the Arnot Forest bore predominantly RWO. All other collections were exclusively RPP, which made up 86% of all collections. This is opposite the situation in northern Michigan, where O'Brien and Morton (4) found that RWO made up 84% of all collections. W. A. Sinclair (*personal communication*) has frequently found RWO, but never RPP, on Douglas-fir in central New York.

Most trees were infected by a single species of the pathogen; only five of 52 trees bore mixed infections. Only one of 913 needles bore apothecia of both species.

The differences in relative frequencies of the two species in Pennsylvania and Michigan or New York may reflect the different environmental requirements of the pathogens, as discussed by O'Brien and Morton (4). However, the occurrence of a mixed infection in Bradford County plantation 2 but only RPP in plantation 1 on a similar site about 1 km away, as well as a mixed infection in one of seven trees sampled in plantation 3, suggest the differences in the distribution and relative frequencies of the two species may be due to chance introduction. The occurrence of the pathogen in first-rotation Christmas tree plantations in remote areas of Pennsylvania several kilometers from any previous Douglas-fir plantings indicates that the pathogen was introduced on diseased nursery stock. Thus the observed differences in species distribution and frequency may reflect the frequency of occurrence of the species of the pathogen in the area from which the nursery stock was obtained. These differences also may reflect the susceptibility of the strains or provenances of Douglas-fir grown in Pennsylvania versus Michigan or New York.

O'Brien and Morton (4) reported that RPP could be separated from RWO with 94% accuracy by the pattern of epidermal dehiscence above the apothecium. In our study, the patterns of epidermal dehiscence of the two species did differ (Table 1). About three times more J+ apothecia dehisced laterally than medially, significantly different from a 1:1 distribution according to a chi-square test at $P \leq 0.01$. However, contrary to the findings of O'Brien and Morton (4), more J− apothecia also dehisced laterally (50%) than medially (42%). This difference also was significantly different from a 1:1 distribution at $P \leq 0.01$. On the basis of these results, we do not consider the manner of epidermal dehiscence above the apothecium to be a reliable criterion by which to distinguish these two subspecies of *Rhabdocline*.

The structure and strength of the host tissues may significantly affect the pattern of epidermal dehiscence. The differences between our results and those of O'Brien and Morton (4) could be the result of studying the pathogens on different strains or provenances of Douglas-fir.

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