Distribution of Rhabdocline and Swiss Needle Casts on Douglas-Fir Christmas Trees in New Hampshire

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ABSTRACT

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Twenty-nine sites with Douglas-fir Christmas tree plantations were examined in 1984 for Rhabdocline and Swiss needle cast diseases. Rhabdocline needle cast was found at 17 sites, Swiss needle cast at 9, and neither needle cast at 11. *Rhabdocline pseudotsugae* subsp. *pseudotsugae*, reported for the first time in New England, was more prevalent than *R. weirii* subsp. *oblonga*. Neither *Phaeocryptopus gaeumannii* (cause of Swiss needle cast) nor *R. weirii* were detected in southeastern New Hampshire, where winter and spring conditions are usually milder than in the interior of the state.

Rhabdocline and Swiss needle casts are the two most important diseases on Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) Christmas trees in New Hampshire. *Rhabdocline weirii* Parker & Reid and *R. pseudotsugae* Syd. mostly infect developing needles on elongating shoots, usually from mid-May through June (3). By the following spring, reddish brown spots develop on infected, 1-yr-old needles and fruiting bodies (apothecia) begin to mature within these spots. After spore discharge, the infected needles are cast. Occasionally, apothecia do not mature and needles are not cast until 2 yr after infection (6). *Phaeocryptopus gaeumannii* (Rohde) Petr. (cause of Swiss needle cast) mostly infects developing needles during May and June, but infections may also occur later in the summer and on 2-yr-old needles (2). Fruiting bodies (pseudothecia) emerge through stomata, usually 1 yr after infection. Unlike Rhabdocline needle cast, needles with pseudothecia may remain green and not be cast for 2 yr or more after infection.

Both diseases may be controlled by spraying protectant fungicides at bud burst and at 7- to 10-day intervals thereafter until the new needles have elongated (3). Genetic resistance is known and is a potential control, but most currently available nursery stock is highly susceptible to both diseases. Outside the natural geographic range of Douglas-fir, avoidance of the diseases also is possible. *Rhabdocline* spp. and *P. gaeumannii* are known only on Douglas-fir, so their natural ranges are within that of their host, i.e., western North America. These pathogens have been distributed on infected nursery stock to most areas where Douglas-fir is cultivated. Although both needle casts are widely distributed and well established at many locations in New England, plantings of Douglas-fir are typically widely scattered, and some plantations appear to be disease-free.

Unusually heavy rainfall in June 1982 in New Hampshire apparently resulted in ideal conditions for infection by *Rhabdocline* spp. and *P. gaeumannii*. The following year, severe needle casting was noted in many plantations. This prompted a survey of the distributions of the diseases.

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MATERIALS AND METHODS

From questionnaires mailed to Christmas tree growers in the state, 29 sites were identified where Douglas-fir trees had been planted in 1981 or earlier. All 29 sites were surveyed. When more than one plantation was present at a given site (one site had two plantations and another three), each plantation was surveyed separately, but the data from these were totaled for each site.

Each plantation was visited in late May or June 1984. Regardless of the size of the plantation (most ranged from 50 to 200 Douglas-fir trees), at least 15 Douglas-fir were carefully examined for signs and symptoms of the two diseases. The sampled trees were spaced at regular intervals throughout the plantation; intervals were determined from the total estimated number of Douglas-fir trees in the plantation. If Rhabdocline needle cast was present on 1- or 2-yr-old needles, twigs with infected needles of both ages were collected near the midcrowns of three trees for laboratory examination to determine the species of *Rhabdocline* present. Five 1-yr-old and five 2-yr-old needles with apothecia were randomly selected from the twig sample from each of the three trees (15 1-yr-old and 15 2-yr-old needles total per plantation). Each apothecium on the 30 needles (average of 41 apothecia per site) was sectioned by hand, mounted in Melzer's reagent (1.5 g of iodine, 5 g of potassium iodide, and 100 g of chloral hydrate in 100 ml of water), and examined at 400–1,000×. The presence or absence of an amyloid (turns blue in Melzer's reagent) ring at the apex of the ascus was used to identify the apothecium as either *R. weirii* or *R. pseudotsugae*, respectively (6).

RESULTS

Rhabdocline needle cast appeared to be more severe and was more frequently encountered in the survey than was Swiss needle cast. Rhabdocline needle cast was detected at 17 and Swiss needle cast at 9 of the 29 sites (Figs. 1 and 2). Eight of the nine sites where Swiss needle cast was detected also had Rhabdocline needle cast. The 18 sites where needle cast diseases were detected were all planted to Douglas-fir before 1980. Of the 11 sites where no needle cast was detected, seven were planted only 3 or 4 yr before the survey. The diseases may have been present but had not yet reached detectable levels at these seven sites.

Microscopic examination of apothecia indicated that *R. pseudotsugae* is more common (Table 1) and more widespread (Fig. 1) than *R. weirii* in New Hampshire. Of 691 apothecia examined, 414 were identified as *R. pseudotsugae* subsp. *pseudotsugae* and 277 as *R. weirii* subsp. *oblonga* Parker & Reid (6). Six sites had both species, eight sites only *R. pseudotsugae*, and three sites only *R. weirii*. Almost all apothecia from trees within 50 km of the coastline proved to be *R. pseudotsugae*; no *R. weirii* was detected in the southeasternmost county in the state (Fig. 1).

Many of the sampled trees with Rhabdocline needle cast had few or no 2-yr-old needles with apothecia;

apparently, many of the 2-yr-old needles had already been cast and those remaining were only lightly infected. Only 103 of the 691 apothecia examined were from 2-yr-old needles (Table 1). Of these, 75% were identified as *R. weirii*. In contrast, *R. weirii* constituted only 34% of the 588 apothecia on 1-yr-old needles.

At maturity, the host epidermis overlying the apothecium of *Rhabdocline* spp. splits laterally or medially to expose the hymenium and allow spore discharge. Of the mature, exposed apothecia examined, more than 90% of the *R. weirii* apothecia were exposed by lateral dehiscence and 64% of the *R. pseudotsugae* apothecia were exposed by medial dehiscence (Table 1).

DISCUSSION

Rhabdocline needle cast is more widespread and, based on field observations of needle casting in affected plantations, appears to be more severe than Swiss needle cast in New Hampshire. Because plantations of Douglas-fir in New Hampshire are often isolated from other plantations of Douglas-fir, most sites where the diseases were detected in this survey probably represent separate introductions of the respective pathogens on infected nursery stock.

Both lateral and medial dehiscence of host epidermis overlying apothecia were seen in both *Rhabdocline* spp. As found in Michigan (5), *R. weirii* had mostly lateral dehiscence and *R. pseudotsugae* mostly medial dehiscence. However, mode of dehiscence cannot be used confidently for identification of these species in New Hampshire. In Michigan (5), identification of an apothecium as either *R. weirii* or *R. pseudotsugae* based solely on mode of dehiscence was estimated to be accurate in 94% of the cases; in contrast, this criterion was accurate in only 76% (425 of 561 apothecia) of the cases in New Hampshire, where the more variable *R. pseudotsugae* predominates. In New Hampshire, as in Pennsylvania (1), presence or absence of the ascus apical ring is the only reliable diagnostic tool. *R. weirii* was more common than *R. pseudotsugae* on 2-yr-old needles, but this has little diagnostic value.

Neither *P. gaeumannii* nor *R. weirii* were detected near the seacoast in Rockingham County, where winters and early springs are typically milder than in the rest of the state. Presumably, these pathogens were introduced along with *R. pseudotsugae* into at least some of the plantations in the seacoast area, but only *R. pseudotsugae* is well established there. Absence of *R. weirii* may be due in part to host and pathogen phenology. Apothecia of *R. weirii* from the interior of New Hampshire appeared more mature than those of *R. pseudotsugae*, at least on the basis of percentage of apothecia dehisced (Table 1). O'Brien and Morton (5) also found that apothecia of *R. weirii* matured sooner than apothecia of *R. pseudotsugae*, and *R. weirii* apothecia ejected almost all of their spores by 18 May in Michigan. In the milder seacoast region of New Hampshire, most *R. weirii* ascospores may be ejected before the emergence of susceptible needle tissue in mid-May.

Although *R. weirii* has been known in New England since at least 1929 (6), apparently, this is the first report of *R. pseudotsugae* in this region. Parker and Reid (6) reported *R. pseudotsugae* from throughout most of the natural range of its host in western North America and throughout Europe. Recently, this species has been detected in Michigan (5), Ontario (4), and Pennsylvania (1). In contrast, *R. weirii* has been collected only in northern North America, perhaps indicating that it has a narrow range of environmental conditions suitable for completion of its life cycle. It has not been collected in the relatively mild spring climates of Europe (6), southeastern Pennsylvania (1), or near the seacoast of New Hampshire. In Michigan (5), northern Pennsylvania (1), and interior New Hampshire, where winters and springs are colder, *R. weirii* is more prominent on Douglas-fir trees.

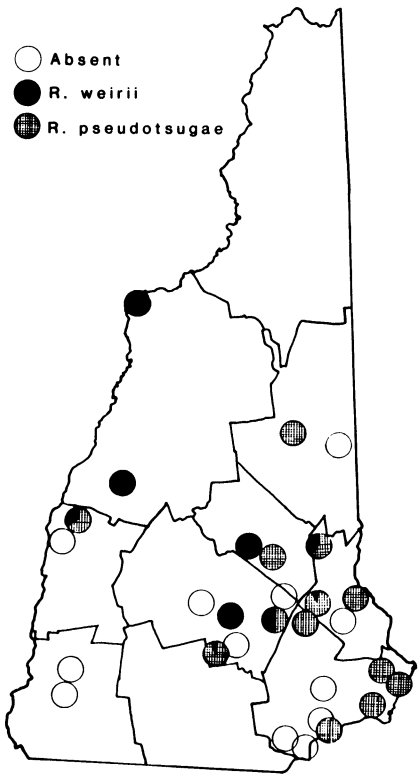

Fig. 1. Distribution of *Rhabdocline weirii* and *R. pseudotsugae* at 29 survey sites in New Hampshire. At the six sites where both species were found, the relative proportion of apothecia of the two species is indicated.

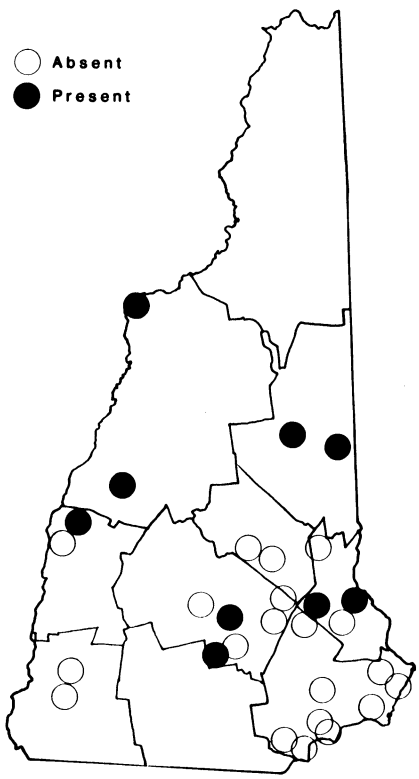

Fig. 2. Distribution of *Phaeocryptopus gaeumannii* (cause of Swiss needle cast) at 29 survey sites in New Hampshire.

Table 1. Number of apothecia on 1- and 2-yr-old needles and mode of epidermal dehiscence of *Rhabdocline weirii* and *R. pseudotsugae* in New Hampshire

	Apothecia examined (no.)					
		Produced on needles		Dehisced		
Species	Total	1-yr-old	2-yr-old	Total	Lateral	Medial
R. weirii	277	200	77	246	223	23
R. pseudotsugae	414	388	26	315	113	202
Total	691	588	103	561	336	225

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LITERATURE CITED

1. McDowell, J., and Merrill, W. 1985. *Rhabdocline* taxa in Pennsylvania. Plant Dis. 69:714-715.
2. Michaels, E., and Chastagner, G. A. 1984. Seasonal availability of *Phaeocryptopus gaeumannii* ascospores and conditions that influence their release. Plant Dis. 68:942-944.
3. Morton, H. L., and Miller, R. E. 1982. Chemical control of Rhabdocline needle cast of Douglas-fir. Plant Dis. 66:999-1000.
4. Myren, D. T. 1984. Needle cast of Douglas-fir caused by *Rhabdocline pseudotsugae* subsp. *pseudotsugae* and *Phaeocryptopus gaeumannii* in Ontario. Plant Dis. 68:1099.
5. O'Brien, J. G., and Morton, H. L. 1983. Occurrence of *Rhabdocline* taxa in Douglas-fir Christmas tree plantations in Michigan. Plant Dis. 67:661-663.
6. Parker, A. K., and Reid, J. 1969. The genus *Rhabdocline*. Can. J. Bot. 47:1533-1545.