The Distribution and Significance of Scleroderris Disease in Ontario

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ABSTRACT

Information on the distribution of scleroderris disease (*Gremmeniella abietina* [Lagerb.] Morelet) was compiled from surveys conducted in Ontario by the Canadian Forest Service from 1985 to 1993. Both the North American and European races of the disease are present in Ontario. The North American race, which is possibly indigenous, has been present in Ontario since at least the 1950's and occurs throughout the range of pines North of 45°. The European race was first isolated in Ontario in 1985. It is restricted in its distribution between 44° 30' N and 45° 45'N. Both races of the disease have been absent from the eastern area of the province near the Ottawa valley. However, the disease has been reported at high levels on the Quebec side of the border. In 1985, 0.5% of the pine plantations surveyed were infected by scleroderris. This level had increased to about 8% by 1993. In most affected plantations less than 5% of the trees were infected; however, levels in excess of 30% were reported in 1985–1987, and again in 1993. The greatest damage caused by either race of the disease has been to trees less than 1.0 m in height. Mortality to this height class ranged from 0.7–13.0%. Trees between 1.0–3.0 m in height usually suffered only branch mortality.

RÉSUMÉ

L'information sur la distribution du chancre scléroderrien (*Gremmeniella abietina* [Lagerb.] Morelet) a été compilée à partir d'études réalisées en Ontario par le Service canadien des forêts entre 1985 et 1993. Les races nord-américaine et européenne de la maladie sont toutes deux présentes en Ontario. La race nord-américaine, qui est peut-être indigène, existe en Ontario depuis au moins les années 50 et elle est présente dans l'ensemble de l'aire de distribution des pins au nord du 45e parallèle. La race européenne a été isolée en Ontario pour la première fois en 1985. On ne la trouve qu'entre 44°30'N et 45°45'N. Les deux races de la maladie sont absentes de la partie est de la province, près de la vallée de l'Outaouais. Toutefois, de nombreux cas de la maladie ont été signalés du côté québécois de la frontière. En 1985, 0,5% des plantations de pins examinées étaient infectées par le chancre scléroderrien. Ce niveau a augmenté pour atteindre environ 8% en 1993. Dans la plupart des plantations touchées, moins de 5% des arbres étaient infectés; toutefois, des niveaux dépassant 30% ont été signalés pendant la période 1985–1987 et en 1993. Ce sont les arbres de moins de1 m de haut qui subissent le plus de dommages par suite de la maladie, quelle que soit la race en cause. Le taux de mortalité dans cette classe de hauteur varie entre 0,7 et 13%. Les arbres dont la hauteur se situe entre 1 et 3 m ne subissent en général que des pertes de branches.

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INTRODUCTION

Scleroderris canker, caused by the fungus *Gremmeniella abietina* (Lagerb.) Morelet, has been regarded as a major pest of pine for over 30 years. The disease is most common to pines although a new variety (*A. balsamea*) has also been found in association with black spruce in Quebec (Laflamme 1988) and Newfoundland (Moody 1989). The current taxonomic state of the organism has been treated by Petrini et al. (1989). Based on results of the serological comparisons, two distinct strains of the fungus are recognized as existing on pines in North America. These are referred to as the North American and European races. The North American race of scleroderris was first identified from plantations in northern Michigan in 1965 (Ohman 1966) although the disease symptoms had been recognized in eastern Canada and the lake states since at least 1950. At that point the disease most often caused mortality of young red pine and jack pine growing on poor quality sites. However, in 1975 in the state of New York, several thousand hectares of semimature red pine and Scots pine were infected and killed by the disease (Skilling 1977). The strain of scleroderris isolated from these plantations showed serological similarities to isolates found in Europe (Dorworth et al. 1977) and was so named the European race. This disease, apparently new to North America, was of particular concern due to the extensive damage it caused on the pine plantations in New York state and its apparent ability to kill large trees. In addition, based on artificial inoculation studies (Skilling et al. 1986), the European race possesses the ability to infect most conifers native to North America. This provides it with a broader host range than the North American strain. In Canada, the European race was first isolated in 1978 from red pine plantations in Quebec (Lachance and Benoit 1978) and New Brunswick (Magasi 1979). Subsequent to that discovery, the European race was also found in Newfoundland in 1980 (Sterner and Davidson 1981). Soon after its appearence in Canada, an extensive ground and aerial survey was initiated by the Forest Insect and Disease Survey (FIDS) Unit in Ontario to detect scleroderris. In 1985 the European race was first detected in central Ontario at three locations (Sajan and Smith 1985).

Scleroderris canker in North America has never established itself for any extended period at latitudes significantly south of 45° N (Marosy et al. 1989). However, the disease is distributed over the range of pines north of that latitude in Canada from northwestern Ontario to Newfoundland (Figure 1). Additionally, the North American race has also been reported at several locations in Alberta (Dorworth 1975) and British Columbia (Hiratsuka and Funk 1976). The European race, while detected in Ontario, Quebec, New Brunswick, and Newfoundland, has a more restricted distribution than the native strain (Figure 1). In Newfoundland, the European race has been confined to several plantations on the Avalon Peninsula. In New Brunswick, the European race has been isolated from six locations since 1978, but has been eradicated from three sites and is silviculturally controlled at the other existing locations (Magasi 1993). In Quebec the disease has been detected in plantations across much of the southwest portion of the province (Laflamme and Lachance 1987) and in several locations on the Gaspe Peninsula (Ministere des Forets du Quebec 1990).

Scleroderris canker of pines (North American race) has been associated with numerous planting failures in Ontario since the 1950s in both red pine (Dorworth 1970a) and jack pine (Dorworth 1972a). The European race, which is considered to be more damaging, has been restricted in its range in Ontario by an agressive system of detection by the FIDS Unit, followed by sanitation undertaken by the Ontario Ministry of Natural Resources (OMNR). The purpose of this document is to report on the distribution and significance of scleroderris canker in Ontario since the introduction of the European race.

Life Cycle / Epidemiology

Two spore types are produced by *Gremmeniella abietina*: ascospores, produced by the sexual state of the fungus; and conidia, produced by the asexual state. Ascospore production, which is generally considered responsible for long range transport of the fungus, is rare in the European race. Unlike ascospores, conidia produced by both races are capable of only short-distance dispersion within plantations via splash dispersal. However, a limited number of conidia might be transported between plantations by wind (Skilling et al. 1986). In both cases rain is usually associated with spore release, which occurs from spring through fall. Skilling (1972) reported that a major spore release would occur after 4–8 hrs of exposure to free water at 17°C, but at 10°C, almost 40 hrs exposure to free water was required for spore release. It is also known that ascospores or conidia are most likely to infect their host during moist conditions (Donauber 1972, Luley and Manion 1984); spores apparently require high humidity or free water for a 36-hr period (Marosy 1988). Infection occurs through buds or the current year's needles. Disease

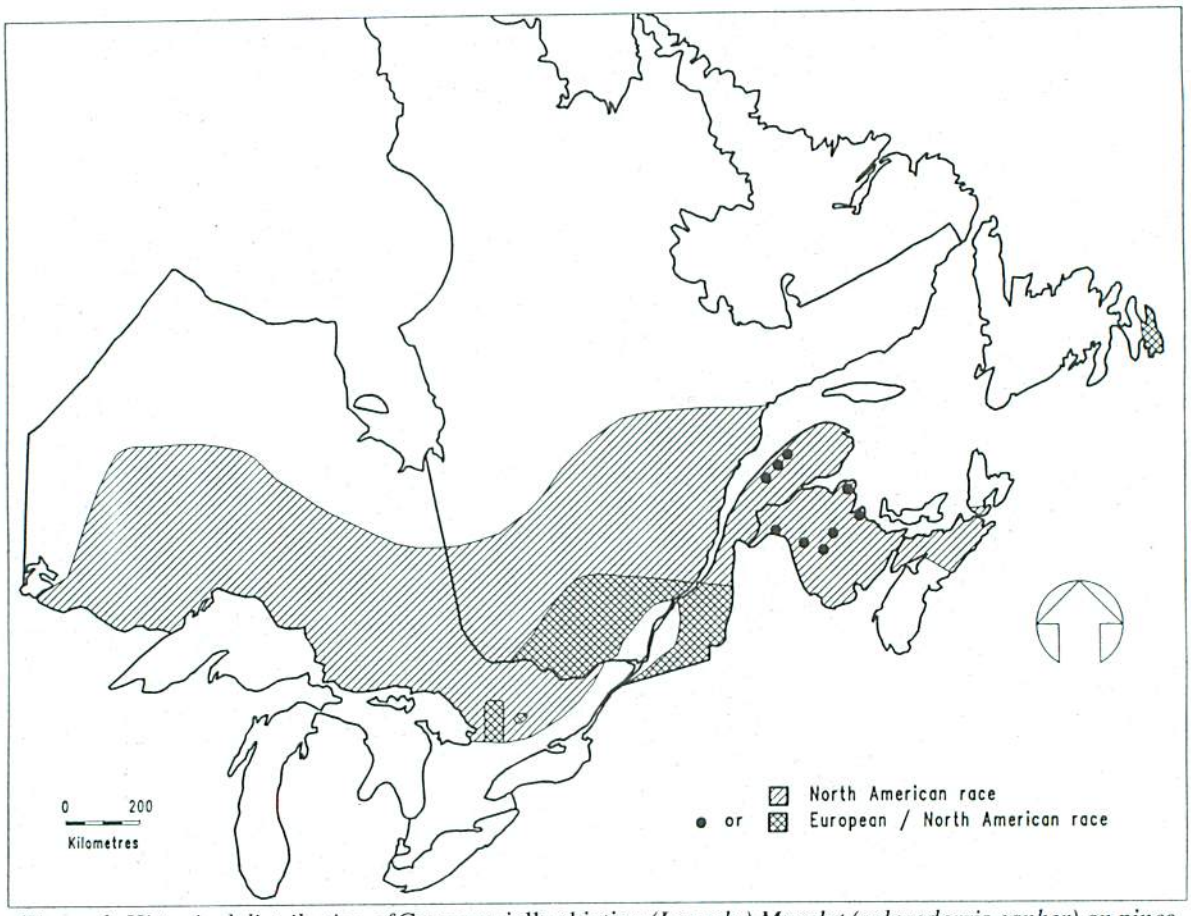

Figure 1. Historical distribution of Gremmeniella abietina *(Lagerb.) Morelet (scleroderris canker) on pines in Canada, 1977–1993.*

symptoms are not evident until the spring, the year following initial infection. This latency is apparently due to the need for a cold period for disease development to occur. Marosy et al. (1989) have suggested that a minimum of 44 days with temperatures between -6 and +5°C is required for the disease to successfully develop. Such conditions must be attained within 2 years following infection or the disease will not develop. Snow cover over the infected branch will also provide a suitable environment regardless of ambient conditions and promotes the development of the disease on lower branches. The low temperature theory would also explain the southern limit to the disease.

In Ontario, the disease is often concentrated in depressions. This is consistent with what is known about the biology of the organism. Dorworth (1972) noted that free water was more frequent in depressions, contributing to an increased probability of both infection and spore release. Dorworth also reported an increase in trapped spores in these depressions as compared to the surrounding area; spore dispersal apparently follows the movement of cold air that drains into depressions. In addition, snow accumulation is greater in these areas. This increases the likelihood of snow covering lower branch whorls and creating a suitable microclimate for disease development.

Control

In Ontario, both European and North American races are considered important plantation problems. Red pine plantations affected by the disease have:

1. been rendered inoperable;
2. experienced regeneration failures;
3. required and frequently been given sanitation control; and
4. required the management of less-valued nonhost species.

The OMNR has established a policy for preventing the spread of scleroderris by nursery stock as well as for disease control in plantations. They have currently recommended that pine (red, Scots, jack, and Austrian) seedlings in nurseries are to be sprayed with Chlorthanonil in the spring when temperatures rise above 0°C and equipment can be moved into the field. Spraying is to be repeated every 2 weeks until early July; this represents the period during which spore dispersal and infection are most likely. It is also recommended that spraying be repeated if rainfall occurs within 24 hrs of treatment. This follow-up treatment is required as the conidia produced by the fungus are rain dispersed (*see* Life Cycle). As disease symptoms are not evident until at least the following

growing season, such treatment is required to prevent the dissemination of the disease on nursery seedlings. Dorworth (1970b) also recommends that susceptible species not be planted in nurseries surrounded by pine windbreaks.

The North American race of scleroderris generally affects only those branches growing on the lower 2 m of the tree. The European race is capable of infecting branches above the 2 m level (Skilling 1986). To date, however, experience in Ontario with the European race has been similar to that with the North American race, i.e., the majority of damage has occurred in the lower 2 m of infected trees. Control measures vary depending on the race of the disease and the severity of infection. In Ontario, after the disease is detected and the race verified the prescribed control method is on-site removal and destruction of diseased material, particularly if the European race is present. Proper pruning of plantation trees, also an effective control measure, reduces both the upward movement of the disease and the amount of inoculum present. In the case of diseased seedlings and saplings up to 1.0 m in height, diseased trees should be removed. For trees over 1.0 m in height, pruning of lower branches is suggested as an effective control measure. Pruning should be performed on the lower one-third of the crown (up to 2.0 m). Both healthy and diseased trees in affected plantations should be pruned. After pruning, slash should be destroyed if possible; Dorworth (1972b) reported that the fungus could survive for up to 10 months on pine slash. However, field work performed in Quebec (Laflamme and Blais 1994) has shown that pruning is most effective in young red pine plantations where the disease incidence is low (less than 5% of the trees infected). When incidence and severity of the disease increase, upper branch whorls are infected and pruning becomes less successful for controlling the disease.

Although pruning of the lower one-third of the crown for all plantation trees is advisable to prevent or reduce the spread of disease it is not always practical. Laflamme (1991) proposed very specific recommendations for young plantations (less than 20 years old). These are equally applicable in all plantations susceptible to scleroderris:

1. Regardless of tree height, if less than 2% of the pines have only one or two infected branches, then only the infected branches should be removed. Plantations should be inspected the following year and the procedure repeated if the disease is present.

2. In plantations with trees less than 1.5 m high, only infected branches should be cut or destroyed. In the following year the plantation should be inspected and the procedure repeated if necessary.

3. For pines over 1.5 m in height, where more than 2% of the trees are affected, the lower whorls should be removed up to one whorl above the highest infected branch. If more than two-thirds of the whorls are infected the tree should be removed and destroyed.

4. If most trees in the plantation are infected, with more than 25% of those dead or severely infected, consideration should be given to complete destruction of the plantation or of those pockets where the disease is most evident.

5. If only the European race is present, planting of jack pine is recommended where suitable.

METHODS AND MATERIALS

Since 1977 a formal survey has been undertaken by the FIDS Unit in Ontario to detect the presence of scleroderris. The scleroderris field program is comprised of both an aerial and ground survey.

1. FIDS field technicians conduct an aerial reconnaissance of pine plantations, generally by fixed-wing aircraft. The aerial survey is conducted over townships containing pine plantations from May to early June when symptoms are most visible. Special attention is paid to areas where the disease has previously occurred.

2. Ground surveys are carried out during the same period as aerial reconnaissance. During a 2–3 week period FIDS Unit field technicians assess pine plantations. Plantations where damage was noted during the aerial survey or those having a previous history of scleroderris (infection within the last 4 years) are given priority, followed by plantations in the same or adjacent townships. Other potential survey locations based on silvicultural records or observations of non-FIDS personnel, are predetermined with assistance from the OMNR. At each plantation visited, a minimum of 500 trees are inspected. Generally, only pine plantations with an average tree height under 3–4 m are surveyed unless infection is suspected in older plantings. This height restriction reflects the fact that to date the disease has caused significant damage only to younger trees in Ontario. Each survey is carried out along a series of transects distributed over the area occupied by the plantation. The number of infected trees is recorded and representative samples are procured. Information recorded concerning the assessed plantation also includes tree species, height, stocking, plantation size, and location. Samples from suspected diseased trees are submitted to the FIDS disease identification unit at the Great Lakes Forestry Centre in Sault Ste. Marie for confirmation and race identification. The location of each sample and the race determination is recorded for every plantation. In addition, a record is made of each plantation where the disease was not observed.

Race Identification

Confirmation of disease presence and race is carried out by the FIDS disease identification unit at the Great Lakes Forestry Centre. Foliage samples are visually inspected for signs of the disease. Isolations from suspected diseased samples are then transferred onto 2% V–8 agar medium. Failure to recover the fungus from the foliage collection constitutes a negative sample. Successful isolations are grown and tested for race according to Dorworth and Krywienczyk (1975).

RESULTS AND DISCUSSION

Since 1985 the North American race of the disease has been found across Ontario over the range of pine species (Figures 1 and 2). The disease has been found predominantly on red pine and jack pine although jack pine is considered less susceptible to the disease (Dorworth 1977). This is particularly true for the European race, which has not been isolated from jack pine in Ontario or Quebec (Laflamme and Bussieres 1990). However, jack pine has been shown to be moderately susceptible when artificially inoculated (Skilling et al. 1986). In Ontario, several isolates of both races have also been collected from Scots pine and Austrian pine. Unlike the North American race, the European strain has a more restricted distribution in Ontario. However, the European race is usually found in combination with the North American race. Earlier work in Quebec has even isolated both races from the same shoot (Laflamme and Brussieres 1990).

The general distribution of the European race is concentrated in central Ontario within the OMNR Parry Sound District. Here it occurs predominantly on red pine. In addition it occurs at several locations in the Bancroft District and the northern limit of the Tweed District (Table 1, Figures 2 and 3). As of 1993 the southernmost extent of the disease in Ontario is at 44° 30' N in Somerville Township, Bancroft District (Table 1, Figures 2 and 5). Prior to 1993 the most southern location was in Mayo Township, Bancroft District, at 45° 10' N (Figures 4 and 5). Presently, a northern limit to the distribution of the European race exists. The organism has not been isolated from plantations north of Strong and Joly townships in the Parry Sound District, 45° 45' N. General distribution of the European race showed little change over the period 1985–1991, with only a limited spread prior to 1992 (Figures 4 and 5, Table 1). However, in 1992 the European race was detected in 13 plantations over six townships. In 1993, the European race was detected in a total of 33

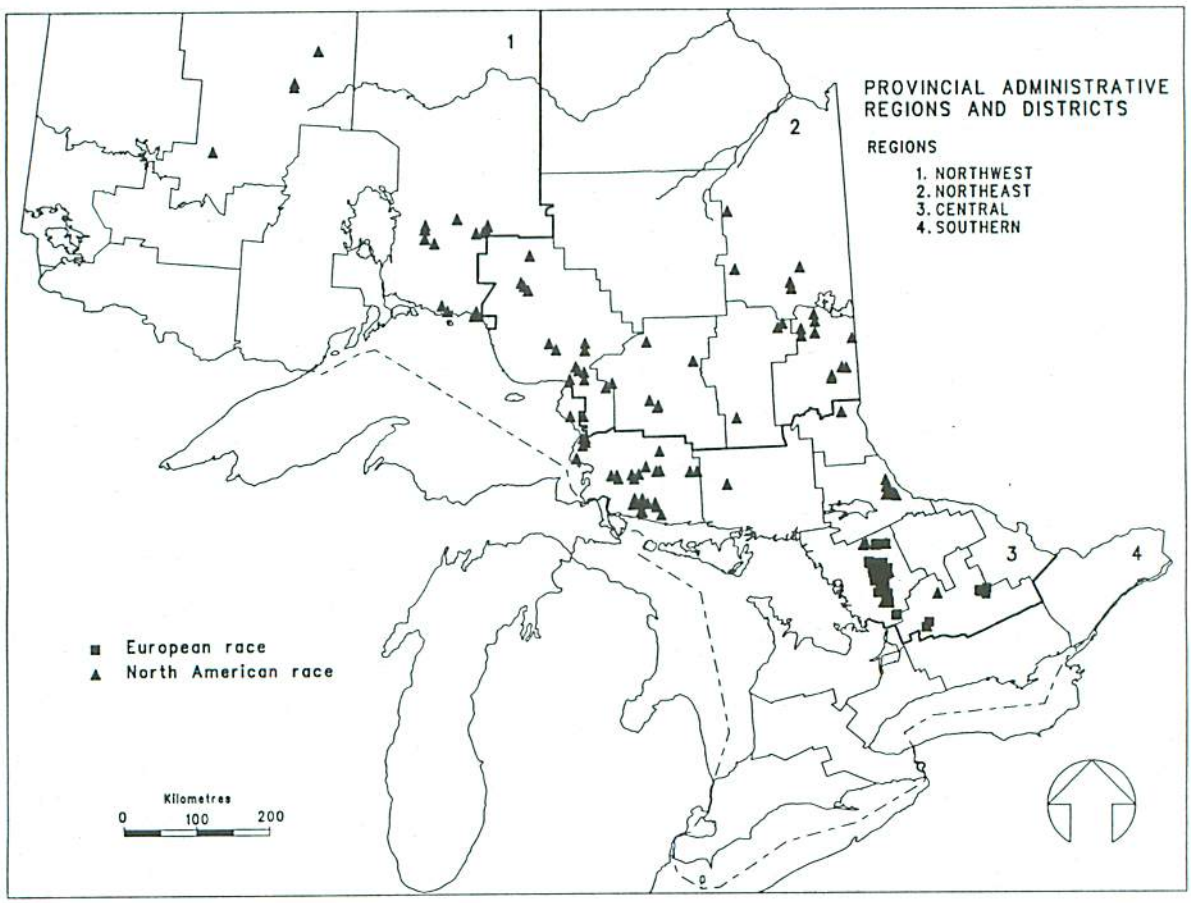

Figure 2. Distribution of Gremmeniella abietina *in Ontario, 1985–1993.*

Table 1. Occurrence of the European race of Scleroderris in central Ontario townships 1985 to 1994.

District	1985	1987	1988	1989	1990	1991	1992	1993	1994
Bancroft	Mayo 1[a]	Mayo 2	Mayo 1	Mayo 1	Mayo 1	Mayo 3	Mayo 1	Mayo 1	Mayo 2
Bancroft								Galway 1	
Bancroft								Somereville 1	
Bancroft									Minden 1
Parry Sound	Macauley 1	Macauley 2						Macauley 1	Macauley 1
Parry Sound	McMurrich 1	McMurrich 3	McMurrich 2	McMurrich 1	McMurrich 1	McMurrich 5	McMurrich 6	McMurrich 13	McMurrich 18
Parry Sound		Ryerson 2	Ryerson 1	Ryerson 2	Ryerson 1	Ryerson 2	Ryerson 4	Ryerson 6	Ryerson 6
Parry Sound				Strong 1				Strong 1	Strong 1
Parry Sound					Stephenson 1	Stephenson 1	Stephenson 1	Stephenson 1	
Parry Sound							Perry 1	Perry 1	Perry 1
Parry Sound							Joly 1		
Parry Sound								Ryde 2	Ryde 2
Parry Sound								Stisted 2	Stisted 2
Parry Sound								Armour 1	
Parry Sound								Chaffey 1	Chaffey 1
Parry Sound								Watt 1	
Total	3	9	4	5	4	11	14	33	35

[a] Number of plantations infected.

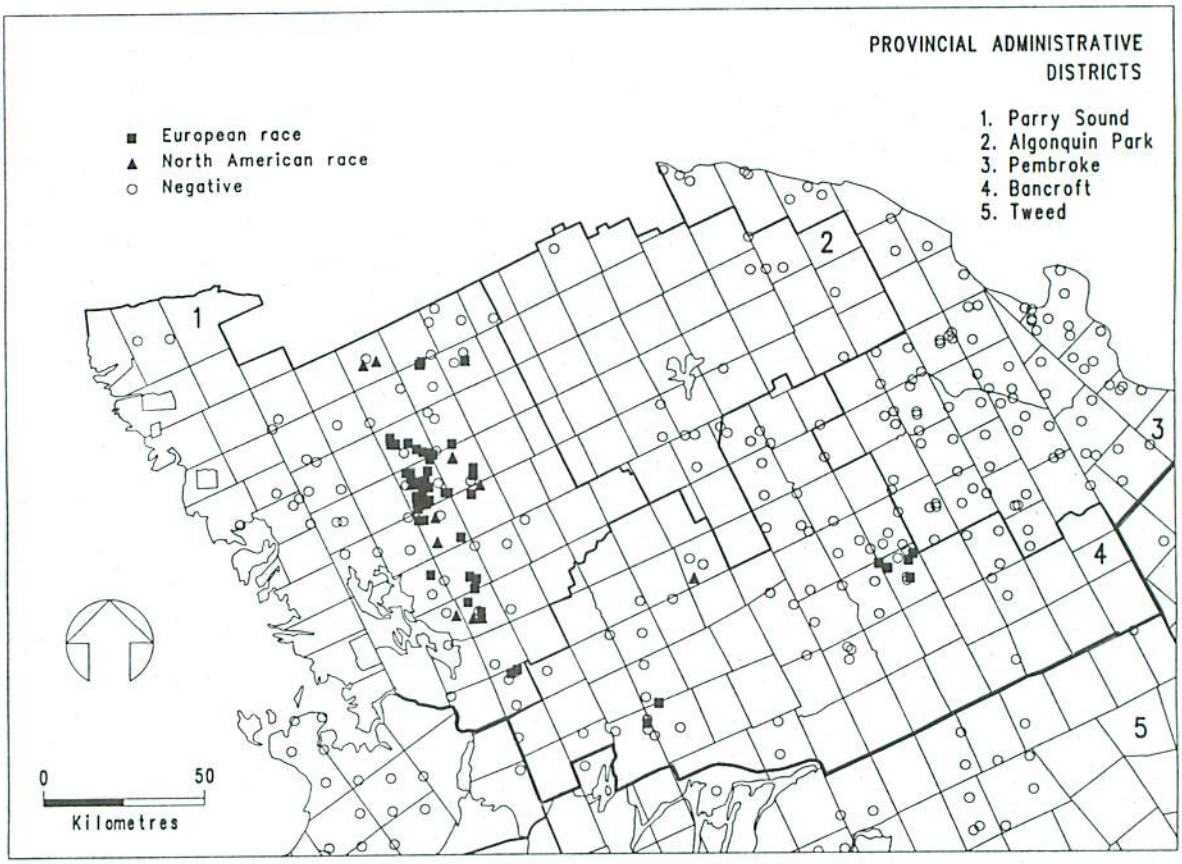

Figure 3. Distribution of Gremmeniella abietina *in central Ontario, 1985–1993.*

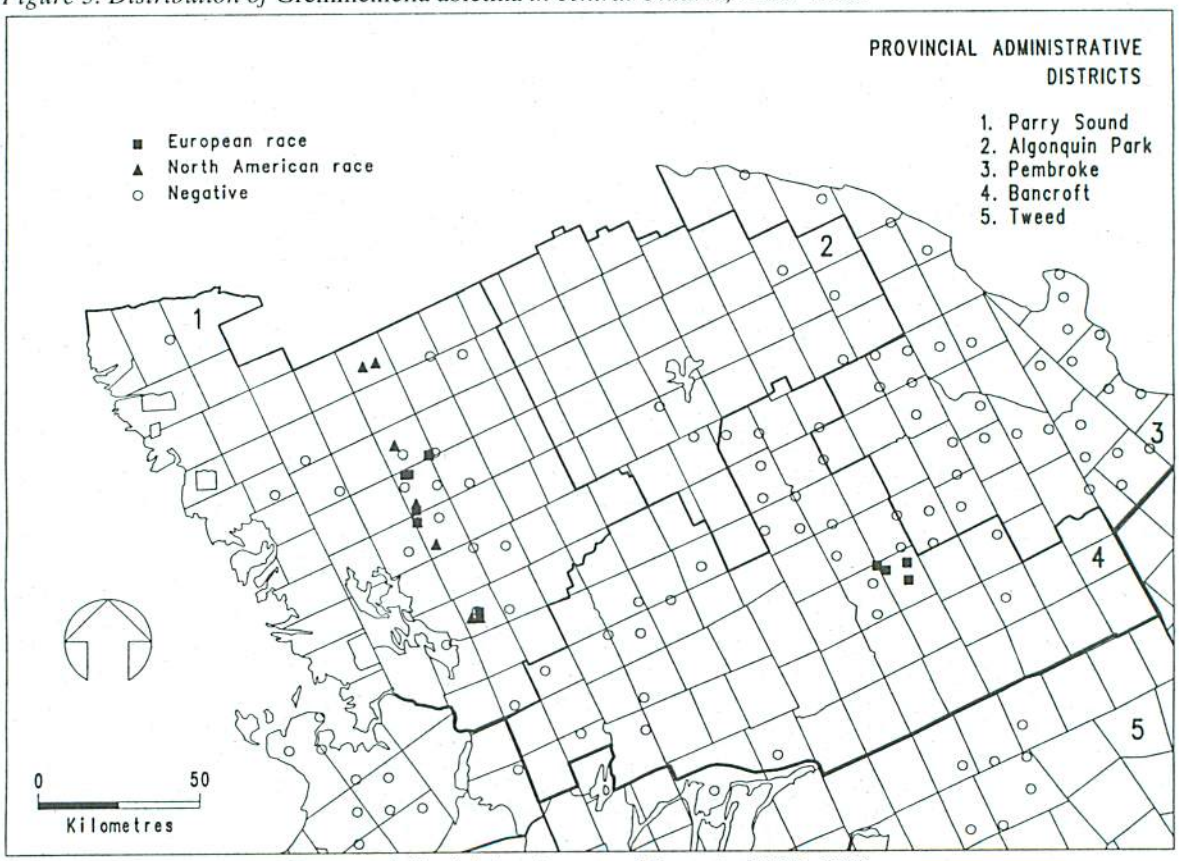

Figure 4. Distribution of Gremmeniella abietina *in central Ontario, 1985–1988.*

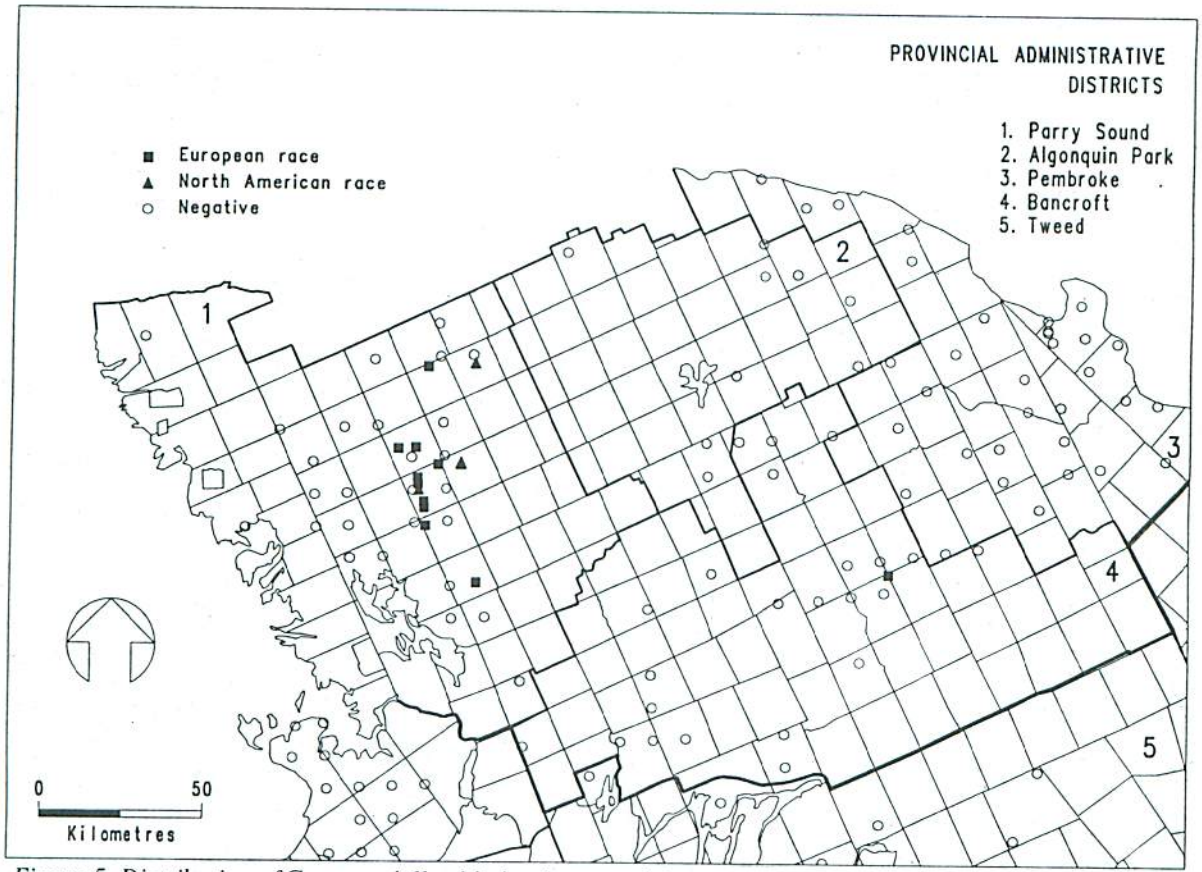

Figure 5. Distribution of Gremmeniella abietina *in central Ontario, 1989–1991.*

plantations over 14 townships. This increase also constituted a southward extension of the disease (Figure 6, Table 1) to Somerville Township in the Bancroft District.

Perhaps the most interesting observation on the distribution of both races of the disease is its absence in eastern Ontario. The disease has occurred at almost epidemic proportions at various times on the Quebec side of the Ottawa river (Laflamme and Lachance 1987), although subsequent pruning has reduced the level of infection (Laflamme and Blais 1994). Neither race of scleroderris has been recovered from pines on the Ontario side, although extensive surveys have been conducted in that area since 1985 (Figures 3–6).

In addition to a broader distribution of sites affected by the European race after 1991, an increase in the percentage of plantations affected (Figure 7) and in the area affected (Table 2) was also observed. Dorworth (1976) reported that between 1971 and 1974, 3,232 ha of forested area was attacked by the North American race of scleroderris. Of this area, comprised largely of regeneration, 260 ha were red pine, and the remaining area was jack pine. The area of red pine affected by the European race has shown a significant increase from 1985 (Table 2). In this respect the overall decrease in total area of pine affected (jack and red) by both races is a result of a more focused survey rather than a decrease in incidence in northern Ontario. Since 1985 the FIDS survey for scleroderris has concentrated on red pine plantations in central Ontario. Surveys for the disease outside this region have been reduced in recent years. So also have surveys for the disease on jack pine. The figures reported by Dorworth (1976) are likely still accurate for the North American race in northern Ontario.

Between 1985 and 1993 the disease has peristed within many areas after becoming established (Table 1). This was the result of a failure to eradicate the disease from infected plantations and to prevent its spread to nearby plantations. Complete eradication of the disease is difficult due to its latent nature, which in turn makes it impossible to detect newly infected trees. Complete eradication of the disease is also seldom necessary if the disease is at low levels (*see* Control). Reoccurrence of the scleroderris within the same townships would suggest that the policy of sanitation is not successful in eradicating the disease. However, the control measures have likely reduced the spread and severity of the disease. Most plantations in Ontario are infected at only trace to low levels (Table 2). The relative success of the control policy is also supported by the restricted distribution of the European race (Figure 1).

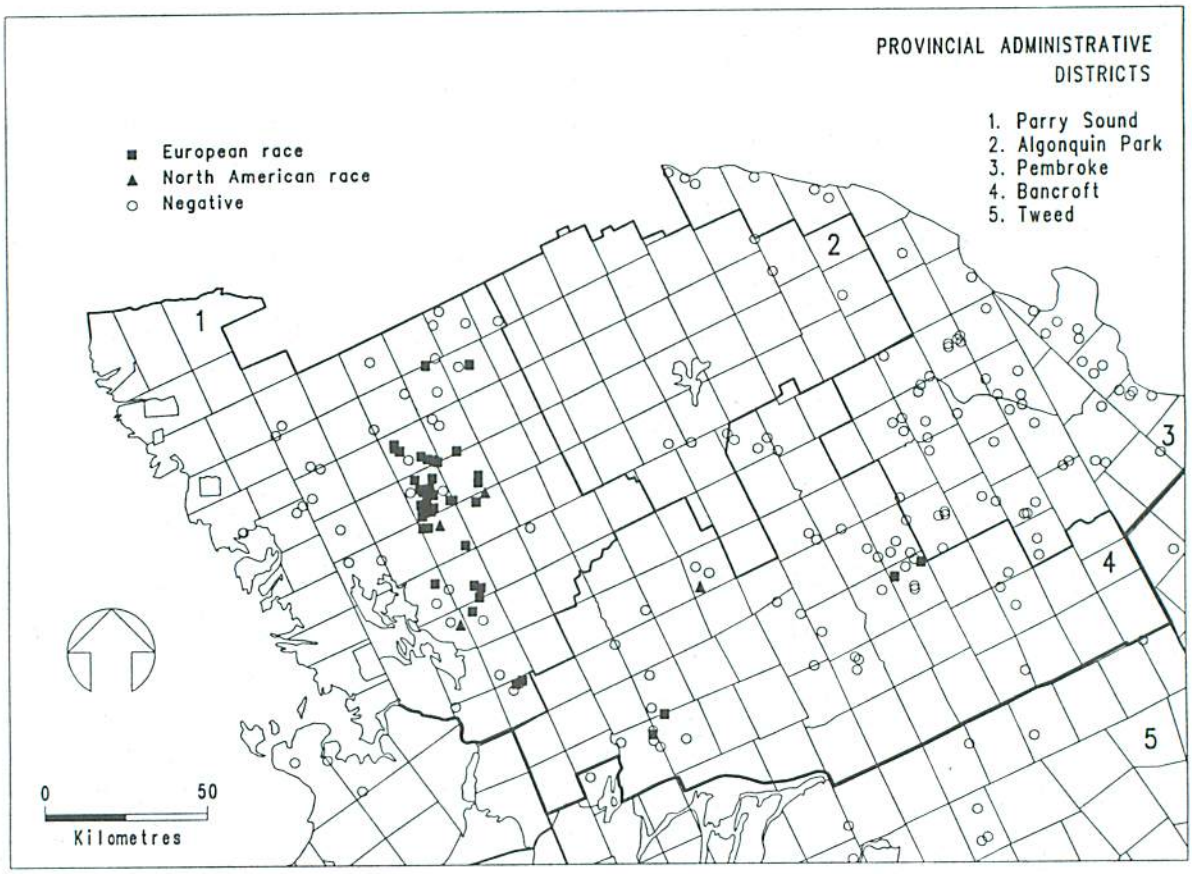

Figure 6. Distribution of Gremmeniella abietina *in central Ontario, 1992–1993.*

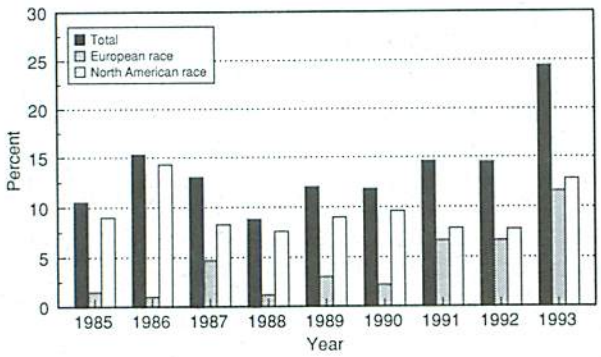

Figure 7. Percentage of pine plantations in Ontario infected with Gremmeniella abietina.

In Ontario, both strains of the disease have been found on seedlings and immature trees. The average height of affected trees is 2–3 m (Tables 3 and 4); although in central Ontario where both races exist, the greatest impact has been to trees under 1 metre in height. On trees over 1 m, damage has usually been limited to infection of lower branches with minimal evidence of stem cankering. Mortality occurrs primarily on the seedlings and young trees under 1 m. However, in Quebec the disease has killed trees over 2 m in height (Figure 8). Earlier reports (Dorworth 1976) suggest that when seedlings under 1 m in height are attacked by the North American race they are usually killed or severely distorted. Older trees, 1–2 m in height, develop increased resistance and usually suffer only branch mortality. Larger trees (>2 m) are generally reported to suffer only lower branch mortality. Recent surveys however suggest older trees might also be at risk (Howse and Applejohn 1994).

Although the European race is reported to show increased virulence, the relative susceptibility of various height classes of red pine in Ontario to this race appears similar to that reported for the North American race. In central Ontario, where both races of scleroderris occur, overall mortality figures from infected red pine plantations are generally at trace levels for the period 1987–1993; however, high levels of infection have been reported (Tables 3 and 4).

An increase in the number and percentage of plantations affected by the disease, in addition to an increase in incidence in some locations, would suggest a possible build up of the population since 1991. In recent years conditions for spore release and infection have been favorable (*see* Life Cycle / Epidemiology). Also, owing to economic reasons, a reduction in control efforts has occurred. The potential for a further population increase and disease-induced mortality might exist. High levels of

mortality caused by the European race of scleroderris have been previously reported for immature red pine plantations in Ontario. Sajan and Smith (1985) reported 13% mortality to 2-m-tall trees in Macaulay Township in 1985. In Quebec, up to 50% mortality has been reported in red pine plantations infected with the European race (Laflamme and Lachance 1987). The North American race has also been associated with high levels of mortality on red pine. In 1985, 23% mortality was reported in one red pine plantation in the OMNR Blind River District (Thomson et al. 1985). This recent build up in the population will likely continue if suitable environmental conditions exist and if control measures are curtailed. However, whether this increase in disease incidence translates into an increase in disease severity and mortality is conjecture at present. Future annual surveys will continue to follow the progress of the disease.

SUMMARY AND CONCLUSIONS

Results of FIDS Unit surveys suggest similar levels of damage are caused by both the European and North American races of scleroderris in Ontario. An expansion of the distribution of the European race has been observed since 1985, particularly in 1992 and 1993. In addition, an increase in the number of infected plantations within previously infected townships was noted during this period. However, the European race is still confined to the central portion of the province in a total of 14 townships: 11 occurring in the Parry Sound

Table 2. Occurrence of the European and North American races of Scleroderris in Ontario, 1985–1993.

Plantations surveyed		European race			North American race		
		% Plantations infected		Affected	% Plantations infected		Affected
Year	Number	T–L[1]	M–S[1]	area[2] (ha)	T–L[1]	M–S[1]	area[3] (ha)
1985	201	0.5	1.0	36	6.0	3.0	91
1986	209	1.0	0.5	10	10.5	3.8	328
1987	190	3.1	1.6	61	5.3	3.0	41
1988	239	0.6	0.6	19	3.8	3.8	162
1989	167	1.8	1.8	36.5	5.4	3.6	185
1990	186	2.2	0	53.2	5.4	4.2	165
1991	164	6.7	0	107	3.7	4.2	40
1992	209	5.3	1.4	138	7.0	0.8	114
1993	283	8.1	3.5	330	8.1	4.7	128

[1]T–L (trace–low) = < 5.0 % trees infected, M–S = > 5.0 % trees infected.
[2]Total area of affected red pine plantations.
[3]Total area of affected red pine and jack pine plantations.

Table 3. Occurrence of the European race of scleroderris on red pine in the Central Region of Ontario, 1985–1993.

Plantations surveyed		Plantations	Incidence %		Mortality %		Tree height	
Year	Number	affected[1]	Average	Range	Average	Range	Average	Range
1985	107	3	31.0	0.7–61	5.3	0–13	3.0	2.0–5.0
1986	99	3	6.7	1.0–15	2.0	0–5.0	2.2	0.5–4.0
1987	102	9	5.7	1.0–30	0.4	0–2.0	3.2	0.4–6.0
1988	104	4	11.4	1.0–27	0.8	0–2.0	1.6	0.5–3.0
1989	67	5	5.2	0.7–16	0.4	0–0.7	2.1	0.8–5.1
1990	120	4	1.4	0.7–3.0	0.4	0–0.7	2.5	1.1–4.5
1991	130	11	1.0	0.7–3.0	0.6	0–0.7	2.1	0.8–6.0
1992	148	14	2.1	0.7–8.0	0.3	0–1.0	1.7	0.7–3.3
1993	176	33	5.3	0.7–37	0.1	0–0.7	2.4	1.0–4.3

[1]Implies European race only, or European and North American races found at the same location.

Table 4: Occurrence of the North American race of Scleroderris on red pine in the Central Region of Ontario, 1985–1993.

Plantations surveyed		Plantations	Incidence %		Mortality %		Tree height	
Year	Number	affected[1]	Average	Range	Average	Range	Average	Range
1985	107	16	na	na	na	na	na	na
1986	99	30	na	na	na	na	na	na
1987	102	3	na	na	na	na	na	na
1988	104	6	na	na	0	–	na	na
1989	67[1]							
1990	120	3	0.7	0.7	0.7	0.7	1.7	1.2–2.6
1991	130	5	0.8	0.7–1.0	0.5	0–0.7	2.2	1.7–4.2
1992	148	12	7.1	0.7–41	0.4	0–0.7	2.3	0.7–3.6
1993	176	18	10.4	0.7–84	0.2	0–2.7	2.0	0.9–3.6

[1] Found only on sites also infected by the European race.

Figure 8. Mortality induced by scleroderris canker to young red pine in Quebec. (Photograph courtesy of G. Laflamme.)

District. Overall, the average incidence of the disease within infected plantations is similar to previous years although a significant increase has been observed at some locations. However an increase in mortality has not occurred to date despite the increased distribution and incidence.

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