Scleroderris canker on pine

Gaston Laflamme

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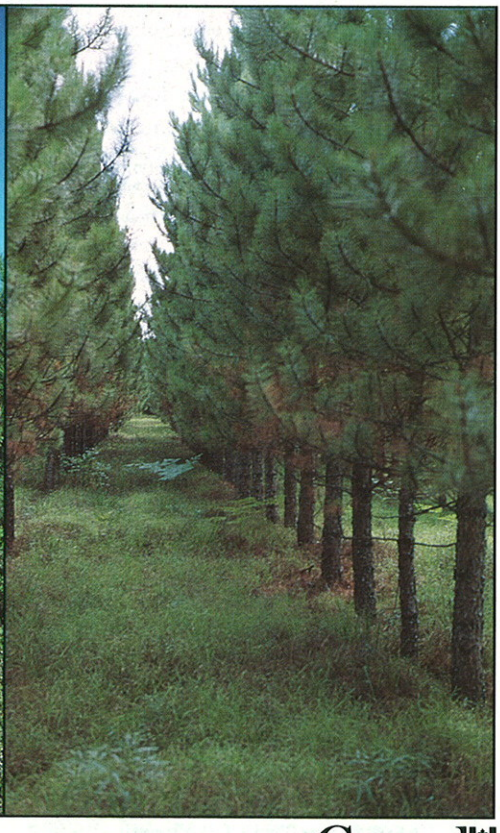

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Cover:

a) Red pine with symptoms on three lower whorls in June (Photo: G. Laflamme).

b) Same plantation five years after systematic pruning of pines. Photographed in autumn, which explains the coloration of old needles. (Photo: G. Laflamme)

Problems due to scleroderris canker are a relatively recent occurrence in North America. In the early 1950s, American foresters observed a disease that was wreaking havoc in conifer plantations in Michigan, but the cause, a microscopic fungus, Gremmeniella abietina *(Lagerb.) Morelet (=*Ascocalyx abietina*), was identified only about fifteen years later in both the U.S. and Canada (Ohman 1966). The disease had, however, been well known in Norway in the nineteenth century (Brunchorst 1888) and had been studied in Switzerland as early as 1945 (Ettlinger 1945).*

The disease was first identified in Quebec in 1964 (Smerlis 1967), and research began shortly after (Lalonde, A. 1970. Observations sur une maladie du pin rouge en plantation. *M.Sc. Thesis. Laval University. 123 p.) and, by 1974, five infection zones had been identified in plantations across the province (Lavallée 1974). It was also forecast that greater damage might occur in a 100 km radius around Mont-Laurier, and this prediction unfortunately proved correct when a special survey was carried out in 1984 (Laflamme and Lachance 1987). Today, the known distribution of this disease covers practically the entire forest area of Quebec since the fungus persists at endemic levels in natural forests and has no doubt progressed with more intensified reforestation. Scleroderris canker has caused the destruction of hundreds of thousands of pine seedlings in nurseries. Some plantations of diseased pines have been completely devastated, while others show pockets of mortality and trunk deformation.*

HOSTS

The disease was first identified in North America on red pine (*Pinus resinosa* Ait.), and it is this native species that was most severely damaged in plantations. Jack pine (*Pinus banksiana* Lamb.) ranked second, but, unlike red pine, it exhibits great variation in its resistance to the disease and does not seem to be affected by the European strain. Eastern white pine (*Pinus strobus* L.) is affected only under extreme conditions, i.e. when planted near severely infected pines that release large quantities of spores into the environment. The majority of exotic pines may also be affected in varying degrees by this disease.

Other coniferous species, such as balsam fir (*Abies balsamea* [L.] Mill.), spruce (Laflamme 1988), and tamarack (Funk 1981), may also be infected with scleroderris canker, but the disease is caused by other varieties or species of the fungus (Table 1) not described in this publication.

Table 1: Species, varieties, and strains (serotypes) of *Gremmeniella* identified on forest species

FUNGUS	HOSTS
Gremmeniella abietina (= *Ascocalyx abietina*)	
var. *abietina*	
North American serotype	*Pinus* spp.
European serotype	*Pinus* spp.*
Asian serotype	*Abies sachalinensis*
var. *balsamea*	*Picea* spp. *Abies balsamea*
Gremmeniella laricina (= *Enceoliopsis laricina*) (= *Ascocalyx laricina*)	*Larix* spp.

* In Europe, this is also reported on *Picea abies* and occasionally on tamarack.

Photo : G. Laflamme

Figure 1.
Brown apothecia (sexual fructifications) of *G. abietina* on a Jack pine stem.

THE PATHOGEN

When the cause of this disease was identified in the 1960s, the fungus was known as *Scleroderris lagerbergii* Gremmen, and the adjective "scleroderris" was adopted for the disease. Although the name of the fungus has since changed, we have kept the appellation scleroderris canker. In France, Morelet (1980) named it Brunchorstia disease, from the name of the asexual form of the fungus, *Brunchorstia pinea* (Karst.) v. Hohn.

The fungus thus has two forms of reproduction, each producing a different type of spore and playing a different role in spreading the disease. The sexual (teleomorph) form, *G. abietina*, releases ascospores from a dark-brown apothecium (Figure 1), which can be examined with a magnifying glass since it measures approximately 1.5 mm in diameter. The ascospores (Figure 2) can disseminate the disease over long distances (Skilling et al. 1986). The asexual (anamorph) form, *B. pinea*, produces conidia formed in spherical black pycnidia (Figure 3) measuring about 0.5 mm in diameter and thus also visible under a magnifying glass. Conidia (Figure 4) are disseminated by the impact of raindrops, which spreads the disease over short distances, e.g. within a plantation. Pycnidia normally appear on the surface of shoots as early as the first year in which symptoms appear and are accompanied the next year by apothecia. Another type of pycnidia, known as cryptopycnidia (Figure 5), may be produced in infected tissue even before symptoms appear (Cauchon and Lachance 1980). These fructifications are extremely useful when early diagnosis of the disease is needed, as in the case of nursery seedlings.

Photo : G. Laflamme

Figure 2.
Ascospores produced by apothecia.

Photo : G. Laflamme

Figure 4.
Spores (conidia) produced inside pycnidia and cryptopycnidia.

Photo : G. Laflamme

Figure 3.
Black pycnidia (asexual fructifications) of *G. abietina* on a Jack pine stem.

Photo : G. Laflamme

Figure 5.
Cryptopycnidia seen on a red pine shoot after cutting the bark surface with a sharp scalpel.

Photo : P. Therrien

Figure 6.
Red pine with needles of lower branches reddened by scleroderris canker.

Three strains (serotypes) of the fungus are currently identified (Table 1) : the **North American** strain, found in all forest areas of Quebec and active only on the first two metres of trees ; the **European** strain, which has approximately the same distribution area in Quebec as red pine and may infect the full height of the crown, and the **Asian** strain, found only in Japan on native fir (*Abies sachalinensis* Mast.). These strains can only be distinguished in the laboratory using serological methods or electrophoresis (Ouellette et al. 1988).

SYMPTOMS

In the majority of cases, the disease is detected by the presence of characteristic symptoms. These may vary depending on the season, species, and propagation rate of the disease. Symptoms are always found first on low branches or on seedlings (Figure 6). Very early in the spring, when the ground is still frozen, the disease may be detected by grasping the previous year's shoots firmly ; if needles come off easily, this means they are rotted at the base. The diagnosis should be confirmed by laboratory examinations for signs of the disease, i.e. cryptopycnidia (Figure 5). A little later in the spring and even in early summer, a reddish-brown coloring at the base of needles is a typical symptom of the disease (Figure 7). Needles should detach easily,

Photo : G. Laflamme

Figure 7.
Reddish-brown coloring at the base of red pine needles in June.

since other factors such as drying or attack by the twig-infesting scolytid (*Pythiophtorus puberulus*) may cause the same discoloration without affecting the needles' firm attachment to the shoot. Throughout the summer, the reddening at the base of needles spreads to cover the whole needle. Infected shoots then appear completely reddened. This symptom is generally known as shoot blight. If the bark is removed from diseased shoots, those familiar with the disease will recognize the yellowish-green coloring of the wood, another typical symptom of the disease. After a few seasons, reddening of needles will be seen on several low branches.

In some years, symptoms may appear on needles of two-year-old shoots instead of those from the last growth season (Figure 8). Although unusual (Laflamme 1986), this

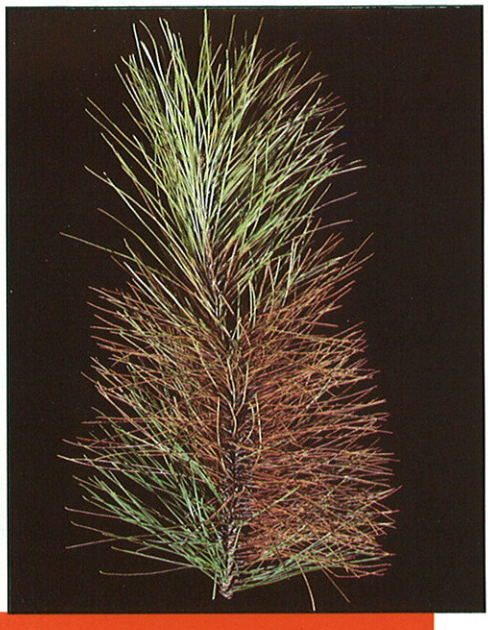

Photo : C. Moffet

Figure 8.
Unusual symptoms appearing on two-year-old needles instead of those of the current year.

Photo : A. Carpentier

Figure 9.
Canker on red pine trunk.

symptom of the disease indicates that the previous year's weather conditions did not favor development of the infection. It remained latent for a year, thus delaying the appearance of symptoms.

In the first year symptoms appear, fructifications of the fungus (pycnidia) may be seen on shoots (Figure 4). As the years pass, the fungus progresses down the branch to the trunk, where it may cause a canker (Figure 9). This deformation is due to the reaction of the tree to infection by the fungus, from either the North American or the European strain. The pathogen may rapidly girdle the trunk and cause the death of small-diameter trees. Cankers may also form on branches. The yellowish-green color of the cambium may be seen under diseased bark. When cankers are seen in a plantation, apothecia (Figure 1) have often been present

for some time and producing ascospores. Apothecia are more frequently associated with the North-American strain but may occasionally be found in plantations where the European strain is present.

The symptoms described above also apply to red pine and Austrian pine (*Pinus nigra* Arnold var. *austriaca* Aschers & Graebn.) (long-needled species), but in the case of Jack pine (short-needled) and even Scots pine (*Pinus sylvestris* L.), reddening at the base of needles may only be evident for a very short period. The coloring of shoot blight is also somewhat different (Figure 10).

Photo : G. Laflamme

Figure 10.
Jack pine with needles of lower branches browned by scleroderris canker.

The various strains of the fungus cannot be distinguished in the field by signs or symptoms except when reddened shoots appear higher than two metres (Figure 11). It is then quite likely that the European strain of the fungus is present, but, at this stage, survival of the plantation is already in jeopardy. The two strains may be present in the same plantation, and we have identified them on the same tree and even on the same branch.

Photo : G. Laflamme

Figure 11.
Symptoms of shoot blight at a height over 2 m, associated with the European strain of scleroderris canker.

FACTORS FAVORING DEVELOPMENT OF THE DISEASE

Spores of this fungus need high humidity (100%) to germinate and infect needles or buds on the host tree. For the infection to take, these humid conditions must last for at least three days; then the infection process ceases and the fungus remains dormant in the host tissues. Shoots will be infected only if the fungus encounters favorable conditions, otherwise the disease does not develop. Favorable conditions would be a period of about fifty days, which need not be successive, when temperatures are around 0°C (+ or - 5°C). These conditions are found in the lower part of the tree during the tree's dormant stage, mainly in valleys or depressions. We believe that the accumulation of snow in these depressions helps maintain favorable conditions.

After a few years of infection, the fungus produces enough spores to spread the disease through the plantation. Subsequently, if conditions are still favorable to the fungus, spore production and the resulting infection will continue to increase, leading to the epidemic phase of the disease. The rate of propagation seems highly dependent on weather conditions.

A noteworthy mechanical effect of snow accumulation on branches is the bending of trunks or breakage of branches. The weight of snow on the branches pushes shoots under the snow cover when they would normally be free of it (Figure 12). The shoots are thus kept in an environment that favors development of the disease.

DAMAGE

The extent of damage in **plantations** varies considerably, from infection of a few branches to total loss of the plantation. In the first in-depth survey carried out in Canada in the Ottawa Valley in 1983 (Laflamme and Lachance 1987), it was noted that 15% of the 1 200 plantations of red and Scots pine were infected with scleroderris canker. About half of the diseased plantations were severely infected, and some of them could not be saved; however, appropriate treatments enabled us to protect the majority of these plantations.

In **nurseries**, damage may be even greater since seedlings normally die when attacked by this fungus (Figure 13). As well, since seedlings are near the ground in closely spaced rows, conditions are ideal for development of the disease. Even a low incidence of the disease may lead to rejection of seedling stocks as a preventive measure, to avoid introducing the disease into reforestation sites.

Photo : G. Laflamme

Figure 12.
Effect of snow accumulation, which, in addition to bending trunk, keeps shoots in an environment which promotes development of the disease.

Photo : M. Thibault

Figure 13.
Damage by scleroderris canker to red pine seedlings in a nursery.

PROTECTION PLAN

1- NURSERIES

The first preventive measure to be applied in existing nurseries is the elimination of infection sources such as hedges or plantations of infected pines near production areas. When setting up new nurseries, the same measures should be carried out before undertaking any production, but the site should be chosen after assessing the risks of infection in Jack pine, red pine, and exotic pines by the scleroderris canker. If possible, it is also wise to avoid low terrain and areas where large accumulations of snow melt late in the spring.

The second preventive measure is the application of a fungicide. The only fungicide currently approved against the scleroderris canker is Daconil® 2787 W-75 (active ingredient: chlorothalonil), in concentrations of 2.3 or 4.7 kg per 1 000 litres of water, depending on whether a sprayer or a fogger is used. This product should be applied in the spring before new shoots appear, every two or three weeks until July, and then every four weeks until September. Even with application of this treatment, infection with scleroderris canker nevertheless occurs on pine seedlings in forest nurseries. Tests with higher concentrations of this product (20 kg/1 000 L) and only two applications were successfully carried out by Forestry Canada – Quebec Region (Smerlis, 1983), but such concentrations would be difficult to apply in normal operations. Additional tests under our climatic conditions will be necessary to increase effectiveness of the treatment under operational conditions.

2- PLANTATIONS

Before planting

If a pine species vulnerable to scleroderris canker is chosen for reforestation, care should be taken to ensure that the reforestation site is within the natural distribution area of this species. In addition, before planting new trees, nearby pine plantations should be inspected to determine whether the scleroderris canker is present. If

needed, treatment should be applied. Insofar as possible, sensitive species should not be planted in valleys or depressions, or in areas where drifted snow is likely to accumulate. When replanting pine in an area already devastated by the scleroderris canker, any infected wood should be destroyed by burning or chipping, or be buried. It is not necessary to destroy this material if only the European strain has been identified and the species chosen for reforestation is Jack pine. When disease-resistant Jack pines are available, they are preferable for high-risk sites. Of course, care should be taken to ensure that seedlings used for reforestation are free of the disease.

After planting

1) Detection and monitoring

Once planting is completed, it is recommended regular inspections be made every two or three years. Investigation for disease symptoms should be carried out mainly on pines in depressions or locations where snow is likely to accumulate.

2) Diagnosis

The symptoms described above will allow a preliminary diagnosis of the problem in plantations and an assessment of intensity (i.e. percentage of trees infected). It is recommended, however, that a few samples be checked in the laboratory to confirm the initial diagnosis since symptoms may be atypical, as in Jack pine, or in the early stages at the beginning of the season, or due to something else such as climate, insects, rodents, or other fungi. If the sample examined in the laboratory yields a positive diagnosis of scleroderris canker, it may then be used to isolate a pure culture of the fungus to identify the particular strain of *G. abietina*.

3) Prognosis

When the scleroderris canker is present in a plantation, it is important to analyze the situation before taking any action. The factors to consider are the **rate of infection**, i.e. the proportion of trees attacked by the disease, and the **severity** of infection, i.e. the height or the number of whorls infected by the fungus. Where necessary, the **mortality rate** must be determined, and it is important to determine whether diseased and dead trees are scattered throughout the plantation or concentrated in a specific area. These factors are particularly important when different treatments are to be applied to different sections of the plantation. Other essential data are the size of the plantation, its age, and the pine species grown. The location and condition of neighboring pine plantations should also be noted.

Depending on the available funds and development objectives, the forest manager or owner may have several alternatives, according to current recommendations for combatting this disease.

4) Control Measures

Since scleroderris canker disease always begins on the lower branches of pine crowns, **we generally recommend** pruning these branches, whether healthy or diseased, from at least a third of whorls (cover photos). The purpose of this is to remove diseased branches, whether or not symptoms are apparent, thus decreasing the inoculum rate, and to remove the healthy branches most likely to become infected. The pruned branches may be left on the forest floor provided there is a space of more than 60 cm between the remaining lowest branches and the forest floor, failing which the pruned branches should be destroyed. If the disease is concentrated in one section of the plantation, pruning may be done only in this area, thus decreasing the cost of treatment. All dead and dying trees (with more than two-thirds of whorls affected) should be cut and debranched.

All pine plantations of course have their particularities, and we would therefore make **more specific recommendations** following field tests. These would apply to red and Jack pine, as well as to certain exotics such as Austrian and Scots pine. It is assumed that these plantations are less than twenty years old and that the forest cover has not yet closed.

Recommendation 1 :

Whatever the age or height class, if less than 2% of pines have at most one or two infected branches, only the infected branches should be cut and destroyed. Another inspection should be made the following year and any infected shoots removed and destroyed.

Recommendation 2 :

If trees are less than six years old or 1.5 m high, only infected branches should be cut and destroyed. An inspection should be made the following year and the same action taken if warranted. (Note : if pines over six years old are mixed with or close to pines of less than six years, the branches removed from the older pines should also be destroyed.)

Recommendation 3 :

If pines are over five years old or measure 1.5 m or more, and if 2% or more are infected, pruning should remove the lower third of whorls or up to the highest infected whorl plus one, but always up to at least 60 cm. The cut branches may be left on the forest floor. If more than two-thirds of whorls are infected on some trees (= dying trees), these trees must be cut and debranched. All branches and trunks are left on the forest floor except for logs that can be used commercially.

Recommendation 4 :

If almost all trees are affected, with over 25% of pines dead or dying, the plantation may be considered a total loss unless mortality is limited to only one section of the plantation. Trees should be cut, debranched, and left on the forest floor, except for logs that can be recovered for commercial use.

Recommendation 5 :

If a plantation of Jack pine in the natural distribution area of this species is affected by scleroderris canker but the majority of trees are over 2 m high, no action is necessary as the disease should disappear by itself.

Whatever action is taken, the quality of the work should be closely monitored as this is a prerequisite for success in such operations. The main points to watch are described in an article by Laflamme and Blais (1988). The use of pruning shears or a pruning saw is recommended. If a power saw is used, pieces of wood should be attached to each side of the chain guide so as to avoid damaging bark on the trunk.

CONCLUSION

Although the scleroderris canker may cause major losses in both nurseries and plantations, remedies already exist to reduce the effects of this disease (forest management, silvicultural practices, genetics, chemical control, etc.). We have described the preventive measures and treatments that exist, but research is still being pursued to further improve their effectiveness.

REFERENCES

Brunchorst, J. 1888. Über eine neue verheerende Krankheit der Schwarzfohre (*Pinus austriaca* Hoss). Bergens Museums Aarsberetning, VI, 1887: 1-16.

Cauchon, R.; Lachance, D. 1980. Recherche sur les cryptopycnides pour un diagnostic rapide de *Gremmeniella abietina*. Can. J. Plant Pathol. 2:232-234.

Ettlinger, L. 1945. Über die Gattung Crumenula-Triebsterbens des Pinus-arten. Beitr. Kryptogamenflora Schweiz 10: 1-75.

Funk, A. 19981. Parasitic microfungi of Western Trees. Can. For. Serv., Pacific For. Res. Cent., Victoria, B.C. BC-X-222.

Laflamme, G. 1986. Symptôme inusité du chancre scléroderrien en plantation de pin rouge au Québec. Can. J. Plant Pathol. 8:1-5.

Laflamme, G. 1988. Description et distribution du chancre scléroderrien sur *Picea mariana* (Mill.)B.S.P. Eur. J. For. Pathol.: 230-239.

Laflamme, G.; Blais, R. 1988. Vérification de la qualité des travaux de contrôle du chancre scléroderrien en plantation. For. Chron. 64:12-17.

Laflamme, G.; Lachance, D. 1987. Large infection center of scleroderris canker (European race) in Quebec province. Plant. Dis. 71:1041-1043.

Lavallée, A. 1974. Le chancre scléroderrien et le reboisement en pin au Québec. For. Conserv. 40:23-26.

Morelet, M. 1980. La maladie à Brunchorstia. I-Position systématique et nomenclature du pathogène. Eur. J. For. Pathol. 10:268-277.

Ohman, J.H. 1966. *Scleroderris lagerbergii* Gremmen: The cause of dieback and mortality of red and jack pines in Upper Michigan plantations. Plant Dis. Rep. 50:402-405.

Ouellette, G.B.; Benhamou, N.; Lecours, N.; Lachance, D. 1988. Investigations on new means of identifying races of *Ascocalyx abietina*. Pages 73-79 *in* E. Donaubauer and B.R. Stephan, compilers. Recent Research on Scleroderris Canker of Conifers. Mitt. Forstl. Bundes-versusanst. No. 162. Osterreichischer Agrarverlag, Vienna.

Smerlis, E. 1967. Occurrence and Pathogenicity of *Scleroderris lagerbergii* in Quebec. Plant Dis. Rep. 51:584-585.

Smerlis, E. 1983. Évaluation de fongicides utilisés pour le contrôle du *Gremmeniella abietina* IV: Résultats des essais effectués sur le terrain en 1979-1980. Can. For. Serv., Laur. For. Res. Cent. Sainte-Foy, Que. Inf. Rep. LAU-X-58.

Skilling, D.D.; Schneider, B.; Dasking, D. 1986. Biology and control of scleroderris canker in North America. USDA For. Serv. Res., Rep. NC-275. 18pp.

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