SCLERODERRIS LAGERBERGII GREMMEN IN THE BOREAL FOREST OF ONTARIO

C. E. DORWORTH AND P. E. BUCHAN

GREAT LAKES FOREST RESEARCH CENTRE

SAULT STE. MARIE, ONTARIO

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Frontispiece. Terminal and lateral branch dieback of an 8-yr-old jack pine caused by Scleroderris lagerbergii *(by E.R. Rayner).*

ABSTRACT

The fungus *Scleroderris lagerbergii* Gremmen will undoubtedly exercise its full potential as a forest tree pathogen among the young jack pine (*Pinus divaricata* (Ait.) Dumont = *P. banksiana* Lamb.) stands of the Boreal Forest Region. Great numbers of juvenile pines are destroyed by the fungus in parts of the Boreal Forest, the damage becoming increasingly severe as stand density increases. This situation is most notable in regeneration on areas cleared by fire or logging. Equally serious are those situations in which *S. lagerbergii* is endemic in the pine understory, being a potential source of infection for regeneration that appears after the area is logged, and a continuing source of inoculum to infect young pines in adjacent areas.

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INTRODUCTION

The fungus *Scleroderris lagerbergii* Gremmen has been recognized as an important pathogen of pines in Europe for nearly a century, and is receiving increasing attention in North America (Dorworth, 1971). Damage to pines in Ontario has been documented in two companion reports dealing with red pine (*Pinus resinosa* Ait.) plantations in central Ontario (Dorworth, 1970a) and nursery seedlings (Dorworth, 1970b).

Recent information gathered by personnel of the Great Lakes Forest Research Centre (GLFRC) indicates that Scleroderris canker has become an established disease of the Boreal Forest of northern Ontario, where it promises to become a chronic problem in natural stands of jack pine (*Pinus divaricata* (Ait.) Dumont = *P. banksiana* Lamb.). Two types of damage predominate: 1) damage to and destruction of young stands, and 2) destruction of seedling regeneration in and around older stands.

GEOGRAPHIC RANGE AND SPREAD OF SCLERODERRIS IN ONTARIO

The known geographic range of *S. lagerbergii* prior to 1969, taken from the records of the GLFRC Forest Insect and Disease Survey, encompassed much of central Ontario (Dorworth, 1971). Distribution of the fungus in the Boreal Forest was confined largely to those areas where infected seedlings from provincial and private nurseries had been planted.

Over the past two years, the GLFRC Forest Insect and Disease Survey has found additional infection centers, several of which occur in naturally regenerated jack pine and for which the original source of inoculum that caused the infection could not be determined. Figure 1 shows the known range of *S. lagerbergii* in Ontario. Currently active infection centers are designated by the numerals 1 through 8 and by the symbol ▲ . Unnumbered spots (●) designate outbreaks noted by Dorworth (1971) or new outbreaks to the south of the Boreal Forest, in the Great Lakes-St. Lawrence Forest Region. Continuing investigation by the Survey field technicians will undoubtedly reveal further infection centers in coming years. From present knowledge, infections in natural jack pine in the Boreal Forest can be categorized as:

CASE I--Outbreaks originating directly from infected nursery stock (Stands 5 and 6, Fig. 1); these do not differ substantially from those in red pine noted by Dorworth (1970a).

CASE II--Infections in mixed-age stands, of which the areas near Graham and Manitouwadge (Stands 2 and 4, Fig. 1) are good examples.

CASE III--Infections in young pure stands of jack pine (Stands 1, 3, 7, and 8, Fig. 1), the most notable example of which is that above Pickle Lake (Stand 1) where tens of

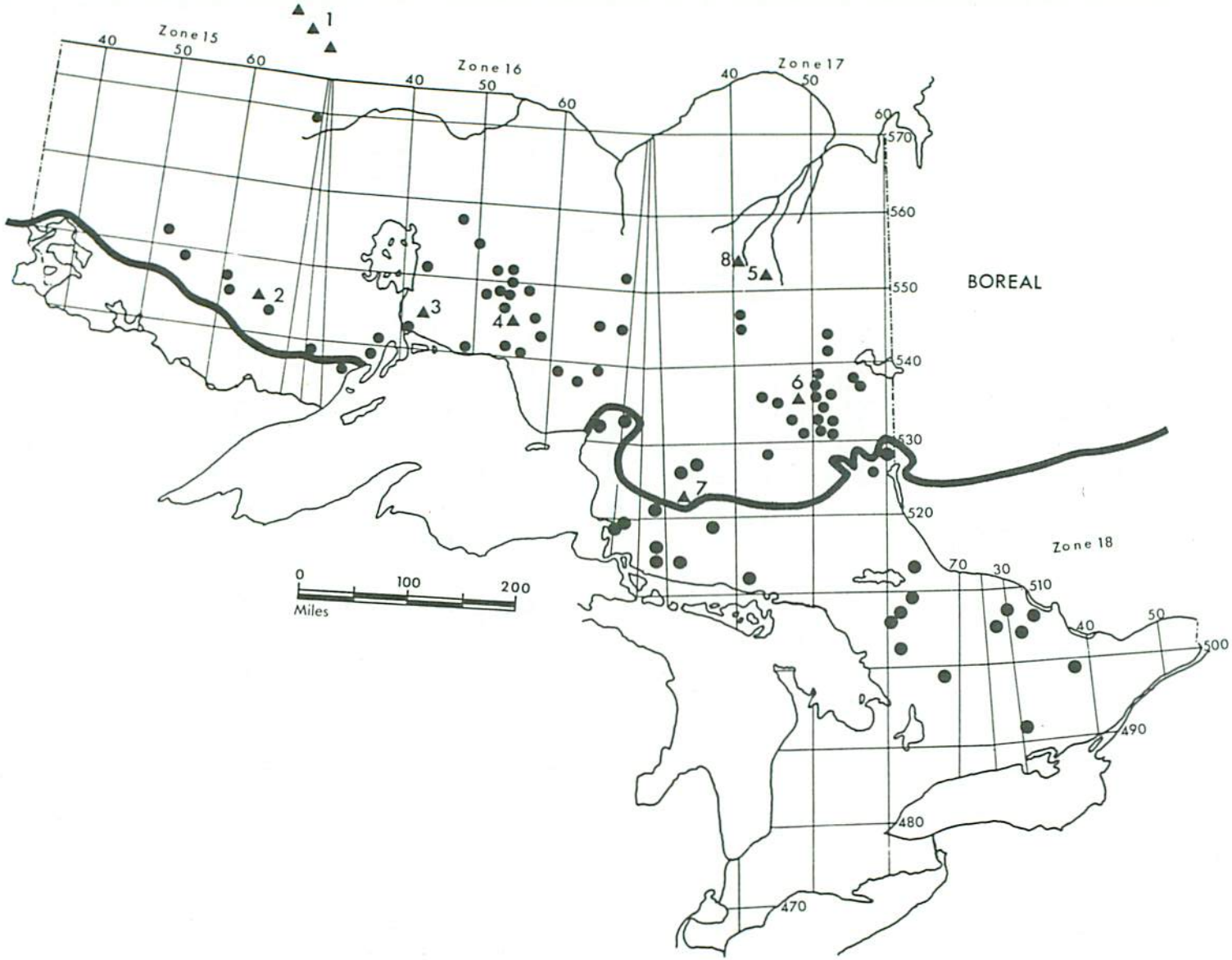

Figure 1. Points in Ontario from which confirmed collections of **Scleroderris lagerbergii** *were recorded by the Ontario Forest Insect and Disease Survey. New locations in the Boreal Forest Region are numbered and designated ▲ , and those recorded previously as ● .*

thousands of hectares of timber were destroyed by fire approximately 10 years ago, and the forest has regenerated from heat-released seed. The infection near Chapleau (Stand 7), located in 1970, is similar though the land was originally cleared by logging rather than by fire.

Situations such as those described in CASE I should now be a thing of the past, because noninfected planting stock is being used in most cases.

Scleroderris lagerbergii was unknown in North America until 1964, and a number of infected plantations were established before the problem could be eliminated at the source. Infections of the native jack pine occurred whether the originally infected planting stock was red or jack pine.

CASE II describes a serious problem because not only regeneration on cutovers and along roadsides, but also that in uncut blocks may be affected. Such stands (uncut blocks) are usually two-tiered, with a semimature to mature overstory and a suppressed seedling to sapling understory. Density of stocking in the understory increases as that of the overstory decreases, and the disease becomes chronic within the understory. Spores of the fungus are released from fruit bodies on the dead trees or dead tissues to infect new seedlings. This process has no immediate effect on established stands of jack pine, which at present seem resistant to serious damage caused by *S. lagerbergii*, but it does make improbable the establishment of a new stand by natural or artificial processes after logging. Even burning the logging slash and the infected seedlings may be ineffective as a control because the boundaries of infected areas are often difficult to define without a tree-by-tree examination. The original source of inoculum may have been infected nursery stock in certain cases, but it is unknown in others. CASE II situations may remain unnoticed because the often widely scattered jack pine beneath an overstory are usually characterized by poorly developed branches and partially etiolated foliage, and close examination is required to detect the somewhat similar effects of infection by *S. lagerbergii*.

CASE III describes a situation which, in North America, is unique to Ontario and Quebec (Martineau and Lavallee, 1970) according to the present published record, though similar infections occur in northern Scandinavia. Burns of many thousands of hectares have become infected at random points. Mortality is generally light in the faster-growing stock, becoming quite heavy in areas where seedlings are suppressed either by poor site or by dense stocking. Inspection of residual, old-growth trees that survived in strips and patches around and within the burn revealed no infections.

IMPACT AND LOCAL SPREAD

A detailed study of the Pickle Lake Area (CASE III) was made in spring, 1971, to determine the extent of damage caused by *S. lagerbergii* and to establish a basis for later determination of spread. Strips of 100 x 5 m (328 x 16.5 ft) were located in regeneration in the area from approximately 95 to 130 km (60 to 80 mi) north of Pickle Lake (Stand 1; Fig. 1), and data recorded as--degree of infection, tree height, and density of stocking. Two such strips were measured per site, the data averaged and listed in order of increasing stand density (Table 1). An infection center is defined here as a clearly defined patch of dead and infected trees in which the original point of infection can be identified and infection of the surrounding trees clearly resulted from immediate local spread of the fungus.

Table 1. Incidence of *Scleroderris lagerbergii* in jack pine regeneration in the Pickle Lake burn

Strip no.	Stand characteristics			Degree of infection by *S. lagerbergii*/1000 m^2				
	Stems/1000 m^2	Avg ht m	Avg age yr	No. infection centres	Trees dead	% mortality	Trees with branch infections No.	Trees with branch infections %
1	920	1.0	6.7	0	0	0.0	91	9.9
2	3,100	1.1	6.8	4	6	0.2	50	1.6
3	4,800	1.1	7.6	8	39	0.8	560	11.7
4	7,500	1.2	7.1	14	203	12.7	329	4.4
5	15,240	0.7	8.2	38	1,075	7.0	1,602	10.5
Average	6,312	1.0	7.3	12.8	265	4.2	526	8.3

Note: Data expressed on a per 1000 m^2 basis may be multiplied by 4 to convert to a per acre basis.

The data (Table 1) indicate that percent mortality increases with increasing stand density[1]. Local spread, i.e., immediate tree-to-tree spread within a stand, is accomplished largely by means of asexual spores, or *CONIDIA* (Dorworth, 1970b), of the fungus that are disseminated by splashing rain. Thus, as stand density decreases, the chance that a rain-splashed spore will encounter susceptible tissues of an adjacent tree decreases, and the conidia are restricted largely to the trees on which they were produced.

As stand density decreases toward optimum, trees are inclined to be more vigorous than when overcrowded and to have better-developed lower branches. The fungus thus has less immediate access to the main stem: a tree is not ordinarily killed unless the main stem is invaded. Thus, where spacing favors growth and development of the lower branches, a predominance of nonlethal lower-branch infections can be expected at the expense of the lethal bole infections, and local spread of the fungus is impeded. As density of stocking increases, local spread occurs with greater facility and more infection centers are recorded (Table 1).

The sexual spores of the fungus, *ASCOSPORES*, are formed in fruit bodies on dead infected tissues of the suscepts. These spores are disseminated by wind rather than by splashing rain, and tree-to-tree spread can occur over greater distances. As is the case with the conidia, the total number of ascospores produced increases as the number of infected trees per unit area increases. The more densely stocked and heavily infected parts of a stand constitute the best sources of ascospore production and, consequently, represent the most serious threat to adjacent trees within the stand. If these wind-disseminated ascospores remain viable after an appreciable exposure in the atmosphere, then areas such as the Pickle Lake burn represent potential threats to adjacent forest regions and, indeed, to adjacent provinces. The questions of effective distance of inoculum dispersal by wind and of longevity of the spores when exposed to conditions in the atmosphere remain to be answered. Aerial spread of spores of *S. lagerbergii* over a distance of 15 km (9 mi) was noted near Sault Ste. Marie in 1970, and spores of certain other fungi remain viable after travelling several thousand miles through the atmosphere.

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[1] These data must be interpreted realistically, in light of the actual field situation. Consequently, the estimate of the number of infection centers is undoubtedly conservative, because two or more coalescing centers had to be counted as one if they could not be clearly separated. Similarly, as stand density increases, it becomes more difficult to separate trees killed and damaged by *S. lagerbergii* from those killed by overcrowding or other causes, and even the experienced observer must expect some degree of overlap in his data.

CONTROL OF SCLERODERRIS LAGERBERGII IN THE BOREAL FOREST

The total affected area north of Pickle Lake covers at least 800 km^2 (300 sq mi), and the epiphytotic must be regarded as beyond control in terms of present knowledge and the degree of attention economically feasible in the far north. The importance of this situation must not be minimized, however, because the area is only now being opened to commercial exploitation, and will most likely be managed with the objective of yielding a continuing supply of pulpwood.

Where *S. lagerbergii* has affected only those trees in a readily circumscribed area, and counteraction is considered economically feasible, adequate sanitation measures will, at the very least, result in a reduction of hazard and loss. At the very best, the area may be sanitized to the extent that susceptible species of trees can be replanted. We emphasize that replanting of areas in which previous infections have not been eliminated can only result in plantation failures.

The intermediate situation, in which replanting of burns and logged sites within several kilometers of infected stands is contemplated, has not yet been studied in detail. Such areas can not be disregarded in the total replant effort, yet the economic loss experienced in plantation failure owing to infection by *S. lagerbergii* can be significant. Where the possibility of infection by *S. lagerbergii* exists, planting of pine only on the higher ground should reduce failure significantly. Spruce, being less susceptible to infection, might be used alternatively in depressions, or these areas could remain unplanted. Both red and jack pine are more easily killed when growing on low sites, and the depressions then become infection centers from which spores are spread into adjacent areas.

POTENTIAL FOR DAMAGE AND FUTURE SPREAD

Scleroderris lagerbergii now occurs as far east as New Brunswick[2], with northwestern Ontario forming the present western boundary (Fig. 1). Unless some environmental barrier exists to westward spread, it could well be found on the west coast within the next several decades. A nearly continuous belt of jack pine occurs across northern Canada, and lodgepole pine (*Pinus contorta* Dougl.), ponderosa pine (*P. ponderosa* Laws.), and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) are all susceptible to infection.

The actual damage caused by this fungus in the Boreal Forest is yet to be ascertained. Significantly, the greatest mortality in

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[2] Personal communication: Dr. L. P. Magasi, Maritimes Forest Research Centre, Canadian Forestry Service, Fredericton, New Brunswick.

regeneration on the Pickle Lake burn (CASE III) occurred in stands so dense that stagnation would have been inevitable. Damage decreased as desirable stand characteristics became more prominent, especially where site and stand density permitted the most rapid growth. Many trees on the best sites will undoubtedly mature to form a crop, largely because infection did not occur until the trees had had several years to become established and the most vigorous trees passed through their most susceptible stage of growth before infections became general in the area.

This fungus is now becoming established as a chronic problem in parts of the Boreal Forest (CASE II), much as it has in central Ontario (Dorworth, 1970a). The effects will become obvious as adjacent areas are replanted with susceptible species, and as presently infected semimature stands are logged.

As noted previously, CASE I situations (those outbreaks derived from infected nursery stock) should not be prominent in the future. However, even the most attentive nursery supervisor will fail to observe infected seedlings in his beds if lifting of stock precedes the appearance of foliar symptoms (Dorworth, 1970b).

Assessments over the next 10 years will provide information concerning the potential of *S. lagerbergii* to damage pines under the situations described. The prime danger may be one common to all infection areas. Regeneration does not survive under a heavy spore load and establishment of subsequent crops will likely provide a difficult challenge to the forest manager and the forest pathologist, where the proper conditions for development of the disease occur.

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