U.S. FOREST SERVICE
RESEARCH PAPER NC-3
MAY, 1966

SCLERODERRIS CANKER

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on National Forests in Upper Michigan and Northern Wisconsin

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FOREWORD

The Scleroderris canker survey was a cooperative project between the Division of Forest Insect and Disease Control, Northeastern Area, State and Private Forestry; and the North Central Forest Experiment Station. Both are field units of the Forest Service, U.S. Department of Agriculture.

Acknowledgment of assistance in making the field survey is due the Timber Management staff, entomologists, and Ranger District personnel on the four National Forests surveyed.

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Cover picture. — The pycnidiospores shown here are the asexual spores of Scleroderris lagerbergii. *During moist weather, these spores ooze out of the pycnidium in delicate whitish tendrils. Most are 3-celled and range in size from 26 to 48 microns long. During this survey, viable spores were found from May to early December.*

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by

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INTRODUCTION

During the past several years, many young red pine (*Pinus resinosa* Ait.) and jack pine (*P. banksiana* Lamb.) plantations in Upper Michigan and northern Wisconsin have suffered from poor growth and mortality. These symptoms of disease were first noted in red pine plantations on the Kenton Ranger District, Ottawa National Forest, in the spring of 1951. Severe red pine plantation damage was also reported on the Ontonagon Ranger District in 1956. An apparently similar problem had been noted in a 15-year-old red pine plantation on the Dunbar Experimental Forest near Sault Ste. Marie, Mich., in 1942 (Day and Strong 1944).

In 1957, the Lake States Forest Experiment Station established a study to identify the factors associated with failing red pine plantations on the Kenton Ranger District (Benzie 1958). The results showed that the youngest age class sampled (5 to 9 years) had only 13 percent survival. The other two age classes sampled, 10 to 14 and 15 or more years old, had 38 and 40 percent survival, respectively. Apparently the problem was severe in all three age classes but was most severe in the youngest. Symptoms were also found on living trees in natural red pine stands.

A survey in plantations on the Ontonagon District in 1958 showed 55 percent mortality over a 2-year period. In 1960, the Kenton Ranger District had approximately 1,200 acres of severely damaged red pine plantations.

Even though the problem had existed on the Ottawa and Hiawatha National Forests for a number of years, the causal agent was not determined until 1964. John Ohman,[2] Plant Pathologist, North Central Forest Experiment Station, isolated a fungus from both red and jack pine stem cankers, which he identified as *Scleroderris lagerbergii* Gremmen. Eric Jorgensen,[3] at the University of Toronto, had previously isolated the same fungus from diseased red pine in Ontario, Canada, in 1962. These are the first confirmed reports of this fungus in North America.

S. lagerbergii, however, has a long history of pine plantation and nursery injury in Europe (Bjorkman 1963; Read 1963; Roll-Hansen 1964). The disease, Scleroderris canker, was first described by Brunchorst in 1888. Since that time, Scleroderris canker has periodically caused serious mortality of conifers in Europe. Approximately 75 million Scotch pine nursery seedlings, along with extensive forest areas, were damaged in Sweden

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[1] *Plant Pathologists of the North Central Forest Experiment Station and the Northeastern Area, State and Private Forestry, U.S. Forest Service, respectively.*

[2] *Personal communication with Dr. Ohman.*

[3] *Communication between Drs. Ohman and Jorgensen.*

between 1950 and 1960 (Kohh 1964). Twenty million seedlings were lost in 1959 alone. In Great Britain the fungus is important, primarily on Corsican pine (Peace 1962).

A recent survey in Ontario revealed serious damage in young red pine plantations (Martin 1964). Of 50 plantations sampled in 1963, approximately two-thirds of them had 50 percent or more mortality. Scleroderris canker has now been implicated as the causal agent.

Because of these reports of severe damage in Ontario and Michigan plantations and the history of this disease in other countries, a survey was conducted during the summer and fall of 1965 to determine the distribution and intensity of Scleroderris canker on four National Forests in the Lake States. The results are reported in this Paper.

SURVEY METHODS AND PROCEDURES

The Scleroderris canker survey was conducted on the Ottawa and Hiawatha National Forests in Upper Michigan and the Nicolet and Chequamegon National Forests in northern Wisconsin. All Ranger Districts with 2- to 10-year-old red and jack pine plantations were surveyed. Field observations had indicated that this age class was most susceptible to the disease. Host symptoms resulting from Scleroderris canker are also easier to detect in this age class.

On each District, the following sampling method was used: A minimum of five 2- to 10-year-old red and jack pine plantations was surveyed, if available; and one additional plantation was surveyed for each 500 acres of such plantations present. The two species were sampled proportionately to their total acreage. The sample plantations were selected at random; but whenever possible, at least one plantation per township was sampled to provide a broader and more representative distribution.

In each sample plantation, at least 50 trees with disease symptoms, such as dead lateral branches and terminals or stem cankers, were examined (Plate 1, page 6). Since the disease had been observed most frequently on trees in depressions or "frost pockets," these areas were inspected first. The bark was removed from damaged portions of the trees to see if a yellow-green discoloration was present beneath the bark (Plate 2, page 7). If no discoloration was found on any of the suspect trees, the plantation was considered free of the disease.

If the discoloration was found on even one tree, however, *Scleroderris lagerbergii* was recorded as present on the plantation, and samples were taken to the laboratory for diagnosis. Precautions were taken to keep the samples cool in transit, as the fungus is very sensitive to temperatures above 60° F. In the laboratory, the fungus was identified either by the characteristic sickle-shaped conidia or by cultural diagnosis using a modified malt agar medium.

The discoloration proved to be a very reliable diagnostic symptom of the disease. Over 90 percent of the samples taken from trees with the discoloration produced the fungus in laboratory cultures.

If the discoloration was present, sample plots were taken to determine the severity of the disease. Strips were laid out across each plantation at 5-chain intervals, beginning 2½ chains from the plantation boundary. Sample plots were taken at 5-chain intervals along each strip, beginning 2½ chains from the starting point. Each sample plot consisted of 20 trees or planting spaces.

The data recorded on the plantation and plot tally sheets included the species, year and season planted or replanted, plantation and estimated infected-tree acreage, topography, aspect, exposure, tree condition, and symptom classes. The tree condition classes included healthy, poor vigor, dying, dead, and missing (vacant spaces that represented probable planting locations). The symptom classes included the yellow-green discoloration, dead laterals or terminals, stem cankers, and other disease and insect damage.

Each tree on the plot was examined for any disease symptom or abnormal condition. The bark was removed from damaged portions of all suspect trees to determine the presence or absence of the yellow-green discoloration. This provided an estimate of the present amount of fungus infection. Any additional disease and insect problems detected on the sample plots were also recorded.

RESULTS AND DISCUSSION

Scleroderris canker is widespread over the Ottawa and Hiawatha National Forests in the Upper Peninsula of Michigan and the Nicolet and Chequamegon National Forests in northern Wisconsin. The disease is present on every Ranger District on these four Forests where red or jack pine have been planted since 1955. The fungus was found in 116 of the 176 red pine plantations (66 percent) and 12 of the 14 jack pine plantations (86 percent) sampled.

The disease was not detected by very limited spot-check examinations on either the Huron-Manistee National Forests in Lower Michigan or the Chippewa and Superior National Forests in northern Minnesota. The known distribution of the disease on National Forest land in the Lake States is shown in figure 1.

Mortality in red pine plantations where Scleroderris canker was present averaged 40 percent. Jack pine mortality averaged 39 percent. (As explained later, not all mortality was due to *S. lagerbergii.*) The most severe damage in terms of percent of plantations with Scleroderris canker and tree mortality has occurred on the Ottawa and Hiawatha National Forests in Upper Michigan. Considerable losses have also occurred on portions of the Chequamegon and Nicolet National Forests in northern Wisconsin. The disease situation on each Forest is summarized in tables 1 and 2.

Although the jack pine plantations seemed to be more resistant to the disease than red pine at an early age (under 5 years), 8- to 10-year-old jack pine plantations were severely damaged.

The age of the sample plantations (both red and jack pine) should be remembered when interpreting the survey results. The jack pine plantations averaged 8 years old, while the red pine averaged only 4 years. Seventy-four percent of all the plantations with Scleroderris canker sampled on the four Forests were planted between 1960 and 1963. This 2- to 5-year-old age group already had an average of 37 percent mortality and will remain susceptible to the disease for at least 5 more years. If the present rate of mortality continues, the majority of these plantations will be destroyed before they are 10 years old.

Both the incidence of the disease and mortality have increased in the past 5 years. This conclusion is based on the high percent of 2- to 5-year-old plantations with severe Scleroderris mortality detected during the survey. Additional field observations revealed the presence of the fungus on several red pine plantations planted in 1964 and 1965; on some of these, severe mortality was already occurring.

The widespread distribution of the disease in the very young red pine plantations suggests that either the fungus is capable of rapidly infecting susceptible hosts or the planting stock becomes infected in the nursery. Nursery stock examined repeatedly during 1965, however, disclosed no infection.

Although the fungus was positively identified in all plantations tallied as having Scleroderris canker, not all the missing-tree mortality can be attributed to the disease. Other factors such as insects (primarily white grubs), animal damage (deer and rabbits), and poor planting practices were observed in

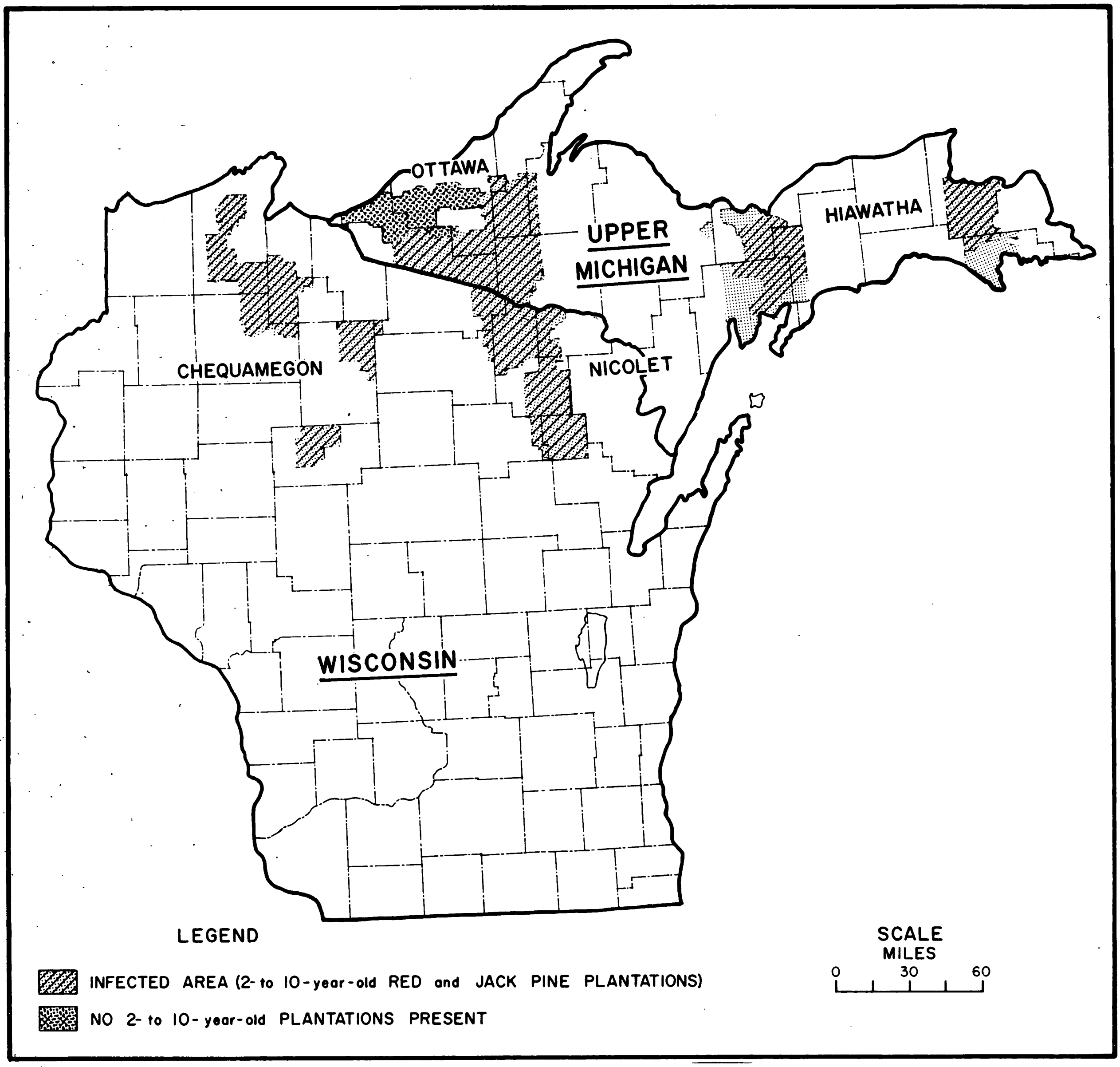

FIGURE 1. — The distribution of Scleroderris canker on National Forest land in the Lake States, 1965. On the four National Forests shown, the only 2- to 10-year-old sample plantations remaining uninfected were in some parts of the Hiawatha National Forest (light grey areas). Limited spot checks on Minnesota and Lower Michigan National Forest disclosed no canker.

a number of plantations. Positive evidence of *S. lagerbergii* infection was found on 44 percent of the dead and dying red pine and 77 percent of the dead and dying jack pine tallied. This strongly suggests that a large portion of the total mortality can be attributed to the disease.

The percentage of plantations with Scleroderris canker was not greatly different for spring plantings (73 percent) compared with fall plantings (60 percent). Mortality was much higher, however, in the fall plantings, 48 percent compared with only 26 percent in the spring plantings. These figures suggest

Table 1.--The incidence of Scleroderris canker in 2- to 10-year-old red pine plantations on four National Forests

National Forest and Ranger District	Sample plantations: Number examined	Disease present: Number	Disease present: Percent	Average acreage	Percent of trees: Missing[1]	Percent of trees: Dead and dying[2]	Percent of trees: Infected[3]
Ottawa:							
Ontonagon	2	2	100	30	17	16	12
Watersmeet	5	5	100	31	69	17	5
Kenton	5	5	100	36	18	7	4
Bessemer	9	6	67	39	25	7	9
Iron River	6	3	50	42	16	15	13
Total or average	27	21	78	37	32	11	8
Hiawatha:							
Munising	12	8	67	61	40	8	5
Rapid River	7	3	43	18	24	11	5
Manistique	12	10	83	37	30	14	22
Soo	16	12	75	71	29	8	5
St. Ignace	5	1	20	43	36	2	1
Total or average	52	34	65	51	31	10	10
Nicolet:							
Eagle River	8	7	88	35	32	15	5
Florence	11	7	64	17	26	8	5
Three Lakes	7	6	86	31	29	5	2
Laona	12	6	50	17	(4/)	(4/)	(4/)
Lakewood	13	4	31	27	24	9	1
Total or average	51	30	59	24	29	10	3
Chequamegon:							
Washburn	15	13	87	43	35	4	4
Park Falls	7	7	100	42	21	4	2
Glidden	8	5	63	50	44	2	1
Hayward	10	4	40	25	49	3	1
Medford	6	2	33	24	(4/)	(4/)	(4/)
Total or average	46	31	67	38	36	4	3
Total or average all Forests	176	116	66	38	32	8	6

1/The causal agent could not be determined for this mortality.
2/Forty-four percent of these trees were infected with *S. lagerbergii*.
3/Includes all trees positively infected with *S. lagerbergii* in all condition classes.
4/Not tallied because of deep snow.

PLATE 1. — Red pine stem canker caused by the fungus *S. lagerbergii*. Most cankers are not this obvious without removing the bark.

PLATE 2. — Removal of the bark on this red pine stem disclosed the yellow-green discoloration where *S. lagerbergii* was active. This color is similar to that of the fungus mycelium in culture.

Table 2.--The incidence of Scleroderris canker in 2- to 10-year-old jack pine plantations on three National Forests

National Forest and Ranger District[1/]	Sample plantations				Percent of trees		
	Number examined	Disease present: Number	Disease present: Percent	Average acreage	Missing[2/]	Dead and dying[3/]	Infected[4/]
Ottawa:							
Ontonagon	1	1	100	10	41	17	17
Watersmeet	1	0	0	26	--	--	--
Kenton	2	2	100	19	2	3	5
Total or average	4	3	75	18	15	8	9
Hiawatha:							
Munising	4	4	100	95	40	10	12
Soo	2	2	100	89	(5/)	(5/)	(5/)
Total or average	6	6	100	93	40	10	12
Chequamegon:							
Washburn	4	3	75	40	24	6	8
Total or average all Forests	14	12	86	57	30	9	10

1/No 2- to 10-year-old jack pine plantations were present on the Nicolet National Forest or on the Bessemer or Iron River Ranger Districts of the Ottawa; Rapid River, Manistique, and St. Ignace of the Hiawatha; or Park Falls, Glidden, Hayward, and Medford of the Chequamegon National Forest.

2/The causal agent could not be determined for this mortality.

3/Seventy-seven percent of these trees were infected with S. lagerbergii.

4/Includes all trees positively infected with S. lagerbergii in all condition classes.

5/Mortality was so severe on these plantations that sample plots could not be established.

that spring plantings may have almost twice as much chance of survival as fall plantings.

Any type of cover seemed to influence both the percentage of plantations with Scleroderris canker and the mortality within plantations. Seventy-nine percent of the plantations planted on open, exposed sites had Scleroderris canker as compared with 51 percent of the plantations growing under cover, such as aspen sprouts. Mortality was 42 percent for exposed sites versus 20 percent for covered sites. Similar results have been obtained in Canada and Sweden by Martin (1964) and Kohh (1964). Kohh attributes this difference to significantly higher temperatures and fewer nights with frost on covered sites. Frost injuries in young susceptible trees may serve as major infection courts for *S. lagerbergii*.

The results of this survey agree with Kohh's conclusions; i.e., the disease was detected most frequently in "frost pocket" areas. It is important to note, however, that areas of frequent frost include not only local depressions but also large, flat fields with poor air drainage (Pomerleau and Ray 1957; Duffy and Fraser 1963). In this survey, Scleroderris mortality was equally severe on both of these sites. Thus, the disease is not confined to the low areas, but is also present on large, flat fields which comprise a much larger portion of the Lake States pine plantations.

The most obvious symptoms associated with the disease were dead terminals and lateral branches (flagging), stem cankers, and the yellow-green discoloration beneath the bark of infected trees. As stated previously, the yellow-green discoloration was very reliable in identifying the fungus in the field. The symptoms were most obvious in July and August but were easily discernible throughout the year.

At this time, the disease presents a serious threat to existing and future young red and jack pine plantations on the four National Forests surveyed.

RECOMMENDATIONS

The following management practices in establishing and caring for red and jack pine plantations may help to reduce the incidence of Scleroderris canker:

1. Until suitable control methods are developed, discontinue the replanting of either red or jack pine on sites where Scleroderris has caused mortality.
2. Substantially reduce or discontinue the initial planting of either species on Ranger Districts where mortality has been severe.
3. Favor spring plantings over fall plantings as much as possible.
4. Avoid natural depressions or low, flat areas (frost pockets) as planting sites.
5. Whenever compatible with current silvicultural practices, provide partial overhead cover for the young pines.

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