Inland spruce cone rust of black spruce in Newfoundland and Labrador

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This article is the first record of inland spruce cone rust of native black spruce, Picea mariana, caused by Chrysomyxa pirolata, from Newfoundland and Labrador. It also discusses the distribution, severity and status of the disease, particularly in relation to the economic value of the host in this Region. A "Cone Rust Intensity Rating Scale" (CRIRS) is proposed to quantify the intensity of the disease on cones.

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Le present article constitue le premier rapport sur la rouille des cônes de l'epinette noire, Picea mariana, causee par Chrysornyxa pirolara, à Terre-Neuve et au Labrador. Il porte sur la distribution, la gravite et la frequence de la maladie et tient surtout compte de l'importance economique de l'hôte dans cette region. On y propose également une ''échelle d'evaluation de l'intensite de la rouille des cônes'' afin de quantifier la gravite de la maladie.

Introduction

Black spruce, ***Picea mariana*** (Mill.) B.S.P., is a mundane, hardy and one of the most widespread softwood trees of North America. Along with balsam fir and a few other spruces, it is the mainstay of Canada's pulp and paper industry. It is the second most valuable forest species used in the manufacture of high quality paper in Newfoundland and Labrador. The species constitutes about 34 and 70% of the total volume of merchantable standing timber on the island of Newfoundland and in Labrador, respectively. On many lowland sites, black spruce is the only commercially important tree species.

Inland spruce cone rust, caused by ***Chrysomyxa pirolata*** Wint. ***[Chrysomyxa pyrolae*** (DC.) Rostr.], is a widely distributed disease in North America. In Canada it has been observed on the cones of Engelmann's spruce, ***Picea engelmannii*** Parry: white spruce, ***P. glauca*** (Moench) Voss; black spruce: Colorado blue spruce, ***P. pungens*** Engelmann: sitka spruce, ***P. sitchensis*** (Bong.) Carr.; and on the foliage of ***Moneses uniflora*** (L.) A. Gray and ***Pyrola*** species from British Columbia, Alberta, Manitoba, Northwest Territories, Saskatchewan, Yukon, Ontario, Quebec and Nova Scotia (Conners, 1967; Ziller, 1974). In the summer of 1979, symptoms of the disease were observed on the young cones of native black spruce in a regeneration stand near Swift Current on the Burin Peninsula of the island of Newfoundland. Since then special surveys have been conducted in many cone producing areas and the pathogen has been observed on the host in several regenerating stands scattered on the Island and in eastern Labrador: so far it has not been observed on any other species of spruce. This article is the first record of the occurrence of the cone rust on black spruce in Newfoundland and Labrador. It also describes the distribution and severity of the disease on the Island and in eastern Labrador, suggests a Cone Rust Intensity Rating Scale (CRIRS), and discusses the damage potential of the disease in relation to the economic value of the host species in the forest industry of the region.

Study areas and methodology

Surveys for the cone rust were conducted in several cone producing areas' of black spruce forests on the Island and in eastern Labrador. However, detailed examination of the disease, and data on its incidence and intensity were obtained from six plots located in different regenerating stands of black spruce (Nos. 1, 2, 3, 4, 5 and 6 in Fig. 1 and Table 1); four of these plots were on the Island and two in Labrador. These stands were selected because of greater abundance of the rust. Data on the location, elevation, moisture regime, history, forest capability class, stand composition, and average age and height of the stand in the six plots are given in Table 1.

The following observations and data were recorded from a maximum of 56 trees in each of the six 5,625 m' plots: number of cones per tree, number of infected cones per tree, number of opened and unopened cones, amount of infection as enunciated by the newly devised cone rust intensity rating scale (CRIRS).

The identity of the pathogen was confirmed from symptoms and aeciospore characteristics (Saville, 1950, 1955; Ziller, 1974).

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[2] Department of Forest Resources and Lands, Government of Newfoundland and Labrador have designated some of these areas for seed collection.

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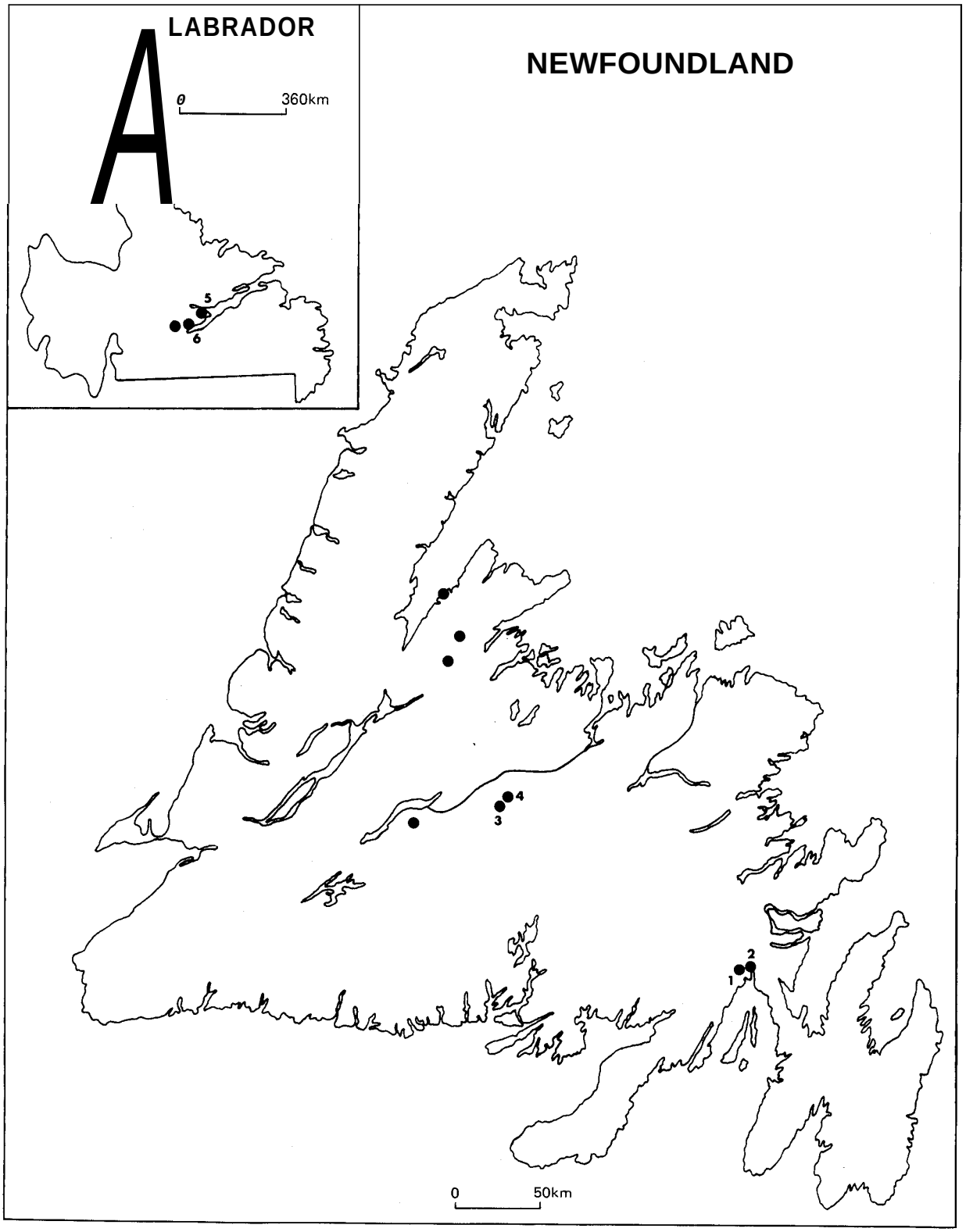

Fig. 1. Location of 11 cone rust areas and six plots in Newfoundland and Labrador.

Table 1. Location, elevation, moisture regime, history, forest capability class, stand composition and average age and height of the stands in the six plots."

Plot No.	Location	Elevation	Moisture regime**	History	Forest capability class***	Stand composition and dominant species	Average age of the stand (years)****	Average height of the stand (metres)
1	8 km southwest of Swift Current; 47° 55'. 54° 20'W	152 m (500 ft)	Barrens, but the plot was located on somewhat moist to moist site - 3-4.	Burned in 1961, regenerating	5	Black spruce regeneration with scattered young trees of balsam fir, Abies balsamea (L.) Mill.; pin cherry, *Prunus* pensylvanica L.f.; sheep laurel, *Kalmia angustifolia* L.; smooth serviceberry, *Amelanchier laevis* Wieg.; trembling aspen, *Populus* tremuloides Michx.; white birch, Betula papyrifera Marsh; dominant species - black spruce.	14 (9-17)	2.3
2	7 km southwest of Swift Current; 47° 55'N, 54° 19'W	152 m (500 ft)	Barrens, but the plot was located on somewhat moist to moist site - 3-4.	Burned in 1961, regenerating	5	Black spruce regeneration with some regenerating balsam fir, pin cherry, and white birch; dominant species - black spruce.	10 (7-13)	1.8
3	51 km southwest of Grand Falls; 48°46'N, 56°07'W	213 m (700 ft)	Well drained to moist - 2-4.	Cutover, regenerating	4	Black spruce regeneration with some regenerating balsam fir; blueberry, *Vaccinium* angustifolium Ait.; pin cherry; pussy willow, *Salix* discolor Muhl.; sheep laurel; dominant species - black spruce.	12 (8-17)	2.5
4	42 km southwest of Grand Falls; 48° 50'. 56' 02'W	183 m (600 ft)	Well drained to moist - 2-4.	Cutover, regenerating	4	Black spruce regeneration with scattered young trees of balsam fir; pin cherry; speckled alder, *Alnus* rugosa var. americana (Regel) Fern; white birch; dominant species - black spruce.	18 (10-22)	3.3
5	8 km southwest of Northwest River; 53° 31'N 60° 14'W	31 m (100 ft)	Moist to very wet - 4-7.	A poorly regenerating site, very wet and boggy	4	Black spruce regeneration with regenerating balsam fir and trembling aspen; dominant species - black spruce.	12 (10-16)	2.0
6	3 km west of Happy Valley 53° 17'N, 60° 22'W	31 m (100 ft)	Somewhat moist to moist - 3-4.	An old burned over	4	Black spruce and balsam fir regeneration, mostly spruce, scattered pin cherry and trembling aspen; dominant species - black spruce.	14 (8-18)	2.3

"All figures are rounded off to the nearest whole number
**After Damman (1964).
***After McCormack (1967).
****Figures within parentheses denote the range.

Results and discussion

The pathogen, *Chrysomyxa* pirolata, attacked only the cones and not the needles (Ziller, 1974). The most conspicuous symptoms of the disease were small, yellow or orange-colored spots on young cones. In late summer the rusted, prematurely brown and the opened cones showed conspicuous yellow or orange-yellow powdery masses of aeciospores on the surface of cone scales. This indicated a substantial internal development of the pathogen (Fig. 2a, b, c, and d).

The disease was found in patches at eight widely scattered locations in eastern and central parts of the Island (46°37''N to 52°01''N; 52°37''W to 59°25''W) and four locations in eastern Labrador (51°25''N to 60°30''N; 55°38''W to 67°49''W) (Fig. 1). It was most conspicuous in young regenerating stands of black spruce growing on moist sites with forest capability class varying from 4 to 5 (McCormack, 1970). The average age and height of 6 of those stands varied from 10 to 18 years and 1.8 to 3.3 m, respectively (Table 1).

The incidence and intensity of the rust in the six plots varied considerably (Table 2). The percent trees affected varied from 12 to 85 and percent cones affected per tree varied from 3.7 to 26.8. Similar reports of light to severe infection have also been published from Alberta, British Columbia, Ontario and Saskatchewan (Forest Insect and Disease Survey, 1951-1976; Ziller, 1974)

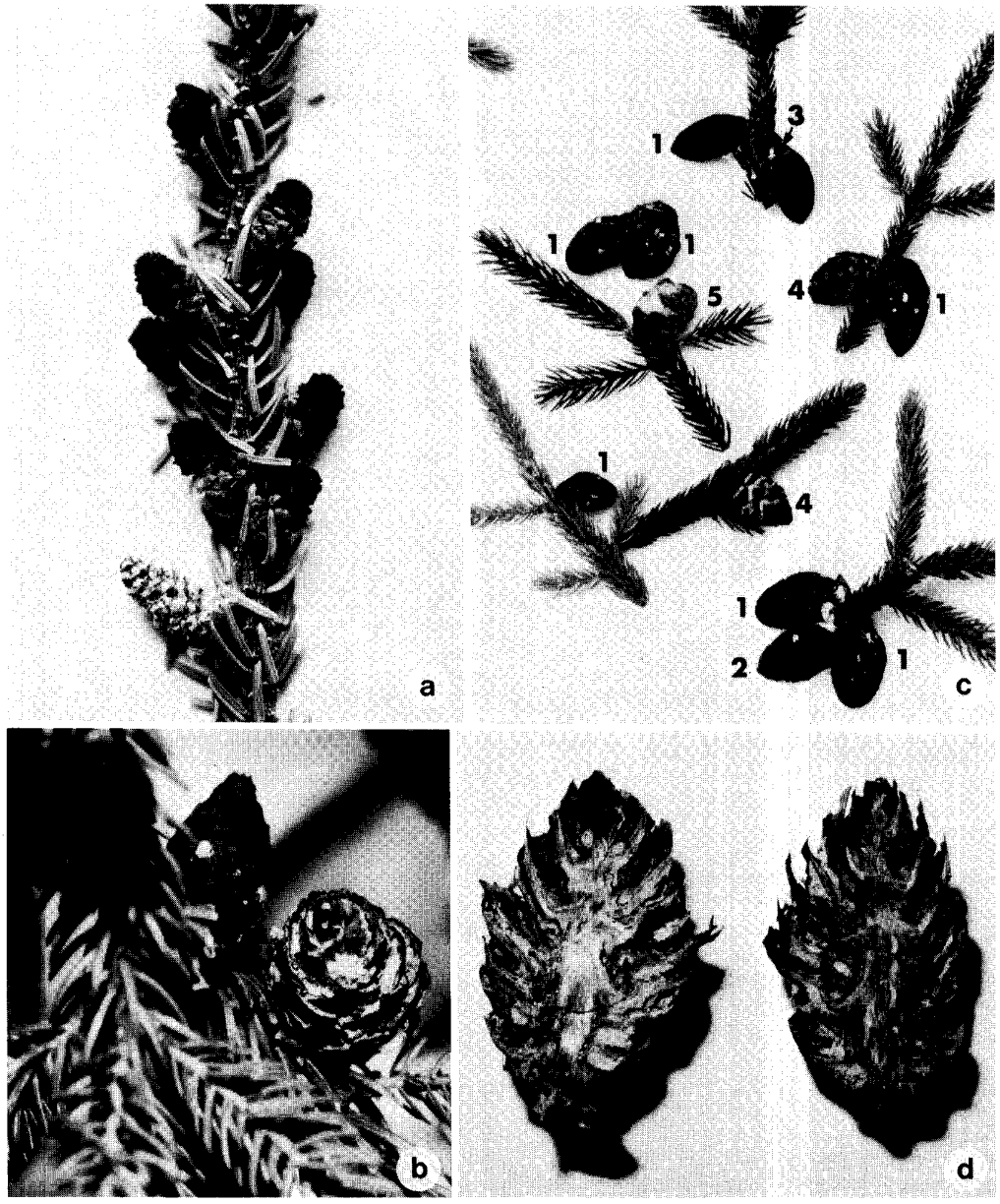

Fig. 2. Cone rust symptoms. a & b. Severely rusted cones on shoots: c. Different levels of the cone rust intensity (CRIRS); and d. Longitudinally cut severely infected cone.

To obtain a better understanding of the severity of the rust on individual cones, a Cone Rust Intensity Rating Scale (CRIRS) is suggested (Table 3). It is a visual rating scale from 1 to 5, and shows a relationship between the amount of infection on the cone and premature opening of the cone. The CRIRS values in the six plots varied from 1 to 5 (Table 2). The highest average value (3.5) was observed in Plot No. 3, located in a well-drained to moist site, 51 km southwest of Grand Falls on the Island, and the lowest average value (1.0) was observed in Plot No. 5 (1980 data), located in a moist to very wet site 8km southwest of Northwest River in eastern Labrador. The CRIRS values do not seem to be related to the percent trees and percent cones infected (Table 2). This shows that to obtain an overall estimate of the incidence and intensity of the rust, one would have to collect data on three parameters: percent trees infected, percent cones infected, and the amount of infection on individual cones through CRIRS value.

The damage by the rust in the areas examined is light to moderate and does not warrant any immediate need for control of the disease. However, because the pathogen is known to cause severe damage in parts of Europe (Jorstad,

1951) and North America (Ziller, 1974), its potentiai on the Island and in Labrador should not be underestimated, particularly when the host species is vitally important to the forest industry and economy of the Region. Also, with increasing emphasis on reforestation of the species in this Region, there is going to be a greater need for a healthy seed source. Since the disease is known to deform or destroy cones, reduce seed production and decrease viability of seeds (Forest Insect & Disease Survey, 1951-1976; Nelson & Krebill, 1970) and since in Newfoundland it was observed in areas designated for seed collection, it has caused concern to forest managers. This concern is increased because Matthews and Maloy (1960) reported that the rusted cones are particularly attractive to cone insects and that further losses may occur when insects leave rusted cones and attack healthy cones.

Table 2. Incidence and intensity of Inland Spruce Cone Rust in six plots.

Plot No.*	Total number of trees examined	Avg. % trees infected	No. of cones examined	Intensity: Avg. % cones infected	Intensity: Cone rust intensity rating scale-(CRIRS) avg. figures**
1 '79	36	12.1	3,686	3.7	3.2 (1-5)
'80	35	19.5	1,201	12.6	1.2 (1-5)
2	30	29.3	668	13.8	1.5 (1-5)
3	30	85.0	818	21.3	3.5 (1-5)
4	20	35.0	808	16.3	2.5 (1-4)
5 '79	40	30.0	1,924	26.8	3.0 (1-5)
'80	56	17.6	1,186	9.3	1.0 (1-2)
6	47	46.5	1,675	14.4	2.0 (1-4)

*Includes 1979 and 1980 data for Plot Nos. 1 and 5
**Figures within parenthesis denote the range.

Table 3. Cone rust intensity rating scale (CRIRS).*

Rating scale	Amount of infection on the cone	Amount of cone opened
1	1 to few rust spots	Closed
2	¼ infected	Opening slightly
3	½ infected	Opening slightly to ¼ opened
4	¾ infected	¼ to ½ opened
5	Fully infected	½ or more opened

*Based on an examination of 360 infected cones.

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