

Eastern Dwarf Mistletoe: Distribution and Severity in Black Spruce Stands of Newfoundland

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ABSTRACT

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Eastern dwarf mistletoe, *Arceuthobium pusillum*, has been known in Newfoundland since 1902. It has since become more prevalent and is considered as one of the principal agents damaging black spruce on the island, causing up to 86% infection and up to 37% tree mortality. The distribution of the parasite is patchy in western and central Newfoundland. It is observed in stands of varying age and height and those growing in moist to very wet sites.

Dwarf mistletoes have long been recognized as highly damaging parasites of conifers in western North America. Eastern dwarf mistletoe, *Arceuthobium pusillum* Peck., is widespread in spruce stands in the Great Lake states and the northeastern states of the United States and in eastern Canada (5,7,9,10,13). However, not much is known about the parasite in eastern Canada. In Newfoundland, eastern dwarf mistletoe has been known to cause witches' broom of black spruce (*Picea mariana* (Mill.)

B.S.P.) since 1902, when Howe (11) observed the parasite in a black spruce stand near Deer Lake in western Newfoundland. It has since been observed to be causing considerable damage to this species in some parts of the island.

Black spruce is the second most valuable forest species used in the manufacture of high-quality paper; it comprises about 34% of the total volume of merchantable standing timber on the island (2). On many lowland sites, black spruce is the only commercially important tree species. This article describes results of special surveys conducted to determine the distribution, severity, and status of the parasite in the forests of Newfoundland.

MATERIALS AND METHODS

Study areas. Surveys were conducted

throughout the island of Newfoundland during 1976-1980. However, detailed investigations on symptoms, morphologic characteristics of brooms, and incidence and intensity of damage in black spruce stands were conducted in three plots selected in three separate areas of western Newfoundland (1: 48° 36' N, 58° 15' W; 2: 48° 22' N, 58° 30' W; 3: 48° 35' N, 58° 16' W [Fig 1]). These areas were selected because of greater abundance of damage and apparent absence of any other insect or disease problem. They were located at elevations varying from 122 to 152 m on moist to wet sites (moisture regime scale of 4-6 [6]) and had predominantly softwood forests. The dominant species was black spruce with an average age of 73 yr (range 11 to 153 yr), average height of 6 m (range 2 to 18 m), and an average diameter at breast height (DBH) of 8 cm.

Methodology. Nine sample points were established in each plot: a center point and two additional points (15.2 m apart) along a transect in each cardinal direction from the center. The following observations and data were recorded on a maximum of 18 infected and two healthy trees within a radius of 7.6 m from each sample point: age, height, and DBH of the tree; whether alive or dead; number of broomed and unbroomed trees; number of brooms per tree; number of brooms on

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the trunk and branches; condition of the treetop (alive, broken, or dead or spiked); number of swellings on the trunk and branches; and some characteristics of brooms.

The incidence of the parasite or infection was expressed as percentage of broomed trees; the intensity or severity was expressed as percentage of tree mortality, Hawksworth's dwarf mistletoe intensity ratings (8), percentage of brooms on trunk and branches, average number of brooms per tree, and percentage of swellings. The age of a broom was determined by counting the growth rings at its base under a Dendrochronograph equipped with a Bausch & Lomb stereomicroscope (Derouen Products, Trinidad, CO).

RESULTS AND DISCUSSION

Parasite and damage symptoms. *A. pusillum* was found only on black spruce in Newfoundland. Dense, dark green brooms (17) were the most conspicuous symptoms (Figs. 2 and 3).

The brooms varied in age from 3 to 37 yr, in height from 3 to 183 cm, and in width from 3 to 155 cm. They were palm or spindle shaped, open or compact, upright or pendulous, and were located on the trunk or branches. The palm-shaped brooms were usually flat, and their branches were upright and spreading outwards. However, the spindle-shaped brooms were thick and subglobose, their branches upright and compacted inwards (Fig. 2A,B). The data show that the spindle-shaped brooms were most common regardless of the DBH of the infected tree or the plot location and that most of the brooms were present on branches (Table 1).

Although no data were collected, upright brooms were apparently more common. Von Schrenk (18) reported two forms of witches' brooms based on the vigor of the infected branch rather than the overall vigor of the host tree. Anderson and Kaufert (1) later reported two principal broom types, "bush-type" and "leader-type," depending on the vigor of the host tree. These two types of brooms were observed during the present investigations, but no attempt was made to relate them with the age or vigor of the trees. It was, however, noted that the bush-type was mostly found on the main stem, as nodal and terminal brooms, and that the leader-type was seen only on lateral shoots. The palm- or spindle-shaped brooms of the present investigations were not restricted to either the bush- or leader-type of Anderson and Kaufert. Their prevalence did not show any relationship to a particular site, height, or age class of the trees examined.

Other symptoms on the affected spruce trees included the spindle-shaped or spherical swellings on the branch or the trunk below the broom (Table 1). The presence of these swellings resulted in

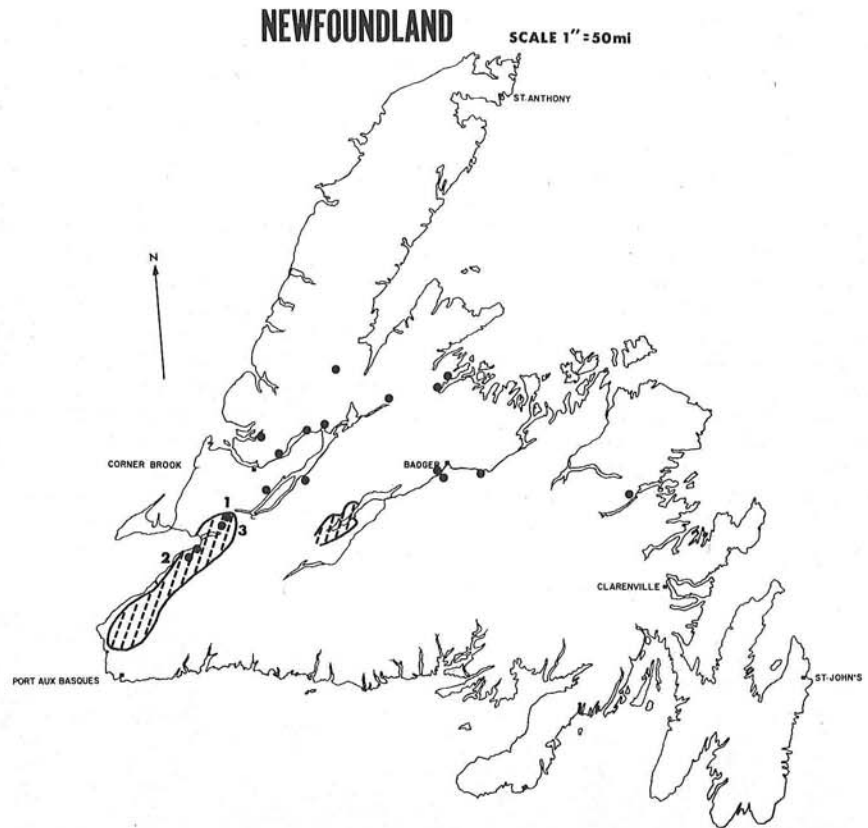


Fig. 1. Distribution of eastern dwarf mistletoe (hatched areas and closed circles) and location of three study plots (1, 2, and 3) on the island of Newfoundland.

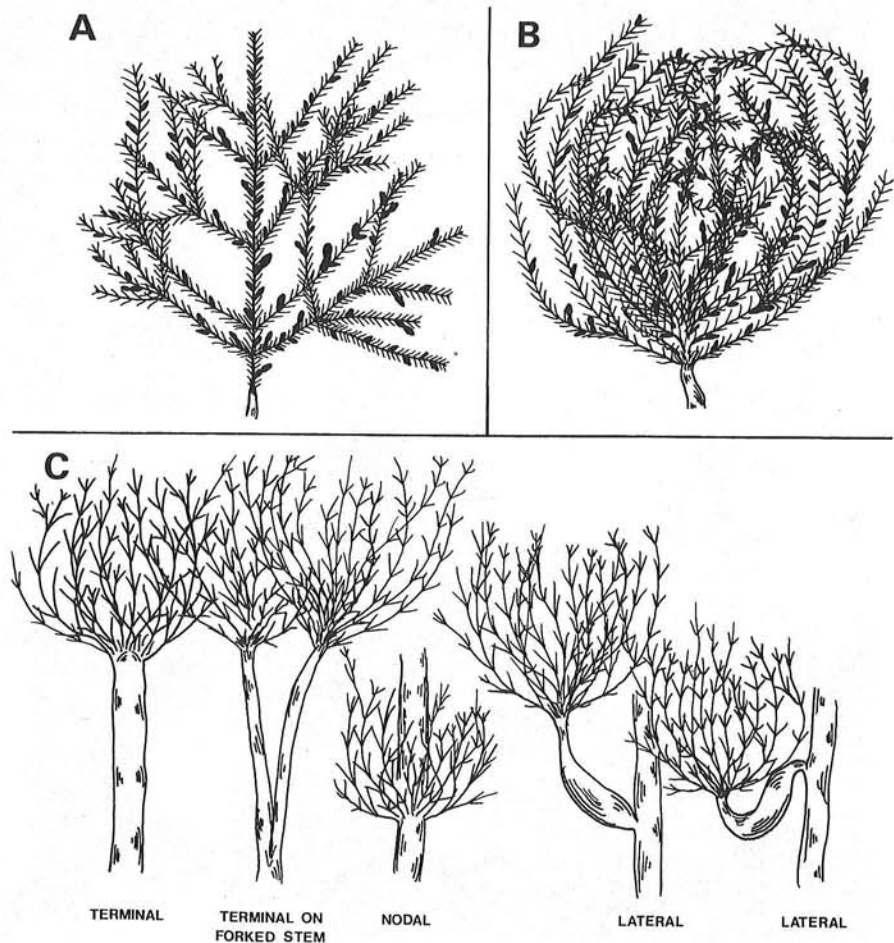


Fig. 2. Shapes and locations of brooms caused by eastern dwarf mistletoe on black spruce: (A) Palm-shaped brooms. (B) Spindle-shaped brooms. (C) Location of brooms.

stouter and deformed tree limbs. Such deformed limbs also had larger knots. The tops of most infected trees were alive (Table 1).

Distribution, incidence, and intensity. Dwarf mistletoe was found in scattered, large or small patches in the stands of black spruce in western and central Newfoundland (Fig. 1). Although the parasite and damage have been observed occasionally at several locations during the past 79 yr, it has become unusually conspicuous during the past few years. It is now particularly severe in two large areas (Fig. 1), the larger of which covers about 1,000 km² (10⁵ ha) (47° 47' N to 48° 38' N latitude). So far we have no record of the parasite from the eastern part of the island or from Labrador. It is believed that the parasite was first established in the western part of the

island and has since spread mostly towards the east. To date, the limits of distribution of the dwarf mistletoe are 49° 37' N to 47° 46' N latitude and 59° 17' W to 54° 17' W longitude.

The present surveys also showed that the parasite was well established; the oldest broom recorded was 37 yr old. Many young brooms were also observed, indicating that the parasite was active and progressing. The young brooms were mostly observed in the understory and in smaller and younger trees at a short distance from the older brooms, indicating a local spread of the parasite.

The mistletoe was usually confined to stands growing in low-lying, moist to wet (moisture regime varying from 4 to 6 [6]), and poor sites with a forest capability class of 4-7 (15). The parasite was not found on drier or upland sites.

Hawksworth and Wiens (10) from the United States and Kettela and Moran (14) from New Brunswick, Canada, also reported greater prevalence of this parasite on black spruce in swampy areas. Bernard (3) reported that *A. pusillum* is restricted in Quebec to within 1.6 km of lakes or rivers; Nash (16) found the parasite on *P. glauca* within 400 m of the coast in Maine. Bonga (4) suggested that *A. pusillum* requires an uninterrupted period of high atmospheric humidity in the spring, which might explain the absence of the parasite in upland or drier sites of Newfoundland. Hawksworth and Shigo (9) also reported that the parasite is not widely known to occur in upland sites of *P. rubens* (red spruce) in the White Mountains and elsewhere in New England. They believed that *A. pusillum* causes little damage in the northeastern

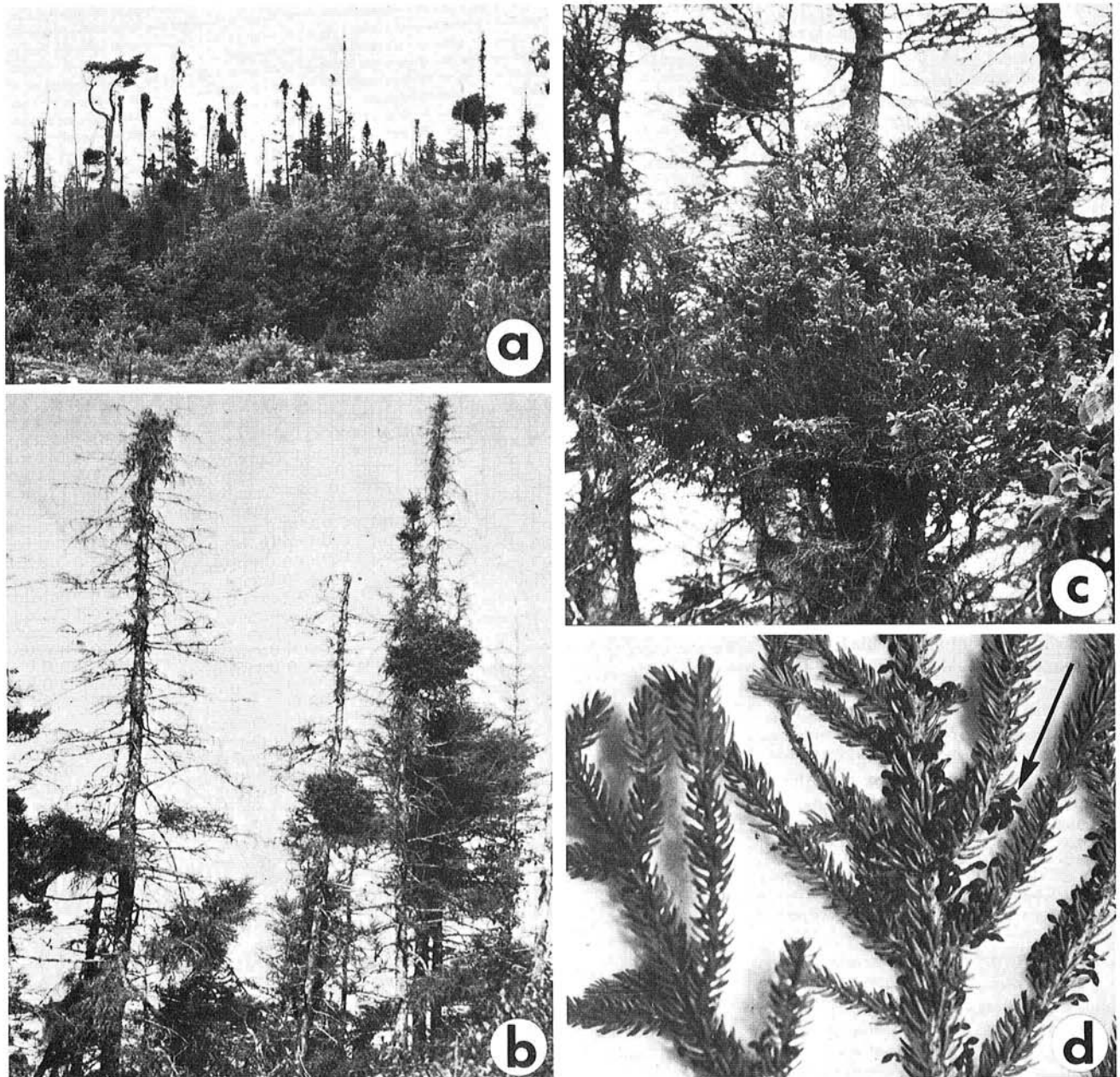


Fig. 3. Eastern dwarf mistletoe on black spruce trees: (A) Groups of trees damaged by mistletoe. (B) Brooms on dead and dying trees. (C) Close-up of a broom. (D) Mistletoe (arrow) on a black spruce shoot.

Table 1. Characteristics of eastern dwarf mistletoe on black spruce trees in three plots in Newfoundland^a

	Plot 1			Plot 2			Plot 3		
	Trees <15.2 cm DBH ^b	Trees >15.2 cm DBH	Total	Trees <15.2 cm DBH	Trees >15.2 cm DBH	Total	Trees <15.2 cm DBH	Trees >15.2 cm DBH	Total
Trees examined (no.)	122	58	180	178	2	180	162	18	180
Broomed trees (%)	80	67	76	74	100	74	86	83	86
Tree mortality (%)	19	23	20	25	0	25	40	13	38
Brooms per tree (avg no.)									
Live	6 (1-34) ^c	11 (1-21)	5 (1-34)	5 (1-20)	4 (1-7)	5 (1-20)	5 (1-28)	8 (1-20)	6 (1-28)
Dead	12 (2-40)	11 (4-22)	2 (2-40)	4 (1-17)	0	4 (1-17)	6 (1-33)	9 (4-13)	7 (1-33)
Intensity ratings ^d			4.9 (3-6)			4.1 (3-6)			4.5 (3-6)
Broomed trees									
Avg age (yr)	71 (19-153)	114 (87-133)	80 (19-153)	68 (27-109)	0	68 (27-109)	73 (30-183)	0	73 (30-183)
Avg ht (m)	5 (2.1-9.7)	13 (9.6-17.5)	7 (2.1-17.5)	4 (2.7-10.5)	0	4 (2.7-10.5)	5 (2.4-11.6)	0	5 (2.4-11.6)
Treetops (%)									
Live	71	60	68	66	100	67	59	57	58
Broken	15	15	8	37	0	3	4	14	6
Dead or spiked	24	25	24	31	0	30	37	29	36
Swellings (%) on									
Trunk	32	50	38	80	0	80	47	50	47
Branch	68	50	63	20	0	20	54	50	54
Brooms (%) on									
Trunk	19	19	19	59	0	59	36	100	36
Branch	81	81	81	41	0	41	64	0	64
Broom type and shape									
Open (%)	68	33	58	45	0	45	33	0	33
Compact (%)	32	67	43	55	0	55	67	0	67
Upright (%)	76	69	71	69	0	69	77	0	77
Pendulous (%)	24	31	30	31	0	31	24	100	24
Most common shape	Palm	Spindle	Palm or spindle	Spindle		Spindle		Spindle	Spindle
Broom width and height (cm)	155 × 183 (max) 3 × 3 (min)	74 × 53 (max) 5 × 3 (min)	86 × 81 (max) 3 × 3 (min)

^a All percentage and average number figures have been rounded off to the nearest whole number.

^b Average diameter at breast height.

^c Figures within parentheses denote the range.

^d Average dwarf mistletoe intensity ratings; after Hawksworth (8).

states, partly because of its association with poor quality black spruce in bog sites.

The dwarf mistletoe was observed mostly in sites inhabited by Newfoundland gray jay (*Perisoreus canadensis sanfordi*), and its seeds were found sticking to the feathers of some birds. Hudler et al (12) demonstrated that gray jay (*Perisoreus canadensis*) has a potential to disseminate the parasite.

The incidence and intensity of the damage caused by the dwarf mistletoe varied between the plots and areas examined (Table 1). The incidence averaged 74-86%, and the associated mortality averaged 20-38%. There was no significant relationship between the incidence of the disease and DBH, age, or height of trees. Similarly, there was no such relationship between the intensity of the disease, as shown by the average number of brooms per live or dead tree, and DBH, age, or height of trees. However, the percentage of tree mortality

was higher in older trees and those having a DBH more than 15.2 cm.

According to the mistletoe rating system of Hawksworth (8), the three plots averaged 4.9, 4.1, and 4.5; the range was within classes 3-6 (Table 1). There was no apparent relationship between the rating classes and DBH, age, or height of trees. Because brooms were found on trees of all heights and ages, it is obvious that the parasite can infect trees regardless of their age, height, or vigor. Data collected from infected trees between ages 11 and 183 yr, however, indicate that there was a larger number of brooms on trees within the age range of 34-70 yr. Hawksworth and Shigo (9) reported that damage by the mistletoe in red spruce appeared most prevalent in old trees (100 yr or more), although several areas of severe damage were noted in younger trees.

The maximum average number of brooms per tree was 12 (range of 1 to 40). More brooms were present on branches than on trunks; hence, more swellings on

branches (Table 1). Most of these swellings were smaller and less conspicuous than those observed by Hawksworth and Shigo (9), perhaps because of younger trees in our surveys.

The present surveys, conducted over a period of 5 yr, are not yet complete because of the inaccessibility of some areas. The parasite appeared to be the primary and in many areas the only killer of black spruce. In situations where *A. pusillum* did not kill, it grossly deformed the trees and rendered them unmerchantable. It also made them unsightly, thus affecting the aesthetic value of some of the scenic areas and parks.

Although the parasite is now limited in distribution, the intensity of damage is moderate to severe. In view of the severe impact of dwarf mistletoe in the forests of British Columbia, Alberta, and western parts of the United States and of eastern dwarf mistletoe in eastern parts of the United States, the parasite poses a serious threat to black spruce in Newfoundland.

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