HEMLOCK AND LARCH DWARF MISTLETOE SEED DISPERSAL

By RICHARD B. SMITH[1]

ABSTRACT

During 1964-65, approximately 49,050 hemlock dwarf mistletoe seeds were dispersed from a severely infected 35-ft. western hemlock tree, and 3,750 larch mistletoe seeds were dispersed from a lightly infected 63-ft. western larch tree. Seeds were trapped over an area 5,800 ft.² in extent around the hemlock, and over an area of 2,200 ft.² around the larch.

The peak of larch mistletoe seed dissemination was about 1 month earlier than for hemlock. Seed counts for both years and both mistletoes were highest in the southwest and least in the northeast quadrants of the trapping areas.

FIGURE 1. Clearing of slash and trees in progress around the infected western hemlock tree.

[1] Department of Forestry and Rural Development, Forest Research Laboratory, Victoria, B.C.

It was firmly established that small trees, even if lightly infected, are a serious potential source of dwarf mistletoe seed; they must be removed if satisfactory dwarf mistletoe control is to be achieved.

Introduction

Arceuthobium campylopodum f *tsugensis* (Rosend.) Gill and *A. campylopodum* f. *laricis* (Piper) Gill are widespread in British Columbia and severely damage western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) and western larch (*Larix occidentalis* Nutt.) respectively (Buckland and Marples, 1952; Wellwood, 1956; Pierce, 1960). Spread of the disease, which is by forcible ejection of the seed from the fruit, is accelerated when infected trees remain after logging, fire, or other disturbances. The effectiveness of these infected trees in promoting new infections depends in part on the quantity of dwarf mistletoe seed produced and on the extent and pattern of dispersal. An investigation was undertaken to determine the relative importance of these factors.

FIGURE 2. Traps in place in cleared area surrounding the infected western larch tree.

Methods and Materials

A severely mistletoe-infected hemlock near Cowichan Lake, Vancouver Island, and a lightly infected larch near Cranbrook in southeastern British Columbia were isolated by removing all trees and shrubs within a radius of 50 ft., and all susceptible hosts within 100 ft. of their boles. The hemlock, 35 ft. in height and approximately 35-40 years of age, was growing in an area logged about 1943 (Fig. 1). Increment cores and growth segments indicated that the tree was approximately 2 inches in diameter 2 ft. above the ground and 10 ft. in height at the time of logging. Ages of the mistletoe infections were not precisely determined, but the size and position of the largest swellings suggested that the tree had been infected prior to logging. The larch tree, 63 ft. in height and 55-60 years of age, was growing in a selectively logged stand (Fig. 2).

Sixty-four traps, each 2 ft. x 2 ft. wooden frames supporting cheesecloth, were placed on the ground in a 10-ft. grid around each tree, thus achieving a sampling intensity of 4%. Four additional traps were placed 45 ft. from each tree at cardinal points of the compass (Fig. 3).

Seed counts were made twice monthly commencing in August and continuing to early November for the larch mistletoe, and to the middle of December for the hemlock mistletoe. Throughout seed dispersal the trapping areas were kept clear of vegetation that might interfere with seed flight.

Results

Hemlock Dwarf Mistletoe

In 1964 hemlock dwarf mistletoe seed was less abundant, dispersed less widely, and the date of peak dispersal was later than in 1965 (Tables 1 and 2). In the former year, 284 seeds were trapped over an area of 2,600 ft.^{2}, and peak dispersal was about the third week of October (Fig. 4). In 1965, 1678 seeds were trapped over an area of 5,800 ft.^{2}, and peak dissemination was during the first week of October. Seed counts for both years were highest in the southwest quadrant of the trapping area (Fig. 3). Dissemination ceased about December 15.

Larch Dwarf Mistletoe

Similar to the hemlock, larch dwarf mistletoe seeds were less abundant and less widely dispersed in 1964 than in 1965 (Tables 1 and 2). In the former year, 41 seeds were trapped over an area of 1,100 ft.^{2}, and peak dispersal was about the middle of September (Fig. 4). In 1965, 109 seeds were trapped over an area of 2,200 ft.^{2}. Peak dispersal was about 1 week earlier than in 1964. Seed counts for both years were highest in the southwest quadrant of the trapping area (Fig. 3). Dissemination had nearly ceased by the time of the final observations in early November.

Discussion

Large quantities of mistletoe seed can be produced on relatively small trees. Considerable seed is intercepted by the infected tree itself, so the number trapped gives a conservative estimate of the total production. Based on the 1965 seed production, dwarf mistletoe on less than 10 evenly spaced hemlock per acre, or 20 larch, similar to the ones studied, could produce and disseminate

TABLE 1
DISTANCE AND NUMBER OF HEMLOCK AND LARCH DWARF MISTLETOE SEED DISPERSED

A. WESTERN HEMLOCK

Distance from bole (ft.)	Number of traps	Number of seeds trapped		Number per sq. ft.[1]	
		1964	1965	1964	1965
7.1	4	157	701	9.8	43.8
15.8	8	83	544	2.6	17.0
21.2	4	17	120	1.1	7.5
25.5	8	19	141	0.6	4.4
29.2	8	4	95	0.1	3.0
35.4	12	4	48	0.1	1.0
38.1	8	0	17	0.0	0.5
43.0	8	0	6	0.0	0.2
45.0	4	0	4	0.0	0.2
49.5	4	0	2	0.0	0.1
Total Collected		284	1,678		
Total Dispersed[2]		7,100	+ 41,950 = 49,050		

B. WESTERN LARCH

7.1	4	30	60	1.9	3.8
15.8	8	9	25	0.3	0.8
21.2	4	0	6	0.0	0.4
25.5	8	2	14	0.1	0.4
29.2	8	0	2	0.0	0.1
35.4	12	0	0	0.0	0.0
38.1	8	0	1	0.0	T
43.0	8	0	0	0.0	0.0
45.0	4	0	1	0.0	0.1
49.5	4	0	0	0.0	0.0
Total Collected		41	109		
Total Dispersed		1,025	+ 2,725 = 3,750		

[1] Based on a trap size of 4 sq. ft.
[2] Based on a 4% sampling intensity. Does not include interception by source trees.

sufficient seed to potentially infect trees on the whole acre. Subsequent crops would increase the number of infections, although they may not enlarge the area of infected trees.

The earliest matured hemlock mistletoe seed seems to have been propelled farthest. Possibly, the seeds on shoots within the crown take longer to mature and, when dispersed, their flight is impeded by the dense foliage.

The greater dispersion of seed to the southwest may be associated with greater shoot, flower, and fruit production, enhanced by presumably higher temperatures and light intensities on that side of the tree. Winds, which were mainly south to northwest in both areas, would not favor dispersal to the southwest.

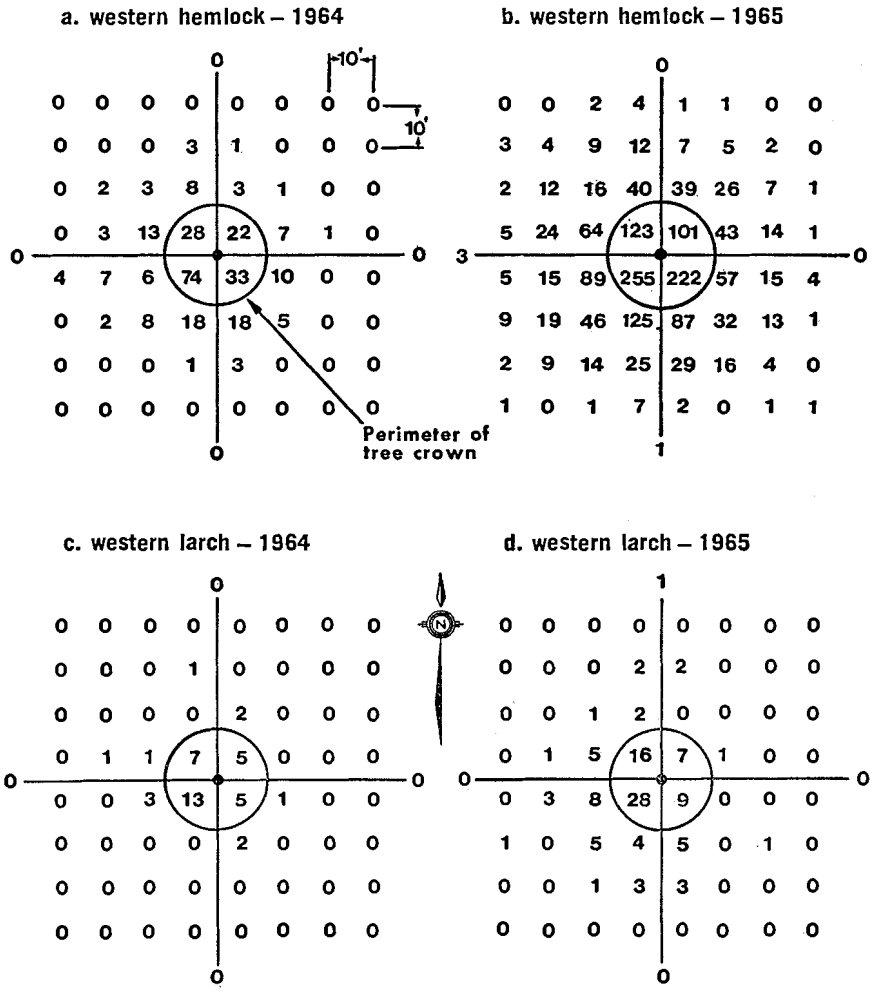

FIGURE 3. Pattern and magnitude of dwarf mistletoe seed dispersal from hemlock and larch, 1964 and 1965. Numbers are seed collected from traps in indicated locations. Note scale in 3a.

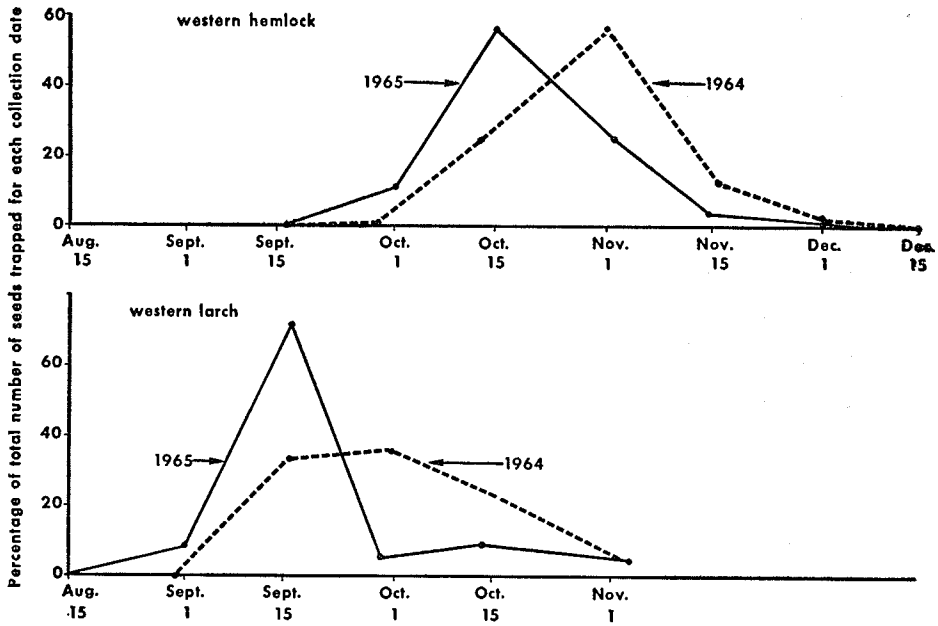

FIGURE 4. Period of seed dispersal for larch and hemlock dwarf mistletoe, 1964 and 1965.

Observations during 1962 and 1963, and the results of this investigation, indicate that the peak period for hemlock dwarf mistletoe seed dispersal on southern Vancouver Island is the middle of October. This relatively late period may reflect the disease's adaption to a maritime location with a mild climate. The peak for larch mistletoe, which occurs in a more continental environment, is a month earlier. In an analogous situation, Scharpf (1965) reported that the mid-point of seed dissemination of *A. campylopodum* on digger pine (*Pinus sabiniana* Dougl.) and Monteray pine (*P. radiata* Don.) on the California coast may be more than 1 month later than for the same species on red fir (*Abies magnifica* Murr.) and white fir (*A. concolor* (Gord. and Glend.) Lindl.) in the Sierra Nevada.

Annual variation in dispersal period may be related to climatic variations. Scharpf (1965) attributed early dispersal of *A. campylopodum* in California to above normal summer temperatures. In this investigation, the earlier dispersal obtained in 1965 may be related to the warmer summer temperatures recorded that year. The daily maximum temperatures from April to September 1965 averaged nearly 3.8°F. higher at Cowichan Lake, and 1.5°F. higher at Cranbrook than for the corresponding periods in 1964 (Canada Dept. of Transport, 1964-65).

Removing large, infected, residual trees during or immediately after logging is considered essential for satisfactory dwarf mistletoe control in coastal hemlock stands. This investigation has demonstrated that small infected trees must also be removed. It has been established that an infected

TABLE 2

TIME AND AVERAGE DISTANCE OF SEED DISPERSAL FOR HEMLOCK AND LARCH DWARF MISTLETOE

A. WESTERN HEMLOCK

Date of collection 1964	1965	Number of seeds 1964	1965	Average distance from bole (ft.) 1964	1965
Aug. 29	Aug. 31	0	0	—	—
Sept. 14	Sept. 15	0	4	—	11.4
Sept. 28	Oct. 1	3	200	17.6	17.7
Oct. 13	Oct. 15	72	953	14.7	16.6
Oct. 31	Nov. 1	162	429	12.4	11.6
Nov. 16	Nov. 15	38	83	8.6	10.8
Dec. 1	Dec. 1	8	8	8.2	9.4
Dec. 15	Dec. 15	1	1	15.8	7.1
		284	1,678	12.4	15.1

B. WESTERN LARCH

Aug. 15	Aug. 15	0	0	—	—
Aug. 31	Sept. 1	0	9	—	20.8
Sept. 16	Sept. 16	14	79	9.6	12.4
Sept. 30	Sept. 29	15	6	11.9	7.1
Oct. 15	Oct. 14	10	10	7.1	18.1
Nov. 3	Nov. 4	2	5	11.4	10.8
		41	109	9.9	13.3

hemlock that is only 10 ft. in height at the time of logging can become a heavy producer of dwarf mistletoe seed within 25 years. Unlike hemlock, larch trees are not usually a component of advanced regeneration, but they are frequently left as individuals in an overstory after selective logging and fire, and even if lightly infected will become an important potential source of inoculum.

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