PACIFIC SOUTHWEST
Forest and Range
Experiment Station

FOREST SERVICE
U.S.DEPARTMENT OF AGRICULTURE
P.O. BOX 245, BERKELEY, CALIFORNIA 94701

Seed production and dispersal by DWARF MISTLETOE IN OVERSTORY JEFFREY PINES in California

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*USDA Forest Service
Research Note PSW-247*
1971

Abstract: Studies in northeastern California showed that the number of dwarf mistletoe *(Arceuthobium campylopodum)* seeds trapped declined at a logarithmic rate as the distance from overstory source of infection increased. The most seeds were dispersed in the direction of prevailing winds. It is quite likely that storms also aid dispersal. Total numbers of seeds trapped varied from year to year, suggesting good as well as poor years of seed production. A distance of 100 to 150 feet from infected overstory trees is necessary to prevent infection in regeneration.

Oxford: 442.1:176.1 *Arceuthobium campylopodum*–181.523:174.7 *Pinus jeffreyi.*
Retrieval Terms: Arceuthobium campylopodum; seed dispersion; seed flight; windflow; forest damage; *Pinus jeffreyi.*

In much of the Western United States, dwarf mistletoes *(Arceuthobium* spp.*)* continue to cause widespread damage to conifer species. In seeking to prevent infection by this plant parasite, forest managers want to know how far and in which direction dwarf mistletoe spreads from an infected overstory to understory trees. And they want to know how much infection can be expected in trees at varying distances from an overstory infection.

This note reports information on (a) the distance and pattern of dwarf mistletoe *(A. campylopodum)* seed dispersal from infected overstory Jeffrey pine *(Pinus jeffreyi);* (b) number of dwarf mistletoe seeds produced from heavily infected overstory trees; and (c) variation in seed production over several successive years.

The explosive mechanism of seed dispersal by dwarf mistletoes is known, and the ballistics of seed flight has been carefully studied.[1] But information about pattern and distance of spread from infected overstory to understory trees for several host-dwarf mistletoe combinations is conflicting. According to Gill and Hawksworth[2] and Hawksworth[1], the pattern of spread of *A. vaginatum* on ponderosa pine *(Pinus ponderosa)* in the Southwest is roughly circular, and nearly all infected young trees are within 50 feet of the overstory and none more than 86 feet away. On the other hand, Roth[3] found that *A. campylopodum* on ponderosa pine in Oregon spread 130 feet in the direction of the prevailing winds. Heavy infection was concentrated within 33 feet of the overstory, however. Scharpf and Parmeter[4] reported that the distance of spread of *A. campylopodum* into a plantation of Jeffrey pine, at the Institute of Forest Genetics, Placerville, California, was similar to that reported by Roth.[3]

Figure 1—*Two heavily infected overstory trees stood in the center of Plot 2. Brooms project conspicuously in the lower and mid crowns of the overstory trees.*

Smith[5], studying dispersal of dwarf mistletoe, *A. tsugensis*, on hemlock *(Tsuga heterophylla)* and *A. laricis* on larch *(Larix occidentalis)* in British Columbia, found that practically all mistletoe seeds were deposited within about 40 feet of the bole of the infected overstory tree. Dispersal occurred primarily in a southwesterly direction. Smith[5] calculated that in a 2-year period nearly 50,000 seeds were dispersed by dwarf mistletoe in a severely infected 35-foot hemlock and 3,700 seeds dispersed from a lightly infected larch. Nearly seven times as many hemlock seeds and about three times as many larch seeds were dispersed in 1965 as in 1964.

Hawksworth[1] trapped five times as many seeds of *A. vaginatum* in 1956 and twice as many in 1957 as in 1955.

METHODS

The site for this present study was the Manzanita Chute, an old burned-over area on the Lassen National Forest, about a mile from the north gate of Lassen National Park in northeastern California. Isolated, widely scattered groups of old-growth overstory trees heavily infected with *A. campylopodum* were found there.

Figure 2—*Aerial view of Plot 2 shows the placement of seed traps (white squares) around the overstory trees. (Scale: approximate 1/500 feet.)*

The two study plots were selected with infected overstory trees in the center *(fig. 1)*. The boundary of each plot was set at about 100 feet from the edge of the crown of the infected overstory.

Plot No. 1 consisted of 60,262 square feet, had a radius of 138.5 feet, and held three overstory trees. Plot No. 2 consisted of 56,800 square feet, had a radius of 134.5 feet, and held two overstory trees. Heights of trees and of mistletoe infections were:

	Tree height	*Maximum height of mistletoe*
Plot 1:		
Tree 1	90	85
Tree 2	110	105
Tree 3	134	130
Plot 2:		
Tree 1	128	108
Tree 2	124	109

Data on dwarf mistletoe seed production and dispersal were obtained by trapping seeds that fell on 3-foot square wooden frames on 4-foot legs over which was spread cheesecloth. Forty-eight traps were placed on each plot at 20-foot intervals along eight radiating lines starting from the edge of the crown of the overstory *(fig. 2)*. Direction of seed dispersal on each plot was determined by orienting the traps in eight directions (N, NE, E, SE, S, SW, W, NW).

Seeds were trapped for 4 successive years (1964-1967). Before dispersal in early fall of each year cheesecloth was replaced on the traps and mistletoe plants in understory trees within 50 feet of the traps were defoliated. After dispersal in late fall the total number of seeds on each trap was recorded.

RESULTS

Seed trapping proved to be an effective method of sampling the number of seeds dispersed at varying distances from the overstory. On both plots a rather uniform logarithmic decrease in number of seeds per square foot resulted as distance increased *(fig. 3)*. About two-thirds of all seeds on the plots were trapped within 40 feet of the overstory—even though this zone comprised only about a third of the total plot area. Some seeds probably were dispersed at distances beyond the perimeter of the plots, but their numbers per square foot likely were quite small.

Except in 1967 the two plots did not differ markedly in the total number of seeds dispersed in any one year *(fig. 4)*. Differences were noted in the number of seeds produced and dispersed from one year to the next, however. For example, 1965 represented a year of rather low seed production

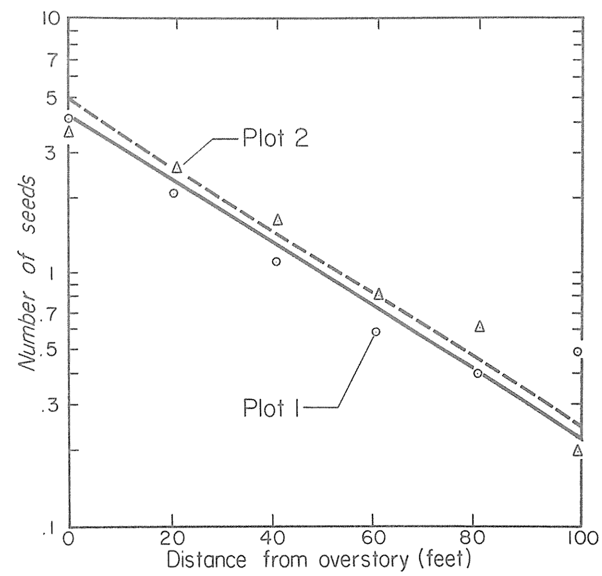

Figure 3—*Average number of seeds per square foot of seedtrap (1964-1967) declined as distance from overstory trees in two plots increased.*

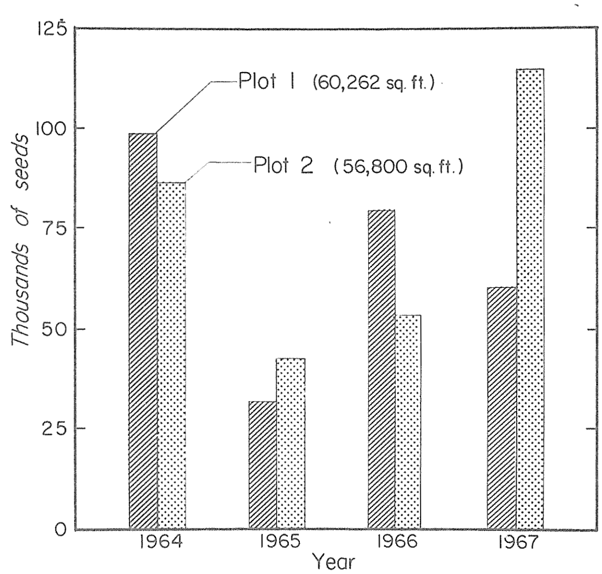

Figure 4—*Total number of dwarf mistletoe seeds dispersed for 4 years was estimated from seed traps placed in two plots.*

whereas in 1964 and 1967 there was abundant seed production.

Direction of seed dispersal varied somewhat among the 4 years of study. In 1964 and 1967, the direction of dispersal was predominantly north and east, but in 1965 and 1966, direction of dispersal was mostly north and west. In general, the dispersal pattern for the 4 years was north, northeasterly, and northwesterly *(fig. 5)*. Considerably fewer seeds were dispersed in a south, southeasterly, and southwesterly direction. The predominant direction of seed dispersal conforms to the direction of the prevailing winds and direction of storms in the area in September and October.[6] For example, in these months in 1964-1967 more than half of the winds with an average afternoon wind speed of more than 10 m.p.h. came from either a south, west, or southwest direction.

DISCUSSION

The estimated total number of dwarf mistletoe seeds produced in any one year from an infected overstory was considerably greater in this study than in the one reported by Smith.[5] But Smith[5] was dealing with single smaller overstory trees, and a different dwarf mistletoe species. Undoubtedly production of dwarf mistletoe seed varies widely because of differences in intensities of infection, size of the infected trees, and perhaps seed producing capacity of dwarf mistletoe species.

Marked variation in dwarf mistletoe seed production from the same infected overstory trees for different years was noted by Hawksworth[1] and by Smith.[5] Similarly, in this study a greater degree of variation in the number of seeds dispersed was generally noted among the 4 years of study than between the two plots. This difference suggests that certain environmental factors or climatic conditions are important in determining fruit development or seed production in any one year.

Results of this study agree with those of Hawksworth[1] in that the number of dwarf mistletoe seeds trapped at distances from an overstory source of infection decreased logarithmically with distance from the overstory. Hawksworth[1] found that irrespective of overstory tree height, dwarf mistletoe seeds were dispersed a maximum distance of about 50 feet. In this study, a logarithmic relationship of dispersal was noted for a distance of up to about 100 feet. Seed dispersal was undoubtedly aided by wind. Roth[3] noted that in Oregon the prevailing winds were responsible for seed dispersal to distances of up to 130 feet.

Because dwarf mistletoe discharges its seed from the fruit in September and October, it is possible that dispersal is aided not only by prevailing winds but also by storms. Storms accompanied by high winds are common in September and October in the Sierra Nevada and southern Cascades. In 1967, for instance, at the U.S. National Park Service's Manzanita Lake Weather Station, near the north gate of Lassen National Park and about 1 mile from the plots, the average afternoon wind speed for October 2 was 32 m.p.h. and for October 21, 22 m.p.h. In winds of this velocity, dwarf mistletoe seeds could be dispersed from tall trees for quite a distance.

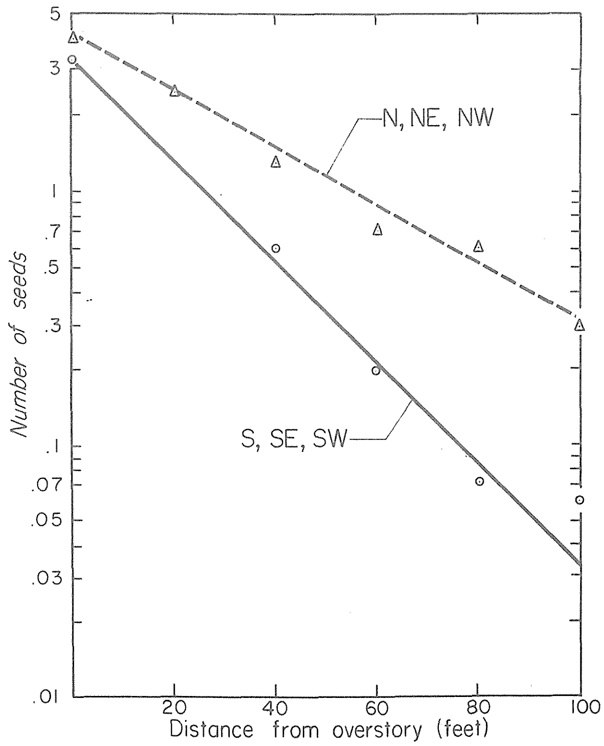

Figure 5—*Average number of seeds per square foot of seed trap on Plots 1 and 2 with regard to direction of dispersal (1964-1967), based on counts of seeds on traps in two plots.*

It is also possible that seeds are discharged from the fruit primarily during periods of high winds. Shaking or jarring mature fruit can trigger seed discharge. Surely considerable shaking and jarring of clumps of dwarf mistletoe shoots bearing fruit in the tops of overstory trees must occur during storms or periods of high winds.

Forest managers concerned with managing Jeffrey pines should recognize that seeds of dwarf mistletoe in infected overstory may travel 100 feet or more to surrounding regeneration, particularly in the direction of prevailing winds or storms. Therefore harvesting of infected overstory within 100 to 150 feet of surrounding understory is necessary to prevent infection by this damaging parasite.

Further studies are now underway on infection and buildup of dwarf mistletoe in understory Jeffrey pines.

NOTES

[1]Hawksworth, Frank G. *Dwarfmistletoe of ponderosa pine in the Southwest.* U.S. Dep. Agr. Tech. Bull. 1246, 112 p., illus. 1961.

[2]Gill, Lake S., and Frank G. Hawksworth. *Dwarfmistletoe control in southwestern ponderosa pine forests under management.* J. Forestry 52: 347-353, illus. 1954.

[3]Roth, L. F. *Dwarfmistletoe on the Pringle Falls Experimental Forest.* U.S. Dep. Agr., Pacific NW. Forest & Range Exp. Sta., Res. Note 91, 3 p. 1953.

[4]Scharpf, R. F., and J. R. Parmeter, Jr. *Spread of dwarfmistletoe into Jeffrey pine plantation...trees infected after 22 years.* U.S. Forest Serv., Pacific SW. Forest & Range Exp. Sta. Res. Note 141, 6 p., illus. 1967.

[5]Smith, Richard B. *Hemlock and larch dwarf mistletoe seed dispersal.* Forestry Chron. 42(4): 395-401. 1966.

[6]Weather data from the Manzanita Lake Station, Lassen National Park, located about a mile from the plot area.

The Authors

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GPO 981-312

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