

# Effects of Habitat Type and Elevation on Occurrence of Stalactiform Blister Rust in Stands of Lodgepole Pine

T. H. BEARD, Former Graduate Research Assistant, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow 83843, N. E. MARTIN, Research Plant Pathologist, Intermountain Forest and Range Experiment Station, Ogden, UT 84401, and D. L. ADAMS, Head, Department of Forest Resources, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow

## ABSTRACT

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Stalactiform blister rust, caused by *Cronartium coleosporioides*, occurs on hard pines throughout the northern United States and Canada. Locations of lodgepole pine reported in disease surveys of Idaho forests, 1968-1980, showed stalactiform blister rust occurring at elevations between 1,500 and 2,477 m. *Abies lasiocarpa*/*Xerophyllum tenax* and *A. lasiocarpa*/*Vaccinium scoparium* were the most common habitat types supporting lodgepole pine and stalactiform blister rust.

Additional key words: *Peridermium stalactiforme*

Stalactiform blister rust, caused by *Cronartium coleosporioides* Arth., is a disease of hard pines in North America causing cankers that reduce volume and induce some mortality in all age classes. The distribution of lodgepole pine (*Pinus contorta* Dougl.) is from southeastern Alaska and the interior Yukon Territory to northern Baja California and east to the Black Hills of South Dakota (3). Stalactiform blister rust occurs in much of the lodgepole pine range and the jack pine (*P. banksiana* Lamb.) regions of the north central United States and Canada (1,5,6,11). The lodgepole pine host is divided into three geographical varieties: eastward, *P. contorta* var. *latifolia* Engelm.; westward, shorepine, *P. contorta* var. *contorta* Dougl.; and Cascades and Sierra Nevada, *P. contorta* var. *murrayana* (Grev. & Balf.) Engelm. (3). Although the host distribution and effects of this disease are generally

known, specific data for predicting the potential occurrence on lodgepole pine are lacking. This study was developed to locate stalactiform blister rust in Idaho lodgepole pine forests and to identify environmental conditions where this rust disease can occur. *Cronartium coleosporioides* is used as the specific name for the fungus, the aecial state of which is *Peridermium stalactiforme*.

## MATERIALS AND METHODS

Plots in Idaho of lodgepole pine infected with stalactiform blister rust were obtained from survey procedures developed by the Forest Pathology Unit of the College of Forestry, Wildlife and Range Sciences at the University of Idaho and from responses to a request of ranger district personnel of the USDA Forest Service.

Random plots were located (1968-1980) by randomizing the mileage from a point along forest roads. Five random numbers determined the plot-center tree and the four accompanying sample trees located upslope, downslope, and two along the contour but in opposite directions (4,7). Observations included the presence or absence of lodgepole pine and if stalactiform blister rust had invaded any sample lodgepoles or others in the vicinity. Elevation, habitat type, position of slope, percent slope, and aspect were noted.

Habitat classification used for the Clearwater and Idaho Panhandle national forests were those of Daubenmire and Daubenmire (2). Classifications by Steele et al were used for the portion of the Bitterroot National Forest in Idaho and Nez Perce National Forest (8); the Boise, Challis, Payette, Salmon, and northern half of the Sawtooth national forests (10); and the Caribou, southern half of the

Sawtooth, and the Targhee national forests (9).

To enlarge the stalactiform blister rust survey, a request to report stalactiform blister rust stands was sent to the supervisors of the Bitterroot, Boise, Caribou, Challis, Clearwater, Nez Perce, Payette, Salmon, Sawtooth, Targhee, and Idaho Panhandle national forests (Fig. 1). Ranger district personnel recorded the township, range, section, habitat type, and elevation of stalactiform blister rust stands in their areas.

Earlier survey records of the Forest Pathology Unit did not specifically include stalactiform blister rust but instead inventoried damage to main stems thought to result from mechanical causes other than fire. Stand history did not show any stand management activity, excessive blowdowns, or other probable cause. Because the descriptions of the damage recorded for 19 such plots better describes stalactiform blister rust, and because stalactiform blister rust was found in the same vicinities during the author's later survey, these notations of damage were designated probable locations of lodgepole pine infected with stalactiform blister rust (Fig. 1); the 19 plots were not used in analysis of habitat type or elevation, however.

## RESULTS

The elevational occurrence of lodgepole pine sampled in 142 plots ranged from 838 m (2,750 ft) to 2,560 m (8,400 ft). Because of inadequate habitat classification data in some records, 44 of the 64 plots where rust was found were used to associate stalactiform blister rust with habitat type (Table 1).

The most common habitat type in which lodgepole pine was sampled was *Abies lasiocarpa*/*Xerophyllum tenax* (Abla/Xete), followed closely by *A. lasiocarpa*/*Vaccinium scoparium* (Abla/Vasc). Both habitat types occur from middle to upper elevations, on various slopes and aspects, and in them lodgepole pine dominates the stand (8-10). Nearly 40% of the plots containing lodgepole pine occurred on these two habitat types, with the remaining 60% distributed over 28 other habitat types. Of the 44 plots containing lodgepole pine infected with stalactiform blister rust, 89% were in the *A. lasiocarpa* climax series. The most common habitat

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types containing infected lodgepole pine were Abl/Xete and Abl/Vasc. The frequencies of stalactiform blister rust in these habitat types were 32 and 25%, respectively, and together represented about 56% of those plots containing stalactiform blister rust (Table 1).

Nine percent of the plots were in the *P. contorta* climax or community series. The only habitat type in this study where lodgepole pine is the climax species is *P. contorta*/*Festuca idahoensis* (Pico/Feid). This habitat type occurs in broad valleys at upper elevations (8–10). Two plots in the Boise National Forest representing the Pico/Feid habitat type were sampled. At one plot, stalactiform blister rust was present in lodgepole pine. The aspect of this plot was northeast, whereas that of the rustfree plot was southeast. The elevation of both plots was about 2,000 m (6,550 ft).

Two percent of the plots were in the *Pseudotsuga menziesii* climax series, which were represented in nine plots—five in Boise National Forest, three in Challis National Forest, and one in Targhee National Forest. Only the plot in Targhee National Forest in habitat type *Pseudotsuga menziesii*/*Calamagrostis rubescens* (Psme/Caru) contained stalactiform blister rust.

All 19 plots with highly probable infestations of stalactiform blister rust occurred in central Idaho (Fig. 1) at elevations from 1,500 to 2,134 m. Nine locations were Abl/Vasc and seven were Abl/Xete. The remaining three locations were in three separate habitat types.

## DISCUSSION

Lodgepole pine is a component in 56 habitat types throughout Idaho (2,8–10). Forty of the 56 habitats occur in central and northern Idaho where the majority of our sampling points are located. Twenty-five of the 40 habitats encompass a major portion of the land area (2,8–10). Twenty of these 25 habitats are dominated in numbers of mature lodgepole pine but environmental conditions range from warm and dry to extreme cold and wet.

The habitat types (8–10) in which stalactiform blister rust was found to be common had the following characteristics: Lodgepole pine was the dominant tree species in the stand, the climates were cool and dry, and the stands occurred on middle to upper elevations (1,500–2,438 m). The slopes and aspects were variable and nondescriptive. Middle slope appeared to be related to the occurrence of stalactiform blister rust ( $P = 0.99$ ), but we believe this to be bias to the greater number of stands at middle slopes (37 of 95) and feel that position on the slope is unrelated. Also, no relationship could be shown to percent slope, which ranged from flat to 80%, or to aspect ( $P = 0.65$  and  $P = 0.67$ , respectively).

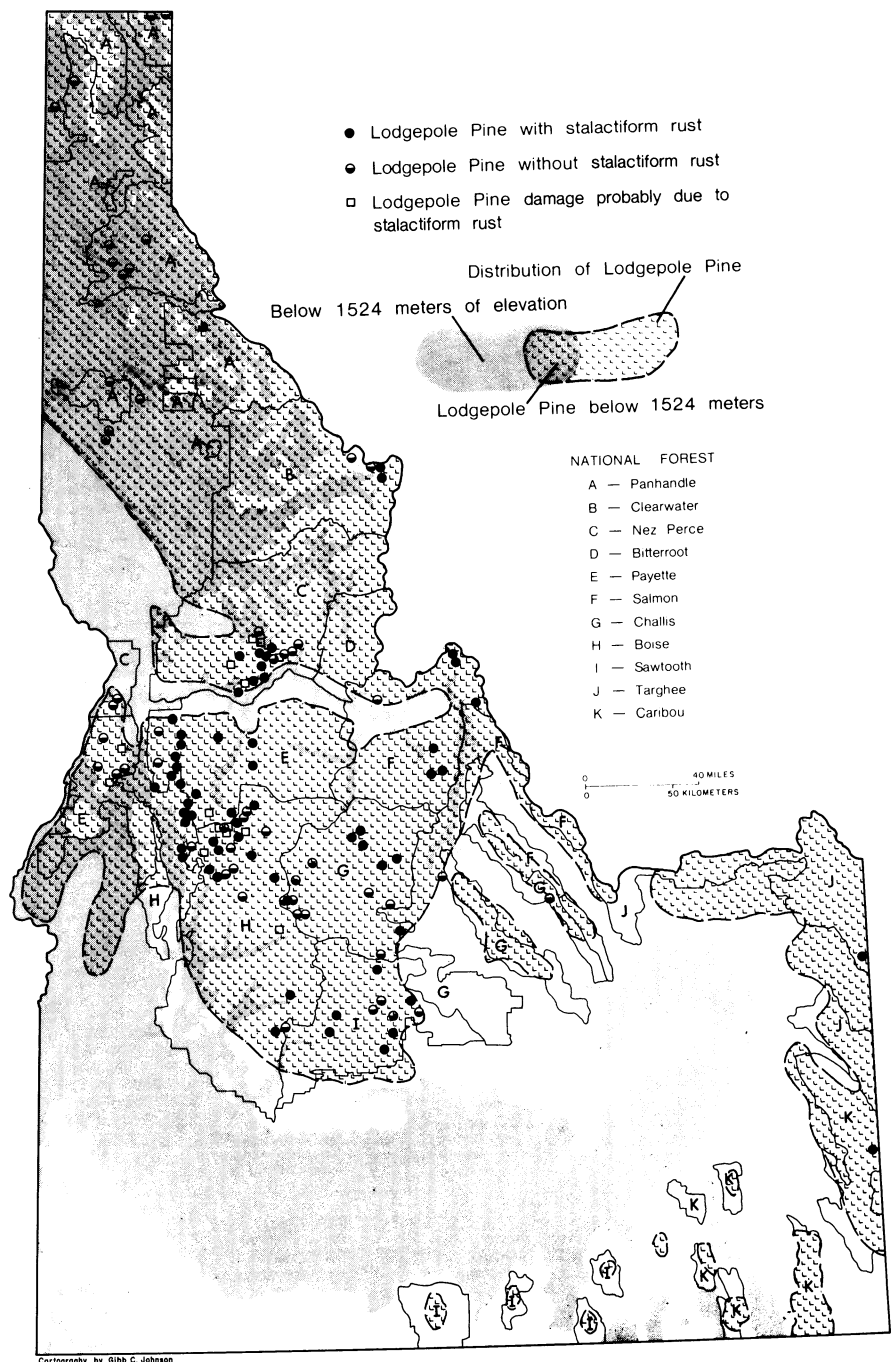
*P. contorta* is a common seral species in both *A. lasiocarpa* and *Pseudotsuga*

*menziesii* climax series and may occupy the site through many generations before giving way to the competitive ability of the climax species. *P. contorta* may persist in compatible habitat types on gentle terrain where cold air pockets exist and the water table fluctuates (8–10).

At lower elevations, lodgepole pine dominates as a seral in the *Pseudotsuga menziesii* climax series. At upper elevations, *A. lasiocarpa* was identified as the climax series through the understory vegetation of the *P. contorta* community type (8–10). Warm and dry environmental conditions favor the *Pseudotsuga menziesii* climax series, whereas cool and moist conditions favor *A. lasiocarpa*

climax series. Middle elevations are transition zones between the *Pseudotsuga menziesii* and *A. lasiocarpa* climax series. Throughout this study when *P. contorta* community types were encountered and a climax species was not present, the understory vegetation belonged to habitat types in the *A. lasiocarpa* climax series.

The habitat types in the *Pseudotsuga menziesii* climax series sampled were *Arnica cordifolia* (Psme/Arco), *Calamagrostis rubescens* (Psme/Caru), *Carex geeyeri* (Psme/Cage), *Symphoricarpos albus* (Psme/Syal), and *Juniperus communis* (Psme/Juco). Psme/Arco, Psme/Syal, and Psme/Juco occur at



Cartography by Gibb C. Johnson

Fig. 1. Locations of lodgepole pine with and without stalactiform blister rust recorded in Idaho 1968–1980.

lower elevations where environmental conditions are warm and dry (8-10). Lodgepole pine dominates the Psme/Syal habitat type and may occur in Psme/Arco and Psme/Juco habitat types (8-10). Psme/Cage occurs at middle to upper elevations where the environmental conditions are cool and dry, but lodgepole pine is either accidental or a minor seral species in some stands (8-10). Psme/Caru occurs at middle to upper elevations where the environmental conditions are cool and dry (8-10), but lodgepole pine is a minor seral in some stands in central Idaho (8,10) and can

dominate the stand in eastern Idaho (9). The single habitat type (Psme/Caru) that contained stalactiform blister rust was in an eastern Idaho stand where lodgepole pine was dominant. The environmental conditions were similar to those in Abla/Xete and Abla/Vasc habitat types.

The range of environmental characteristics of habitat types (8-10) indicates that stalactiform blister rust decreases as moisture increases irrespective of temperature. Moreover, when temperature increases, as it does in the range of *Pseudotsuga menziesii* habitat types, stalactiform blister rust disappears. In

other habitat types, temperature was also the limiting factor for stalactiform blister rust plots. Habitat types containing lodgepole pine that have warm (below 1,500 m) or cold to extremely cold (above 2,440 m) temperatures do not support stalactiform blister rust. Thus, stalactiform blister rust is limited to an elevational range of approximately 1,000 m, between 1,500 m (4,925 ft) and 2,477 m (8,125 ft) in Idaho (Fig. 2).

All 19 locations designated as having probable infected lodgepole pine were surrounded by confirmed locations of infected lodgepole pine (Fig. 1). Eighty-five percent of the locations were in Abla/Xete and Abla/Vasc habitat types, and the elevations were within the range predicted for stalactiform blister rust. Although circumstantial, the inclusion of these locations into disease status reports for stalactiform blister rust seems appropriate.

Latitude determines where this 1,000-m range is located elevationally. The 1,000-m range is at higher elevations at southern latitudes where average temperatures are warmer but decreases in elevation in the cooler northern latitudes. For example, Abla/Xete in central Idaho, where stalactiform blister rust was found, was above 1,850 m, but the same habitat type in northern Idaho was below 1,550 m.

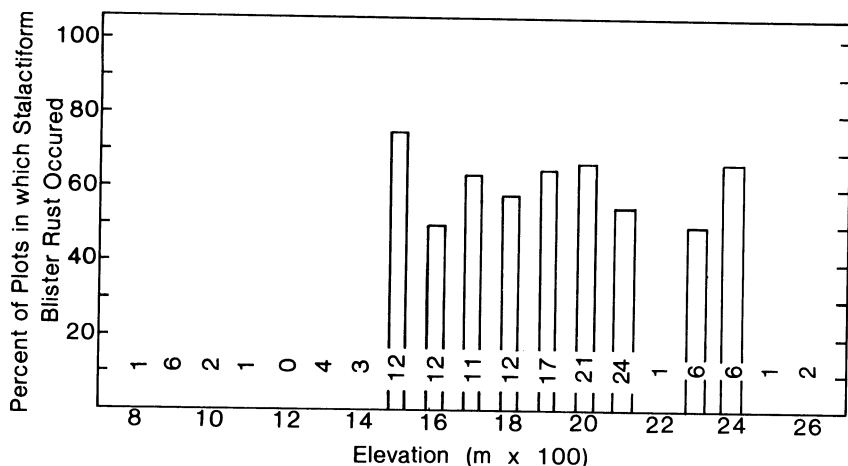
Stalactiform blister rust is not known to spread from pine to pine, and like some other pine rusts, a herbaceous alternate host is involved in completing the life cycle. The reported major alternate hosts, *Castilleja* spp. and *Pedicularis* spp., are not major components of any habitat type defined by the *A. lasiocarpa* climax series where lodgepole pine is a component (8-10) and stalactiform blister rust is frequent. *Castilleja* spp. were observed growing in numerous disturbed sites, however, and *Pedicularis* spp. were common in moist locations. Both conditions occur with high frequency along many roads. Hence, an alternate host, although not present within the stand, is close enough for stalactiform blister rust inoculum to be windborne to neighboring stands.

**Table 1.** Frequency of habitat types in Idaho with lodgepole pine and stalactiform blister rust

Habitat type	Number of plots		
	In each habitat type	With stalactiform blister rust	Without stalactiform blister rust
<i>Abies grandis</i> / <i>Linnaea borealis</i>	1	...	1
<i>Pachistima myrsinites</i>	7	...	7
<i>Spiraea betulifolia</i>	1	...	1
<i>Vaccinium globulare</i>	1	...	1
<i>Abies lasiocarpa</i> / <i>Arnica cordifolia</i>	2	1	1
<i>Calamagrostis canadensis</i>	9	6	3
<i>Calamagrostis rubescens</i>	3	2	1
<i>Carex geyeri</i>	7	4	3
<i>Coptis occidentalis</i>	1	...	1
<i>Juniperus communis</i>	1	...	1
<i>Spiraea betulifolia</i>	1	...	1
<i>Vaccinium caespitosum</i>	4	1	3
<i>Vaccinium globulare</i>	4	...	4
<i>Vaccinium scoparium</i>	17	11	6
<i>Xerophyllum tenax</i>	23	14	9
<i>Pinus contorta</i> / <i>Calamagrostis rubescens</i>	1	1	...
<i>Festuca idahoensis</i>	2	1	1
<i>Vaccinium caespitosum</i>	1	1	...
<i>Vaccinium globulare</i>	2	1	1
<i>Pseudotsuga menziesii</i> / <i>Arnica cordifolia</i>	2	...	2
<i>Calamagrostis rubescens</i>	4	1	3
<i>Carex geyeri</i>	1	...	1
<i>Juniperus communis</i>	1	...	1
<i>Symphoricarpos albus</i>	1	...	1
<i>Thuja plicata</i> / <i>Athyrium filix-foemina</i>	1	...	1
<i>Pachistima myrsinites</i>	2	...	2
<i>Tsuga heterophylla</i> / <i>Pachistima myrsinites</i>	1	...	1
Total	101 <sup>a</sup>	44 <sup>b</sup>	57

<sup>a</sup>Only 101 of 142 total plots had habitat type data.

<sup>b</sup>Only 44 of 64 plots with rust had habitat type data.



**Fig. 2.** Occurrence of plots with stalactiform blister rust in each elevation class. Number within bar represents total number of plots studied in each elevation class.

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