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FOREST-SITE RELATIONSHIPS WITHIN AN OUTBREAK OF LODGEPOLE NEEDLE MINER IN CENTRAL OREGON

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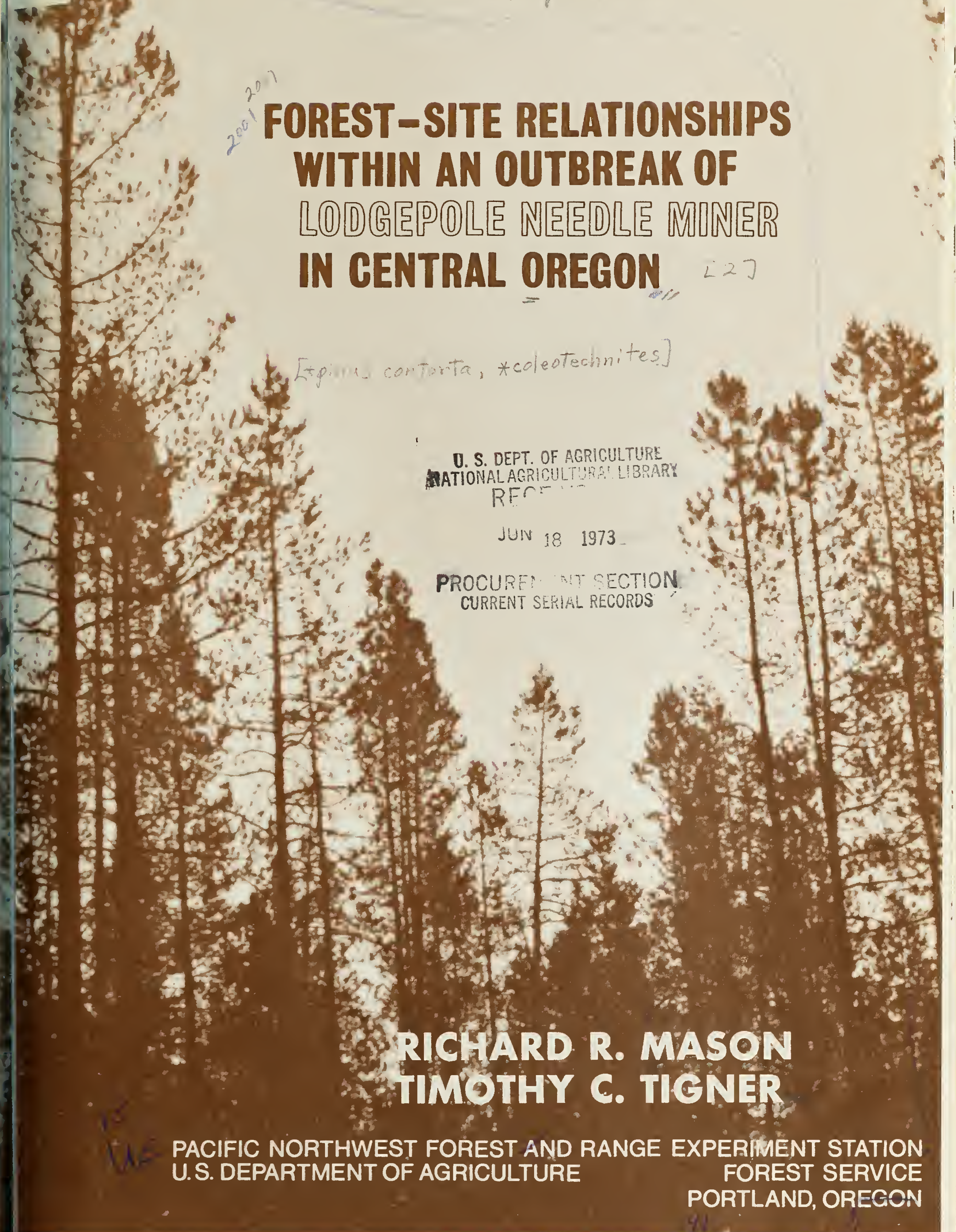
[+pinus contorta, *coleotechnites]



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ABSTRACT

The distribution of an outbreak population of lodgepole needle miner, *Coleotechnites* near *milleri* (Busck), in central Oregon was studied in relation to forest stand and site characteristics. The outbreak occurred primarily in topographic basins where lodgepole pine, *Pinus contorta* Douglas, grows in pure stands and is the topo-edaphic climax species. Tree defoliation was not continuous but was interrupted by uninfested stands in basin drainage systems and on well-drained slopes. The transition from infested to uninfested stands was usually marked by changes in topography, soils, tree stocking, and plant communities. Needle miners were virtually absent on sites characterized by high seasonal water tables, deeply developed soil profiles, and dense tree stocking. Similarly, populations usually declined abruptly on well-drained slopes where lodgepole pine was seral or was growing in mixed stands with ponderosa pine, *Pinus ponderosa* Laws. In general, *Pinus contorta/Purshia tridentata* communities were severely infested, but adjacent *Pinus contorta/Purshia tridentata-Arctostaphylos patula* and *Pinus contorta/Arctostaphylos uva-ursi* communities were relatively free of attack. Degree of infestation is apparently influenced by a combination of environmental and tree physiological factors that vary significantly under different forest-site conditions.

KEYWORDS: *Pinus contorta* Douglas, lodgepole pine, *Coleotechnites* near *milleri*, lodgepole needle miner, tree diseases, insect pests.

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INTRODUCTION

Forests of lodgepole pine, *Pinus contorta* Douglas, in the pumice region of central Oregon are periodically infested by a hitherto undetermined needle miner in the genus *Coleotechnites* (Lepidoptera: Gelechiidae). The most recent outbreak developed in 1965 and continued at a high level through 1968 when populations again subsided to a relatively endemic status. At the peak of the outbreak in 1967, 148,000 acres of lodgepole pine suffered defoliation (Pettinger and Dolph 1967).

During this period, degree of defoliation was highly variable throughout the infested region. It was inconspicuous in stands with low needle miner populations, but trees were almost completely defoliated in stands with high populations. Distribution of defoliation was especially noteworthy because it was closely associated with changes in forest composition, topography, and drainage patterns. A preponderance of evidence indicated that these factors strongly affected, either directly or indirectly, the population density of needle miners in a particular forest stand. The purpose of this study was to investigate in detail some of the environmental factors apparently associated with the distribution and intensity of defoliation caused by needle miners.

DESCRIPTION OF THE INSECT AND STUDY AREA

The lodgepole needle miner in Oregon is a small univoltine insect that spends most of its larval stage within the mined needle. It is similar taxonomically to *C. milleri* Busck, a serious enemy of lodgepole pine in central California (Koerber and Struble 1971), but the California needle miner differs by having a 2-year life cycle. Moth flight occurs in late July, and eggs are laid in old mined needles by early August. Amount of tree damage during outbreaks depends on the intensity and duration of defoliation. Although prolonged defoliation may cause tree mortality, damage in Oregon seems to be limited primarily to severe loss of growth.

Eggs hatch in late summer, and the larvae migrate to undamaged green needles where they construct new mines. A single larva feeds inside the needle, eventually devouring all but the epidermis. Pupation occurs in early July the following year, in either the same needle or possibly a second mined needle.

The 1965-68 outbreak occurred in the Winema and Deschutes National Forests in south-central Oregon. Studies were concentrated in two separate areas of the outbreak in the northern end of Klamath County. This is a high plateau extending from the east slope of the Cascade Range to the high desert. Elevations vary from 5,000 to 6,000 feet above sea level. Annual precipitation averages about 20 inches, of which only about 2.5 inches fall in the 3 summer months. Winter precipitation is mostly in the form of snow.

The soil, site, and vegetation relationships of the region have been thoroughly described in numerous publications (Dyrness and Youngberg 1958 and 1966, Youngberg and Dyrness 1959, Youngberg and Dahms 1970). The area is overlain by several feet of pumice originating from the final eruption of Mount Mazama (Crater Lake), approximately 6,600 years ago (Fryxell 1965). Soils formed on pumice deposits have little profile development because the parent material is of recent origin. Most of the well-drained soils belong to the Lapine series which is characterized by a thin litter layer, an A horizon about 2 inches thick, a weathered AC horizon from 8 to 14 inches thick, and an unweathered C horizon of sands and gravels. The C horizon is largely a function of total depth of the pumice mantle and may vary in depth from 1 foot to several feet. Because of their porous nature, pumice soils are able to store sizable amounts of water. However, most plant roots in the Lapine soil are confined to the A, AC, and buried soil horizons, so that very little moisture is extracted from the C horizons.

Dyrness and Youngberg (1966) found that, even on shallow pumice soils, all available moisture may not be depleted until late in the growing season. Pumice soils are also subject to high and low temperature extremes which have considerable influence on the character and distribution of vegetation (Cochran et al. 1967).

Ponderosa pine (*Pinus ponderosa* Laws.) and lodgepole pine are the predominant tree species in the area. They are sometimes associated at higher elevations with white fir (*Abies concolor* [Gord. and Glend.] Lindl.) and sugar pine (*Pinus lambertiana* Dougl.) and along streams with Engelmann spruce (*Picea engelmannii* Parry). Common understory species include bitterbrush (*Purshia tridentata* [Pursh] DC.), manzanita (*Arctostaphylos patula* Greene), snowbrush (*Ceanothus velutinus* Dougl.), Idaho fescue (*Festuca idahoensis* Elm.), and needlegrass (*Stipa occidentalis* Thurb.).

In the outbreak area, lodgepole pine occurs extensively in pure stands in broad basins. On these sites, lodgepole pine is generally recognized as the topo-edaphic climax species possibly because of low spring temperatures which are believed to prevent the establishment of ponderosa pine (Berntsen 1967). On well-drained slopes where ponderosa pine and lodgepole pine are growing together, ponderosa pine is usually the climax species and lodgepole pine is a seral component in the stand. If lodgepole pine is found as a pure stand on slopes, it is usually as a result of logging or fire.

METHODS

The general distribution of the needle miner outbreak was determined from aerial and ground observations and from aerial color transparencies taken at the peak of the infestation. Because of extreme tree defoliation over much of the region, low population centers with little or no defoliation contrasted sharply with outbreak areas.

Six pairs of observation plots were established in the lodgepole pine basins for investigating needle miner outbreaks in relation to tree and site conditions. Three pairs of plots were located immediately northeast of Crescent Lake and three pairs to the east of Chemult in the broad basins east of Skookum Butte. Each paired plot overlapped zones of high and low population intensity, one plot of a pair in each intensity zone. In addition to the six paired plots, four random plots were located on adjacent slopes in zones of low needle miner intensity.

Considerable site and vegetation information was collected on the plots. Site index was measured by determining total height and age of 10 dominant trees nearest each plot center. Corrections in site index were made for stand density as described by Alexander et al. (1967). Basal area, crown competition factor, and number of stems were estimated from 1/5-acre sample plots. Annual radial increment throughout the life of the stand was investigated on dominant and codominant trees from increment cores taken at 3 feet above the ground. Extent of pruning and characteristics of tree crowns, such as fullness, density, and length, were noted but not quantified. Plant communities were described from the relatively abundant plants on randomly located milacre quadrats.

Soil profiles and tree rooting characteristics were examined from hand-dug soil pits and from excavation. Water table fluctuations in the soil pits were recorded throughout the season.

At four of the paired plots and on the four slope plots, soil moisture depletion and tree moisture stress were measured during two growing seasons. Soil moisture determinations were made with a neutron probe at three access tubes on each plot. Tree moisture stress was estimated by measuring xylem water pressure with a portable pressure bomb similar to the technique described by Waring and Cleary (1967). Sap pressure was read separately on an excised twig from each of three lodgepole pines at each plot. All pressure readings on twigs were completed within 1 minute from the time of excision from the tree. Maximum stress was determined from readings at midday and minimum stress from readings between 12 midnight and dawn, after trees had regained turgor.

As a means of diagnosis of possible nutrient deficiencies on different sites, foliage from all sites was analyzed for nitrogen, phosphorus, potassium, calcium, and sulfur. First-year needles were sampled from the midcrown of trees in September 1969. Analyses were made by the Department of Agricultural Chemistry, Oregon State University, Corvallis.

To gain information on the temperature environment, soil temperatures were monitored on plots at four of the paired plots during 1 week in early July 1970 by Dr. P. H. Cochran of the U.S. Forest Service, Bend Silviculture Laboratory, Bend, Oregon. Data were automatically recorded at 2-hour intervals for a 24-hour period at each location using thermistors for sensors. Temperature was measured at 2.5 inches above the soil surface and at depths of 2, 4, and 6 inches.

OBSERVATIONS AND RESULTS

Distribution of Outbreak Populations

Throughout the outbreak, heaviest needle miner defoliation was confined to extensive pure stands where lodgepole pine is regarded as the topo-edaphic climax species. The highest populations usually occurred in stands growing on level flats in broad basins except that defoliation was negligible on trees growing in and around intermittent drainages, meadows, or local depressions in such basins. Frequently, there were only slight topographical differences between infested and uninfested areas in the basins.

Nonetheless, as seen in the aerial photographs in figure 1, the contrast between defoliated and nondefoliated sites was definitely related to the drainage network. Other discontinuities in defoliation, especially around the fringes of basin outbreaks, were not clearly related to any obvious drainage patterns. Outbreak populations were also common in lodgepole pine growing on benches and along the sloping edges of large basins where ponderosa pine was still not present in the stand.

Needle miner populations rarely reached outbreak proportions on well-drained upper slopes where lodgepole pine is a seral species or is currently associated with ponderosa pine.

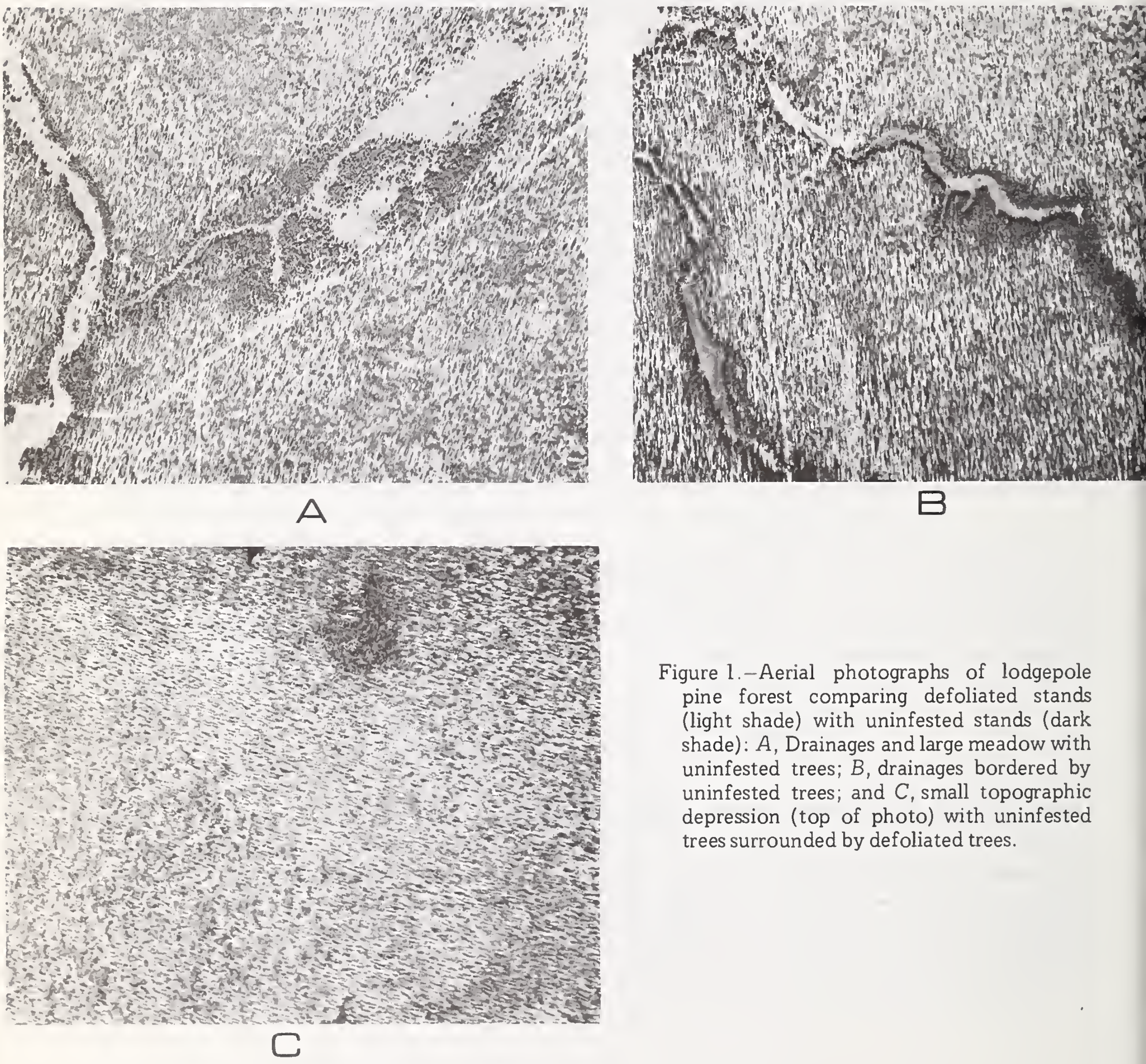

Figure 1.—Aerial photographs of lodgepole pine forest comparing defoliated stands (light shade) with uninfested stands (dark shade): *A*, Drainages and large meadow with uninfested trees; *B*, drainages bordered by uninfested trees; and *C*, small topographic depression (top of photo) with uninfested trees surrounded by defoliated trees.

Soil Characteristics and Water Table

A seasonally high water table was a common feature of all uninfested sites studied. During the early spring of 1969, ground water was at or near the surface; and by the end of the summer, it was still only 3 feet deep. By comparison, the water table in infested areas was usually several feet deep in early spring and at the end of the summer was frequently well below the pumice mantle. An example of water table changes at infested and uninfested sites at one paired plot is shown in figure 2.

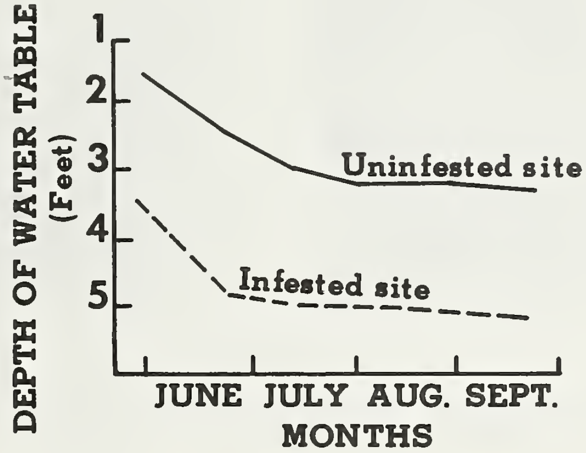

Figure 2.—Comparison of water table fluctuations at paired plot near Crescent Lake.

Soil profiles were also conspicuously different between some infested and uninfested sites. For example, in the drainages and poorly drained depressions, the weathered A and AC horizons were often 24 inches thick, whereas the same two horizons seldom exceeded 10-inch thickness in the surrounding flats (fig. 3). However, such differences were not consistent throughout the paired plots. Not all uninfested sites in the basins contained deep A and AC horizons, although they were usually associated with drainage networks and a high water table.

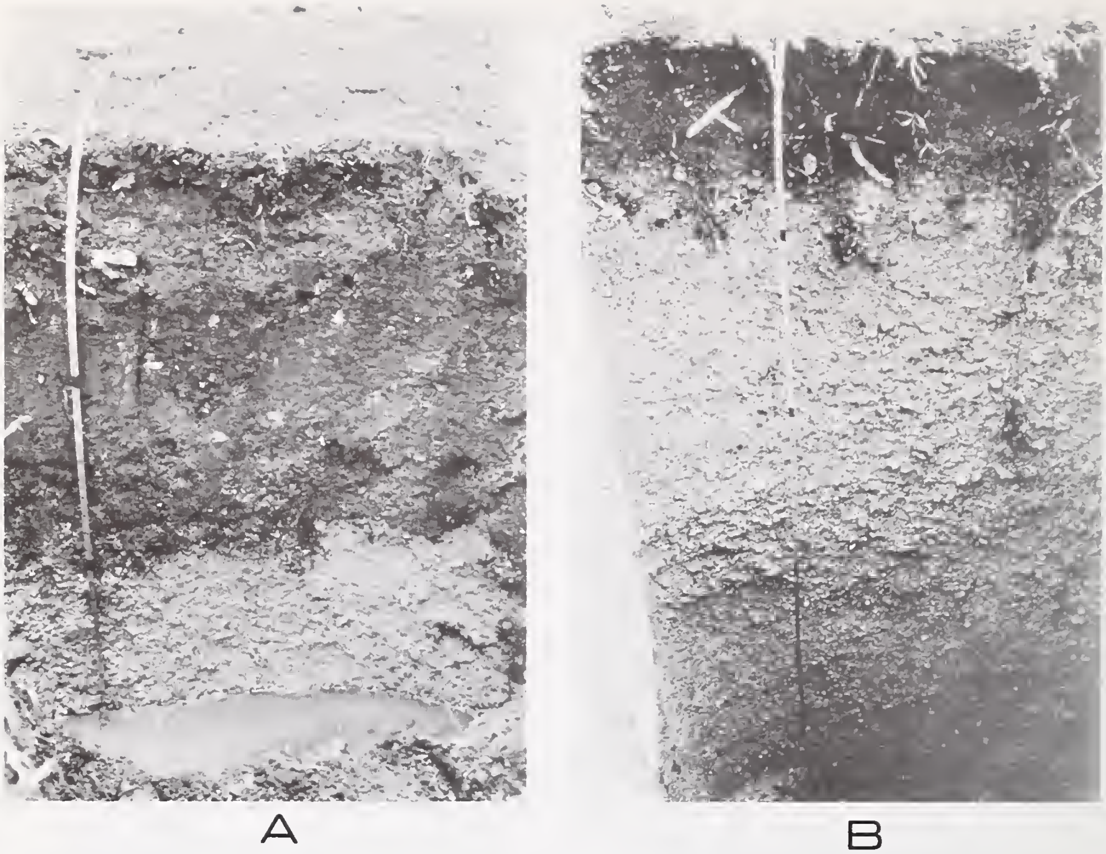

Figure 3.—Soil profiles showing the depth of the A and AC horizons on: *A*, An infested basin site; and *B*, an uninfested drainage site.

Tree Rooting and Crown Characteristics

In the infested basins where the pumice mantle was deep, lodgepole pine roots were generally confined to the A and AC horizons which included about the surface 10 inches of soil (fig. 3). Roots were generally not present in the gravelly C horizon. On poorly drained uninfested sites where the pumice mantle was relatively shallow, rooting was stratified into layers according to the suitability of the soil horizons for root growth (Bishop 1962). The top layer of roots occupied the A and AC horizons, and another layer connected to the first by "sinker roots" developed at a lower level (fig. 4). The stratified patterns apparently developed because of a high water table or because an older buried soil was near the surface.

In general, the crowns of lodgepole pines on uninfested sites were conspicuously larger and fuller than crowns of trees on infested sites. This characteristic prevailed before defoliation took place.

ERRATA SHEET

Photos of Figure 3, page 6, of the following publication should be reversed. Right photo should be "A"; left photo "B" in:

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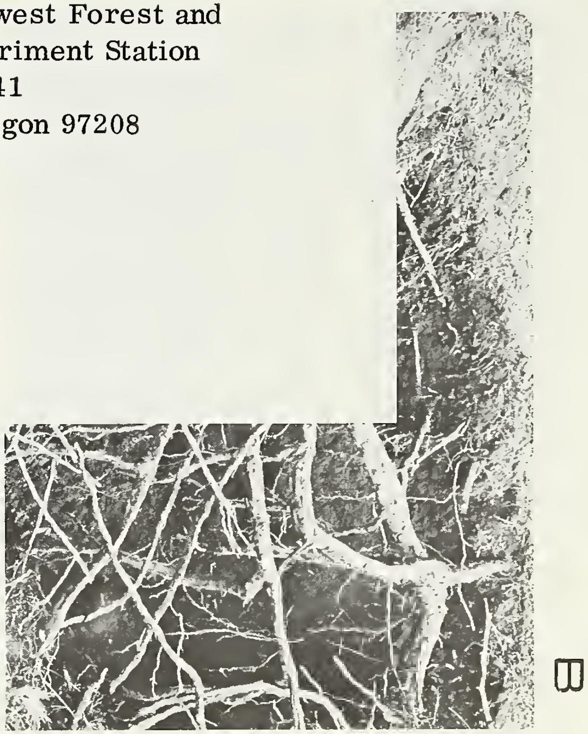

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Table 1.--*Comparison of lodgepole pine site index, stand density, and stand stocking on infested basin (BA) and uninfested drainage (DR) sites at five paired plots*

Paired plot	Site index[1]		CCF[2]		Basal area[3]		Number of trees[4]	
	DR	BA	DR	BA	DR	BA	DR	BA
Skookum Butte:								
I	64	61	151	109	140	82	451	568
II	78	66	213	110	167	95	1,118	455
III	62	67	153	86	120	66	774	546
Crescent Lake:								
IV	73	58	196	104	175	82	630	475
V	80	66	153	87	130	74	634	305
Mean	71	64	173	99	146	80	721	470

[1] Average height in feet at 100 years.

[2] Crown competition factor. A base value of 100 implies complete occupancy of space without crown competition between trees. From this base, stand density is expressed as a percentage (Krajicek et al. 1961).

[3] Square feet per acre.

[4] Per acre.

Figure 5.—Stand stocking on: *A*, An infested basin site; and *B*, an uninfested drainage site.

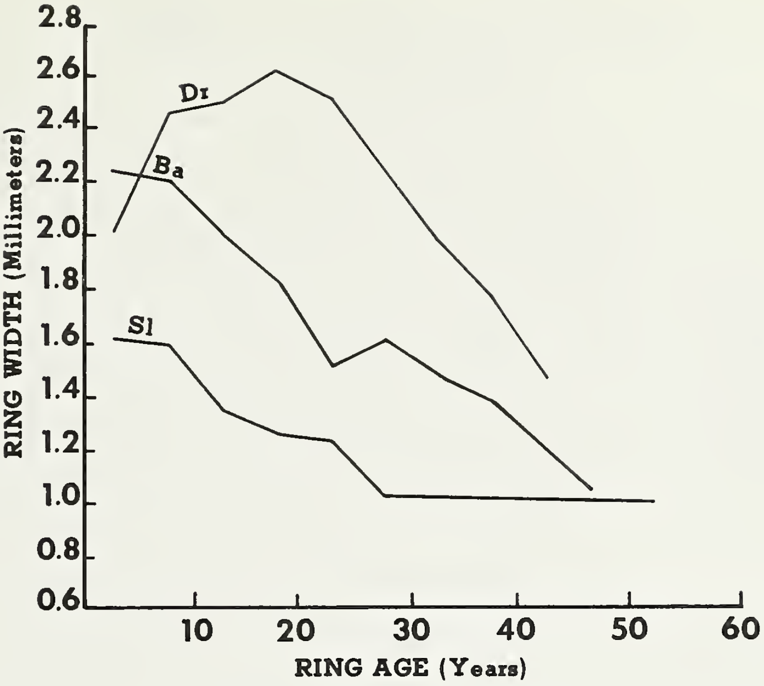

Figure 6.—Comparison of annual increment of lodgepole pine on three sites in outbreak area (Sl—slopes, Dr—drainages, Ba—basins).

As needle miner populations diminished at the border of the basins, there was a simultaneous change in the associated plant communities. Most conspicuous was the entry of manzanita and snowbrush into the understory with a slight increase in elevation. Similarly, ponderosa pine eventually became a component in the overstory because of improved drainage and warmer surface temperatures associated with the slopes. Vegetation on the uninfested slopes was comparable to the *Pinus contorta/Purshia tridentata-Arctostaphylos patula* community where lodgepole pine is largely a seral species. The climax phase of this community, the *Pinus ponderosa/Purshia tridentata-Arctostaphylos patula* association, has been described by Dyrness and Youngberg (1966).

Soil Moisture Depletion

Overwhelming empirical evidence suggested that within the needle miner outbreak, sites having a particularly favorable supply of soil moisture were unsuitable for the buildup of needle miner populations. Trees growing near drainages or on high water tables in the basins were relatively free of defoliation. Outbreak populations were also absent where lodgepole pine was growing with ponderosa pine on well-drained slopes, a site where trees were more deeply rooted and were expected to come under less

Table 2.--*Relative abundance of common plants on infested basin sites and uninfested drainage sites*

Species	Uninfested drainages		Infested basins	
	Density[1]	Constancy[2]	Density[3]	Constancy[2]
Trifolium longipes	300	4	0	0
Fragaria virginiana	(4/)	4	0	0
Penstemon cinicola	2.4	4	0	0
Rumex paucifolius	11.1	2	0	0
Potentilla gracilis	7.1	2	0	0
Horkelia fusca	.5	2	0	0
Stipa occidentalis	8.7	4	20.0	5
Achillea millefolium	8.3	4	3.5	3
Lupinus lepidus	.3	2	3.0	5
Spraguea umbellata	0	0	2.2	4
Viola purpurea	0	0	.9	3
Haplopappus Bloomeri	0	0	.4	3
Purshia tridentata	0	0	.3	2
Eriophyllum lanatum	0	0	.2	2
Agoseris glauca	6.8	2	.4	2
Sitanion hystrix	.6	2	.1	1
Poa sp.	(4/)	1	0	0
Moss	(4/)	1	0	0
Others[5]	11.3	4	.2	1

[1] Mean of 15 milacre plots.

[2] Number of paired plots where found.

[3] Mean of 25 milacre plots.

[4] Dense.

[5] *Vaccinium* sp., *Silene* sp., *Aster* sp., *Castilleja* sp.

moisture stress than in the basins. Therefore, soil moisture flux in drainages, basins, and on slopes was investigated in some detail during the 1969 and 1970 growing seasons.

Soil moisture depletion from the three sites at 12- and 24-inch depths is shown in figure 7. Field capacity occurs at about 40-percent moisture content, and the soils are completely saturated at 50 percent (Youngberg and Dyrness 1964). On the drainage and basin sites, water content below 24 inches remained near or above field capacity because of high water tables or lack of water use at that depth. On slope sites where rooting was deeper, water was depleted from lower depths but at a slower rate. Soil moisture was higher on drainage sites than on basin sites early in the summer but was depleted faster from the drainages, so that by the end of the summer there appeared to be more available water in the top foot on basin sites than on drainage sites. On both sites, moisture appeared to be readily available for tree use throughout the summer.

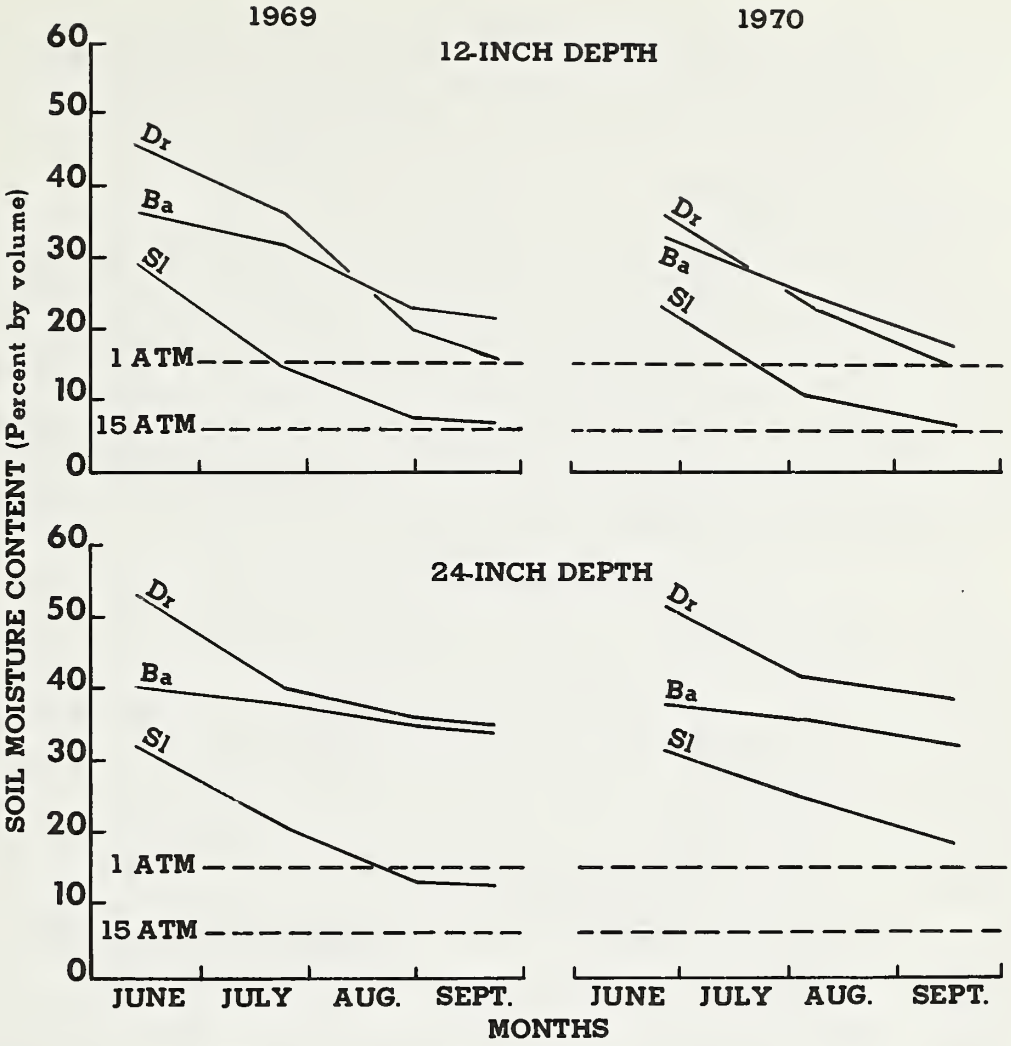

Figure 7.—Soil moisture depletion at two soil depths on three different sites (S1—slopes, Dr—drainages, Ba—basins).

By comparison, soil moisture content at the 12-inch depth on slope sites approached the permanent wilting percentage late in the summer. However, moisture was still available at lower depths.

Total water consumption from mid-June to mid-September at the 24-inch depth was greater on the drainage sites than the other sites. In terms of percentage reduction in soil moisture content, from 1-1/2 to two times as much water was used during that period on the drainage sites as on the basin sites. In the basins, water use may have been reduced somewhat by the lack of a normal complement of foliage due to past needle miner defoliation. However, by midsummer of 1969, all trees contained at least 2 years' undamaged needles. Depletion of water at the 24-inch depth was also greater in the drainages than in the basins. In general, vegetation of all types was more dense, tree foliage more abundant, and soils more completely occupied by roots in the drainages. As a result, water was withdrawn more rapidly from drainages than from basins. Total water use on the slopes seemed to be comparable to that in the drainages except that water was withdrawn from a greater portion of the soil profile.

Tree Moisture Stress

Trends of maximum and minimum moisture stress values during peak 1969 and 1970 drought periods as determined with the pressure chamber are given in figure 8. Maximum and minimum tension values increased 0 to 3 bars over the course of the 6-week measurement periods as moisture was depleted from the soil. Tension values decreased 5 to 6 bars during overnight recovery. Moisture stress appeared to be highest on slope plots, but there was little measured difference in the stress values on drainage and basin sites. These findings seem to support the results of the soil moisture depletion studies which showed that moisture was equally available to trees on drainage and basin sites but was less available on the slopes.

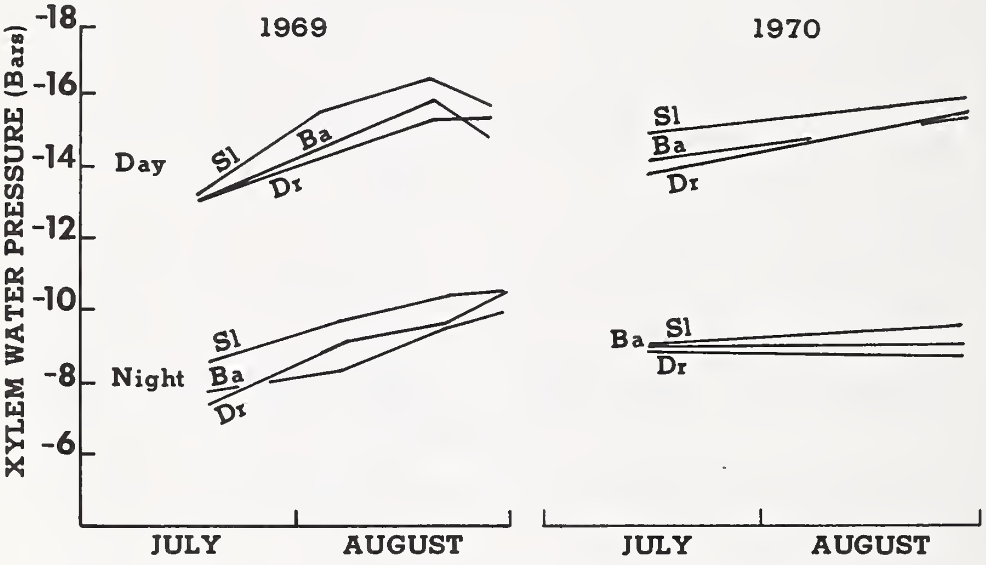

Figure 8.—Seasonal trend of moisture stress in lodgepole pine on three different sites (Sl—slopes, Dr—drainages, Ba—basins).

Possible differences in tree moisture stress were investigated further by determining diurnal stresses on each site. Examples of the pattern of daily moisture stress at two different areas during the peak drought period are shown in figure 9. In both years, the rise in tree moisture tension from early to midmorning was almost identical on the drainage and slope sites. Tension trends on the basin sites were also similar to the other sites at Skookum Butte but did not appear to be as steep at Crescent Lake. Peak moisture stress usually occurred between 10 a.m. and 12 noon and was often followed by a slight drop in tension. After 3 p.m., moisture stress declined again to an eventual equilibrium point as illustrated by the 1969 data. The general pattern of daily stress was closely related to vapor pressure deficit.

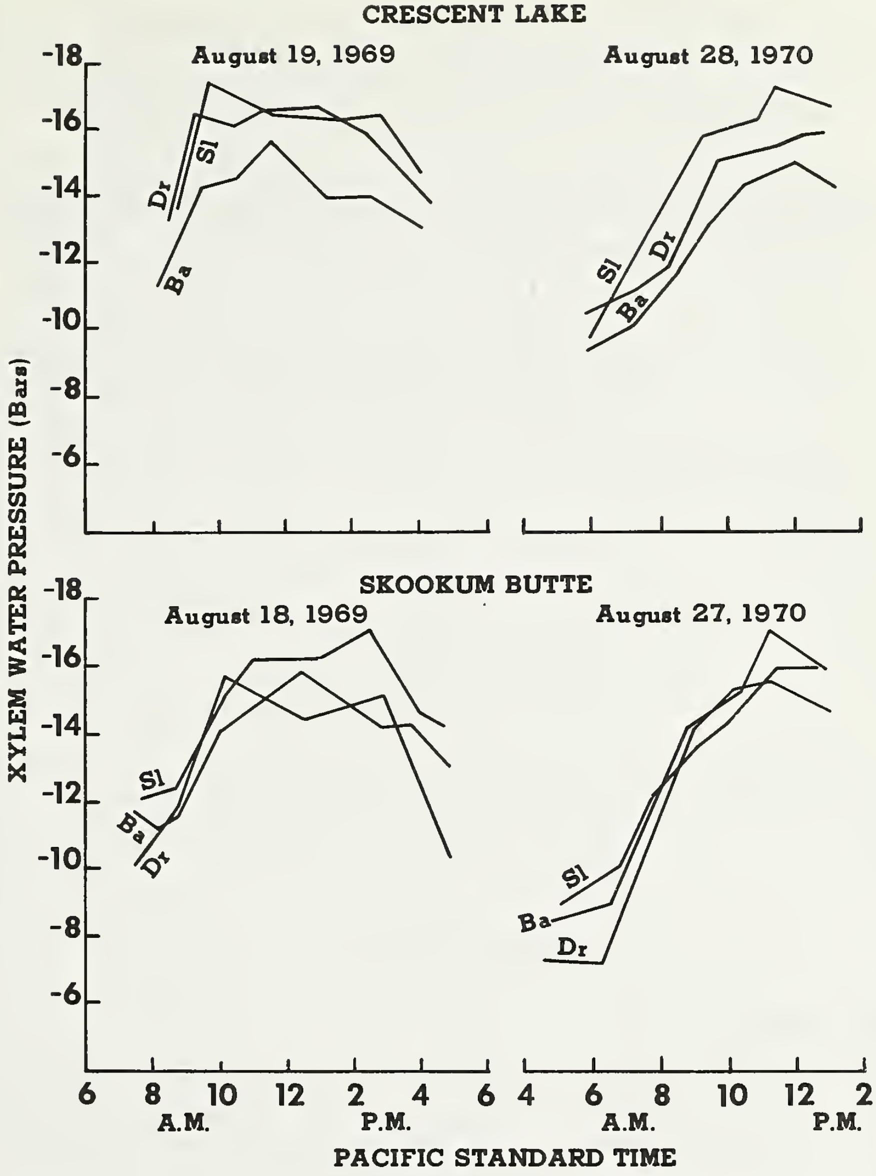

Figure 9.–Diurnal trend of moisture stress in lodgepole pine on three different sites (Sl–slopes, Dr–drainages, Ba–basins).

Foliar Analyses

The chemical composition of foliage is considered to be a good indicator of the availability of essential nutrients for tree use (Kramer and Kozlowski 1960). An obvious deficiency in the foliage of an essential element might indicate a shortage of that nutrient in the soil. In studies of pumice soil fertility in central Oregon, Youngberg and Dyrness (1965) found that nitrogen, phosphorus, and sulfur were the nutrients that were most often deficient. Tree growth characteristics and poorly developed soils associated with the basins gave every indication that these sites might be relatively deficient in certain nutrients compared with the uninfested drainage sites. However, in the foliar analyses of trees on three sites at each of two locations, there were no statistically significant differences in concentration of any of the five elements examined (table 3).

The slightly lower concentrations of nitrogen in foliage from the slope plots were the only consistent differences at both locations. No consistent nutrient difference is discernible between basin and drainage sites.

Table 3.--*Concentration of five elements in first year foliage from the midcrown of lodgepole pines*

Location and site	N	P	K	Ca	S
	Percent of dry weight				
Crescent Lake:					
Basin	1.04	0.18	0.29	0.10	0.13
Drainage	1.02	.06	.28	.08	.13
Slope	.92	.16	.27	.08	.13
Skookum Butte:					
Basin	1.03	.06	.32	.09	.16
Drainage	1.12	.06	.29	.10	.14
Slope	.90	.09	.26	.08	.10

Soil Temperature

The temperature environment, particularly at the forest floor, appeared to be cooler on the drainage sites than in the basins. Because of high stocking of pines and relatively dense crown canopy, much of the forested portion of the drainage was well shaded most of the day (fig. 5). To investigate possible temperature differences between sites, we recorded midsummer soil temperatures on drainage and basin sites at four different locations. The mean values of these readings at 2-hour intervals and at three soil depths are plotted in figure 10. They show that drainage soils were consistently cooler and that, at midday, temperatures near the surface may be as much as 10° C. lower than the more exposed basin sites. Discrepancies were less at night and at deeper soil levels; however, temperatures at the 4- and 6-inch depths in the drainages remained several degrees lower than at comparable depths in the basins. Lodgepole pines growing in the basins are extremely shallow rooted, and most of the roots are restricted to the top 10 inches (fig. 4). Therefore, the soil temperatures in that zone probably accurately characterize the rooting environment of basin trees. Tree roots in the drainages grow to a much lower depth where they may encounter temperatures even lower than those measured.

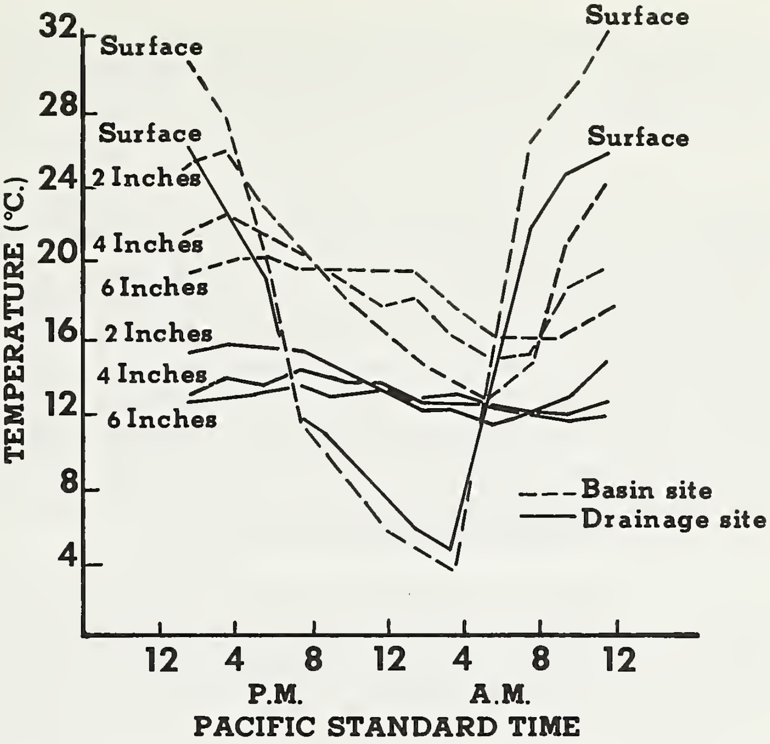

Figure 10.–Diurnal trend of surface (2.5 inches above) and soil temperatures (2-, 4-, and 6-inch depths) at basin and drainage sites during week of July 6 to 10, 1970. Plotted values are the mean of readings from four paired plots for each type of site.

DISCUSSION

The results clearly show that site influenced the distribution of populations in the needle miner outbreak. High populations occurred only in pure stands in broad basins where lodgepole is considered the climax species. Outbreaks did not develop on imperfectly drained sites in the basins or on well-drained slopes where lodgepole pine is seral. Based on these conclusions, the probable risk of sites to needle miner infestation might be noted according to vegetational classifications as follows:

Pinus contorta/Purshia tridentata community	High risk
Pinus contorta/Arctostaphylos uva-ursi community	Low risk
Pinus contorta/Purshia tridentata-Arctostaphylos patula community or *Pinus ponderosa/Purshia tridentata-Arctostaphylos patula* association	Low risk

Relation of site variability to infestation raises a question concerning the causes responsible for population buildup. Such a question cannot be answered conclusively without long-term studies in needle miner population dynamics where causes of population change are identified. However, we can look at certain factors that vary conspicuously between high and low risk sites and speculate on their importance to population survival.

The *Pinus/Purshia* community has a relatively simple structure compared with other vegetation classes. It is dominated by a single-species overstory and consists of only sparse vegetation in the understory. As a result, the buildup of populations may be favored in this community by both a continuous supply of food for infestation and a lack of natural enemies due to the scarcity of diverse cover types. The other communities mentioned are generally characterized by a richer composition of species which could result in needle miner populations being stabilized at a lower level. For example, in the *Pinus ponderosa/Purshia-Arctostaphylos* association, the primary food is not continuously available in a spatial sense but is interspersed with nonhost foliage of ponderosa pine. Also, there is probably a greater range of natural enemies in this community because of the mixture of species and cover types.

The low incidence of infestation in *Pinus/Arctostaphylos* or similar wetland communities may be due significantly to physiological differences in trees. Most of the drainage sites are relatively narrow and were subject annually to invasion by ovipositing moths from the surrounding infested forests. However, the trees remained relatively free of infestation, apparently because the foliage was resistant to serious attack.

In field and laboratory studies, Tigner and Mason[1/] found that lodgepole pine foliage has variable resistance to needle miner infestation. Degree of resistance is influenced by foliage age, the location of foliage in the crown, and by tree growing conditions. These studies demonstrated that first instar larvae are significantly more successful in mining needles from basin sites than from drainage sites. The same experiments also showed that the top portion of the crown, where growth processes are particularly active, exhibits a higher degree of resistance to infestation than lower parts of the crown. These results indicate that tree growth processes have an effect on the quality of needles available for mining. Consequently, the physiological state of a tree or stand may well determine its degree of resistance to infestation.

Environmental conditions in the drainage sites were especially favorable for tree growth. This was reflected in site index, basal area, tree density, and annual increment, all of which were significantly higher on the wet, uninfested sites than on the basins. Increased productivity was apparently due to the deeper, seasonally wet and perhaps cooler soils in the drainages. Surprisingly, these conditions did not result in lower moisture stresses in the current trees but must have had considerable influence on tree characteristics and stand development. A high water table and deep soil apparently provided favorable conditions for the establishment and growth of a much denser stand of trees than where these conditions were lacking. Subsequent shading of the

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[1/] *T. C. Tigner and R. R. Mason. Resistance to a needle miner in lodgepole pine varies with foliage source. Environmental Entomology (submitted for publication).*

ground modified summer temperatures and may have further enhanced site quality. Thus, because of a combination of interacting factors, vigorous stands of lodgepole pine have developed in the drainages of an area which otherwise supports relatively poor quality trees. All evidence indicates that these types of stands are physiologically resistant to heavy needle miner infestation and defoliation.

Obviously, all portions of a forest type are not equally subject to the same degree of insect infestation. Because of the complexity of the variables and interactions which affect most population systems, we can only rarely expect to understand adequately the processes causing variations in population levels. However, from the management point of view, a useful alternative is the recognition of patterns of population distribution as they may be related to land use, topography, or stand and vegetational classifications. Identification of these relationships should be valuable for planning courses of action in pest population management and for predicting probabilities of infestation.

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The distribution of an outbreak population of a lodgepole needle miner, *Coleotechnites* near *milleri* (Busck), in central Oregon was studied in relation to forest stand and site characteristics. It was concluded that degree of infestation is influenced by a combination of environmental and physiological factors that vary significantly under different forest-site conditions.

KEYWORDS: *Pinus contorta* Douglas, lodgepole pine, *Coleotechnites* near *milleri*, lodgepole needle miner, tree diseases, insect pests.

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