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WEEVILS ATTRACTED TO THINNED LODGEPOLE PINE STANDS IN MONTANA

DAVID G. FELLIN

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APR 10 1974

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ABSTRACT

Silvicultural operations often alter the forest environment to provide conditions suitable for the development of forest pests. In this study, weevils [Magdalis gentilis LeC. (Coleoptera: Curculionidae)] were attracted to thinned stands of lodgepole pine, Pinus contorta var. latifolia Engelm., in west-central Montana. Adult weevils fed on current-year needles of crop trees, often resulting in loss of 75 to 100 percent of the foliage. Weevils did not appear to feed on, or breed in, the slash, nor were they found in unthinned stands. Although not considered to be serious, weevil damage can be reduced, or perhaps eliminated by not thinning lodgepole pine stands before late July or mid-August. With an increase in the acreages of forest plantations and naturally regenerated areas in the northern Rocky Mountains, it can be expected that problems involved with insect pests of young trees will be experienced more frequently.

Introduction

There are approximately 25 million acres of stocked commercial forest land in the northern Rocky Mountains:¹ 51 percent is in sawtimber; 37 percent, pole-size trees; and 12 percent, seedlings and saplings. Land supporting mature sawtimber stands is rapidly being converted to growing young trees; each year, about 2.8 billion board feet of sawtimber is harvested. These cutover lands are restocked either artificially by the land manager using direct seeding and planting, or by natural seeding. Artificial methods often are desirable because they assure well distributed trees over the area, as well as giving strong species control. However, cutover areas that regenerate naturally are often overstocked, particularly in forests of western larch, *Larix occidentalis* Nutt., and lodgepole pine, *Pinus contorta* var. *latifolia* Engelm. These dense young stands are often thinned to minimize competition and to provide optimum growing conditions for crop trees (fig. 1).

This paper describes the association of a tiny defoliating weevil, *Magdalis gentilis* LeC., with young, precommercially thinned stands of lodgepole pine. It is based on 4 years of observations (1965-1968) and describes the development of the problem and assesses the (a) nature of the weevil feeding; (b) damage caused by the weevil; (c) relationship between the occurrence of the weevil and silvicultural thinning operations; (d) role of slash in weevil infestations; and (e) seriousness of the problem. The paper also discusses some other forest insect problems associated with forest management practices.

¹Encompassing western Montana, northern Idaho, and northeastern Washington.

Figure 1.--A young stand of lodgepole pine shortly after having been thinned in the Rumsey Mountain area of the Deerlodge National Forest. When thinned, the stand was extremely overcrowded. Cut trees are lying just as they fell; remaining crop trees are spaced about 10 feet apart. Stumps from earlier clearcutting are visible throughout the area.

Development of the Problem

Magdalis gentilis LeC. belongs to a group of small black or blue weevils, the larvae and adults of which feed on the foliage or shoots of pine in many forests of the United States and Canada, as well as of other countries. Most species of *Magdalis* breed in slash, or in dead and dying portions of standing trees; accordingly, they are not particularly troublesome. However, some species are significant pests of young pine stands.

Until the mid-1960's, there were no records that any species of *Magdalis* had caused any significant amount of damage in the northern Rocky Mountain region. The known collections made since the weevil was first reported in the northern Rockies in 1923 have been scattered and infrequent, as shown in the following tabulation:

<i>Species</i>	<i>Locality</i>	<i>Year</i>
<i>M. gentilis</i> LeC.	Glacier National Park, Montana	1923
<i>M. lecontei</i> Horn	New Meadows, Idaho	1929
<i>M. imbellis</i> (LeC.)	Coeur d'Alene, Idaho	1932
<i>M. lecontei</i> Horn	Setters, Idaho	1963

In 1965, a rather severe infestation of *M. gentilis* was detected on an 18-acre tract of lodgepole pine regeneration on the Lewis & Clark National Forest in west-central Montana. This site had supported a 150-year-old stand of lodgepole pine which had been clearcut in July of 1954. The logging residue was dozer-piled in October and was burned in November of that year. Lodgepole pine regenerated naturally; between June 1 and 10, 1965, the young overstocked stand was thinned.² Early in August, foresters working in the area noticed that foliage on many of the crop trees was discolored. I examined the trees late in August and found numerous *M. gentilis* adults feeding on the needles (Fellin and Schmidt 1966).

Since this discovery in 1965, I have observed several other instances of *M. gentilis* damage to lodgepole pine regeneration on the Lewis & Clark National Forest. In all instances, weevils appeared in stands that had regenerated naturally following clearcutting and then had been precommercially thinned.

²The forest management practices on this site are typical of those being used over extensive areas of lodgepole pine on the Lewis & Clark National Forest (fig. 2).

Figure 2.--Clearcut areas in various stages of management on the Lewis & Clark National Forest in west-central Montana. A recently cut area with unburned dozer-piled slash shows in foreground. Near the center are two areas where slash has been piled and burned. To right of center are two areas that have naturally regenerated to lodgepole pine. The lower one has been thinned; the other has not. Other clearcut areas can be seen scattered throughout the rest of the forested area. Nontimbered areas in upper left of photo are natural mountain parks.

Nature of Weevil Feeding and Damage

Weevil damage is in the nature of defoliation caused by adults feeding on the needles of the current year's shoots. In preparing to feed, adults position themselves longitudinally on the needle (fig. 3) usually facing the tip. As feeding begins, the needle epidermis is first punctured by the mandibles, then feeding continues on into the palisade layer and other needle tissues. At times, a weevil will abandon a feeding site at this point and move elsewhere to begin a new feeding puncture. When this happens, the needle is not completely punctured. At other times, the weevil feeds at a given point until a hole is punctured clear through the needle (fig. 4).

Shortly after the punctures are made, those portions of the needles outward from the feeding site desiccate and discolor, providing the puncture went deep enough into the needle (fig. 5). Dried-up portions of the needles are blown away by wind, or broken off by rain or snow, leaving only a needle stub proximal to the feeding puncture. Occasionally, damaged portions of needles persist through the following spring and summer.

If feeding is only superficial, the portion of the needle beyond the puncture remains green and persists. The second needle from the left in figure 5 shows such a superficial feeding puncture. When a deep puncture is made through the needle sheath, both needles are usually damaged and the entire fascicle is lost. Weevils do not restrict their feeding to any particular area along the length of the needle.

Figure 3.--Adult *Magdalis gentilis* LeC. preparing to feed while astraddle a lodgepole pine needle.

Figure 4.--Four lodgepole pine needles showing feeding punctures made by adult weevils, *Magdalis gentilis* LeC. Feeding on the second needle from the left has completely punctured the needle. Feeding on the other three represent only partial punctures.

Figure 5.--Seven lodgepole pine needles damaged by feeding of adult *Magdalis gentilis* LeC. Those portions of the needles outward from the feeding punctures have desiccated, discolored, and curled up along their longitudinal axis. The second needle from the left shows two feeding punctures; only the outermost one was severe enough to cause desiccation and curling.

Damaged shoots are quite distinctive soon after the feeding period is over, while dead portions of needles remain attached. Distal portions of damaged needles, though still attached, hang down or lie at all angles throughout the foliage (fig. 6). As long as damaged discolored portions of the needles remain attached, trees have an overall reddish-brown color. Undamaged needles or portions of needles remain green. The condition of a shoot bearing many damaged needles, as seen in figure 6, is more easily realized when compared to an undamaged shoot (fig. 7).

Near the end of the growing season the year following *Magdalis* defoliation, the damaged shoot generally lacks needles; many of those that are present are only stubs remaining after distal portions broke off. At that time, undamaged current year's foliage appears as a tuft on the end of the branch (fig. 8).

Defoliation resulting from needle feeding is the only type of *Magdalis* damage I observed on the young crop trees in thinned areas. There was no indication that adults oviposit nor that larvae feed in or on the shoots or any other portions of the standing trees.

Figure 6.--Current shoot of lodgepole pine showing many needles damaged by adult *Magdalis gentilis* LeC. as seen shortly after the feeding period is over. The distal portions of those needles that have been punctured hang down or lie at all angles throughout the foliage.

Figure 7.--Normal shoot of lodgepole pine on which needles are free of *Magdalis* damage.

Figure 8.--Terminal section of lodgepole pine shoot showing undamaged current-year foliage and defoliation of the year-old shoot. The year-old growth shows a general lack of needles (compared to abundant foliage on the current year's shoot) and short needles remaining after distal portions broke off beyond feeding punctures.

Association of Weevil Damage With Precommercial Thinnings

There is a positive relationship between the occurrence of weevil damage and precommercial thinnings. The presence of weevils is also closely related to when the thinnings are made. Slash resulting from thinning operations appears to attract the weevils to the area thinned but apparently is not utilized by the insect during any stage of its development.

Weevil Damage in Thinned Areas

During 1965 through 1968, I examined 75 areas on the Lewis & Clark National Forest that had regenerated naturally following clearcutting. Forty-five of these had been precommercially thinned--the remainder left unthinned. I found no significant weevil damage to foliage on trees in any of the unthinned areas. However, occasional needle punctures often could be found most everywhere because of the vast areas of lodgepole pine regeneration and the abundance of the weevil.

I devised a numerical system to analytically evaluate damage. Several dozen new growth shoots that represented varying amounts of damage were examined and the numbers of damaged and undamaged fascicles were counted. Six general categories of damage were arbitrarily chosen as follows:

<i>Damage category</i>	<i>Percent of fascicles damaged</i>
0 (None)	0
1 (Occasional)	<1
2 (Light)	2-25
3 (Light to moderate)	25-50
4 (Moderate to heavy)	50-75
5 (Heavy)	>75

Adult weevils usually confine their damage to crop trees within thinned stands. However, if a young unthinned stand borders the thinned area, weevils often damage trees along the periphery of the unthinned area. Seldom though will damage extend more than 15 or 20 feet from the thinning area boundary. However, weevils do not damage foliage of mature trees bordering thinned stands even where crop trees are heavily damaged.

In one instance, weevils were attracted to an area where logging slash--composed of treetops and limbs--accumulated following clearcutting for posts and poles. They fed on foliage of young lodgepole pine along the periphery of a dense unthinned stand adjoining the clearcut, because there were no young crop trees on which to feed.

There appeared to be no relationship between incidence of weevil damage and the height or size of crop trees--damage was evident throughout the crown. In one thinning, heavily infested crop trees varied from 1.5 to 6 feet tall and from one-half to 3 inches in diameter (at a point 1 foot above the ground). In other thinnings, weevils damaged crop trees 15 feet tall. Another species of *Magdalis*, *M. perforatus* Horn, attacks trees of all ages but adult weevils prefer to oviposit and feed on trees under 10 or 12 feet in height in red pine (*Pinus resinosa* Ait.) plantations in Ontario, Canada (Martin 1962, 1964).

Two observations were made suggesting that *M. gentilis* adults might prefer a more open and/or less shaded environment. Many young thinned stands were surrounded by stands of mature lodgepole pine. In such cases, trees near the edge of the thinned area, which at times were shaded by the adjacent uncut stand, usually suffered less weevil injury than unshaded trees toward the center of the thinned stand. A second observation was made in an experimental area where trees had been thinned at intensities varying from 6 by 6 feet (1,200 trees/acre) to 18 by 18 feet (150 trees/acre). Examinations of 144 trees in this study area in August 1965 indicated that crop trees in the more intensely thinned plots were more severely damaged (fig. 9).

Figure 9.--Relationship of needle damage by *Magdalis gentilis* LeC. to the number of lodgepole pine crop trees per acre, Lewis & Clark National Forest, Montana. (See tabulation, page 10.)

One might speculate that damage to crop trees in plots having fewer trees per acre might have been the result of a given number of weevils per unit area concentrating on fewer trees. However, other circumstances are known where weevils apparently preferred a more open or less shaded environment. *Magdalis perforatus* are most abundant in young, open plantations in Ontario, Canada (Martin 1964). The white pine weevil, *Pissodes strobi* (Peck), avoids understory white pines because of the effect of shading, rather than because the trees are small (Harman and Kulman 1969).

Weevil Damage and Time of Thinning

Perhaps the most critical factor determining whether crop trees in thinned areas will be damaged--and to what extent--by *Magdalis* adults is the time of year stands are thinned. Examinations of 45 thinned areas³ over a 4-year period indicated that:

(1) Crop trees in areas thinned before late July usually suffered moderate to heavy or heavy *Magdalis* damage; (2) if thinnings were completed early in August, light or light to moderate damage might still occur; and (3) crop trees in areas thinned after mid-August usually will have only occasional needle feeding or will not be damaged in that year. The 45 thinned stands, arranged in a 3 by 3 contingency table by thinning time and degree of damage, were subjected to a test of independence (Snedecor 1956). The calculated chi-square value substantiates the conclusion that the degree of *Magdalis* damage in thinned stands is highly dependent on the time of year stands are thinned.

The proximity of thinned areas further indicates the importance of time of thinning in predicting the intensity of damage to crop trees that can be expected. Many of the thinned areas shown in figure 10 (letters merely designate the cutting units) are only a hundred yards or so from their nearest neighbor; yet time of thinning in any area had no influence on the intensity of damage in any other area. For example, units N, O, P, Q, which were thinned in late July, were heavily damaged; yet weevils only lightly damaged crop trees in unit S, which was thinned in early August. Moreover, crop trees in unit L, which was thinned after mid-August, were undamaged.

Though crop trees in thinnings completed after mid-August usually do not become infested or experience only occasional needle feeding that year, slash from thinnings completed in early October or later usually is soon covered by snow (especially at higher elevations) and sometimes remains attractive to weevils the following spring. In late summer of 1968, I examined crop trees in four areas that had been thinned in early October of the preceding fall. In all areas, I found light weevil damage to the 1968 foliage. Two of these areas (D, M) are shown in relation to other thinned areas in figure 10. Usually, however, slash in areas thinned in early October or later--especially at lower elevations and/or on southern exposures--will deteriorate by the following spring or early summer and no longer be attractive to weevils.

During the period of study, adult *Magdalis gentilis* were flying and were attacking crop trees in thinned areas usually during late June and early August.

³Of these, 43 were thinned using portable rotary thinning saws. Two were thinned using a Marden Brush Cutter, a huge cylinder equipped with cutting blades pulled over the trees by a bulldozer (manufactured by the Marden Mfg. Co., Auburndale, Florida).

Role of Slash

Volatile odors produced by the newly felled trees, perhaps accompanied by other conditions resulting from silvicultural operations, appear to be what attracts weevils to thinned areas.⁴ Though adult weevils feed on foliage of crop trees in the thinned areas, the thinning slash does not appear to be utilized by *Magdalis* either as larvae or adults. This was repeatedly confirmed by carefully examining boles, limbs, shoots, and foliage of newly cut trees as well as of trees in all stages of deterioration from early spring to late fall over the 4-year study period.

The fact that *Magdalis gentilis* did not utilize thinning slash appears to be a unique behavior; other *Magdalis* species feed in or on slash, on other dead or dying material, or on weakened trees. In Ontario, Canada, adults of *M. perforatus* Horn oviposit in recently dead branches and larvae feed in the pith, sapwood, and inner bark of fresh slash from thinnings and prunings of young red pine, *Pinus resinosa* Ait., and Scots pine, *Pinus sylvestris* L. (Martin 1962, 1964). Upon emergence from the slash, adults feed on new shoots of standing trees. *Magdalis austera* Fall, *M. lecontei* Horn, and *M. cuneiformis* Horn breed in dead and dying broken branches, twigs or dead outer wood (Craighead 1950) as well as feed beneath the bark and into the wood of living shoots, killing small branches and terminal twigs (Keen 1952). However, as far as observed, they do no appreciable amount of damage (Doane and others 1936). Adults of the blue pine weevil, *M. frontalis* Gyll., feed on young shoots (Bukzeva 1965) and mine the buds (Karaman 1963) of weakened young pine. Larvae of the red elm bark weevil, *M. armicollis* (Say) often occur in immense numbers under the bark of dying or recently dead elms (Hoffman 1939). Red elm bark weevil adults are reported to have been attracted to and to have infested white elm, *Ulmus americana* L., which were cut as trap logs in Manitoba and Saskatchewan (Hildahl and Wong 1965).

⁴In another study, R. F. Schmitz (Research Entomologist, Forestry Sciences Laboratory, Moscow, Idaho) and I found that volatile material from foliage of ponderosa pine, *Pinus ponderosa* Laws., appeared to be primarily responsible for attracting the weevil, *Magdalis lecontei* Horn. In July 1966, we dissected two ponderosa pines each into three components: bole sections, nonfoliated portions of limbs, and foliage. We placed each component into saran-covered cages, and set the cages, along with empty cages, about 100 feet apart in a ponderosa pine thinning area. In early August, we collected eight and 24 times as many weevils from the cages containing foliage as we did respectively from cages containing nonfoliated limbs and bole sections. No weevils were attracted to empty cages.

Seriousness of the Problem

Damage to current year's foliage of lodgepole pine caused by feeding of *Magdalis* adults will probably continue in young stands as long as thinning operations are continued. However, at least three factors tend to discount the seriousness of the damage, even of heavy damage: (1) Damage is restricted to current year's foliage, and infestations in any thinning area do not persist for more than one growing season; (2) much of the feeding occurs after most of the tree growth has been completed for that season so the effects of defoliation on the tree may be negligible; and (3) there is no damage to newly developing shoots through either feeding or oviposition. Hence, even though defoliation might be reasonably heavy in a given year (fig. 6), a bud will be set and a normal complement of foliage will be produced the following year (fig. 8). Accordingly, I believe that *Magdalis* infestations in these young lodgepole pine stands should not now be considered as a serious forest insect problem. However, the complete role of this weevil in the lodgepole pine ecosystem cannot be assessed until its biology and ecology are thoroughly studied.

In the event that damage is ever felt to be intolerable, some preventive or control measures might be applied. Perhaps the most currently acceptable and permanent approach would be through a change in the time of year when thinnings are made. This study indicates that *Magdalis* damage to crop trees could be substantially reduced if thinning did not begin before late July and that defoliation could be practically eliminated if thinnings were deferred until mid-August.

Though less desirable than a silvicultural approach, chemical control could offer some temporary relief. In recent work (Bukzeeva 1965), 100 percent control of *M. frontalis* adults was achieved by dusting trees with 12 percent BHC (Benzene Hexachloride) at 18 pounds per acre at a period when adults were feeding. This approach could conceivably be taken with *M. gentilis* on lodgepole pine because the feeding habits of *M. frontalis* and *M. gentilis* adults are similar.

The association of the weevil and the lodgepole pine thinnings is an excellent example of how silvicultural operations altered the forest environment to provide conditions suitable for the development of a hitherto unknown pest of forest regeneration. Another instance of *Magdalis* damage associated with forest management practices has been observed since 1968. In 1969, *Magdalis* (probably *lecontei* Horn) adults caused spectacular defoliation to a young stand of ponderosa pine on the Fremont National Forest several miles south of Silver Lake, Oregon (Dolph and Pettinger 1969). According to reports,⁵ weevils were observed on July 26, 1969, feeding on needles around new bud clusters on small trees left standing in a 40-acre area from which the overstory had been logged.

⁵Personal communication on March 13, 1970, with Mr. Benton Howard, former Branch Chief, Insect and Disease Control, Division of Timber Management, USDA Forest Service, Region 6, Portland, Oregon.

Other Forest Insect Problems Associated With Forest Management Practices

Forests of different age classes, like people, usually are troubled by different problems, not the least of which in forest management are forest insects. Insect pests, such as various species of bark beetles, that are usually the most serious enemies of old-growth forests, are seldom troublesome in new forests of seedlings and saplings. On the other hand, forest insects that kill or deteriorate younger trees often are unknown or effect an insignificant amount of damage in the mature forest. Moreover, there are some, like the western spruce budworm, *Choristoneura occidentalis* Freeman, and the larch casebearer, *Coleophora laricella* Hbn., that have an impact, though differentially, on all age classes of their host trees. With time, forest insect problems of old-growth or overmature forests will wane in the northern Rocky Mountains because current forest management practices are converting an increasing proportion of commercial forest land into young even-aged forests of seedlings, saplings, and pole-size trees.

One example of such management practices is the planting of trees on what has heretofore been nonstocked or nonproductive forest land. In 1970, for example, coniferous trees were planted on more than 34,000 acres in the northern Rockies. Much of this acreage is considered to be some of the most potentially productive timberland in the Nation but on which only brush had been growing--a situation created by repeated wildfires over the years.

These wildfires also have been responsible for the development of extensive forests of western larch and lodgepole pine--two coniferous species that depend on fire for their establishment and early survival (Beaufait 1971). These even-aged, often single-species stands as such are predisposed to forest insect infestations, more so than young uneven-aged, mixed conifer forests. Moreover, many of these stands are so dense that they have stagnated to the point where they will never produce usable products. Many of them no doubt will have to be destroyed and replaced by new trees (Wikstrom and Wellner 1961).

Another management practice--clearcutting followed by prescribed burning--is necessary in many forest types to provide suitable site conditions for regeneration and to control species composition. Also, clearcutting is the only practical way to manage certain forests troubled with serious insect or disease problems.

Management of Engelmann spruce, *Picea engelmanni* Parry, forests in the northern Rockies during the last 20 years provides an excellent example of a change in forest insect problems that can occur as old-growth forests are converted to stands of young trees. During the fall of 1949, hurricane-force winds swept through northern Idaho and northwestern Montana laying large volumes of Engelmann spruce on the ground. Severe epidemics of the spruce beetle, *Dendroctonus rufipennis* (Kirby) (= *obesus* (Mannerheim)), developed in much of this downed timber during 1950 and 1951, spreading in 1952 to standing spruce throughout most of the spruce type in the northern Rockies. As a result, approximately 2.5 billion board feet of spruce timber was attacked by this beetle between 1952 and 1956 (Tunnock 1959). During this same period, thousands of acres of spruce forests were clearcut in northern Idaho and western Montana to salvage damaged and/or beetle-killed trees, both standing and windthrown. The outbreak steadily declined following its peak in 1953; by the late 1950's, no infestations were reported in many forest compartments.

As spruce beetle problems diminished with the logging of progressively more acres of mature and overmature spruce during the past two decades, an increasing number of clearcuts have been planted or have naturally regenerated with Engelmann spruce. Damage to these young trees by the Engelmann spruce weevil, *Pissodes strobi* (Peck) (= *engelmanni* Hopkins) steadily increased. These small weevils attack and kill or seriously injure terminal shoots of young trees, causing crooks in the trunk or a stunted, forked, and worthless tree (Keen 1952). By 1966, terminals destroyed by weevils were noticeable in almost all stands of spruce reproduction in the northern Rockies; some stands were recurrently damaged (Tunnock 1966). By 1971, the weevil was distributed throughout spruce stands in this region (McGregor and Quarles 1971), and terminal killing was prevalent throughout many areas. In some young trees, repeated attacks to live portions of the main bole killed the trees outright, or predisposed them to death by secondary insects. "In some areas" according to McGregor and Quarles (1971) "large blocks of young even-aged spruce offer ideal conditions for buildup and maintenance of weevil populations." No doubt this weevil will continue to be a serious problem in the management of Engelmann spruce in the northern Rockies. In British Columbia, the weevil has become generally recognized as an important pest, notably of spruce plantations (Molnar and others 1970).

We are experiencing some, and we can expect more, changes in our forest insect problems as increasing acreages of mature forests are being converted to stands of young trees. In some young stands, problems will develop from forest insects, such as the Engelmann spruce weevil, which characteristically and historically are pests only of young trees. In other young stands, ubiquitous forest insects, such as the western spruce budworm and the larch casebearer, will be responsible. At the present time, for example, western spruce budworm larvae (by severing stems of terminal shoots) are causing disfigurement and as much as a 30-percent reduction in height growth of young western larch (Schmidt and Fellin, in press).

We know very little, and sometimes nothing, of the role forest insects play in the management of young forests of seedlings, saplings, and pole-size trees in the northern Rocky Mountains. If we wish to minimize damage and losses caused by insects in these young coniferous stands, where much of our forest management effort is directed, more research effort must be devoted to the study of the biology, ecology, and impact of insects that affect forest regeneration.

References

- Beaufait, William R.
1971. Fire and smoke in western Montana forests. *In*: Forest land use and the environment, Richard M. Weddle (ed.). Mont. For. and Conserv. Exp. Stn., Sch. For., Univ. Mont., Missoula.
- Bukzeeva, O. N.
1965. The biology of *Magdalis frontalis*. Zool. Z. Moskva 44(1):55-59. (Russian)
Rev. Appl. Entomol. 55:425. (Abstr.)
- Craighead, F. C.
1950. Insect enemies of eastern forests. USDA Misc. Publ. 657.
- Doane, R. W., E. C. Van Dyke, W. J. Chamberlin, and H. E. Burke
1936. Forest insects. 423 p. New York:McGraw-Hill.
- Dolph, R. E., and L. F. Pettinger
1969. Forest pest conditions in the Pacific Northwest, 1969. Unpubl. Rep. Insect and Dis. Control Branch, Div. Timber Manage., Pac. NW Reg., USDA For. Serv.
- Fellin, D. G., and W. C. Schmidt
1966. *Magdalis gentilis* LeConte (Coleoptera: Curculionidae) a newly discovered pest of forest regeneration in Montana. Mont. Acad. Sci. Proc. 26:59-60.
- Harman, D. M., and H. M. Kulman
1969. Dispersion of released white pine weevils in intrastand growth types. Ann. Entomol. Soc. Am. 62(4):835-838.
- Hildahl, V., and H. R. Wong
1965. Distribution of the native elm bark beetle, *Hylurgopinus rufipes* (Eich.) in Manitoba and Saskatchewan. Entomol. Soc. Manitoba Proc. 21:36-38.
- Hoffman, C. H.
1939. Observations on the biology of *Saperda tridentata* Oliv. and *Magdalis armicollis* (Say) (Coleoptera). J. Econ. Entomol. 32(6):848-851.
- Karaman, Z.
1963. The blue pine weevil, *Magdalis frontalis* (Gyll.), in Macedonia. Plant. Prot. 14(75):553-555. (Yugoslavian) Rev. Appl. Entomol. 53(1):335. (Abstr.)
- Keen, F. P.
1952. Insect enemies of western forests. USDA Misc. Publ. 273.

- Martin, J. L.
1962. *Magdalis perforatus* Horn on *Pinus resinosa* Ait. in Ontario. Can. Dep. For., For. Entomol. and Pathol. Branch, Bi-mon. Prog. Rep. 18(4):1.
- Martin, J. L.
1964. The insect ecology of red pine plantations in central Ontario. II. Life history and control of Curculionidae. Can. Entomol. 96(11):1408-1417.
- McGregor, M. D., and T. Quarles
1971. Damage to spruce regeneration by a terminal weevil: Flathead National Forest, Montana. Unpubl. Rep., No. 71-9, Div. of State and Priv. For. USDA For. Serv., North. Reg., Missoula, Mont.
- Molnar, A. C., D. A. Ross, and R. L. Fiddick
1970. Annual report of the Forest Insect and Disease Survey, British Columbia Region. Can. Dep. Fisheries and For., Can. For. Serv.
- Schmidt, Wyman C., and David G. Fellin
In press. Western spruce budworm damage affects form and height growth of western larch. Can. J. For. Res.
- Snedecor, G. W.
1956. Statistical methods applied to experiments in agriculture and biology. 5th Ed., 534 p. Ames, Iowa: Iowa State Coll. Press.
- Tunnock, Archibald, Jr. (now known as Scott Tunnock)
1959. Engelmann spruce beetle evaluation in northwestern Montana--1958. Unpubl. Rep., Missoula For. Insect Lab., 5 p. USDA For. Serv., Intermt. For. and Range Exp. Stn.
- Tunnock, Scott
1966. Forest insect conditions in the northern Rocky Mountains. In: Forest insect conditions in the United States, 1966. 42 p. USDA For. Serv., Apr. 1967.
- Wikstrom, John H., and Charles A. Wellner
1961. The opportunity to thin and prune in the northern Rocky Mountain and Inter-mountain Regions. USDA For. Serv., Intermt. For. and Range Exp. Stn. Res. Pap. 61.

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Field Research Work Units are maintained in:

Boise, Idaho

Bozeman, Montana (in cooperation with
Montana State University)

Logan, Utah, (in cooperation with Utah
State University)

Missoula, Montana (in cooperation with
University of Montana)

Moscow, Idaho (in cooperation with the
University of Idaho)

Provo, Utah (in cooperation with Brigham
Young University)

Reno, Nevada (in cooperation with Uni-
versity of Nevada)