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FOREST MANAGEMENT NOTE

Note 55 Northwest Region

THE LODGEPOLE TERMINAL WEEVIL IN THE PRAIRIE PROVINCES

The lodgepole terminal weevil (*Pissodes terminalis* Hopping [Coleoptera: Curculionidae]), or LTW, and its associated damage to terminals of young lodgepole pine (*Pinus contorta* Douglas), were observed first in 1907 in California (Hopping 1920) and later in Alberta (Hopping 1961).

The LTW phenotypically resembles the white pine weevil (*P. strobi* [Peck]), or WPW, that attacks the terminals of pine (*Pinus*) and spruce (*Picea*) species, but is cytologically distinct (Drouin et al. 1963). Aspects of LTW biology have been studied in the United States (Salman 1935; Stark and Wood 1964; Stevens and Knopf 1974; Cameron and Stark 1989) and in Canada, in British Columbia (Maher 1982), Alberta, and Saskatchewan (Drouin et al. 1963; Stevenson and Petty 1968).

This note consists of a review of the life history of the LTW in lodgepole pine and jack pine (*Pinus banksiana* Lamb.) in the prairie provinces; a summary of variation in seasonal development; a description of damage and symptoms of attack, and suggestions for possible methods of management.

STUDY AREAS AND METHODS

The life history of the LTW in young lodgepole pine stands was intensively studied in Alberta: near Hinton (altitude of 1400–1500 m) from 1989 to 1991, and near Swan Hills (altitude of 1100 m) from 1989 to 1990. Infested terminals were collected every 7–10 days from mid-May until early October, and dissected to determine seasonal development and mortality of the LTW. Some terminals were placed in rearing containers to obtain adult weevils, predators, and parasitoids; other terminals, containing overwintering larvae and parasites, were stored at 2°C for three months before rearing. The flight period of the LTW was monitored using black, vertical stovepipes, that were 1.5 m high, 20 cm in diameter, coated with Tanglefoot, and baited with ethanol and turpentine. Three traps were deployed at each of three localities, two near Hinton and the third near Swan Hills. Trapped LTW adults were collected every 7–10 days from June until late September.

Populations of LTW in jack pine were examined periodically from 1982 to 1985 for seasonal development in Alberta, near Hondo, Fork Lake, Clyde, and Smoky Lake, and, in 1989 and 1990, at two localities in Saskatchewan, one north of Meadow Lake and the other northeast of Prince Albert. Infested terminals were returned to the laboratory and treated as outlined for the LTW in lodgepole pine.

In addition, from 1982 to 1985, thinned and unthinned plots of lodgepole pine were monitored

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for incidences of LTW attack west of Caroline and Sundre, Alberta, as were plots of jack pine at Fork Lake.

DISTRIBUTION AND INCIDENCE

The LTW is distributed from California, north to the Yukon and Northwest Territories, and from Manitoba, west to the Rocky Mountain and Intermountain regions of the United States (Drouin et al. 1963; Stark and Wood 1964; Stevenson and Petty 1968; Duncan 1986). The distribution of the LTW in the prairie provinces and Northwest Territories (Fig. 1) is based on records from FIDSINFOBASE, the forest insect and disease survey information database (Power 1986), and observations by the authors.

In both Alberta and Saskatchewan it was noted that the LTW affected pines 1.5–9 m tall, but attacks were most common on trees 2–6 m tall. Stevens and Knopf (1974) observed that trees 1.5–6 m tall sustained a higher incidence of attack than other size classes in the northwestern United States.

The yearly incidence of LTW attacks is geographically and temporally quite variable, usually ranging from 0.1 to 2% in lodgepole pine and from 1 to 5% in jack pine, but up to 30% in both tree species. When LTW populations are high, most trees in a stand may be infested over a 3-5-year period. From 1982 to 1985, the cumulative incidence of LTW attack was as high as 87% in lodgepole pine stands west of Caroline, and 80% in lodgepole pine west of Sundre, Alberta. At Fork Lake during the same period, the cumulative incidence of LTW attack on jack pine was 32%. However, from 1987 to 1990, the cumulative incidences of LTW attack on jack pine plantations northeast of Prince Albert, Saskatchewan, ranged between 50 and 70%.

The incidence of LTW attack was higher in thinned stands than unthinned at three locations surveyed in Alberta (Table 1). Several earlier studies also reported higher incidences of LTW attack in thinned stands, on open-grown trees, and on peripheral trees in dense stands (Drouin et al. 1963; Stark and Wood 1964; Bella 1985). However, Stevens and Knopf (1974) observed a high incidence of LTW damage to dense stands of lodgepole pine in the Intermountain Region of the United States.

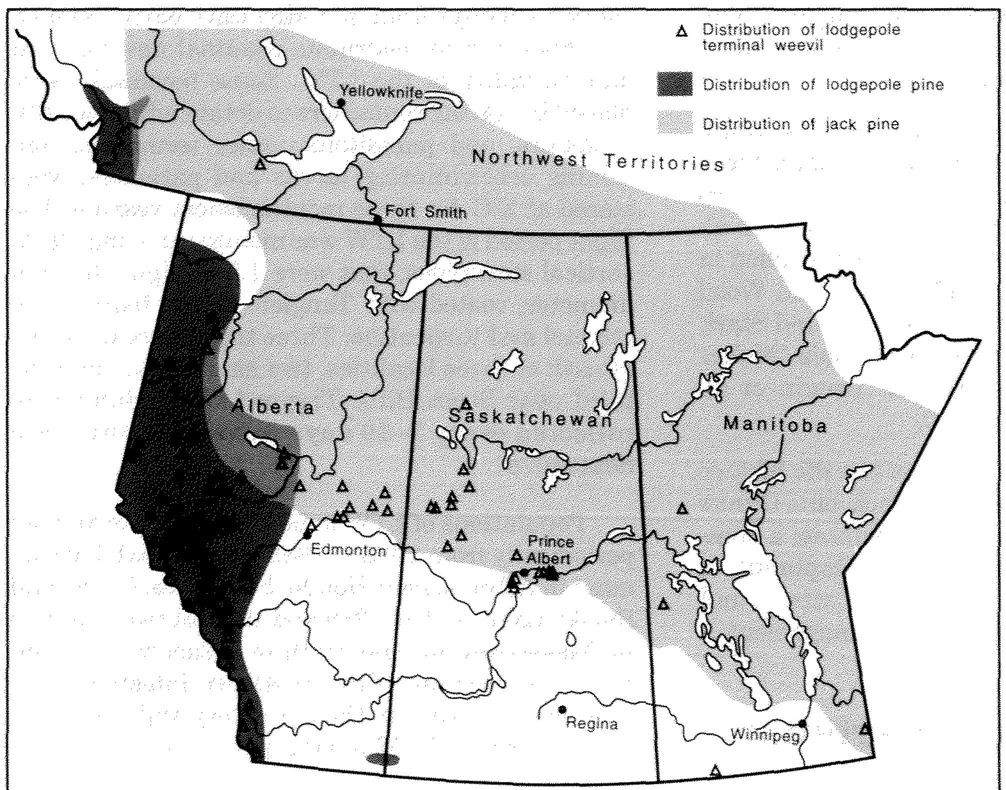

Figure 1. Distribution of the lodgepole terminal weevil in the prairie provinces and Northwest Territories.

LIFE HISTORY AND BEHAVIOR

The LTW has four larval instars that vary in length from 3 mm (first instar) to 12 mm (fourth instar). Larvae are white legless grubs with light brown head capsules. Initially, pupae are white in color, but they develop brown and gray markings 2–3 days before the adults emerge. Adults (Fig. 2A) are a mottled brown color with variable white and yellow spots, their heads have long snouts , and they range in length from 5 to 9 mm.

Table 1. Cumulative incidence (1982-1985) of terminal leaders attacked by the lodgepole terminal weevil in thinned and unthinned plots of lodgepole and jack pine in Alberta (plots were thinned in 1981)

Alberta location	Tree species	Average diameter at breast height (cm)	Average tree height (m)	Percentage of trees attacked (N)[a]	
				Thinned	Unthinned
West of Caroline	Lodgepole pine	5.5	6.5	87 (200)	18 (100)
West of Sundre	Lodgepole pine	6.0	8.0	18 (200)	11 (100)
Fork Lake	Jack pine	6.5	7.5	32 (100)	9 (100)

[a] N = number of trees observed.

Lodgepole Pine

The LTW was found to have a 2-year life history in lodgepole pine near Hinton and Swan Hills, and the population was asynchronous (i.e., only part of the population matured each year). In the first year, mainly fourth and a few third instar larvae overwintered in the pith of the terminal leader (Fig. 2B). In the spring, larvae fed for 1–4 weeks before constructing a cell and pupating in June; some live larvae, however, remained until mid-August. New adults first appeared in early July and emerged between mid-July and late August, with peak emergence in late July. In each terminal, adults exited through a circular hole chewed from the pith, through the wood and bark, to the outside. As many as seven adults emerged from a terminal, but the usual number was one.

After emergence, adults fed on uninfested parts of leaders and at the bases of lateral branches. They did not fly, mate, or lay eggs (oviposit) after they emerged. After feeding for several weeks, beetles moved (crawled or fell) to the ground in September and early October to overwinter.

Adults emerged from the duff in May when most of the snow cover had disappeared and the ground had partially thawed. The beetles dispersed by flight from mid-May until early July; during this dispersal phase, they selected new hosts for oviposition. Observations from this study and previous studies (Maher 1982) indicated that, when selecting a host, beetles preferred longer and thicker terminals to shorter and thinner ones, and unshaded terminals (open-growing trees) to shaded ones (overtopped trees).

Once an appropriate host was found, the beetles began feeding, mating, and ovipositing on the growing terminal from late June until August. Each egg (Fig. 2C) was deposited singly in a feeding puncture (Fig. 2D) on the lower half of the current leader. After an egg had been laid the puncture was usually capped with a brown plug of macerated phloem. From 4 to 32 (an average of 13) eggs were laid in each terminal. Eggs hatched in about two weeks, and the larvae tunnelled in the phloem layer, towards the terminal bud. Larvae fed in the phloem and cortex of the leader until about mid-August when, as third and fourth instar larvae, they penetrated the xylem and entered the pith. Before entering the xylem each larva completely girdled the terminal; one larva was, therefore, capable of killing a terminal. Once in the pith, most larvae mined upwards (but some downwards) for a distance of 1–8 cm. In late September or early October, larvae stopped feeding in preparation for overwintering.

The life history of the LTW in lodgepole pine in Alberta conforms closely to the Type 3 life history pattern for LTW at elevations over 2000 m in Nevada and California (Cameron and Stark 1989), but four 1-year life history patterns were also described in those states, in which the overwintering stages were: adults, pupae, or larvae in the terminals, or adults in the duff (Cameron and Stark 1989). In British Columbia the LTW overwintered in lodgepole pine as third and fourth instar larvae, pupae, and adults (Maher 1982). The reported variation in the life history of LTW in lodgepole pine is probably related to environmental factors, especially temperature. Further studies may reveal

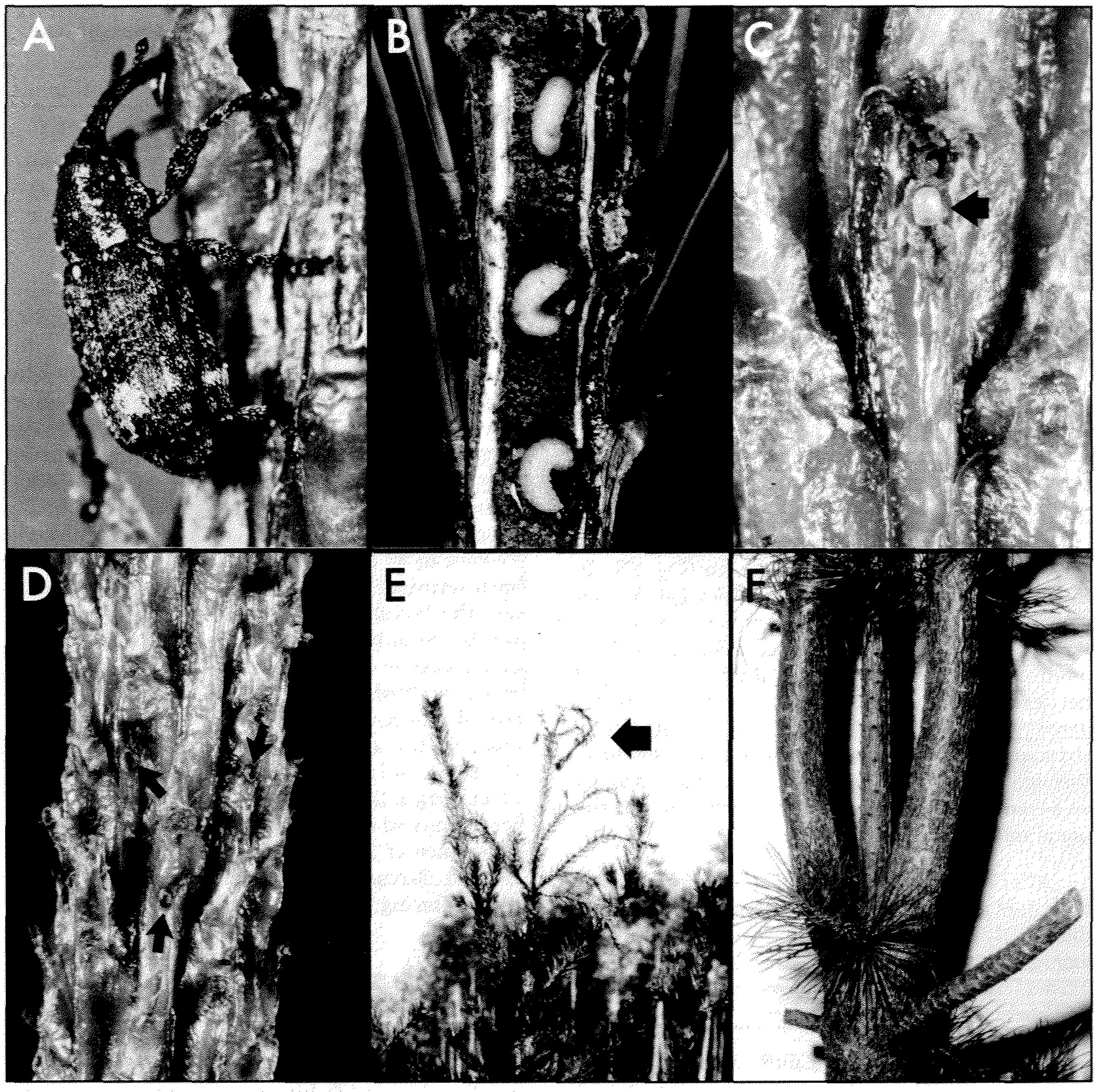

Figure 2. Lodgepole terminal weevil stages and damage symptoms. A. Adult. **B.** Overwintering larva in the pith of a lodgepole pine terminal. **C.** Egg. **D.** Feeding and oviposition punctures in lodgepole pine. **E.** Wilted terminal of jack pine infested by the lodgepole terminal weevil. (Note the shepherd's crook.) **F.** Branching of a pine tree stem caused by the death of the terminal leader due to feeding by the lodgepole terminal weevil.

similar variation in the life history of the LTW in lodgepole pine in Alberta.

Jack Pine

The life history of the LTW in jack pine is a 1-year cycle. This conforms to the Type 1 life cycle reported for LTW populations in Nevada and California (Cameron and Stark 1989). In other words, the entire population is synchronized. The overwintering adults emerge from the soil from mid-May until early July, and their subsequent behavior is similar to that reported in lodgepole pine. It is not known how many eggs are laid in each terminal. Pupation occurs in late July in the pith, and an average of two adults (but sometimes as many as eight) emerge from each terminal from mid-August until September. After a brief feeding period, adults fall or crawl to the ground where they overwinter.

MORTALITY FACTORS

Some information about the mortality of LTW in lodgepole pine is known. Near Hinton, total mortality for the 1989–90 generation was 90–95% and for the 1990–91 generation, over 99%. Egg mortality for the 1991–92 generation was 28%: 5% due to resin, and 23% to unknown causes. Mortality among larvae ranged from about 75–95%. The principal cause of mortality among small larvae (as high as 25%) was entrapment in resin; among larger larvae the principal cause (38–70%) was overwintering—presumably as a result of exposure to low temperatures. Parasitoids caused less than 7% mortality among larvae. The mortality of pupae and adults (before emergence) was only 2–4%.

Little is known about the impact of mortality agents on LTW in jack pine. At the two study sites in Saskatchewan, about 10–15% of larvae were found embedded in resin in the phloem, and mortality due to parasitoids, although not yet measured, appears to be comparable to mortality •ccurring in lodgepole pine. Cold temperatures were not found to be a cause of mortality in the immature stages.

SYMPTOMS AND DAMAGE

The first signs of attack are evident on the terminals in late May or June: beads of resin ooze from feeding and oviposition punctures that are surrounded by necrotic tissue. In jack pine the feeding of larvae, especially when they are girdling a terminal just before entering its pith, cuts off the water supply to the terminal and causes its color to fade slowly to rust by late July. Also, an infested jack pine terminal tends to droop into the shape of a shepherd's crook (Fig. 2E). An infested terminal of lodgepole pine usually fades in late September or October, turning to a brick red color by early spring, but it does not form a shepherd's crook when infested, probably because terminals of this species are much thicker than those of jack pine.

After the leader dies, one or more of the branches at the node below the terminal assume leadership. Stevenson and Petty (1968) reported that leader loss can be recovered in 2–3 years if the tree is not attacked in succeeding years. Repeated attacks on the same tree cause a crooked or forked stem (Fig. 2F) and bushy (or "stag") crowns, thus markedly reducing the tree's value as lumber. Deformities result in the reduction of merchantable volume through lost height growth, and they cause some degrading of the lumber due to grain aberrations at the site of the crook (Maher 1982).

MANAGEMENT

Silviculture

In young lodgepole and jack pine stands it has been found that the incidence of LTW attack tends to be much higher in thinned than unthinned stands (Maher 1982, Bella 1985) (Table 1). Also, it was found that, in young (12- to 15-year-old) jack pine plantations in Saskatchewan, the incidence of attack was much higher (15–20%) in those parts of the plantations where the hardwood overstory had been removed to facilitate stand release than it was where the overstory remained (an attack incidence of only 2–4%). Therefore, a prudent manager should assess the merits of stand thinning and release in light of the potential impact of the LTW (as well as other agents that show increased incidence when stands are opened up). Research is required to ascertain the effects of different degrees of thinning and overstory removal on the incidence of LTW attack.

Pruning

Small infestations of the LTW can be controlled by pruning just above the topmost whorl of branches as soon as damage is observed. The LTW can survive well in cut terminals, so it is important that the pruned terminals be destroyed by burning, chipping, or burying. Clipping all but the strongest shoot of the top whorl of five branches encourages the growth of a new leader. The effectiveness of a pruning program in a specific location depends on the percentage of infested terminals that are removed each year, as well as the proximity to other LTW sources (i.e., untreated stands). To eradicate the population of LTW in an isolated stand, pruning may be necessary for a period of two or three generations (requiring 2–3 years for jack pine, and 4–6 years for lodgepole pine). Stands near uncontrolled beetle sources probably need to be pruned on a regular basis, but this may not be economically feasible.

Biological Control

Several species of parasitoids and predators have been reared from LTW larvae in the prairie provinces and Northwest Territories; they occur throughout the range of the LTW (Stark and Wood 1964; Stevenson and Petty 1968; Stevens and Knopf 1974). In both jack pine and lodgepole pine the two most common species of parasitoid were found to be wasps (*Dolichomitus terebrans nubilipennis* [Viereck]; *Eurytoma pissodis* Girault), and the most common predator was the fly (*Lonchaea corticis* Taylor).

Native predators and parasitoids usually have only a minor impact on LTW populations. It may, however, be possible to augment native parasitoid and predator populations in LTW-infested stands: when stands are pruned, infested terminals can be placed in cages covered in mesh that is fine enough to entrap the weevils but coarse enough to allow parasitoids and predators to escape (Hulme et al. 1987).

The feasibility of importing exotic parasitoids to control the LTW needs to be investigated. In British Columbia, plans are underway to import European parasitoids for the control of the WPW (Kenis and Carl 1990), and it is possible that these parasitoids will also attack the LTW.

Insecticides

No insecticides are currently registered for control of the LTW. Against the WPW, however, two insecticides, methoxychlor and dimethoate, have proved to be of some use (DeBoo and Campbell 1971), and both are registered for its control. The labels for these two insecticides may, in some cases, be worded broadly to allow their use against LTW as well.

Another insecticide, Dimilin, has been the subject of recent research at the Forest Pest Management Institute, which indicated that the biorational insecticide, also known as Diflubenzuron, is very effective against the WPW (Retnakaran 1989). It may be equally effective against LTW. Dimilin is an insect growth regulator that inhibits chitin (outer shell of insects) synthesis; it is ingested by the adults and transferred to the eggs, where it inhibits chitin formation in the embryo and thus prevents the eggs from hatching. In field tests, Dimilin was shown to bind well to the waxes on conifer shoots, remain active for several weeks, degrade within a week after reaching the ground, and have no effect on predators, parasitoids, and pollinators. Field tests of Dimilin sprayed on terminals in the early spring—before weevil emergence—gave near-total control of the WPW (Retnakaran 1989). Dimilin is currently under review for registration in Canada as a controlling agent for the WPW.

For future information on chemicals available for the control of this pest, the Pesticides Directorate of Agriculture Canada should be contacted in Ottawa (toll free) at 1-800-267-6315.

Pheromones and Attractants

No pheromones are currently available that attract the LTW. However, research on two closely related species, the WPW and the eastern pine weevil (*P. nemorensis*), has resulted in the isolation and identification of two compounds (grandisal and grandisol) that are probable sex-attractants (Booth et al. 1983). It is also probable that these compounds are components of the sex pheromone of the LTW. If an effective pheromone can be developed, it will aid in monitoring and controlling LTW populations in high-value stands, such as genetics provenances, Christmas tree plantations, and nurseries.

A combination of ethanol and turpentine is known to be an attractant to many bark and wood boring beetles (Chenier and Philogene 1989), and is moderately attractive to the LTW. This attractant may be used in combination with sticky, stovepipe traps or with multiple funnel traps in monitoring LTW populations in high-value stands. These baited traps may also control populations to some extent by capturing beetles before they attack trees.

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