Lodgepole Needle Miner

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The lodgepole needle miner (*Coleotechnites milleri* Busck) is one of the most destructive insect pests of lodgepole pine in some of California's most scenic mountain forests. The caterpillars of this small, inconspicuous moth feed within the pine needles. Under outbreak conditions they become so numerous that they destroy every needle on all lodgepole pines over thousands of acres.

Successive attacks by the miner weaken trees. After three or four complete defoliations, the growth rate of trees may be reduced by as much as 90 percent, and large numbers of trees die. After five or six defoliations by successive needle miner generations, many trees —especially older ones—lose their capacity to recover; thus, trees that are not immediately killed slowly die for years after defoliation ceases. Though defoliation alone often kills small trees and the tops of large ones, more commonly the weakened trees are attacked and killed by the mountain pine beetle, *Dendroctonus ponderosae* Hopkins (fig. 1). This is particularly the case when defoliated lodgepole pines are killed over large areas.

Within a few years the dead, bleached snags present a weird spectacle, aptly termed a "ghost forest." The dead trees decay slowly in the cold, dry climate of the high mountains. In areas devastated between 1900 and 1916, a crisscross of down logs litters the ground, but some of the dead trees still stand. Gradually a stand of young lodgepole pines grows up to replace the dead trees, but the growth is slow—trees 100 years old are often only 10 to 12 inches in diameter and less than 60 feet tall.

Large numbers of dead trees in a heavily used recreation area are a serious hazard. Because of the risk of damage and injury from the fall of dead limbs or trees, the dead trees are regularly removed from campgrounds and picnic areas. In less intensively developed areas, large numbers of fallen trees on trails impede hikers or riders and greatly increase the cost of maintenance. Tangles of dry, dead trees and thickets of young trees (fig. 2) create a fire hazard, especially along trails and roads or where there are frequent lightning storms.

The death of extensive stands of lodgepole pine sets in motion a series of drastic ecological changes. A cool, shady forest becomes a warm, sunny area. Shade-tolerant understory plants are replaced by grasses and other plants characteristic of dry meadows. Animals and birds that depended

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U.S. DEPARTMENT OF AGRICULTURE
Forest Service
Revised September 1971

F-482776

Figure 1.—Lodgepole pine forest killed by lodgepole needle miner and mountain pine beetle in 1920.

upon the trees for food and cover are replaced by other species adapted to a more open habitat.

Outbreaks have occurred in the southern Sierra Nevada at least three times since 1900. The most recent one started about 1945 in Yosemite National Park. By 1963 it had spread over 90,000 acres in the Tuolumne River Basin and in the adjacent forests of the Merced River headwaters. Outbreaks in the Kings River and Kern River watersheds have caused severe damage on 4,000 acres since 1945.

Range and Hosts

The lodgepole needle miner is native to the high-elevation forests in watersheds of the Tuolumne, Kings, and Kern Rivers, California. It is most prevalent and destructive at elevations between 8,000 and 10,000 feet. Lodgepole pine is the favored host, and ordinarily the needle miner does not attack other trees. Sometimes, however, when the caterpillars have mined all the lodgepole pine foliage, they migrate and attack other coniferous trees growing nearby. Such attacks have been recorded on Jeffrey pine, western white pine, and mountain hemlock.

Other species of needle miners similar to *C. milleri* attack lodgepole pine in different parts of its range. *C. starki* (Freeman) is found in the Canadian Rockies and has caused extensive defoliation in the Banff area. *C. canusella* (Freeman), is found in British Columbia but has never been reported to cause significant damage. An un-

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Figure 2.—This young lodgepole pine forest was heavily infested by the needle miner in 1953. The trees are growing among snags of an earlier kill.

determined species having a 1-year life cycle has several times defoliated extensive lodgepole pine forests in the vicinity of Chemult, Oreg. Still another lodgepole needle miner, which is quite similar to *C. milleri* but differs in adult flight time, is found near Sentinel Meadow on the Inyo National Forest, about 30 miles west of the infested area in Yosemite Park. A small area has been heavily defoliated at times, but only a few trees have been killed.

Evidence of Infestation

Hollowed-out needles clinging

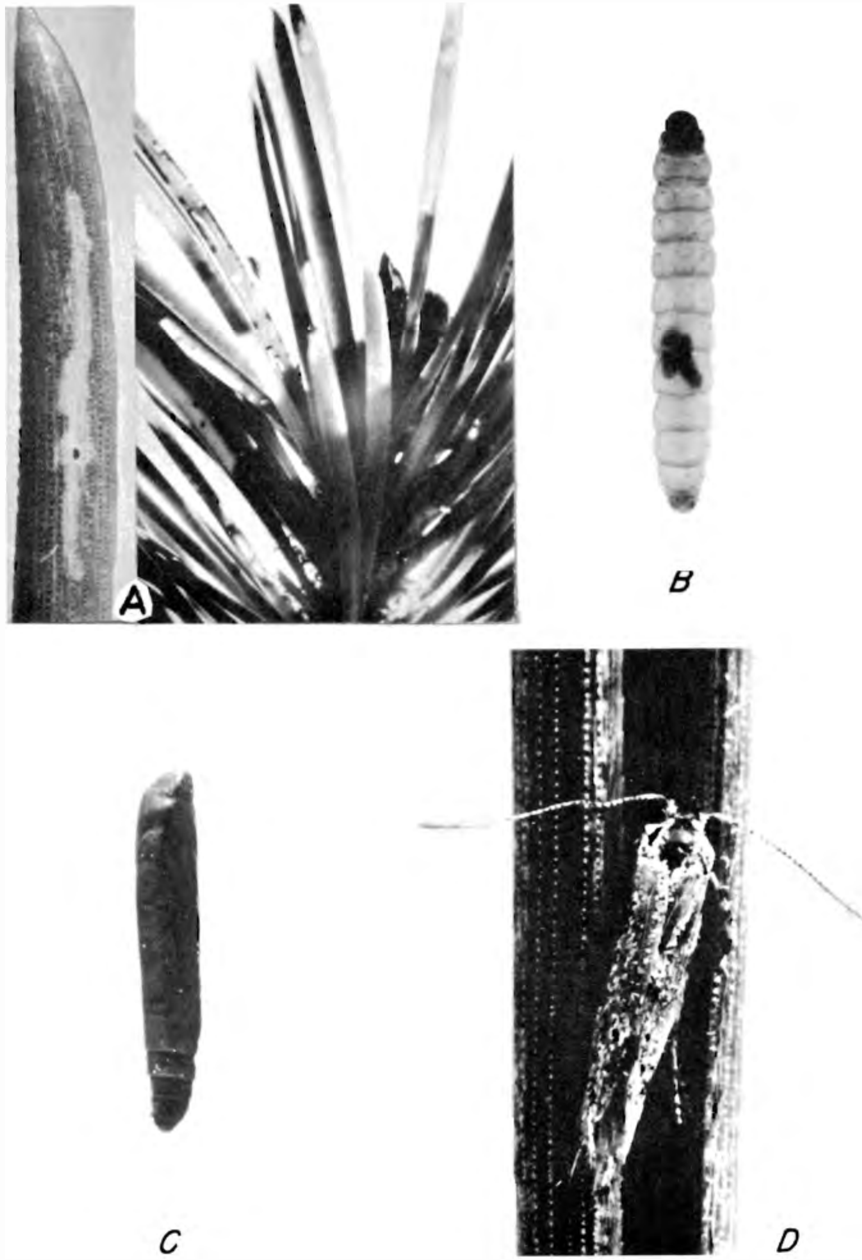

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Figure 3.—Life stages of the lodgepole needle miner: *A*, Mined needles showing, left, entry holes at early stage of larval activity and, right, hollowing by advanced stages before pupation; *B*, larva in fourth instar; *C*, pupa; *D*, adult moth. Larva, pupa, and adult moth are about ¼ inch long.

to branches or on the ground under trees are characteristic of the insect's damage. The mined needles may have one or more small holes, which are often covered with silk webbing, and may contain a few small frass pellets. If the foliage is viewed against the sky or a strong light, the larvae or pupae are visible within the needles (fig. 3, *A*). The damaged needles are straw yellow at first and gradually become reddish brown.

The changing color of the foliage is usually the first symptom of damaged noticed. It becomes evident in fall of an even-numbered year and becomes more prominent early in the following summer. Often vast areas of affected forest look from a distance as though they had been scorched by fire. Later the mined needles fall, and the affected stands take on a grey-bronze cast.

Continued heavy attacks by needle miners cause trees to produce fewer and shorter needles in succeeding years (fig. 4). After two or three generations of miners have attacked the trees, only the shortened terminal foliage remains. Short internodes, dead and dying twigs, and dying branches are characteristic after feeding by three or four generations of needle miners. The growth rate of the trees, as reflected by the width of the annual rings, is greatly reduced (fig. 5). Any trees which survive a needle miner epidemic carry within them a band of narrow annual rings marking the period of defoliation. Needle miner outbreaks which occurred before the earliest written records can be dated by examining the bands of narrow rings in the hearts of old trees.

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Figure 4.—Sparse, short foliage and numerous dying twigs on a lodgepole branch are the result of feeding by five generations of needle miners.

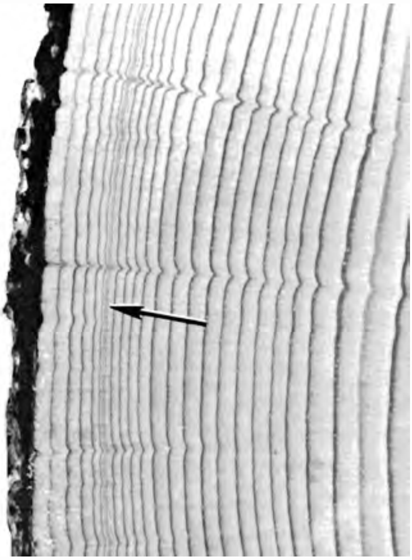

Figure 5.—Narrow growth rings in lodgepole pine are caused by defoliation by the lodgepole needle miner.

Life Stages

Lodgepole needle miner eggs are ovoid and flattened and are barely visible without the aid of a hand lens. The color is lemon yellow at first, but deepens. After about 30 days of incubation, the black heads of the newly formed larvae are visible through the translucent eggshells.

The larvae, or caterpillars, (fig. 3, *B*) vary from lemon yellow to deep reddish orange in all five instars during 21 months of development. They vary in length from about 1/25 inch long in the first instar to about 1/3 inch at pupation.

The pupae (fig. 3, *C*) are black. The pupal stage lasts about a month.

The adults (fig. 3, *D*) are small, rapidly moving, gray moths, about 1/4 inch long.

Biology and Habits

The moths normally mature and fly from mid-July to the end of August of odd-numbered years only. There is no record of any overlapping generation with moths flying in even-numbered years. It is the habit of the moths to fly upward in the early evening, but they are weak flyers. During outbreaks, millions of the tiny moths rise into the air and drift with the gentle evening breeze. In this way, lodgepole pine stands a mile or more from the nearest infestation may become heavily infested overnight.

Courtship and mating take place on the foliage of the trees, starting about nightfall and continuing into the night. Egg laying follows on successive evenings and into the night. Greatest activity occurs at temperatures between 55° and 60°F. from sundown to 9:30 p.m.

Most of the eggs are laid from the last of July through the third week in August. They are deposited in loosely bound groups of 2 to 15 or more, rarely singly. More than 60 percent of the eggs are deposited in needles previously hollowed out by the larvae. Other favored locations are behind the bud scales of the current and previous year's growth. Sometimes eggs are deposited near the bases of new needles or between new needles.

The incubation period averages 35 days, ranging from 27 to 50 days. The eggs hatch in September, and the newly emerged larvae quickly migrate and bore into individual needles. Foliage 2 or more years old is preferred. Young foliage is attacked if the old needles have been destroyed.

Each larva enters a needle 1/4 to 1/2 inch back of the apex along the curved outer surface. Entries are rarely made along the flat inner surface (fig. 3, *A*, left). Usually only a single larva enters a needle. An entry is completed within 24 to

48 hours. By the first week in October, all new larvae have bored into foliage, where they continue feeding until winter, when they become dormant. They resume feeding in the spring, each larva extending its mine in the needle it lived in over winter.

In mid-July the larvae, which are then in the third instar, start to migrate to new needles. The frequency of migration increases as the larvae grow. In the fourth instar (fig. 3, B) they often bind together the two needles of a fascicle with fine silk, then bore alternately in the two. Each larva mines two or more needles during the fall before the second winter dormancy, which is again spent inside a mined needle. In the second spring it mines one or more additional needles before reaching the fifth or prepupal instar. Thus, each larva mines at least five needles before pupation.

Pupation occurs in June in the last-mined needle. Before pupation the mature larva prepares an exit hole for the moth, usually just back from the tip on the flat side of the needle. The jet-black pupa is not enclosed in a cocoon. A thin silk webbing usually lines the mined needle and forms a ramp at the exit hole. The average duration of the pupal stage is 30 days.

Needle miner populations differ greatly in density from place to place and year to year. During the early phases of an outbreak, the population density may exceed 60 larvae per branch tip. At this population level, all the older foliage is soon destroyed so that only one or two of the most recent internodes retain any needles. After this the food supply usually limits the number of larvae to 15 to 25 per tip. Between outbreak periods endemic population may be as low as one larva per 100 branch tips over most of the infested area. During those endemic periods relatively high populations are maintained in restricted favorable areas which are slightly warmer than the surrounding forests. The favorable areas characteristically are in sheltered basins or valleys near 8,000 ft. elevation, are open nearly pure stands of lodgepole pine and support needle miner populations 10 to 20 times as dense as adjacent forests.

Infestations that develop from the moths' invasion of previously uninfested stands often have up to 150 larvae in the foliage of the five most recent internodes of a twig. Here, in a single generation, the larvae tend to concentrate in and destroy the older needles.

Natural Control

Weather conditions appear to be primarily responsible for the rise and fall of the lodgepole needle miner population. The larvae in their mines are well protected and readily survive winter temperatures of —20°F. and nighttime summer temperatures as low as 20°F. The insects become vulnerable during the reproductive period.

During the flight period, the moths may be killed in violent storms and cold weather may interfere with reproduction. The temperature may fall well below the favorable range for mating and oviposition before sundown. If the evening temperature falls below 45°, little or no oviposition takes place.

Violent storms may sweep the mountains at any time, and snow may fall on any day of the year. Storms sometimes knock large numbers of needles bearing pupae or eggs to the ground, where the eggs or pupae may be drowned in water puddles, be killed as the sun heats the ground around the needle, or be preyed upon by ants.

The eggs and larvae are attacked by insect parasites and predators, including members of 42 genera in 16 families. Six of these genera are known parasites, and two have occurred consistently in successive needle miner generations. Parasites have been considered important in controlling outbreaks of other needle miners, but they do not seem to be a dominant factor in the control of *C. milleri.*

The larvae are subject to a granulosis virus infection. A high incidence of granulosis virus among the larvae was found in one area near Tuolumne Meadows in 1953. However, no significant control by disease organisms has been observed.

At least five species of birds are known to feed on the larvae and pupae. The mountain chickadee (*Penthestes atricapillus*) is believed to consume large numbers of larvae during their second winter. Four species of flycatcher and warblers have been observed feeding on the adult moths. None of these biotic factors has been strong enough to end an epidemic in this century.

Applied Control

The methods used in the past for applied control of the lodgepole needle miner are no longer acceptable under current standards for environmental protection. Improved control methods are available but have not yet been tested against this insect. Persons considering applied control of the lodgepole needle miner are advised to contact U.S. Forest Service, Division of Forest Pest Control, South Bldg., 12th and Independence Avenue, S.W., Washington, D.C. 20250.

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☆U.S. GOVERNMENT PRINTING OFFICE: 1971 O—417-914

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