Forest Insect
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U.S. Department
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Eastern Larch Beetle

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Figure 1. Extensive mortality of tamarack caused by the eastern larch beetle in Alaska. (Inset: Adult eastern larch beetle.)

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The eastern larch beetle, *Dendroctonus simplex* LeConte (fig. 1, inset), is a native North American insect that colonizes the phloem of the main stem, exposed roots, and larger branches of tamarack, *Larix laricina* (Du Roi) K. Koch. The adult beetles aggregate on standing and fallen trees or stumps, tunnel through the bark, and feed and

mate in the phloem. Relatively healthy trees can be attacked and killed by this beetle, and since 1970 extensive outbreaks have been recorded throughout North America (fig. 1). Previously, *D. simplex* was considered to be a secondary pest that attacked only trees that had been predisposed through advanced age, or through injury or physiological stress from defoliation, mechanical damage, fire, drought, or flooding.

Distribution and Hosts

Eastern larch beetles can be found throughout the range of tamarack, which includes most of northeastern and north-central North America, western Canada, and Alaska (fig. 2). Two species of larch that are native to North America – western larch, *Larix occidentalis* Nutt., and subalpine larch, *L. lyallii* Parl. – have not been reported as hosts. However, the eastern larch beetle has been reported to infest exotic larch species planted within its range. The beetle has been collected from Dahurian larch, *Larix gmelinii* (Rupr.), planted in an arboretum at the Cloquet Forestry Center in Minnesota; from Japanese larch, *Larix kaempferi* (Lamb.) Carr., planted in the Russ and Kellogg Experimental Forests in Michigan; from Siberian larch, *Larix sibirica* Ledeb., planted in a nursery near Edmonton, Alberta; and from European larch, *Larix decidua* Mill., in plantings near Wanakena, New York.

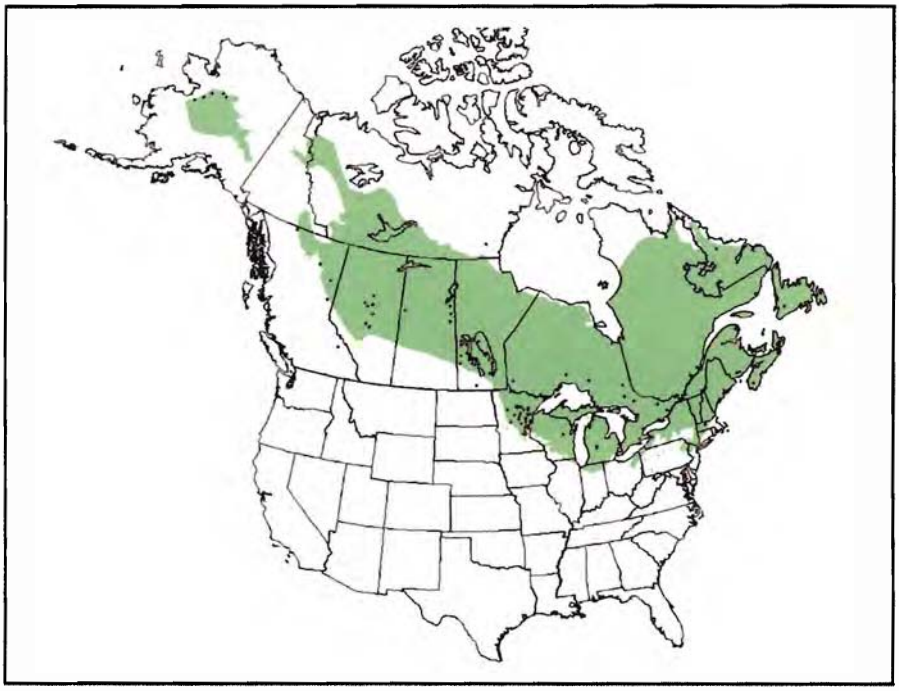

Figure 2. The geographic range of tamarack with collection records (dots) of eastern larch beetle reported by Bright (1976) and Wood (1982) and from the University of Minnesota Insect Collection. The beetle is probably found throughout the range of tamarack.

The eastern larch beetle is a potential risk to stands of nine species of native larch in eastern Siberia and to limited stands of native and exotic larches in Europe. The beetle could be inadvertently introduced into Eurasia through international shipments of barked wood products or solid wood packing materials.

History of North American Infestations

In eastern North America, the eastern larch beetle was reported infesting trees as early as 1897 (West Virginia), 1915 (New York), 1926 (Quebec), and 1939 (Nova Scotia). During the late 1970s and early 1980s, extensive outbreaks throughout that region resulted in mortality of nearly 600 million board feet (1.4 million m^3) of tamarack. In the north-central region, eastern larch beetles were documented killing substantial numbers of trees as early as 1883 (Ontario), 1888 (Michigan), and 1938 (Minnesota). Notable outbreaks occurred in the 1960s (Ontario) and in the 1980s (Michigan and Minnesota). Most recently (2000-2001), eastern larch beetles killed large numbers of tamarack in northern Minnesota in stands that had no obvious history of defoliation, drought, or flooding injury. In western Canada, localized infestations have been reported since 1946. In Alaska, tamarack mortality associated with the beetle occurred between 1974 and 1980 over an area of 8 million acres (3.3 million ha) in the Tanana River Drainage and throughout the central portion of the State. In some areas of interior Alaska, 50 percent of the tamarack were killed in just over 2 years; between 70 and 99 percent of the dead trees were in diameter classes greater than 4 inches (10 cm).

Evidence of Infestation

When infested tamarack trees are examined at close range, there are several clear signs of infestation. During the growing season, adult beetles initiate attack by boring holes through the bark to reach the phloem. Since the entrance holes are small, averaging just over 1/12 inch (2 mm) in diameter, they are easily overlooked if the trees show no other signs or symptoms of attack. Reddish-brown boring dust may accumulate beneath the entrance holes, but since much of the boring dust is left inside the galleries, only small quantities of boring dust will be expelled from most entrance holes. The egg galleries are vertical tunnels that are winding and sometimes branched (fig. 3). The galleries can be observed under the bark, slightly scoring the sapwood. They generally extend about 6 to 16 inches (15 to 40 cm). Egg galleries from different females sometimes intersect.

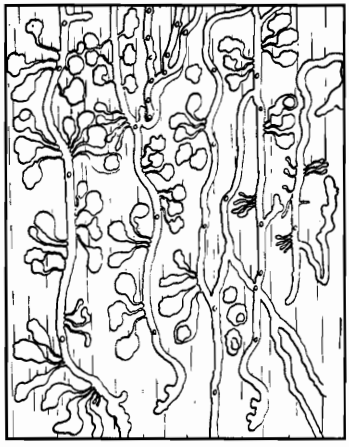

Figure 3. Eastern larch beetle egg galleries. The vertical galleries are slightly winding and sometimes branched (from Hopkins 1909).

Resin flow may be quite heavy and conspicuous, coating the surface of the bark during the summer of attack. It is often heaviest in the middle to upper portion of the stem. Resin flowing down or dripping from the tree can accumulate on the base of the tree as well as on the foliage and soil beneath the tree.

From a distance, the most obvious evidence of current infestation is yellowing foliage that develops by late July or early August. Most trees begin to fade from the bottom, and it is common to see needles in the lower portion of the crown turning yellow, brown, and then falling off while the upper portion of the tree is still green. This can make it difficult to detect currently infested trees from the air. Not all infested trees will fade before the appearance of the normal fall color change. Infested trees generally fail to leaf out during the following spring.

In fall and winter, woodpeckers often remove some or all of the bark from infested trees to search for and feed on overwintering larvae, pupae, and adults (fig. 4). In Minnesota, two species (black-backed, *Picoides arcticus,* and hairy, *Dendrocopos villosus*) of woodpeckers have been observed feeding on eastern larch beetle-infested trees. By late winter and early spring, bark removal reveals the beetle galleries and exposes the reddish-purple inner bark or white sapwood of the tree. Debarked trees can be quite obvious, especially when snow is on the ground, making it easy to identify infested trees from a distance.

Identification of Life Stages

Mature adults are dark brown with reddish-brown wing covers (elytra) (fig. 1, inset). Body length ranges from about 1/7 to 1/5 inch (3.4 to 5.0 mm). Newly formed teneral (callow) adults are soft-bodied and yellow to tan. They eventually harden and darken as they mature. Adults have an evenly rounded posterior margin of the elytra, and spines are absent from this area of the body. Identification of adult bark beetles can be difficult and may require a taxonomic expert for species confirmation.

Figure 4. Infested tamarack debarked by woodpeckers.

Eggs are white, oval to oblong, and small, about 1/25 inch (0.9 mm) long and about 1/50 inch (0.5 mm) wide (fig. 5). Larvae are legless grubs that are white to whitish yellow (cream-colored), with a light brown head (fig. 6). They can be found under bark at the end of tunnels that extend away from the larger egg gallery. Mature larvae are about 1/6 inch (4.5 mm) long. Pupae are initially white to yellowish but darken as they prepare to transform to adults, and the pupae are similar in

size to the mature or last instar larvae (fig. 7). The pupae are found in small chambers at the end of the larval galleries.

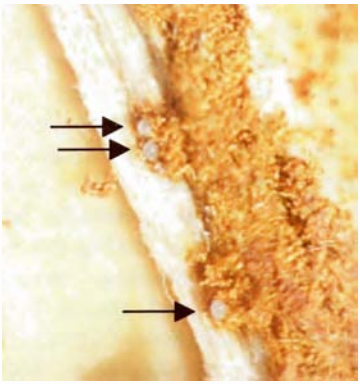

Figure 5. Eastern larch beetle eggs.

Figure 6. Eastern larch beetle larva.

Figure 7. Eastern larch beetle pupa.

Life Cycle

Eastern larch beetles overwinter primarily in the adult stage beneath the bark of infested trees, but where winter temperatures permit survival, larvae and pupae can overwinter as well. These immature stages from the previous year's brood can occur well into June. In Alaska, adult beetles overwinter beneath the snow in the roots and lower trunk of infested trees at the ground-tree interface. Overwintered adults emerge between April and June and fly to new host trees where females colonize by tunneling through the bark to the phloem. Females produce an aggregation attractant that brings males and other females to the colonization site. Arriving males may also contribute chemical components to this attractant (pheromone). Each female is joined within 1 or 2 days by a male, and the pair construct a vertical egg gallery in the phloem by tunneling upward from the entrance hole. Up to four pairs of beetles may use the same entrance hole to construct separate egg galleries.

Females lay up to four eggs in a niche or groove, and they lay an average of 30 to 50 eggs per gallery. The beetles can develop from egg to adult in 60 to 70 days.

Before the new generation develops completely, 90 percent of the original parents can emerge from the first brood tree and initiate a second brood in a new tree. In warmer climates, about 60 percent of parents from the second brood tree may re-emerge and attack a third brood tree. Thus, there is considerable developmental overlap between the different broods during the summer, and the later broods may be more likely to overwinter as immatures. Nonetheless, there is only one generation per year, and outside of Alaska, most newly formed adults remain in their brood galleries at the end of the summer to overwinter. Some (30 to 40 percent) of the newly formed adults will emerge in the fall

and re-enter or initiate tunnels under the bark at the base of trees to overwinter. Larvae, pupae, and adults that overwinter below the snow line have an increased chance of surviving predation by woodpeckers and surviving lethally cold winter temperatures.

Associated Insects

Tamarack is a host for a variety of defoliating insects whose feeding may predispose trees to later successful attack by eastern larch beetles (see Stand Conditions Conducive to Infestation). In addition, other phloem-feeding bark beetles may co-occur with eastern larch beetles under the bark of tamarack (fig. 8), and these associated beetles may be confused with the eastern larch beetle. For example, the red turpentine beetle, *Dendroctonus valens* LeConte, may infest stumps or the lower bole of tamarack, and the Douglas-fir beetle, *D. pseudotsugae* Hopkins, has been reported to infest western larch, and in rare cases, tamarack, in western North America. The adults of *D. pseudotsugae* are similar in appearance to the eastern larch beetle, but are generally larger and darker. Other bark beetles that have been reported infesting tamarack include the four-eyed spruce beetle, *Polygraphus rufipennis* (Kirby) (fig. 8b); the balsam fir bark beetle,

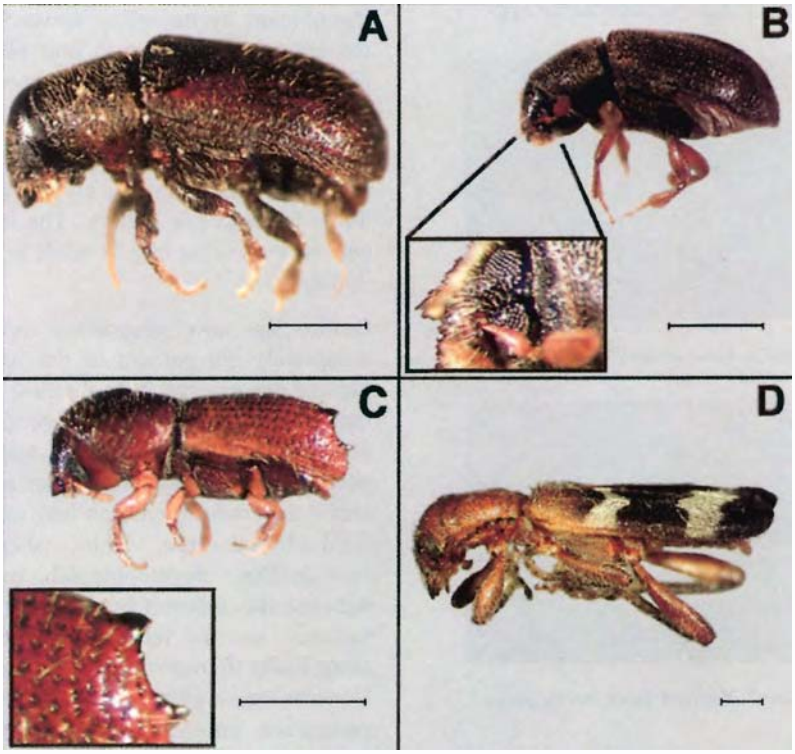

Figure 8. Insects associated with the eastern larch beetle (A) include the four-eyed spruce beetle (B); the balsam fir bark beetle (C); and a checkered beetle (D). Bar in each photo = 1/25 inch (1 mm). Distinctive characters include bisected eye of four-eyed spruce beetle (inset B), and the spines on the wing covers of the male balsam fir bark beetle (inset C).

Pityokteines sparsus (LeConte) (fig. 8c); and a twig-infesting bark beetle, *Pityophthorus opaculus* LeConte. In eastern North America, predators of the eastern larch beetle, such as the checkered beetle, *Thanasimus dubius* (F.) (Family Cleridae) (fig. 8d), may also occur on the bark surface and under the bark of infested trees.

Stand Conditions Conducive to Infestation

The stand conditions that are conducive to outbreaks of eastern larch beetles are poorly understood, and no rating systems are available to identify high-risk stands. Eastern larch beetles attack trees of almost any age or diameter class on the full range of sites from wet lowlands to drier uplands. Trees in pure stands as well as mixed stands are susceptible. However, many infestations are associated with trees under physiological stress, which can be from a variety of causes including defoliation, flooding, drought, cold soils, fire, old age, or damage from windstorms, snow breakage, or logging.

Defoliation is considered to be the most common factor predisposing tamarack to attack by the eastern larch beetle. Outbreaks or damage by defoliating insects such as the larch sawfly, *Pristiphora erichsonii* (Hartig), the spruce budworm, *Choristoneura fumiferana* (Clemens), and the larch casebearer, *Coleophora laricella* (Hübner), have all been reported to precede eastern larch beetle infestations. Moderate to severe defoliation by these insects, primarily in northeastern North America, has generally occurred 1 to 3 years prior to eastern larch beetle infestations. In 1975 and 1976 in Alaska, severe defoliation by a larch bud moth, *Zeiraphera* sp., initiated an eastern larch beetle outbreak in 1977.

Other factors are also important in predisposing stands of tamarack to attack by eastern larch beetles. Localized flooding in tamarack stands is quite common due to road construction or beaver activity that alters water flow. Flooding can kill tamarack trees outright and thereby produce abundant breeding material. Tamarack trees have shallow root systems so drought can also cause substantial stress. In addition, windthrow is more likely in tree species with shallow root systems, and this beetle breeds successfully in trees damaged in storms. It also readily breeds in logging debris. The role that tree age plays in creating physiological stress in tamarack is not well documented. However, as tamarack stands age, they likely become more susceptible to bark beetles. Further, because tamarack trees are considered very intolerant of shade, stress from competition may increase as crowns close in older stands.

Although stressed stands along with storm and logging debris appear to trigger many outbreaks, not all outbreaks have been associated with obvious stressors. Eastern larch beetles appear to be capable of attacking and killing trees when no predisposing condition or factor is apparent.

Management Strategies

Tamarack has not been intensively managed, and therefore few, if any, management strategies directly targeted at the eastern larch beetle have been evaluated. However, strategies that revolve around practices that emphasize sanitation and optimize tree health should reduce the likelihood of significant tree mortality.

Sanitation:

Eastern larch beetles breed successfully in storm-damaged trees or in logging slash and log piles left in the woods. This material may produce large numbers of beetles that can invade standing live trees. Prompt removal of logs and utilization of material larger than 4 inches (10 cm) in diameter should reduce breeding material. This beetle has a 1-year life cycle with most progeny emerging in the spring. Thus, infested trees, logs and/or slash should be removed before warm spring weather. The timing of these activities becomes crucial because access to many tamarack stands is limited to the winter when wet soils are frozen.

Silvicultural Methods:

No studies have been done to evaluate silvicultural practices in tamarack stands and the response of eastern larch beetles to them. Thinning tamarack stands has not been a common forest management practice, but thinning other conifer species to improve tree vigor has proven to be beneficial against other bark beetle species. However, because tamarack trees have a shallow root system, damage to roots during thinning operations and windthrow of residual trees would be a concern. At the landscape level, harvesting or planting to create a diversity of stand ages may prove beneficial. In many areas, tamarack stands are all about the same age.

Trap trees (green trees cut or girdled just before beetle flight in the spring) have been used successfully with other bark beetle species. They are quickly infested by the emerging adults and thus can act as a trap if removed before new adults develop and emerge. Unfortunately, access into tamarack stands can be difficult during the spring and early summer when frozen soils have thawed, thereby hampering timely removal of trap trees. Removal of these trees during the following winter will not destroy all beetles because the parents are likely to have re-emerged and some (at least 30 to 40 percent) of the new adult beetle population are likely to have re-emerged from the trap trees in the late summer and fall to overwinter at the base of live trees.

Chemical Methods:

The aggregation pheromone of the eastern larch beetle may be a potential management tool to monitor periods of maximum flight activity, to predict increases in population density, and to mass trap the dispersing adults. As with most *Dendroctonus* species, the attractant is a blend of insect-produced and host tree odors. In field trials in Alaska and Minnesota, a pheromone component called seudenol (not yet isolated from *D. simplex*, but known from *D. pseudotsugae*) has proven to be highly attractive when combined with host odors such as alpha-pinene. These commercially available attractants can be used as baits for insect traps or in combination with moribund or fallen trees in a baited trap tree strategy.

Insecticides can be applied to the boles of uninfested trees to kill attacking adults. However, this is rarely warranted for forest trees, but could be utilized for individual high-value trees at recreation sites or in landscapes. Once trees are infested, chemical control is no longer an option.

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Assistance
More information about the management of the eastern larch beetle may be obtained from the State Forester's office or the U.S. Department of Agriculture, Forest Service, Forest Health Protection.

The publications listed in the references provide more information on the biology, ecology, and management of the eastern larch beetle.

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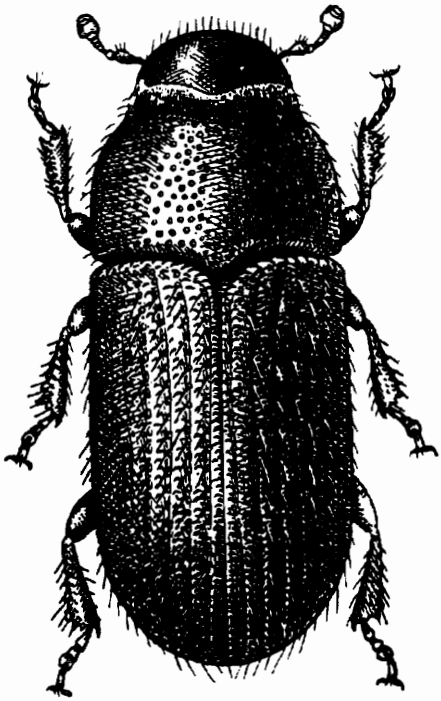

Figure 9. Eastern larch beetle (from Hopkins 1909)

NOTES . . . .

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