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# Ambrosia Beetles of Western Conifers

Gary E. Daterman[1] and David L. Overhulser[2]

Ambrosia beetles, also called pinworms, pinhole beetles, and shothole borers, occur throughout western coniferous forests. The external signs of ambrosia beetle infestation are small piles of white boring dust on the surface of the log, stump or dead tree. In a log, the burrowing beetle's tunnels are generally confined to the sapwood, but may penetrate deeper in western hemlock and certain other conifers.

The term "ambrosia" refers to the fungus the insect carries with it into the host logs. The growth of the fungus in the wood produces the black and gray stain surrounding the beetle tunnels.

When infested logs are processed into lumber and veneer, beetle damage appears as numerous small holes or tunnels in the sapwood surrounded by stain. The appearance of these pinholes and stain results in reductions in the graded values of logs and timber products for domestic and export markets.

Piles of white boring dust indicate ambrosia beetle attacks

[1] Research Entomologist, Pacific Northwest Research Station, USDA-Forest Service, Corvallis, OR

[2] Forest Entomologist, Oregon Department of Forestry, Salem, OR

The highest levels of ambrosia beetle infestation are found in the coastal forests of British Columbia and southeast Alaska, although the coastal forests of Washington, Oregon and northern California also have ambrosia beetle populations capable of damaging high value logs.

The most common and important native species of ambrosia beetles in western North America include the striped ambrosia beetle, *Trypodendron lineatum* (Oliver), and two *Gnathotrichus* species, *G. sulcatus* (LeConte) and *G. retusus* (LeConte). Only these three species are discussed in this paper because of the predominance of their economic impacts.

## Description

Ambrosia beetles are small, cylindrical insects with shiny, brown black outer shells or exoskeletons (fig. 1).

Fig. 1. Adult ambrosia beetles.

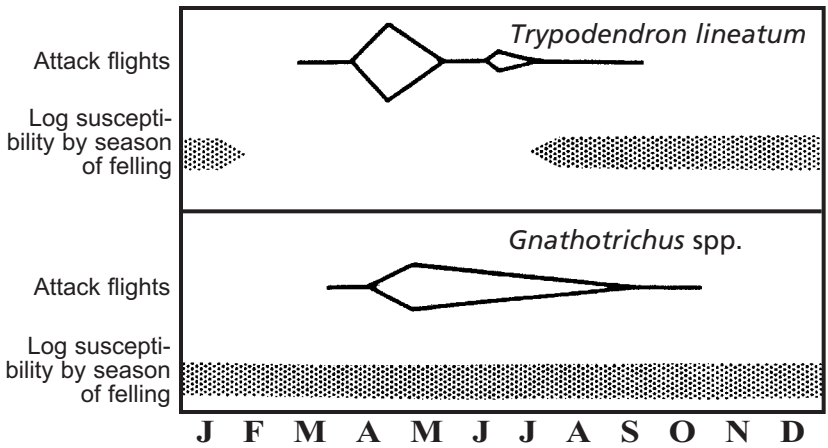
*Trypodendron lineatum* adults are brown to black with two lighter-colored longitudinal stripes on each wing cover. They average 3.5 mm in length by 1.5 mm in width. The dark reddish-brown *Gnathotrichus* adults are slightly longer and less robust, 3.7 mm in length by 1.3 mm in width. The larval stages of these insects are nondescript, small white grubs that grow and change to the adult stage inside the gallery system.

## Seasonal History and Biology

All life stages of *Gnathotrichus* species overwinter within the log, stump, or dead tree, whereas adult *Trypodendron* fly from the host tree and overwinter in nearby forest litter and the bark crevices of trees or stumps.

Adult ambrosia beetles take flight in the spring when daytime temperatures exceed 60 to 65 degrees Fahrenheit for several hours. *Trypodendron* flight can start in March and April, but the major seasonal flight occurs

Fig. 2. Seasonal attack flights of *Trypodendron lineatum* and *Gnathotrichus* spp. and susceptibility of host logs relative to time of felling.



in late April through May (fig. 2). *Gnathotrichus* species require slightly higher flight temperatures and have peak seasonal flights in May and June with some flight activity continuing throughout the warm season.

During the flight period ambrosia beetles locate a suitable log or recently killed tree, and begin boring an entrance hole through the bark and into the sapwood. For *T. lineatum*, the boring is initiated by female beetles, whereas males begin this activity for *Gnathotrichus* species.

During the initial boring activity, both *Trypodendron* and *Gnathotrichus* species produce a chemical attractant called the aggregation pheromone. The attractant draws in many more flying beetles and the log or tree is rapidly colonized.

For all three species, mating takes place on the bark surface near the entrance hole. The pair work together extending the gallery and keeping it clear of boring dust and excrement.

The *Trypodendron* gallery penetrates directly into the wood for a short distance before branching into one to several brood galleries. The brood galleries do not follow an annual ring of the tree, as do those of *Gnathotrichus*, but may slant across the growth rings (fig. 3).

Fig. 3. Sections of Douglas-fir log showing *T. lineatum* galleries and pinhole appearance.

The main gallery of *Gnathotrichus* species penetrates the wood perpendicular to the long axis of the tree, and brood galleries branch off and follow along annual growth rings. Both *Trypodendron* and *Gnathotrichus* cut egg niches into the sides of brood galleries and their larvae enlarge these niches as they grow (fig. 4).

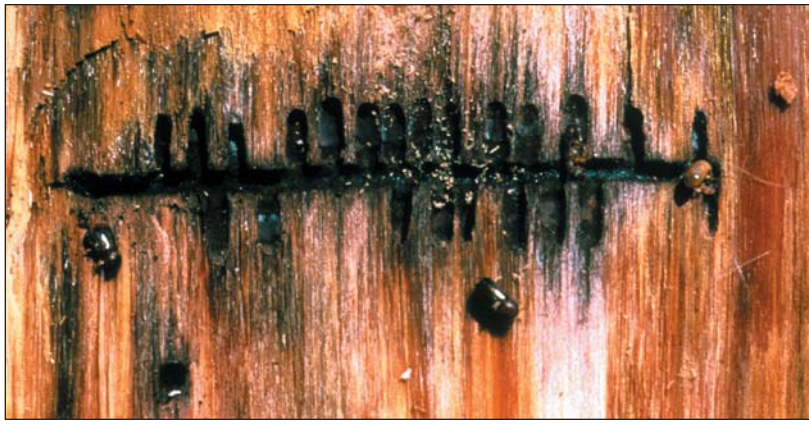


Fig. 4. Exposed egg gallery of *T. lineatum* in sapwood of Douglas-fir showing larval niches or "cradles" and young adults.

The "ambrosia" or fungal spores are carried into the gallery system by the adult beetles. The ambrosia spores germinate, grow, and cause a black stain in the galleries and surrounding wood tissues. The beetles harvest these fungal "gardens" for food and to maintain open galleries. The black stain is a characteristic feature of wood infested by ambrosia beetles (fig. 4, 5).

Fig. 5. Plywood veneer showing pinholes and stain from ambrosia beetle infestation.

Depending on local temperatures, development to young adult beetles occurs in 6 - 10 weeks after egg deposition. In June-July, young adult *Trypodendron* leave the host log and fly to hibernation sites in the forest litter or bark crevices. Young *Gnathotrichus* adults remain in the brood galleries until the following spring.

All three species of ambrosia beetles have a single generation per year, although *Gnathotrichus* parent beetles may continue extending their brood galleries and producing offspring throughout the warmer months.

Both *Trypodendron* and *Gnathotrichus* parent beetles may leave their initial host logs or trees, fly to a second host, and initiate a new attack in mid to late summer. These "second attack" flights may extend over many weeks, but they involve few insects compared to the spring flight (fig. 2) and they are of less economic significance.

## Host Trees

*Trypodendron lineatum* has been reported infesting every major commercial conifer species in the West. Preferred hosts in the Pacific Northwest appear to be Douglas-fir, hemlock, and spruce with diameters as small as 15 cm. Freshly cut and recently killed trees are rarely colonized by *T. lineatum*.

There are occasional reports of trees felled in late winter and early spring (February-April) being attacked by *T. lineatum*. This is unusual, however, and is most likely associated with the metabolic production of ethanol that is attractive to the beetles and is produced under anaerobic conditions within the tree tissues, as recently reported by Kelsey and co-workers (see references).

In contrast, logs cut between August and January are very susceptible to *Trypodendron* infestation the following spring (fig. 2). This beetle does not colonize a log more than one year, and debarked logs are not attacked regardless of age.

*Gnathotrichus* species also have a wide range of conifer hosts. In the

Pacific Northwest, true firs, Douglas-fir, and hemlock are preferred to cedar. In California, *G. sulcatus* is more commonly found in true firs and *G. retusus* in pines. *Gnathotrichus* species are capable of infesting trees that are felled at anytime during the year, including those felled between February and late summer. They may also continue to infest the same log or tree for more than one year, and may colonize logs felled 2-3 years previously. Additionally, they have been known to attack debarked logs.

*Gnathotrichus* galleries are generally more extensive and penetrate deeper than those of *Trypodendron*, sometimes extending into the heartwood of the log or tree.

## Damage

Ambrosia beetles primarily infest the sapwood or outer layers of the log. Often this outer wood is knot free and has the potential to produce clear lumber and veneer-grade plywood. Even light ambrosia beetle infestations in such potentially high-value products can result in a severe downgrading of value.

While ambrosia beetle attacks are most frequently encountered in logs, *Gnathotrichus sulcatus* has also been reported attacking the sapwood area of freshly sawn (green) hemlock lumber.

Lumber degrades result from the stained, pinhole appearance (fig. 5) of lumber processed from beetle-infested timber. Although infestations occur in the sapwood area of logs, the damage can affect a surprisingly high volume of processed lumber. For example, a Douglas-fir log 33 feet in length and 17 inches in basal diameter (10 m long, 44 cm in diameter) infested by *T. lineatum* and *Gnathotrichus* with galleries penetrating the sapwood to a depth of 3 cm, suffers degrade on 28 percent of the volume. A similar sized western hemlock log with beetle galleries penetrating to 8 cm may have degrade on 64 percent of the lumber volume.

Losses to degrade are especially high on large, high-value logs that have lost much of their potential for producing clear veneer or saw timber due to staining and pinholes.

Ambrosia beetles cause both direct and indirect economic losses. One direct impact is the heavier slabbing of infested logs at the mill, which causes a reduction in lumber yield. Indirect losses are related to the prejudice against the purchase and use of pinholed lumber. Many foreign countries have regulations against importation of wood products with any sign of insect infestation.

Wood containing ambrosia beetle damage may be rejected by export markets, or by the importing countries. Alternatively, the importing countries may require expensive pest mitigation treatments as a condition of entry.

## Natural Regulating Factors

The primary factor governing the population density of ambrosia beetles and their associated damage is the availability of suitable host logs and trees. Windthrow or other types of tree mortality may increase local beetle populations by providing an abundance of suitable host material.

The reproductive success of both *Trypodendron* and *Gnathotrichus* species require that the wood of host trees have a moisture content that is optimal for the growth of the ambrosia fungi. When down trees retain limbs and foliage, moisture may be lost more quickly because of transpirational drying. In some cases the transpirational

drying may reduce the susceptibility of trees to colonization by ambrosia beetles.

Relatively little is known about effects of natural enemies on ambrosia beetle populations. Common natural control agents such as microbial diseases, nematodes, or predators and parasites, appear to be rare and may not play a significant role in regulating ambrosia beetle numbers.

## Managing for Damage Reduction

A key factor for avoiding ambrosia beetle damage is the rapid removal and processing of logs. Beetle damage is often reported when storm damage delays access to logging areas, and the timely removal of felled timber is delayed. Log damage in sort yards increases when markets are poor and log inventory turnover is slow.

The best recommendation for minimizing damage at the logging site is to remove all logs from the forest as soon as possible after felling. When logs are temporarily left in the forest, operators should avoid leaving fall- and winter-felled timber through the period of spring beetle flight.

Although *Gnathotrichus* species are capable of infesting spring- and summer-felled timber, it has been repeatedly shown that the more abundant and damaging *T. lineatum* is primarily limited to fall- and winter-cut (August through January) trees.

At sort yards and mills the following procedures will minimize ambrosia beetle damage:

- Maintain a rapid turnover of high value logs
- Avoid storing fall- and winter-cut logs
- Store logs in ponds and watermist storage decks
- Store green lumber away from log storage areas, debris, and tree lines
- Locate sort yards away from forested areas
- Remove potential breeding and overwintering sites near sort yards

Although pond storage clearly reduces ambrosia beetle infestations, the exposed surfaces of logs are still susceptible to beetle colonization. Protection from beetle attack can be further enhanced by misting the pond surface during the beetles' flight season.

Still another management tool for mills and sort yards is the use of

Fig. 6. "Funnel" traps baited with pheromone can be used to reduce local beetle populations.

aggregation pheromone lures for trapping ambrosia beetles to monitor their populations and reduce their numbers (fig. 6).

Trapping programs have widespread acceptance in British Columbia and Oregon and Washington as a method of reducing beetle populations in and around mills and sort yards. Synthetic pheromone lures, traps, and advice on trapping programs are commercially available. Trapping should be done in conjunction with the procedures listed above to minimize ambrosia beetle damage.

## Ecological Roles and Values

Although this paper is written from a perspective of preventing or reducing the economic losses that can be caused by ambrosia beetles, their ecological values in western forest ecosystems are duly recognized.

The ambrosia beetles are among the first organisms to penetrate the bark and sapwood of recently killed trees, thus opening the way for fungi and other organisms to begin the decomposition processes that are fundamental for maintaining nutrient cycling and other processes essential to ecosystem health. The beetles themselves represent a part of the food web, and their feeding and boring activities in large woody debris represent important steps in rendering that material functional as habitat and foraging substrate for other organisms.

Recommended management actions to reduce economic losses are highly site-specific, and will not unduly influence the capabilities of these insects to fulfill their ecological roles in the forest ecosystem.

## Assistance

If more information is needed on the identification and management of ambrosia beetles, readers are encouraged to contact their local State Forestry Office, County Cooperative Extension Agent, or Regional USDA-Forest Service Forest Health Protection Office.

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