

FOREST  
**Pest**  
LEAFLET

# SPRUCE BEETLE

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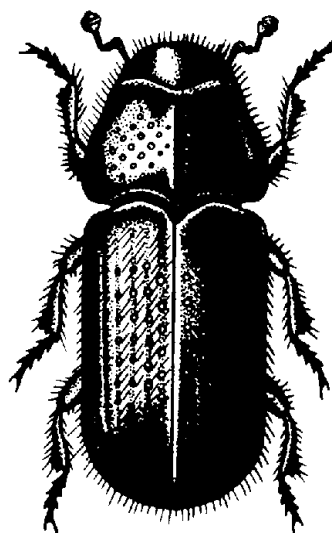
## Introduction

The spruce beetle, *Dendroctonus rufipennis*, is the most destructive pest of mature spruce trees in British Columbia. Outbreaks usually last 2-5 years, and these may severely deplete the large-diameter spruce (*Picea* spp.) component of forest stands.

In the 1940s, an outbreak of this native insect in northwestern British Columbia and southwestern Yukon

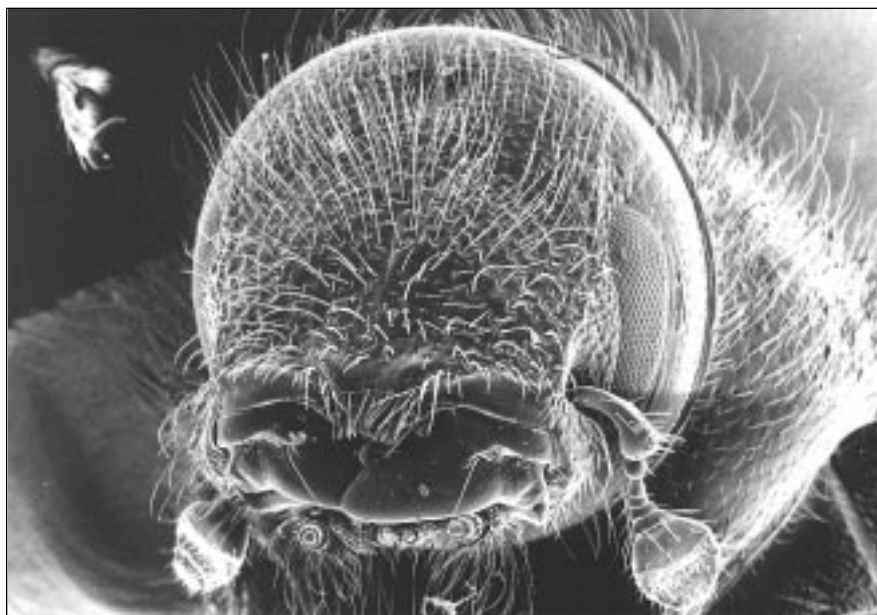
occurred over 375 km<sup>2</sup>.

Up to 90% of the spruce trees were killed and timber losses were estimated at 878 000 m<sup>3</sup>. Another infestation during the same period occurred over 777 km<sup>2</sup> in the upper Nass River Valley. During 1952-1956, 400 000 m<sup>3</sup> of



Adult

spruce were killed in southeastern British Columbia. At the same time, a much more extensive outbreak was in progress in northern Idaho and western Montana. From 1961 to 1965, an epidemic affecting over 243 000 ha in the Prince George and Prince Rupert



Head of an adult spruce beetle

Forest Regions caused losses of over 14 million m<sup>3</sup>. The attack in 1962 accounted for more than half of the total volume killed. In 1967 and 1968, outbreaks in the Prince George Forest Region again occurred over extensive areas, killing 822 000 m<sup>3</sup> of spruce. Extensive tree mortality also occurred in the Nelson and Cariboo Forest Regions from 1967 to 1971, and several large infestations that began in 1969 continued in the Kamloops Forest District until 1973.

Since the early 1970s, further outbreaks of the beetle have occurred across the province, often associated with windthrown spruce, or with poor forest sanitation practices. For example, significant increases in population levels and attack occurred during 1978-1982 in the Prince George



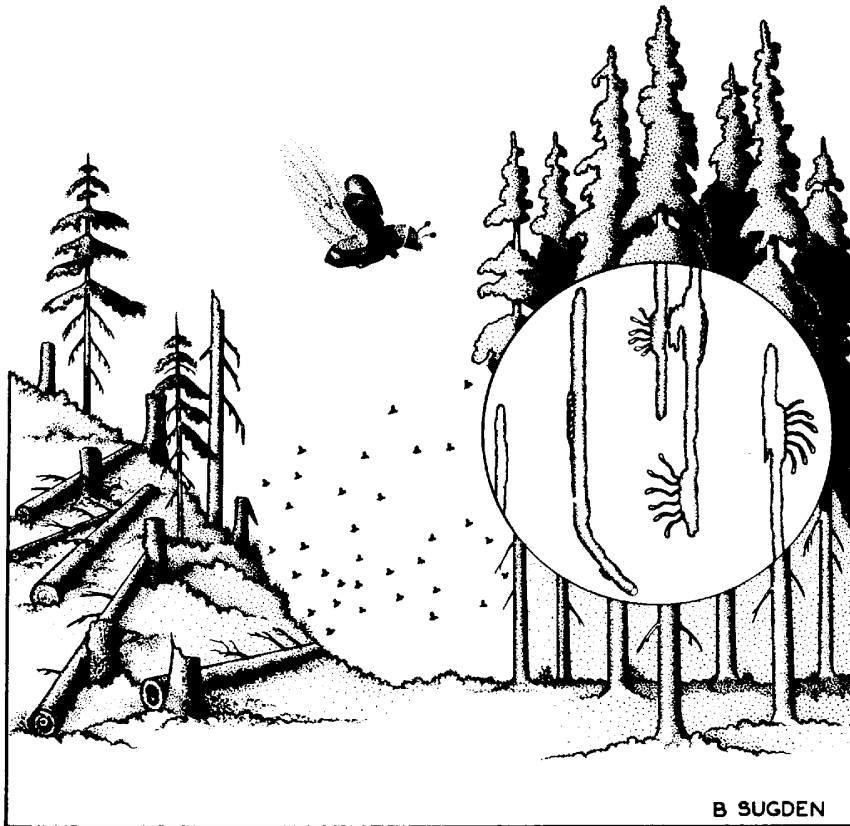
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Adults moving from logs to green trees and closeup of egg galleries and young larval galleries.

Forest Region. Over 60 000 ha were attacked in the Willow, Bowron, McGregor, and several other river drainages. By 1982, trees amounting to over 2 million m<sup>3</sup> of wood volume had been killed. This prompted the forest industry to undertake several large-scale salvage operations.

Spruce beetle populations declined during the mid to late 1980s, but occasional local outbreaks were recorded throughout the province. In 1987, most of the 1675 ha of infested spruce recorded were located in the Kamloops and Nelson Forest Regions. A resurgence of spruce beetle attack was recorded during 1990 and 1991, again primarily in the Prince George Forest Region. Across the region, aerial surveys indicated that infestations were scattered over more than 44 000 ha. Current studies suggest the threat to mature and healthy spruce will continue, particularly in stands north of Mackenzie and

west of Williston Lake after 2-year cycle broods mature in 1993.

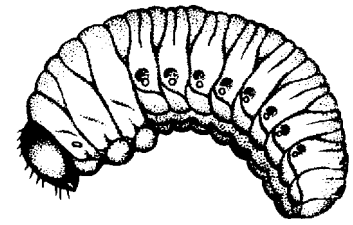
Severe losses to the spruce beetle in any one year can equal or exceed 10% of the volume of spruce harvested in British Columbia; this is cause for concern among all resource managers, not just foresters. Attacks in parks or ecological reserves, for example, can seriously affect aesthetic, recreational, and scientific values, as well as timber values.

### Hosts and distribution

Engelmann, white, Sitka, and (rarely) black spruce are attacked by the spruce beetle. The insect occurs throughout the range of spruce in British Columbia and Yukon.

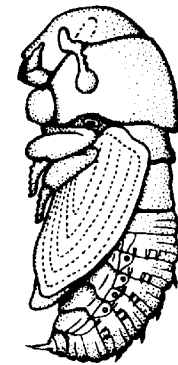
### Description

Egg: Pearly white, oblong, from 0.75-1.0 mm long. Eggs are laid in galleries about 13 cm in length.



Larva

Larva: Stout, cylindrical, legless, and wrinkled. The head is pale tan and the body creamy white. When fully grown, the larva can be 6-7 mm long.



Pupa

Pupa: Creamy white, becoming pale tan near maturity. Pupae have wings, legs and antennae that are visible, and are about 6 mm long.

Adult: Robust and cylindrical, about 6 mm long. Immature adults range from pale yellowish to medium brown; mature adults are all black or have a black head and prothorax and reddish brown wing covers.

### Life history and habits

In British Columbia, the spruce beetle usually has a 2-year life cycle. Some populations (or parts of them) may mature in 1-3 years, according to geographical location, elevation, and variations in the mean temperature of the spring and summer months. In the most exposed host materials such as stumps and log decks and along stand edges, broods often develop as mixtures of 1-year and 2-year cycle individuals, depending on the amount of solar radiation on infested bark.

Young adults that have overwintered and parent adults that have survived after establishing their first brood the previous summer emerge and attack fresh host material from late May to early July. The parent beetles occasionally emerge the same summer, attack fresh material, and establish a second brood, or they may overwinter before attacking again the next year. Windfall, freshly cut logs, stumps and shaded slash are nearly always infested, but standing trees may also be attacked when conditions are favorable. At low population levels, the spruce beetle prefers weakened or decadent trees and downed host materials such as windfall, logs, and logging residue. Outbreak populations - which may develop when such food and breeding materials are ample - can then surge into apparently healthy trees and stands.

In standing trees, the heaviest infestation is concentrated on the lower part of the bole. The female beetle bores through the bark to the sapwood, then begins excavating the egg gallery. The male enters the gallery, mates with the female, and usually remains until the gallery is completed. The egg gallery, a tunnel oriented parallel to the grain, extends upwards from the entrance hole in standing trees, but may extend in either direction in logs and downed trees. Eggs are laid in groups on alternate sides of the gallery. The lower end of the egg gallery is packed with boring dust. Egg galleries made by other bark beetle species are either clear of boring dust, have several arms, or run transverse to the grain. In exposed windfall, logs, and stumps, the heaviest attacks are concentrated on the shaded parts. Attack densities normally range between 40 and 80 beetles per square metre of stem surface area at breast height on standing trees.

The eggs hatch in 2-4 weeks and the larvae move horizontally away from the parent gallery, feeding on the inner bark. They feed together until they are about one-third grown, and then they form individual mines. In the 2-year cycle, the beetle progeny



Spruce beetle galleries in phloem (inner bark)

overwinter as larvae, pupate, and reach the adult stage the following summer. These young adults may spend the winter in pupal cells or, when in standing trees, may emerge and overwinter in chambers in the thick bark at the root collar, protected from woodpeckers and extremes of temperature. The proportion of adults that move to the bases of trees to overwinter varies from year to year.

In the 1-year cycle, the beetle progeny reach the adult stage during the first season and attack the following spring; in the 3-year cycle, the progeny overwinter twice as larvae and once as adults. Both larvae and

surviving parent adults may overwinter in this situation. In either cycle, the spruce beetle must overwinter as an adult before it can attack and reproduce.

## Detection

### Boring dust

Boring dust is an important means of detection during the first year following attack, although it becomes less conspicuous toward fall and winter through the action of rain and wind. It is light brown and about as coarse as sawdust from a hand saw. It may be found in bark crevices, heavily scattered around the root col-



Red spruce crowns - symptom of trees killed by spruce beetle

lar, and on broadleaved foliage of ground cover beneath infested trees. Inspection of every tree is necessary if a detection survey is to be accurate. Care must be taken not to confuse the work of small bark-mining insects with the boring dust produced by bark beetles; the former is pellet-like and not normally found in large quantities. Dust produced by ants and engraver beetles is light colored because of the high wood content and is not likely to be confused with *Dendroctonus* boring dust.

#### **Pitch tubes**

Pitch tubes are occasionally formed by the tree's resin flowing out of the entrance holes made by the attacking beetles. If the beetles are successfully repelled by the tree, the pitch tubes are usually whitish; if the beetles are able to continue their gallery, the pitch becomes intermixed with boring dust and the pitch tubes are reddish brown. Infested trees will often have some

white pitch tubes that indicate unsuccessful initial attacks, and many brown pitch tubes that indicate successful attacks. Beetles attacking late in the season and those in trees of low vigor usually produce no pitch tubes.

Although pitch tubes may be readily visible symptoms of an infested tree, they are often absent. Furthermore, clear or congealed pitch from the region of the lowest branches of the crown frequently results from sapsucker activity or cracks in the bark and is not by itself a reliable indicator of an infested tree.

#### **Woodpecker work**

Flaking of the outer bark scales by woodpeckers is a conspicuous but not infallible indicator of bark beetle attack. Trunks of trees worked over by woodpeckers are reddish-purple instead of the normal gray. This is most noticeable in early spring. Heaps of bark may be lying on the snow around the bases of the trees. Because wood-

peckers occasionally work on healthy trees in search of other bark-mining insects, moderately scaling the bark in the process, the presence of spruce beetles should be verified by evidence of boring dust and galleries.

#### **Foliage color**

Dying and dead spruce do not assume the bright red color common to most other dying conifers. Fading of the foliage to a yellowish green may be noticeable during the winter following attack, particularly in the lower crown. By the second autumn, most of the needles may have been lost and, for a year or two, the tree will have a reddish appearance from a distance due to the color of the small, bare twigs. When these twigs fall, the trees are less conspicuous. In general, foliage discoloration and loss are not apparent until a year or more after attack. Green needles on the ground or on the leaves of ground cover beneath infested trees may appear

before any evidence of fading or thinning is visible in the crown itself.

### Strip attacks

These attacks on parts of tree boles occur frequently and may contain large numbers of insects. The trees may survive, however, if even small strips of cambium remain intact.

### Prevention of outbreaks

Spruce beetles are probably present in every merchantable spruce stand in the British Columbia and Yukon Region, and the occurrence of single, widely scattered infested trees is not necessarily an indication that an outbreak is imminent.

Most studies suggest that the major outbreaks have been brought about by large populations breeding in windthrown trees during periods of suitable climatic conditions, although some (mainly local) infestations have been caused by man-made disturbances. Some causes of infestation that can be avoided are:

- **high stumps**, cull logs and large diameter slash; these may produce high numbers of beetles. Exposed stumps and cull logs do not produce as many beetles as those shaded by debris or residual trees, although the root collar region and the parts of large roots between the duff and the mineral soil are suitable for high production in many years.

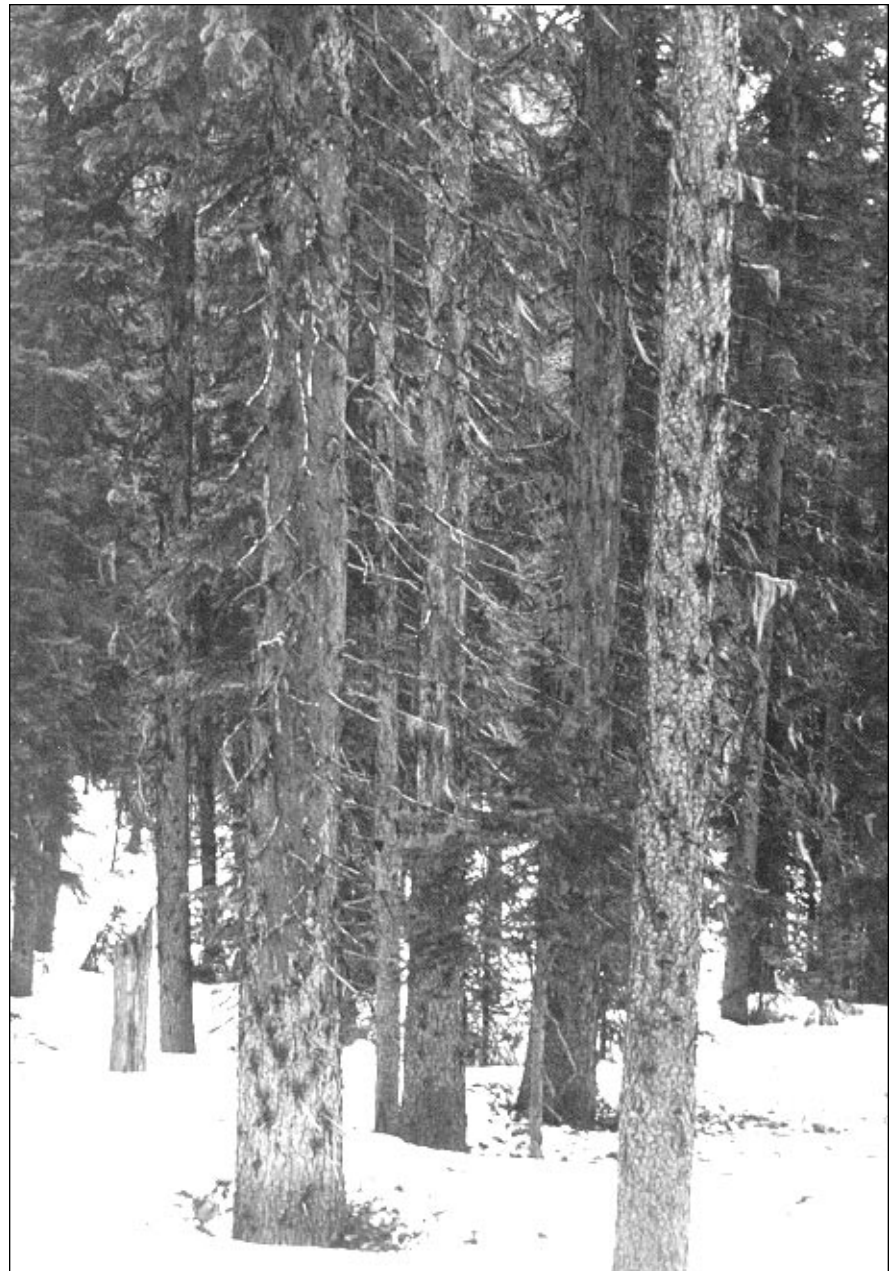
- **windthrown trees** on seed blocks or in stands at edges of logging operations.

- **right-of-way logs** that had not been removed from the forest.

- **extensive soil disturbance** at the edges of clearcuts, done to expose the mineral soil before slash-burning. This can disrupt the subsurface movement of water and may predispose nearby trees to beetle attack and windthrow.

- **cutting boundary** layouts that may make residual stands vulnerable to strong winds, or trees that are located on ground that is not wind-firm.

- **extended rotation ages** (>100 years) that may result in increased



Outer bark flaked off by woodpeckers searching for beetles

risk of attack because of the abundance of prime host trees.

### Natural controls

#### Climatic factors

Low temperatures in winter or early fall have been known to cause the collapse of infestations. During research studies, a temperature of -26°C killed nearly all the adults, but -35°C was required to kill all of the larvae. Hibernating beetles protected by a mantle of snow would rarely be subjected to such extreme temperatures.

Cold, wet weather during the flight period is generally detrimental to successful attack. As well, cool weather during the growing season may significantly extend the period of brood development. Hence, heavy mortality may ensue due to uneven development of the life stages or prolonged exposure to mortality factors.

#### Woodpeckers

Woodpeckers are a very effective check on spruce beetle populations and have been known to



Reddish brown boring dust at base of a study tree

reduce them by over 90%. Because the woodpeckers that live in spruce forests are mainly non-migratory, the numbers that gather in infestations are never very large. A remarkable feature in the Prince George Forest Region, however, has been the immense amount of woodpecker activity. Protected by snow, windfalls, logs and the lower part of the boles of standing trees are inaccessible to woodpeckers throughout most of the winter, and it is unlikely that these birds are able to control an outbreak. The value of woodpeckers lies chiefly in their ability to reduce the damage in established infestations, and to detect scattered infested trees in an incipient outbreak and reduce the danger of an outbreak by concentrating on them throughout the winter.

#### **Insect parasites and predators**

Population reduction by insect parasites and predators is generally low, but can be significant in some situations.

#### **Tree resistance**

In younger stands and smaller infestations, attacks by the spruce beetle can fail and the brood can be killed by trees' resin flow. This is more common after years of vigorous growth that may significantly increase resin production.

#### **Applied controls**

The aim of any spruce beetle control strategy should be to (1) reduce beetle numbers to endemic levels and/or (2) to reduce wood losses and site degradation to acceptable levels. Generally, the effectiveness of a control program is proportional to the thoroughness with which the operation is carried out.

#### **Logging in infested areas**

Sanitation logging is the most effective and commonly used technique for treating moderate to severe infestations. Entire stands, or parts of stands

containing infestations, are logged.

The logs are processed quickly and all bark and slabs are burned before the next beetle flight. As few cull logs and pieces of large-diameter slash are left as possible. Pre-flight baiting, using uninfested spruce trees in a grid pattern or at intervals, is sometimes used in threatened areas before logging. Cutting boundaries can also be designed to concentrate beetle attacks on timber scheduled for harvest. In the years following logging, fringes of residual stands should be checked for blowdown, and those trees removed before beetle flight.

#### **Trap trees**

Two types of trap trees - conventional (untreated) and lethal (treated with a systemic insecticide such as monosodium methane arsenate, MSMA, before falling) - are effective in reducing beetle populations, mainly in lighter infestations, along rights-of-way, and in logging residue. Trap

trees are often used in conjunction with sanitation logging to treat lighter parts of infestations and to mop up populations after logging.

Conventional trap trees are green trees felled in the late winter or the spring, before beetle flight. Although both freshly cut or windfelled trees are more attractive to spruce beetles than standing trees, all can be severely attacked during large and intense outbreaks. However, the downed trees will be attacked for their entire length, whereas only the lower one-third to one-half of standing trees are attacked; downed trees can therefore absorb up to six times the number of beetles than standing trees.

Lethal trap trees are prepared in the spring before flight. A shallow, continuous frill is cut by axe around the base of the bole of live, uninfested spruces. A measured amount of the systemic insecticide is then poured into each frill. Treated trees are felled usually 10-14 days later. Before using MSMA or other insecticides, consult local forestry or pesticide control officials for information on its application.

In British Columbia, the use of trap trees is restricted to situations where they can be readily removed so that the invading broods are completely destroyed (usually within a year of the attack). For example, a recommended practice is to fell trees around the perimeter of beetle management blocks before harvesting. The trees should lie in the shade of the overstory to ensure attack.

### Other treatments

Treatments of individual trees, such as pile-and-burn or the application of bark-penetrating insecticides, are normally used only under special circumstances when infestations are small.

Burning is the most common treatment for infested logging residue. Pheromone-baited, standing, live spruce trees treated with an insecticide are useful for destroying attacking spruce beetles. Such situations might occur for small timber harvest areas requiring protection for a year or two. Submersing infested logs in water or sprinkling them continuously with water for 5-6 weeks are also highly effective in killing the broods. As well, pheromone-baited traps are useful for monitoring when the flight period begins and how long it lasts, and for determining beetle dispersal.

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\* Both of these bulletins are available from Phero Tech Inc., 7572 Progress Way, RR 5, Delta, B.C. V4G 1F9.

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Additional copies of this and other leaflets in this Forest Pest Leaflets series, as well as additional scientific details and information about identification services, are available by writing to:

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