Forest Insect
& Disease
Leaflet 75

U.S. Department
of Agriculture
Forest Service

# *Beech Bark Disease*

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Beech bark disease causes significant mortality and defect in American beech, *Fagus grandifolia* (Ehrh.). The disease results when bark, attacked and altered by the beech scale, *Cryptococcus fagisuga* Lind., is invaded and killed by fungi, primarily *Nectria coccinea* var. *faginata* Lohman, Watson, and Ayers, and sometimes *N. galligena* Bres.

## History and Distribution

Accounts from Europe indicate that the disease was killing beech *(Fagus sylvatica)* before 1849. The scale insect, readily visible on the trees, was considered the cause of death until 1914, when it was learned, that a fungus, then identified as *Nectria ditissima* Tul., infected trees infested by the scale.

Around 1890, the scale was accidentally brought to Nova Scotia. By 1932, the scale and an associated nectria fungus were killing trees throughout the mature beech areas of the Maritime Provinces and in localized areas of eastern and south-central Maine. In addition, isolated infestations of scale were occurring in southwestern Maine and eastern Massachusetts. The scale insect has continued to spread to the north into Quebec and to the west and south throughout New England, New York, New Jersey, and northern and eastern Pennsylvania. In 1981, a 70,000-acre area was found infested in northeastern West Virginia.

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## Disease Pattern

The pattern of insect spread and the subsequent occurrence of nectria infection and tree death have led to an arbitrary classification of disease development over time and space:

- The advancing front—areas recently invaded by the beech scale that are characterized by forests with many large, old trees supporting scattered, sparse, building populations of beech scale.
- The killing front—areas that are characterized by high populations of beech scale, severe nectria attacks, and heavy tree mortality.
- The aftermath zone—areas where heavy mortality occurred at some time in the past and that are now characterized by some residual big trees and many stands of small trees, often of root-sprout origin. In the aftermath zone, young stems are often rendered highly defective through the interactions of established populations of beech scale, nectria fungus, and another scale insect, *Xylococculus betulae* (Perg.) Morrison.

Large trees, over about 8 inches (20.3 cm) in diameter, succumb more readily than small ones. Recent data from plots in Vermont, New Hampshire, and Maine show that about 28 percent of the large beech had died, another 22 percent were dying, and many of the surviving trees were so severely injured that they offer little hope as a source of quality material.

## The Causal Complex

***The scale***—*C. Fagisuga* is a soft-bodied scale insect. At maturity, it is yellow, elliptical, and 0.5 to 1.0 millimeter[3] long (fig. 1). It has reddish-brown eyes, a 2-millimeter stylet, rudimentary antennae and

[3]One millimeter = 0.04 inch.

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**Figure 1**—*Mature beech scale insects (about 1 mm long). The wax was removed before the photograph was taken.*

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**Figure 2**—*Beech scale nymph (about 0.3 mm long).*

legs, and numerous minute glands that secrete a white "woollike" wax.

There are no male scales; reproduction is parthenogenetic. Beginning in midsummer, the insects deposit pale yellow eggs on the bark in strings of four to eight, attached end to end. The eggs usually begin to hatch in late summer and continue hatching until early winter.

The wingless larvae (also called crawlers or nymphs) emerge from the eggs with well-developed legs and antennae (fig. 2). Some larvae remain under the females, which die after the eggs are deposited. Some migrate to cracks and other protected areas; others are washed down or fall to the ground where most of them die; and still others are carried, usually by wind, to other beech trees. If a suitable location is found, the insect forces its tubular stylet into the bark and begins to feed. It then transforms into a second-stage nymph, without legs and covered with woollike wax. The insect overwinters in this stage and, in the spring, molts to become an adult female.

***The fungus***—In North America, two species of the nectria fungi are associated with beech bark disease. The principal one, *N. coccinea* var. *faginata,* is considered a weak parasite; the second species, *N. galligena,* is a common pathogen inciting perennial cankers of many hardwood species. In some areas, for example in West Virginia, *N. galligena* appears to be the major species involved. Both organisms produce several types of spores.

One type of spore is produced in fruiting bodies called perithecia that occur in clusters on the bark. The perithecia are tiny, bright red, and lemon shaped (fig. 3). Each perithecium is filled with elongated sacs, each containing eight spores. The production of these spores constitutes the sexual or perfect stage of the fungus.

The perithecia mature in the fall. Spores are forced out when the perithecia have been sufficiently moistened; when dry, they appear as white dots on the tips of the perithecia. Perithecia on the dead bark continue to produce viable spores the next year.

Other spores are formed by an asexual or vegetative process. Frequently, small white cushions of spores burst through the bark before the perithecia appear (fig. 4). These asexual spores range from single-celled, oval spores to eight-celled, sickle-shaped spores and are produced in a dry head, well suited for dissemination by wind. The asexual spores can be found from midsummer until fall, and can easily be mistaken for small isolated colonies of the scale insect.

## Symptoms and Course of the Disease

The white wax secreted by the beech scale is the first sign of the disease. Isolated dots of white "wool" appear on the bole of the tree on roughened areas of bark, beneath mosses and lichens, and below large branches. Eventually the entire bole of the tree may be covered by the waxy secretion as the insect population increases (fig. 5). It is probable that great numbers of scales feeding on the liquids of bark cells can materially weaken a tree. But serious damage results only after the later invasion of the bark by *Nectria,*

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**Figure 3**—*Sexual fruiting bodies (perithecia) of* N. coccinea *var.* faginata *(about 0.3 mm in diameter).*

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**Figure 4**—*The asexual stage of* Nectria. *The white tufts of spore-bearing branches can be mistaken for isolated colonies of the scale. The asexual stage of* N. coccinea *var.* faginata *is called* Cylindrocarpon faginatum; *of* N. galligena, C. mali.

presumably through injuries made by scale feeding activity.

On some trees, a red-brown exudate called a slime flux or "tarry spot" oozes from dead spots (fig. 6). These dead spots are often the first symptom of nectria infection, and frequently perithecia of *Nectria* later appear around them. The dead areas may extend into the sapwood.

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**Figure 5**—*Heavy infestations of beech scale can cover tree boles with white wax.*

Bark infected by *Nectria* becomes inhospitable for the beech scale. If the outer bark is cut away, a distinct orange color may be seen where *Nectria* is actively invading the bark. The fungi may infect large areas on some trees, completely girdling them. On such trees, the perithecia that often form can redden large areas of the bark (fig. 7). On dying trees, leaves that emerge in the spring do not mature, giving the crowns a thin, open appearance. Later, the leaves turn yellow and usually remain on the tree during the summer. (See cover.)

Frequently the fungus infects only narrow strips on the bole, and the subsequent symptoms differ from those of trees that have been girdled. Callus tissue forms around these strips, and the bark becomes roughened (fig. 8). Small nectria cankers may be walled off from the sapwood by callus tissue (fig. 9).

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**Figure 6**—*A slime flux or tarry spot exudate on a tree that also bears isolated colonies of beech scale covered with woollike wax.*

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**Figure 7**—*Large areas of bark reddened by nectria fruiting bodies.*

## Associated Organisms

Other insects and wood-rooting fungi quickly invade the wood beneath bark killed by beech bark disease. Species of *Hypoxylon* that decay sapwood are among the first to invade. Ambrosia beetles make holes that allow other fungi to enter. The

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**Figure 8**—*The death of long strips of bark results in serious defect when underlying wood is invaded by insects and decay fungi.*

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**Figure 9**—*The craterlike scars indicate where small, isolated nectria cankers were walled off by callus tissue. Since most of the cankers did not penetrate to the sapwood, little damage has occurred.*

shoestring root rot fungus, *Armillariella mellea,* sometimes invades weakened trees and hastens their death. Attacks by these organisms make it difficult to judge when trees will succumb to beech bark disease. Many trees that are partially girdled remain alive, in a weakened state, for years. Many are broken by the wind—a condition termed "beech snap" (fig. 10).

In the aftermath zone, attacks of a second scale insect, *Xylococculus betulae,* create severe defects on young beech stems. Roughened areas resulting from *X. betulae* attack are, in turn, infested by beech scale and then by *Nectria.*

## Control

The fact that marked declines in beech scale populations occasionally occur over large areas suggests that general environmental factors may affect the insect. Air temperatures of -37° C (-35° F) are lethal to those insects not protected by snow. But whether episodes of such temperature extremes are the only events responsible for population crashes is not known.

A ladybird beetle, *Chilocorus stigma,* feeds on the scale; and a fungus, *Nematogonum ferrugineum (Gonatorrhodiella highlei),* parasitizes the nectria fungi. The effects of these organisms on the disease agents

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**Figure 10**—*Beech snap occurs when wind breaks off trees where wood borers and decay fungi weaken the wood beneath scale-*Nectria*-killed bark.*

and on the course of the disease have not been critically evaluated.

Scales on high-value ornamental trees can be controlled with insecticides. Consult your local forest pest management specialist or county agricultural agent to obtain current information on chemicals registered for beech scale control.

The disease in forest stands cannot be controlled at a reasonable cost, and a program of timely salvage cuttings is the only way presently know to reduce disease losses.

Vigorous trees free of the disease are often found in heavily affected areas (fig. 11). Recent trials with some of these trees have shown them to be resistant to the scale. This offers hope that methods can be developed to increase the levels of resistance in affected forests.

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**Figure 11**—*The beech tree with the ribbon is free of beech scale and* Nectria; *the tree on the right is severely diseased. Recent trials have shown such clean trees to be resistant to the beech scale.*

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Revised August 1983

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