

The Beech Scale and Beech Bark Disease in Acadia National Park¹

A. E. BROWER, *Maine Forest Service, Augusta*

Beech scale is by far the most important insect pest of beech in the Northeast. This imported pest, *Cryptococcus fagi* (Baer.), has been known for a long time in Europe. In 1931 it was discovered in Maine in several towns near Calais and at Liberty, both infestations being of several years standing. Scouting during the next 3 years showed that the infestation extended north and west to Vanceboro, Topsfield, and Whiting; and infestations were found in Waltham, east of Millinocket, several towns about Liberty, and an infested area in York and Eliot. By 1936 most stands in the southeast quarter of Maine were heavily infested. Due to its very destructive attacks on beech stands in Nova Scotia, its rapid spread in Maine was viewed with alarm, and surveys have been made to record its advance across the state. It spread rapidly and less injuriously through the mixed younger beech stands of south central and western Maine, reaching the western and northwestern borders and New Hampshire by 1943. Its spread northward has been slower, the first heavy infestation being recorded from the Portage area in 1948. The beech bark disease was found in one spot north of Ashland in the fall of 1948.

The destruction brought on by beech scale is anomalous. Despite the large percentage of bark it kills on the trunks of trees which it attacks, the claim is made that the scale alone does not kill any trees. Trees heavily attacked by the scale are regularly attacked by the otherwise impotent beech bark disease fungus, *Nectria coccinata* var. *faginata* Lohman, A. J. Watson and Ayers, and this combination has killed or badly damaged a great part of the large beech attacked. Occasionally trees as small as 5 inches in diameter are killed, and even small sprouts may be heavily infested with scale. Figures of the percentage dead give a very misleading picture of the damage done because many of the old trees will live on with but a few small trunk branches remaining alive. Near Princeton in 1946 an old beech ridge gave a count of but approximately 50 per cent dead, but the destruction of the

canopy was near 100 per cent and a thick stand of beech sprouts had come up as in a clear-cut area. The destruction of most of the remaining severely damaged beech seems but a matter of time from the heavy infestation of *Fomes fomentarius* which followed. Destruction of the old beech in Acadia National Park has reached 40 per cent in some places, with most of the remainder severely damaged. The beech bark disease has regularly followed heavy scale infestations, being found a few years after the scale.

The beech scale is wingless and parthenogenetic. It spreads in the crawler stage which appears in August and September. Due to the fact that the beech in Acadia National Park on Mount Desert Island is isolated by a water barrier of a few miles or more, in most places, from the nearest beech on the mainland, and still more isolated by low-lying beechless areas of farms and coniferous growth on the northern part of Mount Desert Island and the nearby mainland, it was hoped that the insect would not be able to cross to beech on the Island. The following control work and spraying has been carried out by the National Park Service, the writer acting as a Collaborator of the Bureau of Entomology and Plant Quarantine, U.S.D.A., for Acadia National Park.

Early in 1934 the first few infested trees were found in the Park in one of the central valleys. Since scouting yielded no more infested trees eradication was decided on. The trees were heavily sprayed with kerosene to a height above evident scale, set on fire, and later felled and removed from the woods. In 1935 and 1936 more infested trees were found close by and these were removed from the woods. In 1936 another infestation was discovered more than a mile away in another valley, The Gorge, where about 2 acres of beech were infested. Heavily infested trees were cut and removed. In the spring of 1937 both of these areas and neighboring trees were thoroughly sprayed. Commer-

¹ The author wishes to acknowledge the criticism of Dr. Perley Spaulding, Principal Pathologist, Agricultural Research Administration, in the preparation of this paper.

cial liquid lime sulphur was used at the rate of 5 gallons to 95 gallons of water. In the period 1934 to 1937 many of the important beech stands were examined at varying intervals for the scale, but no thorough examination was made of the beech on Mount Desert Island. During January and February 1938, A. L. Jones and a crew of C.C.C. boys scouted and mapped all of the beech stands on the Island. As was feared, the beech scale was found more or less distributed in the majority of the beech areas. Beech was found on about 1197 acres, with about 1200 of the trees infested. Since then the scale has spread to about all beech trees on the Island.

In the spring of 1938 all known infestations which were accessible to roads were sprayed. Thirty-seven areas were sprayed, as was the beech in an additional 50-foot safety belt around each infestation. About 4000 trees were sprayed. Back pumps were used to reach and spray some of the infested trees too far from a road.

These spraying operations did not eliminate the scale in the areas sprayed. Due to small weak hose, lack of operating pressure, inadequate supervisory force, winds and other factors, the top of the infestation could not always be reached and some trees were missed or incompletely covered. Scale has been found up to 65 feet above the ground. Lime sulphur discolors the trunks and kills all of the moss and lichens, which generally makes unsprayed trees noticeable and facilitates a check on coverage. The higher the pressure the more readily the moss and lichens can be wet thoroughly in order to kill the scales hidden beneath. Inspection of the sprayed areas, with a microscopic check on any suspicious looking patches of scale, showed that complete kill could be secured. Thoroughly wetting the trunks with standard strength liquid lime sulphur 5 gallons to 95 gallons of water, or 20 pounds of dry lime sulphur in 100 gallons of water, will give 100 per cent kill.

In the spring of 1939 the spray program was reconsidered. This led to the abandonment of the plan to spray all of the beech. Four large plots and three smaller ones were selected for preservation. Later the three small areas were abandoned. This revised program was based on the belief that the scale could be controlled by spraying at intervals of a number of

years. Apparently, thorough coverage with lime sulphur before the leaves open in the spring will both kill all the scale present and prevent reinfestation during the year. Light infestations have been observed to require 2 to 3 years or more to build up to the danger point, the danger point being that point causing sufficient injury to permit an injurious infection by the beech bark *Nectria* to be established and to develop. Difficulty in securing enough labor made this time interval most important, and as the war came on labor was less available. One area was sprayed in 1939, but during the next 3 years but one more area was sprayed. Examination of the plots in the spring of 1943 showed that the infestation was heavy on plots which had not been sprayed for 5 seasons. One plot was not sprayed until the spring of 1944 after 6 seasons and the infestation became very heavy, and some of the trees were killed. Spraying this plot destroyed the scale and apparently stopped the *Nectria*.

In the early spring of 1943 well-developed infections of the *Nectria* which causes the beech bark disease were discovered in one and near another plot about 4 miles apart, and later in the year this disease was found on a third plot. This disease develops very slightly, if at all, on uninjured bark. Scale injury is a prerequisite for the development of an important infection. Heavy infestation by the scale may be followed by heavy infection by *Nectria*, but never the reverse. On trees where the scale reaches a medium to heavy infestation, this disease often attacks severely, following the scale in a few years. Many square feet of the trunk may be thickly dotted with the dark red fruiting bodies. *Nectria* fruiting is often strikingly associated with the vertical strips of previous heavy scale infestation. The scale develops a heavy strip infestation running up the northerly side of the trees and this is followed by heavy *Nectria* fruiting on the same area. After the *Nectria* infection kills large areas of bark which encircle the trunk the tree dies. Bark killed by *Nectria* dries, shrinks, and clings tightly to the trunk. Generally the bark on the southerly side, where the scale was lightest or patchy, is irregularly killed by the *Nectria*.

One of the most remarkable things to be seen everywhere is the great tenacity of beech trees. Many trees which seem to be

almost if not completely girdled are evidently able to transfer enough food material through devious slender channels to prevent death, though a considerable portion of the top often dies. The cycle of events is as follows. With some scattered scales to start with, the infestation can build up in 2 to 3 years to the point where dangerous *Nectria* infection may occur. In 3 to 4 years from the start *Nectria* fruiting bodies appear often in large numbers. Then the tree may die or survive more or less severely injured. A large majority survive, but many lose more or less of their tops. On trees which live, first the scale and then the *Nectria* subside to much lower levels of infestation and infection respectively. One to 3 inch trees are often rather heavily attacked by the scale, but not by the *Nectria*. Whether or not they will grow into trees resistant to *Nectria* is a point which must be determined in the future, but apparently injury to the wood and growth is important.

When the first infections of *Nectria* were discovered in the Park in 1943, trees with fruiting bodies were cut, burned, scorched with a gasoline torch, or sprayed with concentrated lime sulphur solution. Most of the diseased trees were removed from the woods. Later discovery of additional infected trees near those removed in other places led to the realization that the disease could not be eradicated or greatly checked with the labor available. The decision was then reached that practical control depends upon keeping the scale infestation low enough to prevent *Nectria* infection, and this became the aim of control work on the plots. Results to date support the conclusion that if the scale is held to a medium or lower infestation the *Nectria* disease will be of small or negligible importance. The disease is evidently dependent for injurious development upon injuries or an abnormal physiological condition produced by the scale in the bark. In this project the term "medium" is applied to the stage when the abundance of the scale reaches the point where a number of patches from the size of a nickel to a quarter are covered with the flocculent whitish covering or when dense vertical lines of scales are present in crevices, with lesser numbers scattered out from these concentrated spots. Nearly always the infestation develops first on the side of the tree least exposed to the

sun and there is also a strong tendency for vertical lines of infestation to develop. In August and early September when the young crawler stage is present, medium infestations have 2 to 3 thousand crawlers per square inch of most heavily infested bark. These concentrations will be limited to one side of the tree. Infestations termed "very heavy" have a crawler population of 4000 to 6000 or more crawlers per square inch.

Any natural control which exists is ineffective in holding the beech scale in check. The twice-stabbed lady-beetle, *Chilocoris stigma* (Say) is frequently found in some numbers feeding on the scale, and in areas where the scale exists in low numbers it may be an important check on the scale. No parasites of the scale have been found. Extremely cold winters seem to kill a large percentage of the exposed scales, but the ordinary winter temperatures apparently are not severe enough to prevent rapid multiplication in numbers.

SUMMARY.—Beech scale has spread rapidly in Maine. In some of the old stands beech has been almost completely killed or badly damaged. The scale crossed the water and beech-less fir-spruce barrier to reach beech on Mount Desert Island. There it became distributed widely in 4 to 5 years, despite attempts to eradicate or control it. Thorough spraying with liquid lime sulphur 5 gallons with 95 gallons of water has been found to give 100 per cent kill. Residual action of a spring application apparently prevents reinfestation during the current season. With thorough coverage the spray interval can be 4 to 5 years, depending on the proximity of unsprayed infested beech to the sprayed trees. The beech bark (*Nectria*) disease is dependant on injuries or an abnormal physiological condition produced in the bark by the scale for successful attack and development. Spraying the beeches before the scale infestation reached a point described as medium to heavy soon stopped development of the disease. Surviving trees develop a resistance, apparently in the bark, to attack, and first the scale and later the *Nectria* disease subside to much lower levels. Sprouts and small young trees show greater resistance to the scale and are not attacked by the *Nectria*, but the amount of injury to the wood and growth may be serious.