Agriculture Handbook No. 211

DISEASES OF SHADE AND ORNAMENTAL MAPLES

Agricultural Research Service • U.S. Department of Agriculture

Contents

Washington, D.C. Issued December 1961

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington 25, D.C. - Price 15 cents

By CURTIS MAY,
plant pathologist, Crops Research Division, Agricultural Research Service

Diseases of Shade and Ornamental Maples

Pathogenic organisms attack shade and ornamental maples and cause diseases of the leaf and flower, woody parts, and root. Leaf scorch, a noninfectious disorder, often seriously damages foliage of sugar, Norway, and sometimes other species of maple. Air pollutants may adversely affect maple and limit its usefulness in some localities.

LEAF AND FLOWER DISEASES AND CONTROL METHODS

Leaf blights and spots of maple sometimes damage large trees and frequently are serious on small or recently transplanted trees or trees growing under adverse conditions. Leaf diseases mar their appearance and detract from their landscape value.

FUNGUS AND BACTERIAL DISEASES

Anthracnose

Anthracnose is caused by *Gloeosporium apocryptum* Ell. & Ev. This fungus invades and kills the leaf tissue, producing small to large circular to irregular spots or necrotic areas, which turn light brown, purplish, or black. If the spots are numerous, they may merge until the whole leaf is affected. Usually they appear from late May until August. Affected leaves of Norway maple have purple to brown diseased tissue along the veins (fig. 1, *A*). On sugar maple large green- or red-brown anthracnose lesions occur along or between the veins, and often they extend to the leaf margin (fig. 1, *B*). On Japanese maple the disease may affect the entire young leaf, which often becomes blackened and shriveled. Trees are not always seriously damaged by anthracnose.

Spores of the anthracnose fungus are produced in acervuli on the diseased leaves and are spread

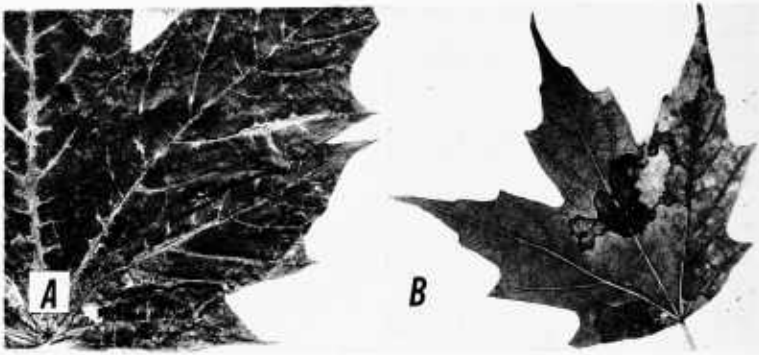

FIGURE 1.—Leaves affected by anthracnose: *A*, Norway maple (× ⅔); *B*, sugar maple (× ⅓).

by spattering rain and wind. These spores are 5 to 12 by 2½ to 5 microns and are oblong to narrowly elliptic.

Anthracnose can be controlled by spraying with a fungicide (see p. 9). This measure will help prevent disfiguration and loss of leaves. It will benefit weak and recently transplanted trees and trees that are diseased year after year. An application of fertilizer will usually improve the vigor of trees that are weakened by repeated severe attacks of anthracnose.

Phyllosticta Spot

Phyllosticta spot is caused by the fungus *Phyllosticta minima* (Berk. & Curt.) Ell. & Ev. This disease is widespread and sometimes serious. On different maple species the spots vary considerably. On sugar and Rocky Mountain maples the spots commonly have a narrow purplish border. The diseased tissue often falls out, and holes are left in the leaf. On Japanese maple, which may be severely damaged by the disease, the spots are straw to tan colored with a definite margin. The central part of the spot may be somewhat transparent. Usually the spots are small, irregularly circular, and reddish brown with narrow to broad purplish borders (fig. 2, *A*).

The spots have minute black fruiting bodies, or pycnidia, of the causal fungus. Not all the spots produce the fruiting bodies. Spores are 5 to 6 by 8 to 9 microns.

A closely related fungus, *Phyllosticta negundinis* Sacc. & Speg., causes a similar leaf spot on boxelder. The fungus *Septoria aceris* (Lib.) Berk. & Br. attacks leaves of the bigleaf maple and also causes leaf spot (fig. 2, *B*). Small reddish-tan to brown spots develop with a narrow yellow border. On other maple species the margin is usually irregular and indefinite.

Spraying with a fungicide should reduce damage from phyllosticta spot (see p. 9).

Tar Spots

Black spots on the leaves are the conspicuous symptom of tar spots. The fungi *Rhytisma acerinum* (Pers.) ex Fr. and *R. punctatum* (Pers.) ex Fr. cause the

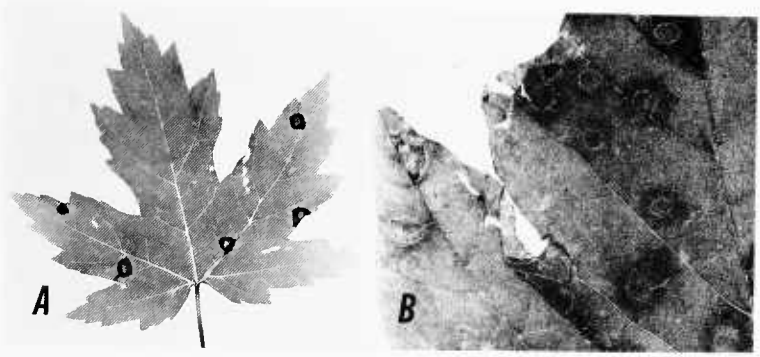

FIGURE 2.—*A*, Maple leaf affected by phyllosticta spot (× ⅛); *B*, bigleaf maple leaf attacked by the fungus *Septoria aceris* (× ½).

disease. When first invaded the leaves develop minute water-soaked spots. Soon small dark dots appear on the upper leaf surface between the veins. The dots enlarge and soon coalesce, and the entire spot becomes black and thickened.

R. acerinum (fig. 3, *A*) is likely to produce one or more relatively large black spots, whereas *R. punctatum* (fig. 3, *B*) produces numerous small ones that often do not coalesce. *R. acerinum*, the cause of common tar spot, attacks many species of maple, but seldom the Norway and sycamore maples. It is rare on the Pacific coast. *R. punctatum*, the cause of black-speckled tar spot, has been reported on many species, especially silver, mountain, and striped maples. It is abundant on bigleaf maple on the Pacific coast. It is not so frequently encountered in

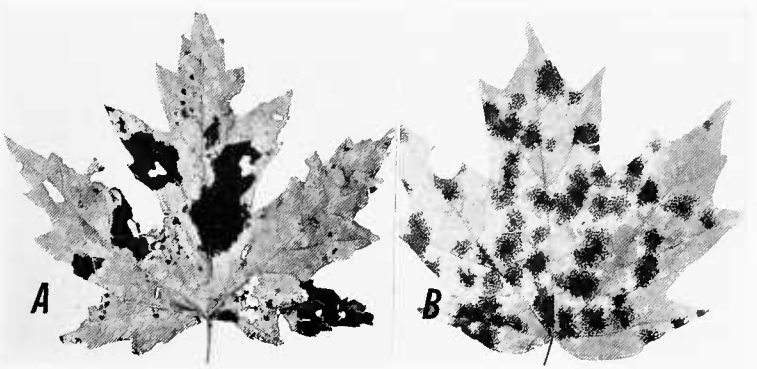

FIGURE 3.—Maple leaves with tar spots caused by the fungi (*A*) *Rhytisma acerinum* and (*B*) *R. punctatum*. (× ½.)

the Eastern United States as *R. acerinum*.

First infections of tar spots in the spring are from ascospores, which are produced in the blackened areas on fallen overwintered leaves. Rod-shaped conidia are produced in the spots on leaves on the tree. They are spread by wind and rain in the summer.

For information on control measures for tar spots, see page 9.

Bacterial Spot

Bacterial spot is caused by *Pseudomonas aceris* (Ark) Starr & Burkh. This bacterial disease affects bigleaf maple in California. It was found on nursery seedlings and on wild tree leaves hanging close above water. The disease seems to be relatively unimportant economically.

Japanese and vine maples and boxelder are reported to be susceptible to bacterial spot. Affected leaves develop pinpoint to one-quarter inch water-soaked spots with yellowish margins. Later the spots become brown. Lesions develop on the petioles.

One outbreak of the disease on seedlings growing under humid conditions was controlled by aeration.

Leaf Blister

Several species of fungi of the genus *Taphrina* cause leaf blister. These fungi are closely related to those causing peach leaf curl and leaf blister of oak.

The following species have been reported on maple:

FIGURE 4.—Maple leaves affected by leaf blister. (× ¼.)

Domed blisters—convex as seen from the upper leaf surface—and curling, twisting, and dying of the leaf are characteristic symptoms of leaf blister (fig. 4). This is not a common disease.

Leaf blister can probably be controlled by applying a fungicide while the trees are dormant. The spray must be used before the bud scales separate and the buds open.

Shoot Droop

Shoot droop, a disease of the leaf and shoot of trident maple in Japan, is reported to be caused by the bacterium *Pseudomonas acernea* Ogawa. Irregular spots appear along the midrib. They enlarge and become gray or black. Affected leaves wither, turn black, and finally dry. The following maples are said to be susceptible

Taphrina species	Maple
bartholomaei Mix (synonym: *aceris* (Dearn. & Barth.) Mix)	bigtooth
carveri Jenkins	silver
darkeri Mix	vine
dearnessii Jenkins	red
letifera (Pk.) Sacc	red and mountain
sacchari Jenkins	sugar and black

FIGURE 5.—Norway maple leaf affected by bulls-eye spot. (× 1.)

to shoot droop: *Acer shirasawanum* Koidz., amur, devil, hawthorn, Japanese, redvein, siebold, silver, and boxelder.

Bulls-Eye Spot

Bulls-eye spot is caused by the fungus *Cristulariella pyramidalis* Waterman & Marshall. The disease is characterized by the development of numerous targetlike spots on the foliage of boxelder and silver, sugar, Norway, and sycamore maples (fig. 5). The spots are yellowish gray with light-brown concentric rings on the upper surface of the leaf. Spots vary in size and may coalesce. On the lower surface of the leaf the spots are brown and without the concentric rings. The spots commonly are larger on leaves of the sugar maple than on those of other species. The disease has not been adequately studied to determine its damage potential. It occurs sporadically and may appear in midsummer.

Spores are produced on pyramidal conidiophores, which are repeatedly trichotomously or dichotomously branched. The spores are hyaline, globose, 2 to 4 microns in diameter, and easily detached from the conidiophore. The fungus produces sclerotia sparingly in culture on Leonian's medium and also forms eight-sided crystals, as described by Bowen [1] for the closely related *C. depraedans* (Cke.) Hoehn. Sclerotia have not been found in nature.

Gray Mold Spot

Cristulariella depraedans (Cke.) Hoehn. causes gray mold spot. The spots are separate or confluent, irregular, and grayish without a definite margin or concentric circles (fig. 6). This fungus

FIGURE 6.—Gray mold spot on sugar maple leaf. (× 1.)

[1] BOWEN, P. R. A MAPLE LEAF DISEASE CAUSED BY CRISTULARIELLA DEPRAEDANS. Conn. Agr. Expt. Sta. Bul. 316: 625–647, illus. 1930.

produces sclerotia in culture, but they have not been found in nature. Very little is known about this disease. It appears late in the summer and apparently is not serious, but it can cause some defoliation.

Leaf Scab

The fungus *Cercospora negundinis* Ell. & Ev. causes leaf scab. Small brownish-red spots with indefinite margins appear on leaves of boxelder (fig. 7). Under a hand lens the spots appear scabby or cracked. They have numerous whitish areas with minute black fruiting bodies on the older parts. Spores of the fungus have indistinct septa, are long and narrow, and vary from 5 to 6 by 50 to 110 microns. The disease has been reported from Nebraska and Wisconsin. It has not caused serious damage.

FIGURE 7.—Boxelder leaflet with leaf scab. (× 1.)

FIGURE 8.—Bigleaf maple leaf affected by bigleaf brown spot. (× ⅓.)

Bigleaf Brown Spot

On bigleaf maple the fungus *Illosporium maculicola* Sacc. causes bigleaf brown spot (fig. 8). A large brown spot up to 3 inches in diameter develops. It usually is rather concentrically zoned and has an indefinite margin. The diseased area frequently spans main veins. Older parts of the spot break out and leave ragged holes. The spots are dark on the upper

leaf surface and lighter on the underside. The fungus *Cercosporella aceris* Dearn. & Barth. causes a similar spot on bigleaf maple. Further study may prove that the two fungi are identical. No study has been made of control measures for bigleaf brown spot.

Septoria Spot

The fungus *Septoria aceris* (Lib.) Berk. & Br. causes septoria spot on leaves of several maple species. The spots are commonly small and reddish tan to brown. On bigleaf maple the spots have a narrow yellow margin, but on other species the border is usually indefinite and irregular. The fungus also attacks immature fruits and causes browning. The extent of damage caused by this fungus cannot be estimated.

Powdery Mildews

The mildews commonly found on maple are *Uncinula circinata* Cke. & Pk., *Microsphaera alni* DC. ex Wint., and *Phyllactinia corylea* Pers. ex Karst. These fungi have distinguishing characteristics, which enable a specialist to identify them.

Powdery mildews often produce a whitish superficial growth on maple leaves, particularly near the end of the growing season. The mycelia of the fungi cover the leaf, but they feed on the interior through absorbing hyphae, which penetrate the leaf cells. Black roughly spherical fruiting bodies of the mildews commonly are abundant on the surface of infected leaves in the autumn. The powdery mildews overwinter as ascospores in the black fruiting bodies on fallen leaves. They usually do not seriously damage maple.

Powdery mildews generally may be controlled by spraying with a fungicide after they develop on the leaves, but no research has been reported on their control on maple.

Flower Blight

The fungus *Ciboria acerina* Whet. & Buchew. causes flower blight, a disease of the inflorescences of red and silver maples. It has been reported from New York. The flowers are killed and seed formation is prevented, but the disease is of minor economic importance.

NONINFECTIOUS DISORDERS

Leaf Scorch

Leaf scorch is a physiological disease affecting particularly sugar and Norway maples. Margins of the leaves or the tissues between the veins of affected trees turn brown in the summer, particularly during or after hot, dry periods. Maples in poor condition are predisposed to develop this disease. Maintenance of vigor by controlling pests, applying fertilizers including minor elements when needed, and watering during hot, dry weather will prevent or alleviate leaf scorch on many trees.

Leaf Distortion and Dwarfing

Maples are sensitive to many herbicides. 2,4–D and 2,4,5–T cause twisting, curling, cupping, browning of margins, and dwarfing of developing leaves (fig. 9). Abnormally narrow lobes are common and give a shoestring effect. Phenyl urea herbicides cause somewhat similar symptoms. Leaves affected by sodium arsenite usually turn black and fall. Since the fallen leaves contain arsenic, they should be gathered and destroyed.

In soils that drain quickly, flooding may help to reduce damage from 2,4–D and 2,4,5–T. Un-

FIGURE 9.—Effect of 2,4–D on red maple leaves. (× ½.)

fortunately the danger from herbicides generally is not recognized until after damage appears. Trees that receive weak dosages may eventually recover from the effects of 2,4–D or 2,4,5–T, but damage may persist for 2 years. Incorporation of activated charcoal, sludge, or other organic materials into soil on which the phenyl urea herbicides have been used may reduce their damage to trees. However, research is needed before such treatments can be recommended.

Poisons may be absorbed through the roots, leaves, or buds. Toxic vapors are formed by some herbicides. The vapors can damage trees at considerable distances from where the herbicides are applied.

Premature Reddening or Yellowing

Young, recently transplanted trees that fail to grow and have small leaves that turn red or yellow prematurely may have defective root systems. Poor internal soil drainage can cause oxygen deficiency. Low oxygen in the soil prevents normal root development (see p. 16).

Gas Poisoning

If leaves die suddenly, one should consider the possibility of gas leaking into the soil from underground pipes. Leaves may wilt and turn brown suddenly or affected trees may decline slowly with top dieback as the most prominent symptom. The bark sometimes cracks. Roots may become bluish black.

Some types of gas contain toxic chemicals and others can kill or injure trees by displacing oxygen from the soil in which the roots are growing.

Usually oxygen-deficient soil has a sour, disagreeable odor. Dig a hole a foot or more deep, remove some soil, and smell it, or smell the air in the hole after a few minutes. The sour, foul odor is readily detectable if oxygen deficiency is serious.

Gas also may contain substances that have a characteristic odor, which can be detected by smelling soil removed from the hole. Gas companies usually will test for leaks if notified that one is suspected.

To treat trees affected by gas poisoning, first stop the leaks. Sometimes aerating the soil will save trees that would die if not treated. Thorough aeration may be accomplished by injecting compressed air or by flooding in soils that drain quickly. Some-

times replacement of soil may be practical.

ABNORMALITIES OF UNKNOWN CAUSE

Tatter-leaf, an irregular, shothole condition of maple leaves (fig. 10, *A*), has been observed in Logan, Utah, Orange, N.J., New Britain, Conn., and Wisconsin. The cause has not been determined. However, frost damage to the leaf before it unfolds from the bud is suspected.

A silvery scablike condition has been observed on leaves of the Crimson King variety of Norway maple. Neither the cause nor the significance of the abnormality is known.

The causes of dieback of maple in Wisconsin and of a recently reported dying of sugar maple in New York are not known.

Also, the cause of a viruslike disease of bigleaf maple in the West has not been determined. This disease has been found in the northern Sierras, the drainages of the Sacramento and Klamath Rivers, and throughout the coastal mountains of northern California.

The cause of puckering of some Norway maple leaves (fig. 10, *B*) has not been determined. This condition may be due to a genetic factor or possibly a virus.

SPRAY MATERIALS AND SCHEDULES

Bordeaux mixture, dichlone, Puratized Agricultural Spray (phenyl mercuri triethanol ammonium lactate), and zineb have effectively controlled anthracnose, phyllosticta spot, and tar spots.[2] Two or three applications with a 2- to 3-week interval between them often give satisfactory results. The first application for anthracnose should be made when the new leaves are about half de-

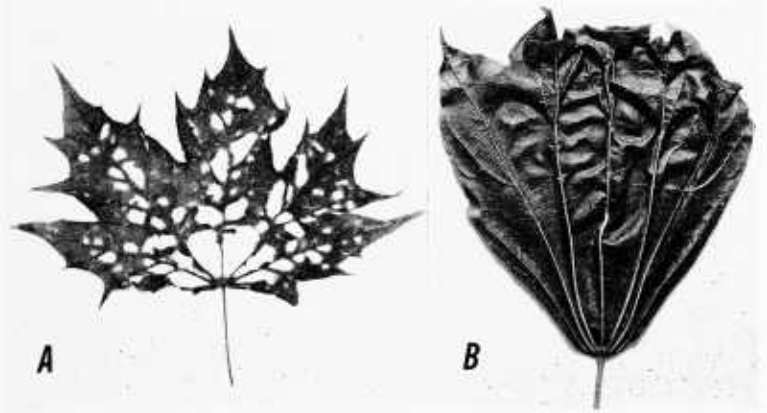

FIGURE 10.—*A*, Tatter-leaf of maple (× ½); *B*, puckering of Norway maple leaf (× ⅔).

[2] Mention of a trade product does not imply its endorsement by the U.S. Department of Agriculture over similar products not named.

veloped and the second about 2 weeks later. If rains are frequent or violent during the early part of the growing season, a third application may be needed and the interval between applications shortened. In wet seasons an extra application may be needed in midsummer to control anthracnose and phyllosticta spot.

Spraying maples with an organic mercury or copper fungicide is recommended to prevent tar spots. The first spray should be applied when the leaf buds are opening. In wet seasons one to four additional applications should be made at 10- to 21-day intervals, depending on the frequency and amount of rain and how much of the fungicide is washed from the leaves.

Bordeaux mixture sometimes causes a marginal drying of leaves of sugar and Norway maples. Black flecking of leaves of Norway maple after spraying with Bordeaux mixture has been reported, but extensive damage to maple from this spray has not been common. Puratized Agricultural Spray sometimes causes a yellow spotting of leaves of Norway and silver maples and russeting of sugar maple.

No research information is available on the effectiveness of spraying to control leaf diseases other than anthracnose, phyllosticta spot, and tar spots. Research is needed to determine which spray materials and schedules will control most effectively the maple leaf diseases.

CANKERS AND OTHER DAMAGE TO WOODY PARTS

EUTYPELLA TRUNK CANKER

The fungus *Eutypella parasitica* Davidson & Lorenz causes eutypella trunk cankers of sugar and red maples and boxelder. Trunks of young trees may break at the canker. On older trees decay may start at the cankers and gradually weaken the trunk.

Characteristics of the canker are swelling and distortion of the trunk, firmly attached bark, heavy white to buff mycelial fans under the bark at the margin of the canker, slightly raised concentric rings or ridges of callous tissue, and long-necked, black beaks of the fungus fruiting bodies in older parts of the canker (fig. 11). The fungus penetrates the sapwood, which becomes brown and brittle. Cankers usually are 2 to 8 feet aboveground, but they may occur at 30 feet.

In culture on malt agar the fungus may produce spores in 4 to 6 weeks on white mycelium. In old cultures mycelium may develop light-buff to cream-colored patches. The long, slender, curved conidia are pointed at the ends and 26 to 34 microns by 1 micron. Ascospores are slightly curved, irregularly two or more seriate, dark brown, slightly attenuated at the end, and 8 to 11 by 2 to 2.3 microns.

No control measures are known for eutypella trunk canker on shade trees.

NECTRIA CANKER

Nectria cankers develop on trunks and other woody parts at the top of both young and old trees. They have been reported on mountain, red, silver, sugar, Norway, sycamore, bigleaf, Japanese, and striped maples and on boxelder. The cankers resemble superficially those caused by *Eutypella*. However, the bark falls from older parts of nectria cankers and dry wood is exposed.

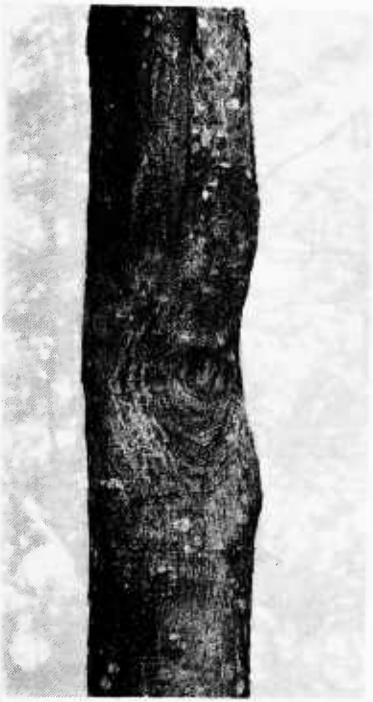

FIGURE 11.—Maple disfigured by eutypella trunk canker. (× ⅛.)

whereas the bark usually clings to the central part of eutypella cankers.

On larger woody parts nectria cankers are characterized by roughly concentric ridges of callous tissue (fig. 12, *A*). Rough excrescences or overgrowths commonly form on affected limbs and branches. The fungus invades the bark through injuries. Dead branch stubs also afford a point of entry for the *Nectria*. The fungus grows in the bark and kills it while the tree is dormant. When the tree resumes active growth, a ridge of callus forms, which is killed when the tree again becomes dormant in the autumn. The alternate killing and formation of callus account for the so-called target or catface configuration of the canker.

Infection by *Nectria* often takes place through injuries in tender bark of twigs. During the growing season the fungus may invade cambium and wood through injuries in the bark. Wood invaded by *Nectria* is streaked with olivaceous green, but the fungus does not penetrate deeply (fig. 12, *B*). The cankers are entrance points for wood-decaying fungi.

The cankers are commonly caused by the fungus *Nectria galligena* Bres., but other closely related species of *Nectria* may also be involved. *N. galligena* produces two-celled elliptic ascospores. They range from 12 to 20 by 4 to 6 microns.

The microconidia are formed in the summer and early autumn in cream-colored pustules of recently killed or dying bark. Later bright- to dark-red globose perethecia may form in these pustules (fig. 12, *C*). Ascospores may be forcibly expelled from the perethecia.

Affected smaller woody parts may be pruned, but usually trunk cankers are incurable. Trees in low vigor often bear numerous nectria cankers, but the relationship between the vigor of maples and the damage by nectria cankers has not been adequately studied.

BLEEDING CANKER

The fungus *Phytophthora cactorum* (Leb. & Cohn) Schroet. causes bleeding canker of maple. Circular to elongated cankers are found in the trunk or branches of infected trees. On young smooth-barked trees the cankers cause sunken or depressed areas in the bark. On older thick-barked trees the diseased bark is usually

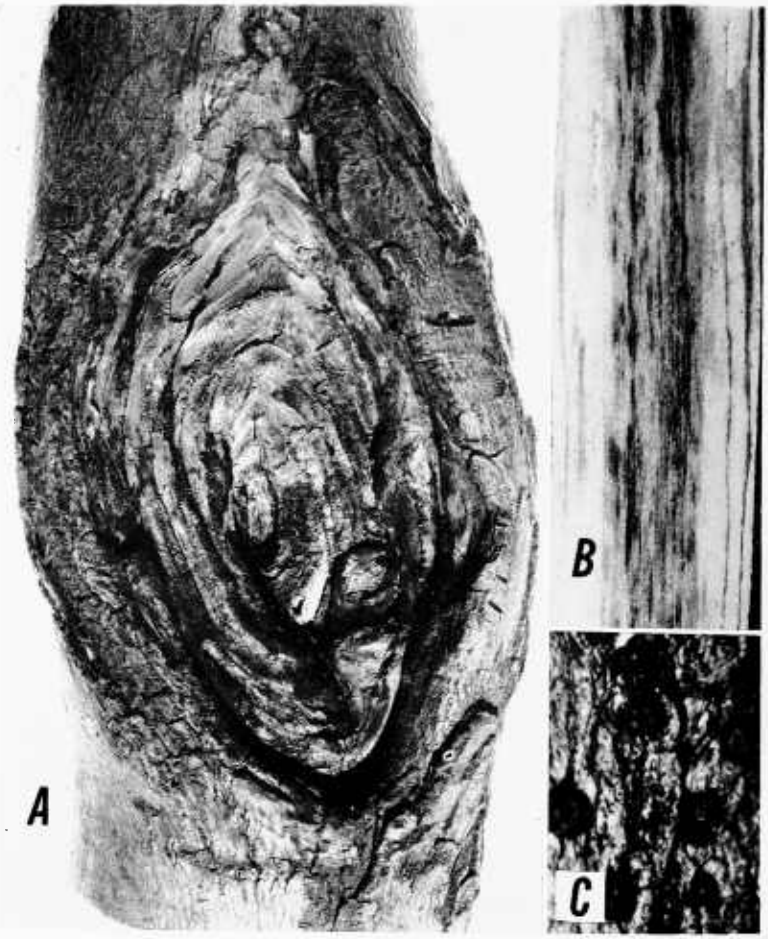

FIGURE 12.—*A*, Nectria canker (× ½); *B*, wood invaded by *Nectria* (× ¾); *C*, perethecia of *Nectria galligena* in recently killed or dying bark (× 4).

not sunken. Moist areas in the bark commonly secrete a blood-red or black fluid (fig. 13). Beneath the surface of the canker the bark tissue is reddish brown, surrounded by an olive-green border at the transition between healthy and diseased tissue. A dark discoloration occurs in the wood beneath the canker and may extend several feet upward from the canker and downward into the roots.

Leaves of trees affected by bleeding canker are often small and foliage may appear to be

FIGURE 13.—Bleeding canker of maple. (× ¼.)

sparse. Dieback of tops may occur, and the trees may produce excessively heavy crops of seed.

Bleeding canker has been reported on black, Norway, red, sugar, and sycamore maples. Trees are especially susceptible to bleeding canker if they have been damaged or weakened by earth cuts or fills, frosts, wind, or soil compaction. These cankers commonly develop around bark injuries produced by frost, storms, or mechanical impact.

Control measures for bleeding canker are not always successful. Excising diseased bark and correcting adverse conditions under which the affected tree may be growing are recommended. In excising the diseased bark remove all discolored tissue plus a narrow margin of healthy bark around the edge of the canker. Then shape the resulting wound so that it is oval or elliptic and the margin is smooth and regular, with the bark adhering tightly to the wood. Disinfect wounds by swabbing or brushing several times with denatured alcohol and then paint with shellac. After the shellac has dried, coat the wound once or twice with an asphalt tree-wound dressing. However, excision or treatment of the cankered area often fails to control the disease unless adverse growing conditions are corrected and the tree is brought into good vigor. Young diseased trees have recovered without treatment of the cankers when the trees were exposed to full sunlight.

BASAL CANKER

A canker developing at the base of the trunk and caused by the fungus *Phytophthora cambivora* (Petri) Buis. was reported on Norway maple in New Jersey. In the United States the fungus has not been found elsewhere or on any other host. It is widespread in Europe and is the cause of the serious ink disease of chestnut.

Basal canker is characterized by reddish-brown discoloration of the bark, cambium, and outer sapwood near and below the soil line. No pink or red exudate is present. Crowns of affected trees are thin. Diseased trees may die within a year or two.

No control measures are known for this canker disease.

SCHIZOXYLON CANKER

Schizoxylon canker is caused by the fungus *Schizoxylon microsporum* Davidson & Lorenz. This disease occurs in the Lake States on suppressed red and sugar maples less than 3 inches in diameter. It is of little economic importance. The catface cankers resemble those caused by *Nectria*. The cankers are shallow and sunken. The wood is often exposed in older areas and often partly decayed. White mycelial fans form beneath the bark at the margin of the canker.

The fungus grows on 2½-percent malt agar, in which it produces a white mycelial mat with occasional light-brown patches in older cultures. This mat is tufted and wavy with numerous globose bunches of mycelium, which appear to be pycnidial primordia. The margin of the mat is thin and irregular.

The light-gray globose pycnidia are embedded in shallow, cuplike depressions. The spores are rod shaped and 2 to 5 microns by 1 micron. Ascospores are filiform, multiseptate, 1 micron in diameter, and up to 170 microns long. They finally break into slightly curved segments or short rods from 2 to 3 or 4 to 8 microns long.

OTHER CANKERS

Fungi of the genera *Hypoxylon* and *Diatrype* cause cankers, particularly on winter-injured trees. The cankers are frequently elongate and have callous beaks, or ridges. They probably are produced annually. They are of relatively minor economic importance on maple.

Weakened boxelder and other maples are attacked by weakly pathogenic canker fungi belonging to the genera *Sphaeropsis*, *Leptothyrium*, and *Phacidium*. Pruning affected parts, fertilizing, and maintaining good cultural conditions will often control these parasitic fungi.

TRUNK SPLITTING, FROST BEAKS, AND BARK FREEZING

Deep winter cold may freeze fluids in the wood. Trunks may crack vertically, sometimes with a loud report. The cracks serve as entrance ports for fungi and bacteria. Callous tissue forms on both sides of the crack and may develop into frost beaks, or ridges, commonly seen on maple (fig. 14). In some areas frost cracks are common on Norway maple.

Treatment consists of cleaning and smoothing the bark along the frost crack and covering with antiseptic asphalt paint. Split trunks may be drawn together with bolts. Bore one or more holes through the trunk. Use washers on both ends of each bolt. Countersink the washers and bolt head and tap into the wood. Cover the bolt ends and surrounding exposed wood with an antiseptic asphalt paint.

Bark may be killed by freezing, often in small patches on upper or exposed surfaces of small limbs or branches. Damage becomes evident in midsummer, when the killed or weakened bark dries. Leaves on parts distal to the injured bark may suddenly dry. Weakly pathogenic or saprophytic fungi soon appear on the damaged parts, and the presence of their fruiting bodies confuses the diagnosis of the cause.

Exposure to full sunlight by pruning previously shaded limbs predisposes to freezing damage

FIGURE 14.—Frost beak on silver maple. (× 1/15.)

and sunscald of thin bark. To minimize this damage, avoid extensive pruning of the crowns of heavily shaded trees, such as those in woodlands. Gradual thinning of crowns reduces danger of damage from both freezing and sunscald.

SAPSUCKER DAMAGE

Sapsuckers sometimes seriously injure maple. The birds peck roughly horizontal rows of holes in the bark (fig. 15). Transfer of food materials downward in the bark is reduced. Injured bark dries and dies, and the injuries serve as entrance ports for fungi.

FIGURE 15.—Section of maple branch severely damaged by sapsuckers. (× 1/2.)

ROOT DISEASES

ROOT-KNOT NEMATODE

Root knot, caused by *Meloidogyne* sp.,[3] was reported on bigleaf maple in Oregon. Roots swell, become stubby, and produce galls when attacked by this nematode. No cure is known, but soil in nursery seedbeds may be disinfected before planting if previous experience indicates that root knot is likely to be a serious problem. Under experimental conditions *Meloidogyne incognita* Chitwood produced galls on roots of Japanese maple.[4]

ROOT ROTS

The fungus *Phymatotrichum omnivorum* (Shear) Dug. causes a serious and often lethal root rot of many species of plants. It has been reported on silver maple in Texas and on boxelder in Texas and California. No cure is known. Avoid planting maples on sites infested with this fungus.

Armillaria mellea Vahl ex Fr. may cause a root rot. It is sometimes called shoestring root rot because of the long, commonly flattened strands of mycelium that the casual fungus produces beneath the bark of affected trees. The fungus is also known as the honey mushroom from the color of its fruiting bodies. *A. mellea* may kill weakened trees. The fruiting bodies of the fungus are usually produced in clusters at the base of dead or dying trees or on the ground from infected roots. The stalk of the fungus is 3 to 10 inches tall with a broad, honey-yellow to brown cap with scales. Gills of the lower surface are whitish and attached to the stalk.

The fungus *Ganoderma lucidum* (Leyss. ex Fr.) Karst. causes a root rot of maple and decay of the bole. The corky fruiting bodies develop annually at the base of affected trees or later on stumps. The upper surface of new conks is red and shining as if varnished. The fungus can enter through wounds. Avoid wounding roots and the base of the trunk.

No practical method of controlling the root rots caused by *A. mellea* or *G. lucidum* is known. However, they are more likely to affect trees in poor vigor. The following practices should help prevent these root rots: Applying fertilizer, correcting unfavorable soil conditions, watering during droughts, and treating wounds on exposed roots at the base of the trunk.

ROOT DAMAGE FROM ADVERSE SOIL CONDITIONS

Young, recently transplanted trees that fail to grow and have small leaves that turn red or yellow prematurely may have defective root systems.

Poorly drained soil is a common cause of poor root development and defective root systems. Roots need oxygen. In clay soil retention of too much water excludes air. In such soil water may collect in a planting hole filled with porous soil. Even though the site may be on a slope, it is advisable to check drainage in the hole. Dig a hole 10 to 15 inches deep. Fill it with water in the spring or fall. The water should drain from the hole overnight. If it does not, provide drainage or slightly elevate the planting site.

[3] Reported as *Heterodera marioni* (Cornu, 1929) Goodey, 1932. This species has been divided and placed in *Meloidogyne*.

[4] Personal communication from R. Schindler, Crops Research Division.

In sandy or gravelly soil or in areas with low rainfall maples may need to be watered during droughts. Wilting of leaves and drying and browning of their margins are symptoms of water deficiency. The sugar maple is particularly sensitive to drought.

Maples that grow slowly and have light-green or small leaves or leaves with various abnormally colored spots may need fertilizer. A standard garden fertilizer is satisfactory. A minimum dosage is 2 pounds per diameter inch of trunk measured at breast height.

GENERAL INFECTIONS

SLIME FLUX AND WETWOOD

The characteristic symptom of slime flux is a persistent or intermittent flow or oozing of sap from cracks or other injuries in the bark and wood of maple. This infection is usually associated with a water-soaked and more or less discolored condition of the wood known as wetwood. Often the fluid exuding from wetwood is so copious that it will flow down the trunk to the ground in a glistening stream, particularly in the spring. Often less fluid may be exuded. It may gradually seep down the trunk or limbs and evaporate before reaching the ground. However, moist streaks or whitish deposits remain on the bark. The exuded fluid frequently thickens until it becomes viscous and sticky. If the flux dries, a light-gray to brown deposit may be left in a more or less vertical streak on the bark (fig. 16).

The clear sap that runs for a short time from fresh wounds is similar to the sap obtained when maples are tapped for sirup and should not be confused with slime flux. However, if injuries do not heal, slime flux may develop later in them.

The cause of slime flux of elm is a bacterium, *Erwinia nimipressuralis* Carter. Although the cause of slime flux of maple has not been investigated thoroughly, it is probably caused by a bacterium.

FIGURE 16.—Slime flux on maple trunk. (× ¼.)

Invasion of the wood by bacteria may be limited to relatively small areas or may be extensive in the trunk and branches. The infected wood becomes more or less discolored and water-soaked, and considerable gas pressure

may develop in it. The pressure is instrumental in forcing fluids out of the affected tissues.

Injurious compounds are produced in affected trees. They spread to the smaller branches and may discolor and wilt the leaves and cause dieback of twigs and small branches. Bark over which the toxic sap flows may be killed, and wound healing often is retarded or prevented. Badly affected trees may eventually lose most of their smaller branches and become stag headed. Healthy sapwood of Norway maple is slightly acid; diseased sapwood is alkaline.

Not all trees with wetwood release toxic sap through injuries, pruning wounds, or other channels from the interior to the outside of the trunk. Many such trees grow poorly and show symptoms of decline, such as small leaves, dying leaf tissue, and dieback of shoot tips.

Control or alleviation of slime flux and wetwood can often be obtained by inserting drain pipes into the infected wood. This procedure does not cure the disease, but much of the toxic fluid is removed from the wood and often the tree benefits.

Drain pipes should be inserted into the trunk and branches near where the flux issues. Sometimes a single pipe installed near the base of the trunk is sufficient.

Galvanized pipes with a driving fit should be inserted into each hole to a depth of 2 to 4 inches. A tight fit is necessary to prevent the pipes from becoming loose and falling out. Sometimes it may be desirable to run the pipe down the trunk to the ground or to a surface drain. Other times the pipe may extend from several inches to a foot or more out from the trunk. The pipe always should be long enough to conduct the toxic sap away from the trunk and the base of the tree. The sap will sometimes kill grass when it drops on it. Pipes one-half to 1 inch in diameter may be used.

After the gas pressure is reduced and the flux has ceased except for drainage through the pipe, the wounds from which the flux issued can be cleaned and painted with a wound dressing. Sometimes the wood around the flux point remains so wet that paint will not adhere to it.

As a supplementary treatment apply fertilizer to help keep affected trees vigorous.

VERTICILLIUM WILT

Verticillium wilt affects Norway, sugar, red, hedge, silver, Japanese, bigleaf, and sycamore maples and boxelder. Characteristic symptoms of this fungus disease are dying of one or more limbs and progressive dying of the crown. Sometimes trees wilt suddenly, but more often the disease develops slowly. Leaves wilt and dry, sometimes remaining on the twigs and sometimes dropping. Wilting and dying are more prevalent in late than in early summer but may occur at any time. Affected trees are predisposed to winter freezing and slime flux is common on them. Maples affected by this wilt often have sparse foliage throughout the crown.

Diseased trees develop a greenish discoloration in the infected sapwood. The green streaks may be found in leaf petioles, twigs, and larger woody parts, especially in the lower trunk. Maples also develop greenish stains in wood around wounds in the absence of this fungus disease. Such a lo-

calized stain development is confusing in the diagnosis of verticillium wilt.

Trees with a trunk diameter of 1 to 2 inches may be killed in a year by the disease. Larger trees may live many years after symptoms appear, but they may decline progressively or remain unattractive.

Maples can be inoculated by inserting the causal fungus *Verticillium albo-atrum* Reinke & Berth. into holes bored into the wood and into wounds. The fungus commonly invades through the roots.

The recommended treatments for maples affected by verticillium wilt include pruning the dying or dead parts, pollarding severely affected trees, improving soil fertility, using fertilizers containing ammonium sulfate as the nitrogen source, and watering during drought periods.

Pruning tools should be sterilized with wood alcohol or other disinfectant after use on such trees. These treatments are not always effective, but they are the best known. No method is known of treating trees internally for this internal disease. Some affected trees recover without treatment.

RED STAIN OF BOXELDER

Red stain of wood of living boxelders is caused by the fungus *Fusarium reticulatum* Mont. var. *negundinis* (Sherb.) Wr., which grows in heartwood and to a less extent in sapwood of all woody parts. The light- to dark-red stain is commonly present in boxelders, but very little is known about its relationship to tree growth. The fungus probably is a weak parasite.

SAP STREAK

Sap streak is caused by the fungus *Endoconidiophora virescens* Davidson. This disease of sugar maple occurs in a national forest in North Carolina. The fungus also causes a sap stain of hardwood lumber throughout the East.

Leaves of affected trees are smaller than normal and often slightly chlorotic. The foliage appears to be sparse because of the small leaves. Dieback of the crown progresses until some trees die after 3 or more years. Occasionally affected trees in full foliage die suddenly, but the dead leaves usually do not fall. Sapwood of affected trees appears water-soaked and has green streaks at the margins of the water-soaked areas. The water-soaked sapwood has a pH of about 8.5, whereas normal maple sapwood has a pH of about 5.5.

SILVER LEAF

The fungus *Stereum purpureum* Pers. ex Fr. has been reported as the cause of silver leaf of maple in South Dakota. The fungus invades woody parts. Diseased trees have small leaves and are stunted. Very little is known about this disease.

WOOD DECAY

All species of maple are subject to damage by wood-decaying fungi. Some of these fungi decay sapwood, some heartwood, and some both. Those causing sapwood decay attack the smaller limbs and branches as well as the trunk. Fungi causing decay of heartwood invade the older and larger limbs and the trunk, eventually weakening them so seriously that they may break in

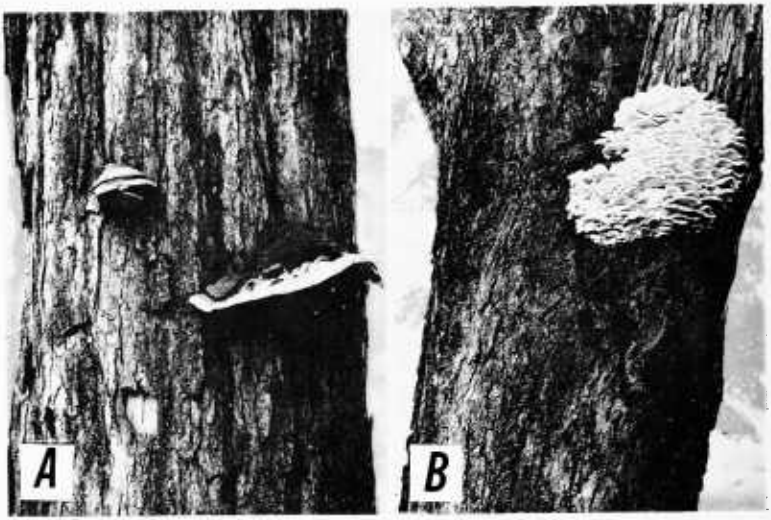

FIGURE 17.—Wood-decaying fungi on maples: *A*, Sporophores of *Fomes applanatus* (× ⅛); *B*, soft, creamy-white sporophore of *Steccherinum septentrionale* (× ⅒).

wind, snow, or ice storms. In general, heartwood decay is more serious than sapwood decay.

Some of the fungi causing decay of maple are as follows:

Fungus	Decay[1]
Armillaria mellea (Vahl ex Fr.) Kumm	S–H–W
Collybia velutipes (W. Curt. ex Fr.) Kumm	S–W
Corticium vellereum Ell. & Crag	W
Daedalea unicolor (Bull.) ex Fr	H–W
Fomes applanatus (Pers. ex S. F. Gray) Gill	H–W
Fomes connatus (Weinm. ex Fr.) Gill	H–W
Fomes everhartii (Ell. & Gall.) Schr. & Spauld.	H–W
Fomes fomentarius (L. ex Fr.) Kickx	H–W
Fomes fraxineus (Bull. ex Fr.) Cke	H–W
Fomes igniarius (L. ex Fr.) Kickx	H–W
Ganoderma applanatum (Pers. ex S. F. Gray) Pat	H–W
Ganoderma lucidum (Leyss. ex Fr.) Karst	S–W
Gymnopilus spectabilis (Fr.) Sing	H
Hericium erinaceus (Bull. ex Fr.) Pers	H–W
Hericium laciniatum Leers ex Banker	W
Peniophora sp	B
Pholiota adiposa (Fr.) Kumm	H–B
Pleurotus ostreatus (Jacq. ex Fr.) Kumm	S–W
Pleurotus ulmarius (Bull. ex Fr.) Kumm	S–H–W
Polyporus adustus (Willd.) ex Fr	S–W
Polyporus glomeratus Pk	S–W
Polyporus hirsutus (Wulf.) ex Fr	S–H–W
Polyporus pargamenus Fr	H–W
Polyporus pubescens (Schum.) ex Fr	S–W
Polyporus resinosus (Schrad.) ex Fr	S–H–W
Polyporus sulphureus (Bull.) ex Fr	H–B
Polyporus tulipiferus (Schw.) Overh	S–W
Polyporus versicolor (L.) ex Fr	S–W
Schizophyllum commune Fr	S–W
Steccherinum septentrionale (Fr.) Banker	H–W
Stereum murrai (Berk. & Curt.) Burt	W
Ustulina vulgaris Tul	W
Valsa leucostomoides Pk	S

[1] S = sapwood, H = heartwood, W = white or light colored, B = brown.

Identification of fruiting bodies of the wood-decaying fungi requires specialized knowledge. The sporophores, conks, or other spore-producing structures may be sent to your State agricultural experiment station or to the U.S. Department of Agriculture for identification.

The spore-producing structures may be hard and woody (fig. 17, *A*), corky, leathery, or fleshy like a mushroom (fig. 17, *B*). Some persist for years, some are annuals, and some last only a few days or weeks.

Recognition of the fruiting bodies of some fungi is useful in estimating the extent of probable decay in a diseased tree. The fruiting bodies of *Fomes connatus* indicate limited decay of not more than 3 to 4 feet, and often less, above and below them. Those of *Steccherinum septentrionale* suggest extensive decay from 6 feet below to 13 feet above them. Conks of *Fomes igniarius* indicate that decay may extend 5 feet below and 9 feet above them. Fruiting bodies of *Ustulina vulgaris* indicate that decay may extend about 9 feet above them. This fungus enters through the roots or at least at the base of the tree. On the other hand, fruiting bodies of *Pleurotus ostreatus* suggest that decay may extend only a short distance from them.

Older trees are more likely to be attacked by wood-decaying fungi than young trees. One investigator in Canada reported [5] that decay occurred in 67 percent of sugar maples 81 to 120 years old and in 85 percent of trees 121 to 160 years old. Increasing diameter of the trunk is associated with increased decay. In the Canadian study sugar maples 10 inches in diameter at breast height had one or more decayed areas and 80 percent of the trees were infected, whereas those more than 10 inches in diameter had decayed wood and 90 percent of the trees were infected.

FIGURE 18.—Decay starting at a pruning wound on sugar maple. (× ⅙.)

Wounds that break through the protective bark and expose wood are points of entry for fungi causing sapwood and heartwood decay. Frost cracks, pruning scars, lightning scars, sapsucker punctures, dead stubs of branches,

[5] NORDIN, V. J. STUDIES IN FOREST PATHOLOGY. XIII. DECAY IN SUGAR MAPLE IN THE OTTAWA-HURON AND ALGOMA EXTENSION FOREST REGION OF ONTARIO. Canad. Jour. Bot. 32: 221–258, illus. 1954.

cankers, fire scars, broken tops, and the parent stump of sprout reproduction serve as invasion routes for wood-decaying fungi (fig. 18).

One investigator in Canada stated [6] that in sugar maple, frost cracks were the access points for about 35 percent of the decay organisms, and branches and stubs for 33 percent. *Armillaria mellea, Ustulina vulgaris,* and *Pholiota* usually enter through the roots.

In the Canadian study *Polyporus glomeratus, Corticium vellereum, Armillaria mellea,* and *Fomes connatus* accounted for slightly over 65 percent of the infections and 62 percent of the volume of decay of sugar maple. *Ustulina vulgaris,* although present in only 3.8 percent of the infections, caused 13.1 percent of the volume of decay. *P. glomeratus* was present in 36 percent of the infections. It should be noted that sugar maple is reaching its northern limits in Ontario.

Valsa leucostomoides is reported [7] to be the principal cause of decay and discoloration associated with tapping of sugar maple. The fungus fruits during July and August in Vermont. The discolored zone the fungus produces in the wood is light yellowish green in the center and deep olive or greenish black at the margin.

The cause of a black stain in the heartwood is not known.

Decayed wood can sometimes be gouged out of limbs and large branches, but if it is extensive, removal of the member may be necessary. Decayed wood can also be removed from tree trunks. The resulting cavity may be filled with concrete or left open. Cavity fillings are usually unsatisfactory in silver and red maples and boxelder.

COMMON AND SCIENTIFIC NAMES OF MAPLES

amur	*Acer ginnala* Maxim.
bigleaf	*macrophyllum* Pursh
bigtooth	*grandidentatum* Nutt.
black	*nigrum* Michx. f.
boxelder	*negundo* L.
devil	*diabolicum* Blume ex K. Koch
hawthorn	*crataegifolium* Sieb. & Zucc.
hedge	*campestre* L.
Japanese	*palmatum* Thunb.
mountain	*spicatum* Lam.
Norway	*platanoides* L.
red	*rubrum* L.
redvein	*rufinerve* Sieb. & Zucc.
Rocky Mountain	*glabrum* Torr.
siebold	*sieboldianum* Miq.
silver	*saccharinum* L.
striped	*pensylvanicum* L.
sugar	*saccharum* Marsh.
sycamore	*pseudo-platanus* L.
trident	*buergerianum* Miq.
vine	*circinatum* Pursh

[6] See footnote 5, p. 21.

[7] SPROSTON, T., JR., and SCOTT, W. W. VALSA LEUCOSTOMOIDES, THE CAUSE OF DECAY AND DISCOLORATION IN TAPPED SUGAR MAPLES. Phytopathology 44: 12–13, illus. 1954.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1961—598364