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A Guide to Major Insects, Diseases, Air Pollution Injury, and Chemical Injury of Sycamore

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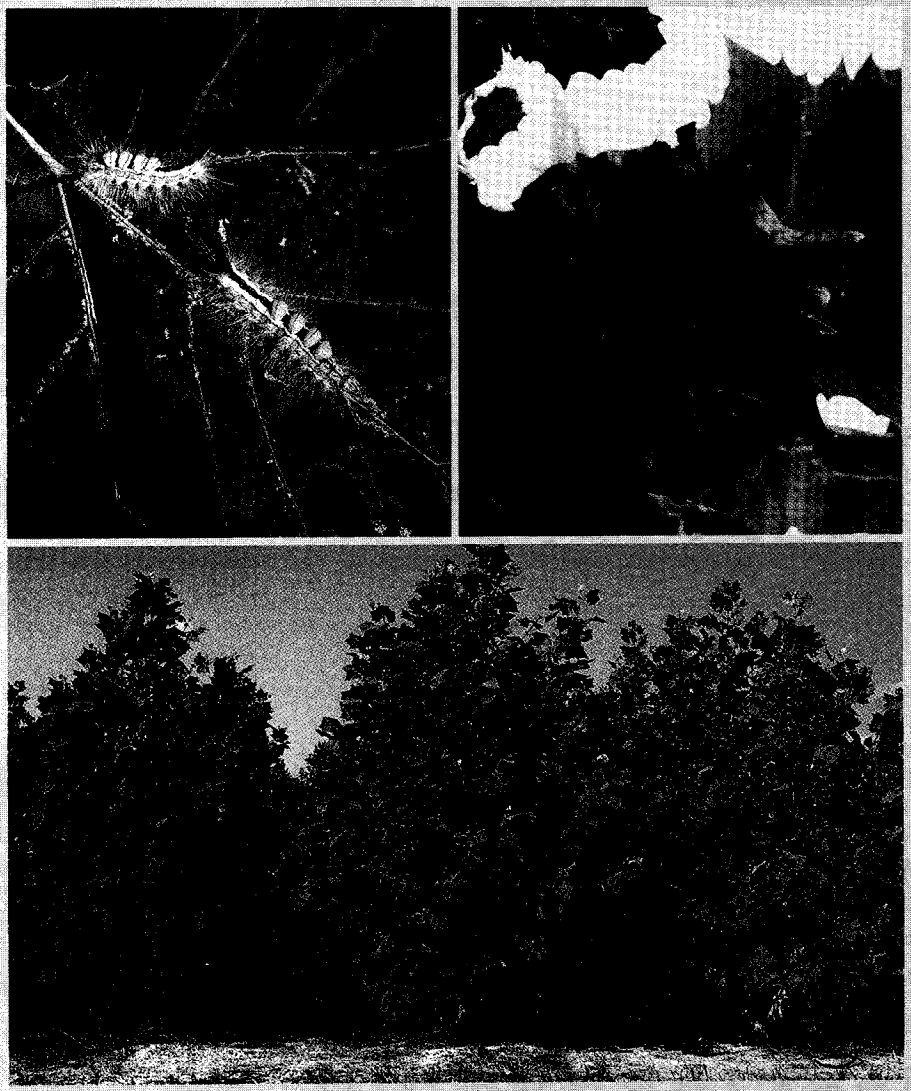

CAUTION

Pesticides used improperly can be injurious to humans, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key- out of the reach of children and animal-and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honeybees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first-aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

Do not clean spray equipment or dump excess spray materials near ponds, streams, or wells. Because it is difficult to remove all traces of herbicide from equipment, do not use the same equipment for insecticides or fungicides that you use for herbicides.

Dispose of empty pesticide containers promptly. Have them buried in an approved sanitary landfill.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Federal Environmental Protection Agency, consult your county agricultural agent or State extension specialist to ensure the product is still registered for use.

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Abstract

This booklet will help nurserymen, forest woodland managers, pest control operators, and homeowners to identify and control pest problems on sycamore trees. The major insect and disease pests of sycamores in the Eastern United States are emphasized. Descriptions and illustrations of the pests and the damage they cause are provided to aid in identification. Brief notes are given on biology and control to aid in predicting damage and making control decisions.

Keywords: Bacteria, biology, borers, control, defoliators, fungi, identification, *Platanus.*

INTRODUCTION

Sycamore *(Platanus occidentalis* L.) is a common **tree** and one of the largest in eastern deciduous forests. Other names are American sycamore, American planetree, buttonwood, and buttonball-tree. Its native range includes the area east of the Great Plains from south-central Texas and eastern Nebraska eastward to Maine and Florida. However, sycamore is planted as an ornamental in many Western States, especially California. It is also found in northeastern Mexico and southern Ontario. Sycamore is often a pioneer species on river fronts, upland old-field sites, and on strip-mined coal lands. However, it grows best and biggest on sandy loam soils with a good ground water **supply, typically** on **alluvial sites** along rivers and in bottomlands. Sycamore timber is valued for both lumber and pulp and is also planted widely as a shade tree because of its broad, dense crown, exfoliating bark on mature stems, and distinctive thin,

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green to greenish-white bark on scaffold branches and young stems. Easily propagated from seeds or cuttings, and second only to cottonwood in growth rate, sycamore lends itself well to artificial regeneration and intensive culture. It is among only a few hardwood species used to establish commercial plantations, an effort that typically requires intensive site preparation, early weed control (cultivation or herbicides or both), fertilization, and, in some cases, irrigation. Some plantations have been established at very close spacing and are being regenerated from coppice on short rotations to maximize fiber production. This kind of culture has been termed "short-rotation forestry," "silvicultural biomass farming," or "fiber farming."

Insects, diseases, pollutants, and chemicals present continuous threats to sycamore growth and production. Many insects feed on sycamore, but few actually cause serious injury. Terminal-feeding insects can sometimes cause serious seedling mortality and misshaped stem form. Insect defoliators, perhaps the most common pests, may strip entire trees or stands in localized areas, weakening trees and causing growth loss. However, those pests seldom cause significant mortality. Insect borers rarely occur in large populations except in stressed or weakened trees and in transplanted ornamentals. Timber beetles sometimes seriously degrade sawtimber and sawlogs.

Sycamore production usually suffers more from diseases than from insects. In some years, leaf diseases can defoliate trees or entire stands, reducing radial and terminal growth and weakening trees, making them susceptible to other pathogens and insect pests. Canker diseases, the most damaging type of sycamore diseases, can cause branch dieback, top dieback, and bole cankers. Dieback and mortality caused by canker diseases, along with other factors, have been so serious in some plantations that a few timber companies in parts of the South have sycamore planting "on hold" until disease-control methods can be developed.

Cultural practices that maintain and promote tree health help minimize losses caused by pathogens and insects. It is better to prevent attack by pathogens and insects than to remedy the aftermath of an attack. Some recommendations are provided in the back of this guide under "Maintaining Tree Health." Chemical or other direct controls may be needed as a last resort.

This guide will help nursery workers, forest managers, insect-pest and disease-control specialists, and homeowners to identify and control insect pests and diseases of sycamore trees. It emphasizes major diseases and insect pests in the Eastern United States and includes descriptions and illustrations of pathogens and insects, as well as the damage they cause. To aid in assessing the risk of further

damage and making control decisions, brief notes describe the biology and control of pathogens and insects.

We have described pathogens and insects both with common names and Latin binomials, including taxonomic authorities. However, a distinction must be made between the treatment of disease and pathogen nomenclature and that of insects. The common name of an insect refers to the insect itself. The common name of a disease typically includes the latin name for the genus of the pathogen causing the disease. For example, the fungal pathogen *Cylindrocladium scoparium* causes the disease Cylindrocladium root rot. For simplicity, we have omitted the words "caused by" between each disease name and its respective pathogen name.

Specific chemical controls are not listed because recommendations change whenever compounds are discontinued or new materials are approved. For information on pesticides or additional assistance with managing sycamore pests, the landowner should contact his or her county extension agent, State Forester, or the nearest office of the U.S. Department of Agriculture, Forest Service, State and Private Forestry, Forest Health Protection.

FOLIAGE INSECTS

Sycamore Tussock Moth, Walsh

Importance.-This insect feeds on sycamore leaves throughout the Eastern United States. It is more likely to defoliate older plantations, seed orchards, and ornamental plantings than nurseries and young plantations. Repeated late-summer defoliation reduces growth and vigor.

Identifying the Insect (fig. la, b).— Larvae have orangish heads and yellowish bodies covered with hair. Caterpillars (30 mm long) exhibit long hair pencils—two pairs of orange and 2 pairs of white hair pencils anteriorly, and one pair of white hair pencils posteriorly. Moths are pale yellow with darker bands on forewings.

Identifying the Injury (fig. 1c).— Young larvae skeletonize the leaves, feeding together on the leaf's underside. Older larvae devour all but the major leaf veins.

Biology.-Moths emerge from overwintering cocoons during May and June and deposit egg masses on the underside of leaves and on bark. Eggs hatch in late May and June. Young larvae feed close together; older larvae scatter and become solitary feeders. Pupation occurs in late June and July in hairy, ball-like cocoons on bark and nearby debris. Moths emerge in July and August to produce a second generation. These larvae spin cocoons and pupate in late September and October to overwinter.

Control.-Natural enemies control most populations. The control of brush and debris in and around plantings will reduce the best pupation sites. Chemical controls may be needed.

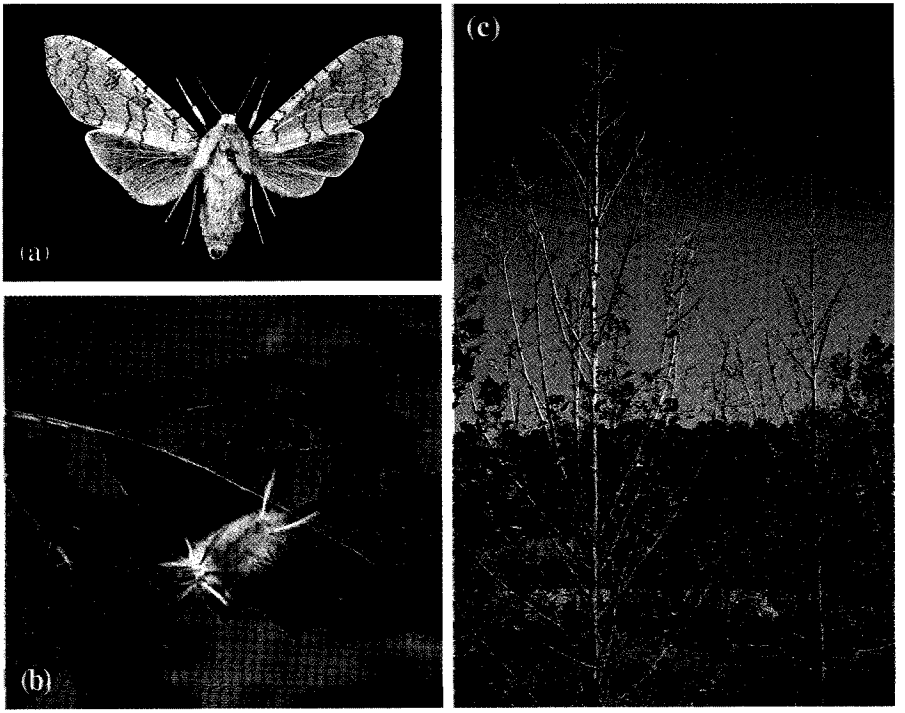


Figure l-(a) Sycamore tussock moth, (b) larva and feeding injury; (c) young plantation sycamore defoliated.

Whitemarked Tussock Moth, *Orgyia leucostigma* (J. E. Smith)

Importance.-This tussock moth defoliates a wide variety of trees, but the sycamore is among its preferred hosts. It occurs throughout the Eastern United States and Southern Canada. Heavy defoliation causes growth loss and dieback but rarely kills trees.

Identifying the Insect (fig. 2a, b).— The yellowish, hairy larva (30 mm long) has a coral-red head and thoracic shield with a black dorsal stripe. Four yellowish, brushlike hair tufts occur dorsally. A pair of black hair pencils arises anteriorly, and a single hair pencil arises posteriorly. Male moths are gray with dark wavy bands on the forewings. Females have no wings. Eggs are deposited in flattened clusters covered with whitish, frothy material.

Identifying the Injury (fig. 2c).— Young larvae skeletonize the undersides of leaves. Older larvae disperse and consume leaf patches, eventually consuming all but the leaf's midrib and main veins. Late-summer defoliation by large populations may cause a skeletonlike appearance to entire trees as well as entire stands.

Biology. — Overwintering eggs hatch from April to June. Newly hatched larvae feed close together but often are dispersed on silken threads by wind. Larvae mature in 5 to 7 weeks and spin grayish, hairy cocoons on the underside of branches and in bark crevices. The pupal stage lasts 2 weeks. Females deposit 50 to 300 eggs in masses usually on or near the old cocoons. There are one to three generations per year. Egg masses overwinter on host plants.

Control.-Populations on small trees can be controlled by destroying the conspicuous, whitish egg masses. Insecticides may be needed.

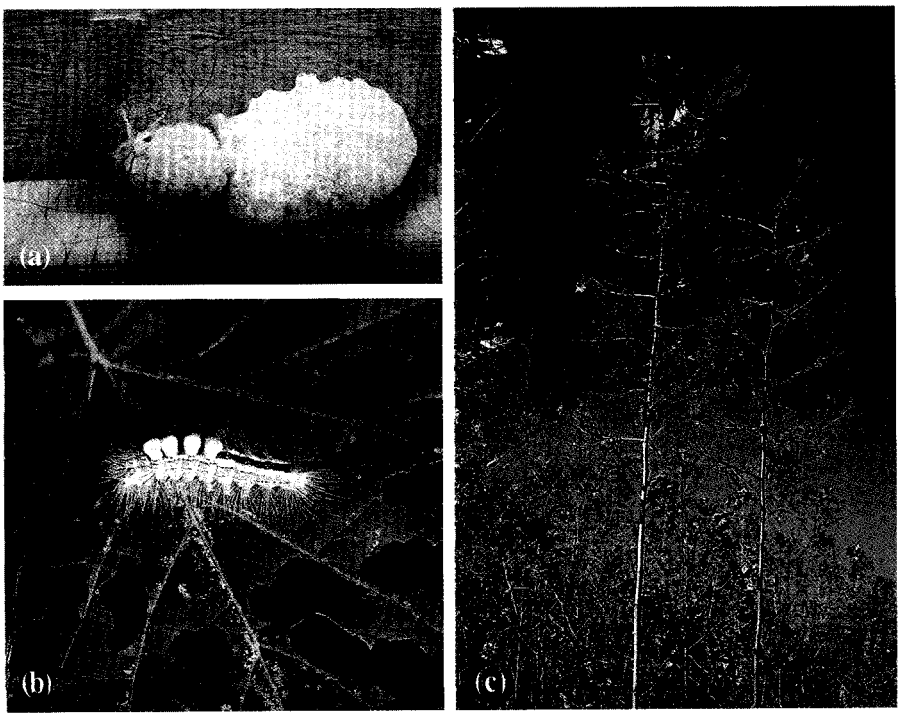


Figure 2-(a) Wingless female whitemarked tussock moth laying a mass of eggs; (b) larvae and feeding injury; (c) young trees defoliated.

Fall Webworm, *Hyphantria cunea* (Drury)

Importance.-The fall webworm defoliates more than 100 deciduous tree species across the United States and Southern Canada. Although seldom entirely defoliated, infested sycamore trees may be severely "ragged" causing premature leaf drop and reduced growth and vigor.

Identifying the Insect (fig. 3a, b).— There are two races of ***H. cunea***— blackheaded and redheaded. Larvae of both are pale yellowish with a broad, dusky dorsal stripe and yellowish lateral stripes. Covered with gray hair, the larvae are about 25 mm long. Moths are pure white to white with small dark spots. The tiny gray eggs are in large masses partially covered with short grayish hairs.

Identifying the Injury (fig. 3c).— Typically, large silken webs enclose one or more leaves and, eventually, entire branches in summer and fall. In sycamore plantations, however, webbing is present, but large tents may not be. Large groups of feeding caterpillars can cause sparse and ragged foliage over the entire crown.

Biology.-Moths emerge from overwintering pupae from March to July and oviposit on the underside of leaves in masses of 300 to 500 eggs, that hatch in 10 days. Distinct silken tents often do not occur on sycamore trees. Larvae may be present from April to October, but the greatest numbers occur in late summer and fall. Pupation occurs in thin cocoons near the soil surface. There are one to four generations per year, depending on locale and race.

Control.-More than 80 natural enemies are known. For young trees, it is possible to control the insect by clipping and destroying the webbed branches while the larvae are small. Insecticides may be required.

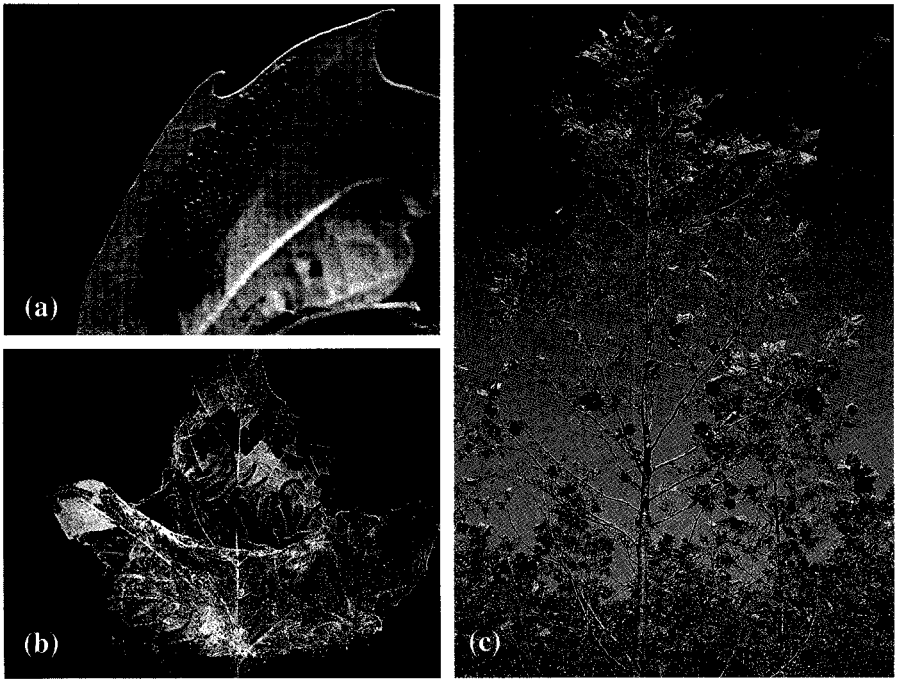


Figure 3-(a) Fall webworm egg mass on underside of leaf, (b) larvae feeding under webbing; (c) partially defoliated sycamore with little webbing.

Leaffolders and Webworms, *Ancylis platanana* (Clemens), ***Pococera militella*** (Zeller), *Adoxophyes furcatana* (walker)

Importance.-A complex of leaf-folding and web-making larvae feed on sycamore leaves. ***Ancylis platanana, oc-*** curring only on ***Platanus*** throughout the Eastern United States, is emphasized here. Heavy defoliation of small groups of trees may occur. Repeated defoliation may reduce growth and incite crown die-back.

Identifying the Insect (fig. 4a).— Larvae of ***A. platanana*** are slender and pale yellow with smooth bodies; mature larvae are 9 to 11 mm long. The forewings of adults are reddish with white markings. Eggs are small, oval, and almost colorless.

Identifying the Injury (fig. 4b, c).— Small, silken shelters are found on the undersurface of partially skeletonized leaves. A leaf gradually becomes folded and is further webbed and skeletonized, often leaving only a brown network of the larger veins. Injury by other webworms is similar but with more extensive webbing.

Biology.-Adults of ***A. platanana*** emerge from March to May and deposit eggs singly on the undersides of leaves. Eggs hatch in 3 to 5 days, and the young larvae feed along the leaf midrib. Older larvae pull the leaf over into a fold and feed for about 6 weeks until they pupate beneath the webbing in the folded leaf. The pupal stage lasts 9 to 11 days before the adults emerge. There are three to four generations per year. Overwintering occurs as prepupae in fallen leaves.

Control.-Natural enemies help control populations. Some control is possible by disking to bury fallen leaves and pupae.

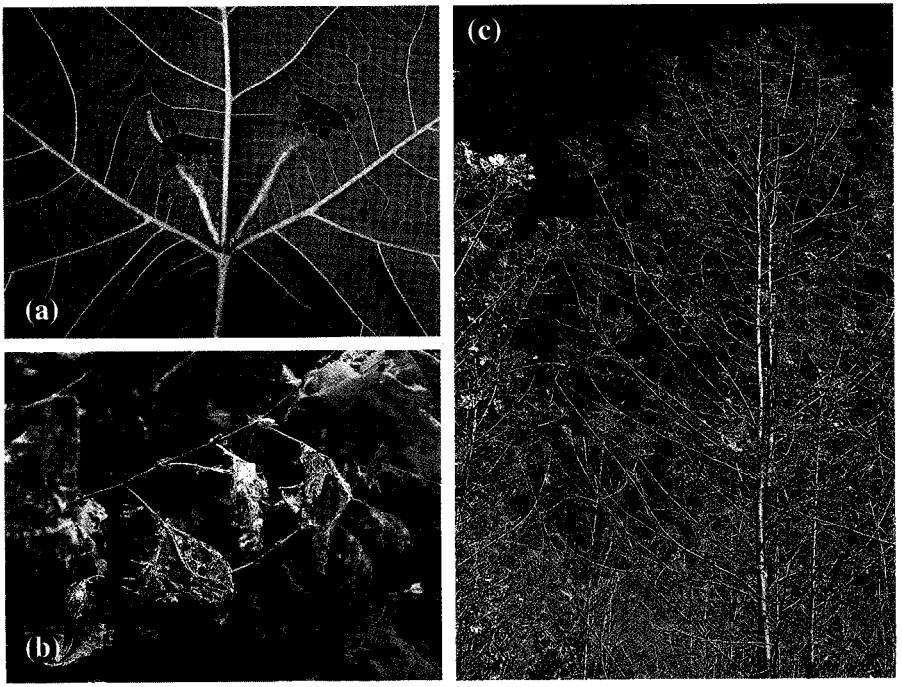


Figure 4-(a) Leaffolder larvae and early-season feeding at base of leaf; (b) advanced feeding and extensive webbing; (c) heavy defoliation.

Case-Bearing Leaf Beetle, *Neochlamisus platani* (Brown)

Importance.-This beetle is known from Massachusetts west to Colorado and south to Florida and Texas. It feeds on sycamore foliage and prefers young trees. Defoliation may result in loss of growth and aesthetic value, but no crown dieback or mortality has been associated with this insect.

Identifying the Insect (fig. 5a, b).— Adults are peculiarly shaped leaf beetles with a rough, knobby, brownish body surface, 4 to 5 mm long, resembling the brown excrement pellets of large caterpillars. When disturbed, beetles feign death and fall from the plants. Larvae are white with black heads and legs, 5.4 to 6.5 mm long, and live in dark-brown cases made of fecal excreta, which conceal all but the head and legs.

Identifying the Injury (fig. 5c, d).— Both adult beetles and case-bearing larvae are found feeding on young foliage. Small, scattered holes appear in the leaf. In time, the holes are enlarged and, typically, uniformly distributed over the leaf surface. Trees may appear "ragged" from heavy leaf feeding but are seldom completely defoliated.

Biology.—Overwintering beetles appear on the foliage of host trees in April and May. Females lay tiny, bell-shaped, excrement-covered eggs singly and on short stalks on the undersides of leaves. Young larvae construct and live within cases made of their own frass. Pupation occurs within the case attached to the underside of a leaf. Highest populations occur in early summer. Only one or two generations occur per year.

Control.-Parasites and predators usually keep populations under control.

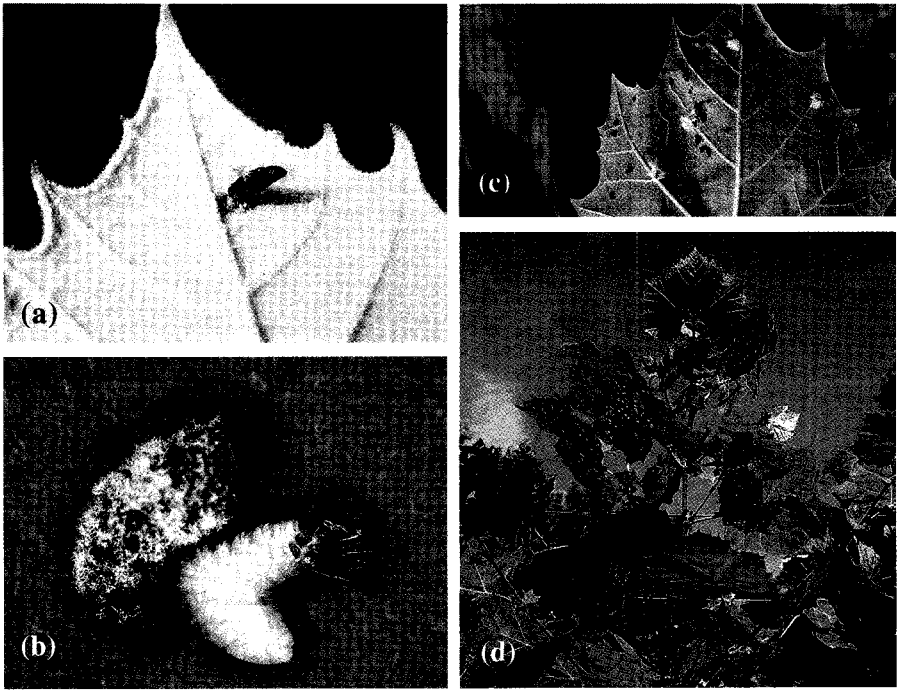


Figure 5-(a) Larval case; (b) larva removed from case; (c) close-up of feeding damage; (d) tree with feeding injury.

Sycamore Lace Bug, *Corythucha ciliata* (Say)

Importance.—One of the most common insects found on sycamore foliage, lace bugs may occur in large numbers on shade or ornamental trees in urban areas, especially in late summer or during dry periods. *Corythucha ciliata* is a problem throughout the Eastern United States.

Identifying the Insect (fig. 6a, b).— The adult is a pale, flattened insect about 3 mm long whose wing covers are extended and so intricately ornamented that they appear to be made of a piece of lace. Immatures are also flattened but are black and covered with spines.

Identifying the Injury.-The lace bug pierces the epidermis and withdraws fluids and cell contents, which results in chlorotic flecking on the upper surface of leaves. Late in the growing season the leaf's lower surfaces may appear messy, having been varnished with lacebug excrement and shed skins. Large populations of lace bugs may cause leaves to turn brown and drop prematurely.

Biology.-Adults overwinter under bark and become active when leaves start to develop. Eggs are glued to the pubescence on the undersides of leaves. Both adults and nymphs feed on the undersides of leaves by sucking sap with piercing mouthparts. Nymphs seldom move to another leaf until they are almost mature. The complete life cycle from egg to adult takes about 30 days, and there may be 2 to 5 or more generations per year. Late in the year, synchrony of generations breaks down, and all life stages may be found on the same leaves.

Control.-Predators usually keep lace bug populations small. Chemical control may be required in late summer and fall when populations are largest.

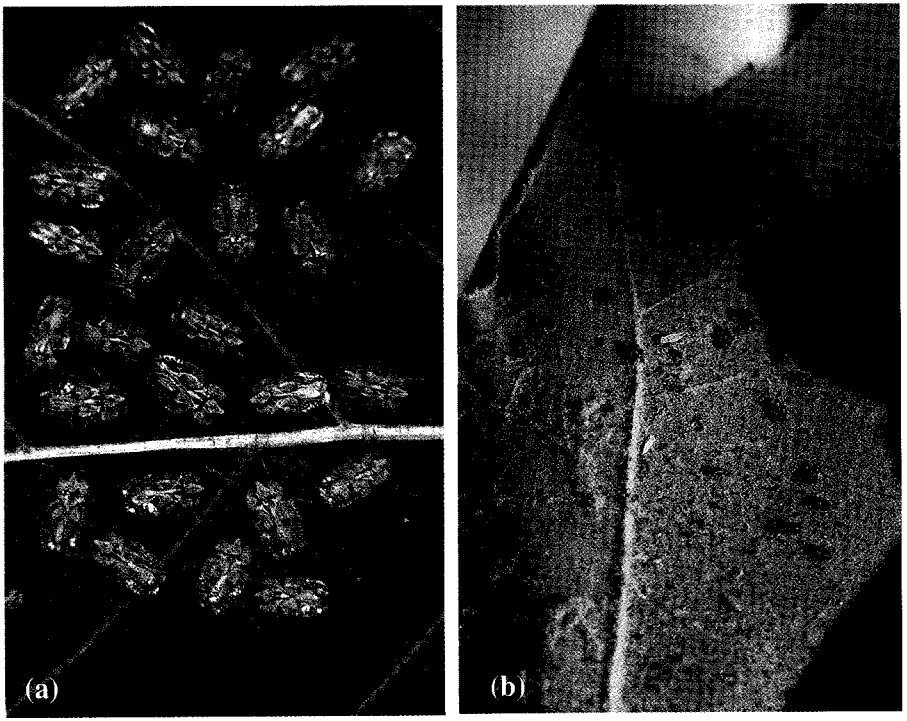


Figure 6-(a) Adult lace bugs feeding on underside of leaf; (b) lace bug nymphs feeding on underside of leaf.

Leafhoppers, *Erythroneura lawsoni* Robinson, *E. arta* Olivier, *E. usitata* Beamer

Importance.-Although many species of leafhoppers may be found on sycamore foliage, the three listed species of ***Erythroneura*** cause most infestations. Leafhoppers suck the leaf sap, reducing tree vigor, and may transmit viruses and mycoplasma diseases.

Identifying the Insect (fig. 7a).— Leafhopper adults are small (6 mm), linear insects that appear tapered at both ends. They vary from yellowish to light green with some speckling or striping. Leafhoppers jump or shoot away when disturbed, earning them the nickname sharpshooters. Immatures have a similar shape but are smaller, wingless, and paler in color with the ability to run backwards on the leaf.

Identifying the Injury (fig. 7b).— Injured leaves become stippled and chlorotic, especially around the midrib and basal veins. Large populations of leafhoppers may be present on the undersides of leaves. Heavy infestations result in poor leaf color, premature leaf drop, and a less pleasing appearance.

Biology.-After overwintering in leaf litter and debris, adult leafhoppers become active on newly opened sycamore buds. Mating and egg laying start early in the growing season. An average generation matures in 41 days. In the late fall, adults move to protected sites to overwinter.

Control.-Leafhoppers are controlled by spiders, wasps, fungal diseases, and abiotic factors such as rainfall and wind. Chemical control may be needed for ornamental trees during summer and fall.

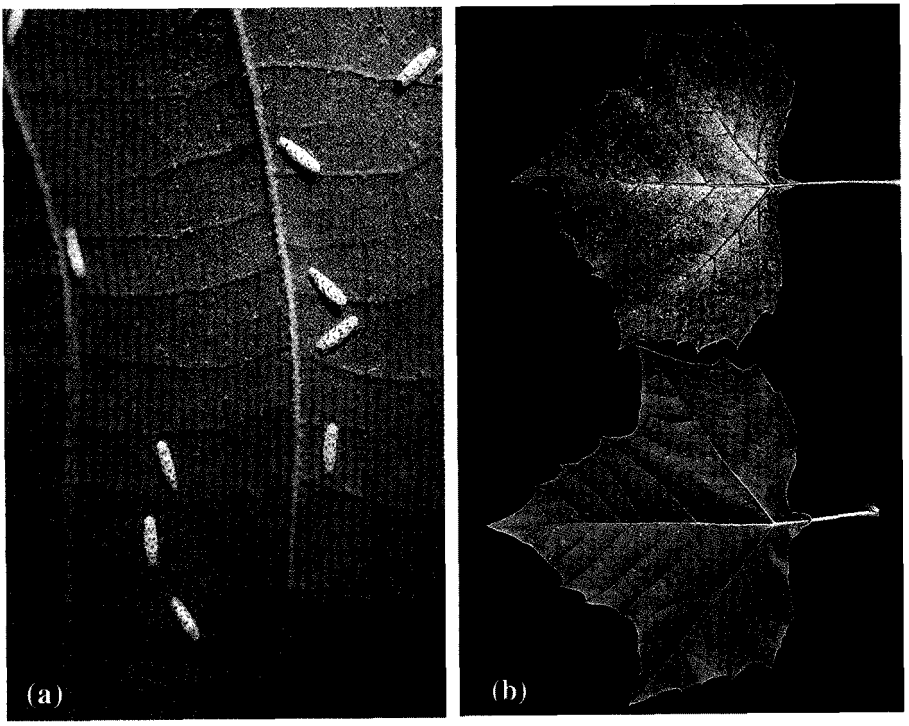


Figure 7-(a) Leafhopper adults feeding on underside of leaf: (b) chlorotic stippling from feeding injury (top leaf), healthy leaf (bottom).

MINOR FOLIAGE INSECTS

Sycamore Leafhlotch Miner, *Ectoedemiu platanella* (Clemens)

Leafblotch miner larvae are pale green, slightly flattened with a retracted head, up to 4 mm long, living singly within distinct leaf mines. The tiny adult moth is seldom seen, but it ranges over much of the Eastern United States. *Ectoedemia* leaf injury appears as a brown, circular blotch mine (± 1 cm diameter) just below the leaf cuticle. Mines originate from a narrow entrance mine and are filled with frass in the center (fig. 8). Heavily mined leaves drop prematurely. Injury is unsightly, but its impact on tree health usually is slight to negligible. Natural enemies control most populations. Direct controls are rarely needed.

Figure 8—Sycamore leaf with brown mines of *E.* platanella.

Drab Prominent, *Misogada unicolor* (Packard)

Drab prominent larvae are light green with a broad, yellowish-white dorsal stripe (with brownish patches) and narrow indistinct lines on each side. A pair of tail-like projections is borne on the last abdominal segment. Mature larvae are 30 to 42 mm long (fig. 9) and may be present from April to September. Young larvae feed close together and skeletonize the undersides of leaves. Large larvae become solitary feeders and will devour all but a leaf's major veins. There are two to three generations per year. Parasites keep most populations in check.

Figure 9-Fully grown larva of *M. unicolor.*

Japanese Beetle, *Popillia japonica* Newman

Japanese beetles are broadly oval, 12 mm long, metallic green and coppery, with small tufts of white hair both behind and on each side of the elytra (fig. 10). Prevalent in some Atlantic Coast States, they emerge from May to July and live for 30 to 45 days. They feed on over 300 plant species and devour sycamore leaf tissue between the veins, commonly leaving only a lacelike network of veins. They may completely defoliate seedlings and young trees. A milky disease bacterium, *Bacilluspopilliae* Dutky, is commercially available to control the larval stage in the soil. Chemical control of adults may be needed.

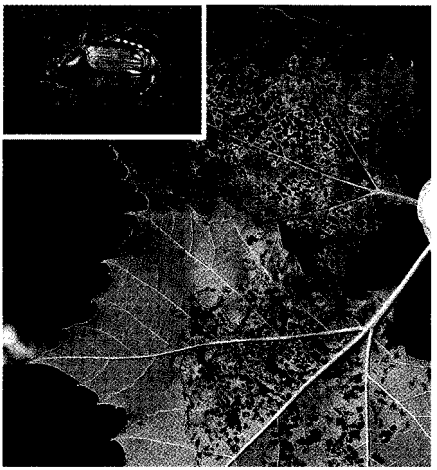


Figure l&Japanese beetle (inset) and feeding injury to leaves.

Sycamore Plant Bug, *Plagiognathus albatus* (Van Duzee)

Adults are pale yellowish, elongated soft-bodied true bugs, 3 to 5 mm long, with piercing-sucking mouthparts (fig. 11). Nymphs resemble the adults but are wingless. These bugs occur over much of Eastem North America. Overwintering eggs, embedded in twig tissue below leaf buds, hatch in April. Nymphs and adults (both present until July) feed on tender leaves, causing tiny irregular brown spots that often fall out, leaving a ragged and tattered leaf (fig. 11). There is one generation per year. Direct controls may be needed to protect high-value trees.

Figure 1 l-Adult of *P. albatus* (inset) and injury to foliage.

SEEDLING, TERMINAL, AND BRANCH INSECTS

Planthoppers, *Ormenoides venusta* (Melichar), *Anormenis septentrionalis* (Spinola)

Importance.-Planthoppers feed on sycamore and many other species throughout the Eastern United States and as far West as Texas and Arizona. Their sap feeding and oviposition injuries sometimes cause serious damage to seedlings and the terminals of older plants.

Identifying the Insects (fig. 12a).— Adults are snow white to pale green and have large prominent wings held at an acute, rooflike angle over the body. They range from 6 to 12 mm long. Nymphs are white or greenish, wingless, slightly flattened with abdomen curved slightly upward, and are partially covered with filaments of white, wool-like wax.

Identifying the Injury (fig. 12b).— Sap feeding by large populations may cause succulent shoots to wilt and grow more slowly but seldom causes dieback. However, large clusters of oviposition punctures along the stems may cause seedling mortality as well as terminal dieback in older plants. Young seedlings planted adjacent to natural stands are most prone to injury.

Biology.-Eggs overwinter inside twigs of host plants and hatch in the spring. The nymphs feed in clusters on succulent shoots. Adults begin appearing in June and are present until fall. Females deposit their eggs in short slits in the bark of the current year's growth. There is one generation per year.

Control.-Shoots containing clusters of oviposition punctures can be pruned and destroyed in fall and winter, although natural enemies keep most populations in check.

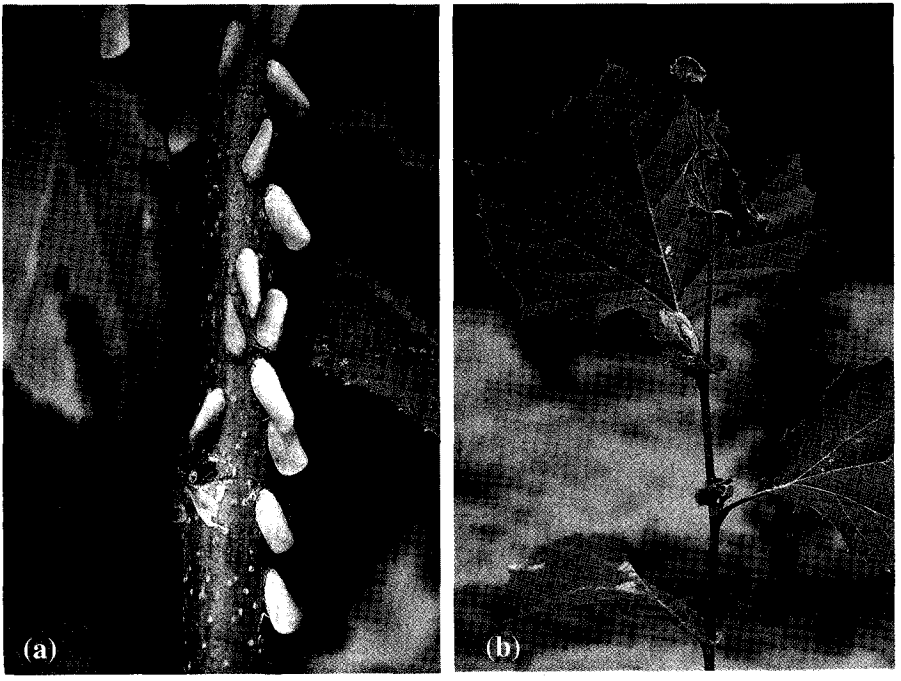


Figure 12-(a) Planthopper adults feeding on a young sycamore stem; (b) a young sycamore terminal killed by punctures of egg-laying adults.

Scale **Insects,** Terrapin *scale, Mesolecanium nigrafasciatum* (Pergande); Cottony maple scale, *Pulvinaria innumerabilis* (Rathvon); European fruit lecanium, *Parthenolecanium corni* (Bouché); Oystershell scale, *Lepidosaphes ulmi* (L.)

Importance.-Scale insects reduce plant vigor and may cause faded areas in affected leaves, premature leaf drop, and even twig mortality. They produce honeydew, which supports the growth of sooty molds that block photosynthesis. Injuries detract from the appearance and value of the tree. These insects occur throughout the United States.

Identifying the Insect. -Terrapin scale females appear as oval-shaped, reddish-brown, shiny bumps (2 mm across) on branches (fig. 13a). Cottony maple scale females look like small powdery popcorn kernels with a dark shell (4 to 6 mm) trailing a large cottony white egg sac (fig. 13b). European fruit lecanium females are distinctly humped (3 to 6 mm), dark brown to reddish, and sometimes covered with whitish powder (fig. 13c). Oystershell scale females look like tiny (3 mm long), chestnut-brown oyster shells. In large numbers they form a "crust" on trunks and branches.

Identifying the Injury.-Injury may appear as yellow spots on leaves, necrotic areas, dieback, shiny leaves, growth of black sooty mold, or leaf drop. Scales can be found by examining the bark.

Biology.-Scale insect life cycles are complicated with large, somewhat sedentary females and relatively small, winged males. There may be several generations per year. Overwintering is typically on branches or under bark.

Control.-Parasites and predators usually keep scales under control. Occasional chemical treatment of ornamental plants may be useful.

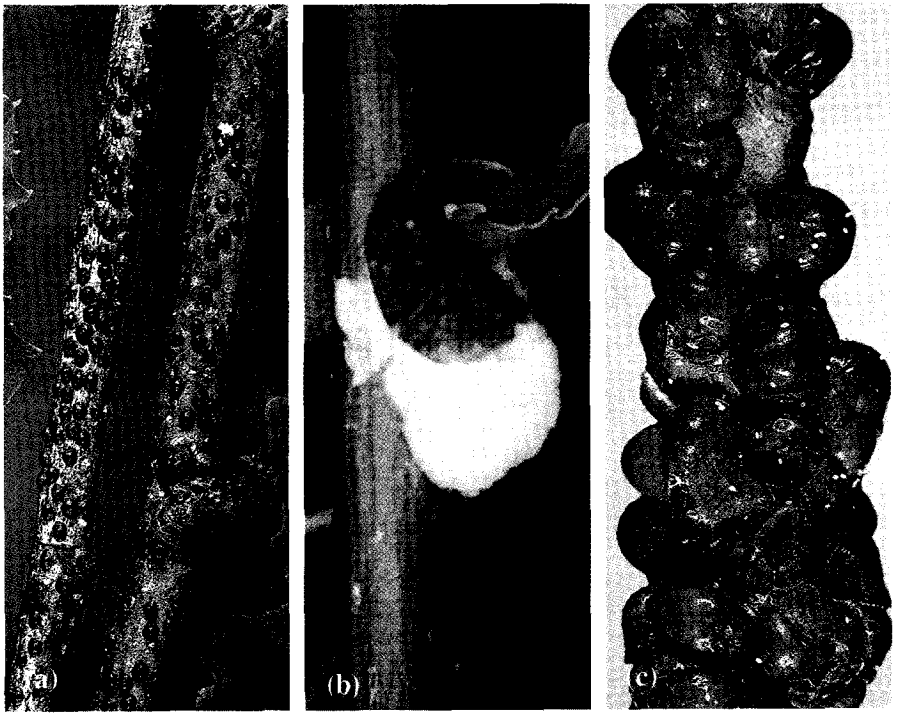


Figure 13-(a) Terrapin scale; (b) cottony maple scale; (c) European fruit lecanium.

Stalk Borer, *Papaipema nebris* (Guenée)

Importance.-The stalk borer is widely distributed throughout the Eastern United States and Canada. It attacks over 175 herbaceous and woody plant species. Corn, grasses, and giant ragweed are favored hosts. However, succulent sycamore shoots are killed occasionally in nurseries and young plantations.

Identifying the Insect (fig. 14a, b).— Larvae have broad stripes of pale white and brown interrupted by a distinct band of purplish brown around the third thoracic and first abdominal segments. Mature larvae are 25 to 32 mm long. Adults are robust moths; their forewings are purplish brown with several small white spots. Eggs are globular and whitish brown.

Identifying the Injury (fig. 14c).— Sudden wilting and flagging of succulent shoots with 3-mm-diameter round entrance holes occur in late spring. Excrement pellets often are present at entrance holes. Opening the shoot will reveal a tunnel and larva.

Biology.-Overwintering eggs hatch from April to June. Young larvae feed on grasses; older larvae seek larger, succulent stems and often migrate from herbaceous plants to young sycamore trees. Larval development varies from 60 to 130 days. Mature larvae abandon their hosts and pupate just below the soil surface. Moths emerge from August to October and deposit up to 2,000 eggs each on grasses where they overwinter. There is one generation per year.

Control.-Damage can be minimized by disking weedy borders of nurseries and young plantations to destroy breeding sites in early August. Direct controls may be needed.

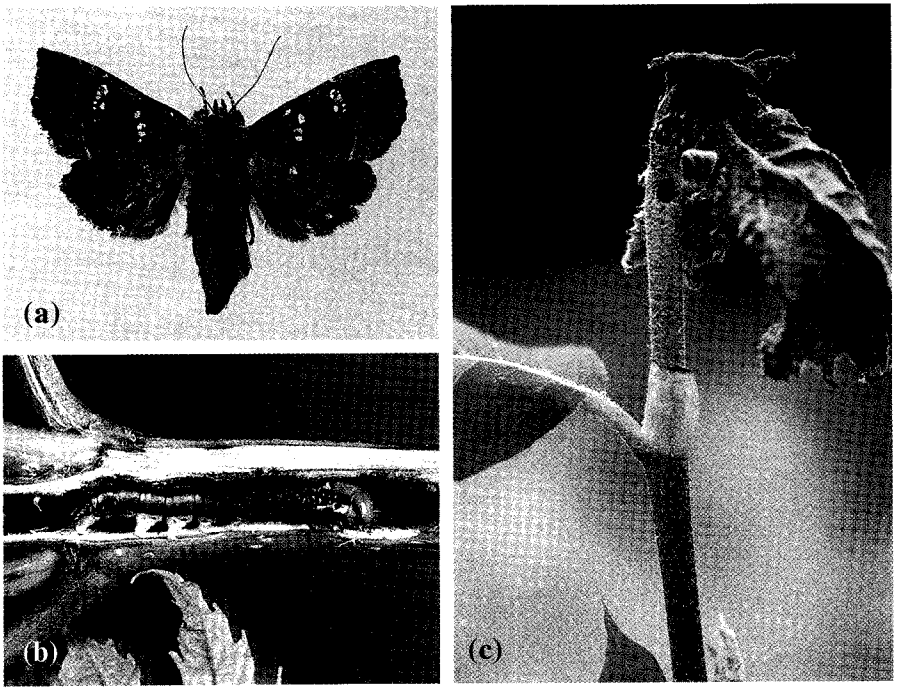


Figure 14--(a) Stalk borer adult; (b) larva tunneling in young shoot; (c) terminal being killed by larval tunneling, gallery entrance near apex.

European Corn Borer, *Ostrinia nubilalis* (Htibner)

Importance.-This pest of corn and over 100 other plants sometimes infests sycamore trees in the Eastern United States. Typically, trees are attacked only when growing near heavily infested preferred hosts such as corn and certain cover crops. In sycamore nurseries, the European corn borer may tunnel through and kill up to 30 percent of the terminals.

Identifying the Insect (fig. 15a).— Larvae have brownish mottled heads and grayish bodies with pinkish-brown stripes and are about 25 mm long. Adult moths are brownish with yellowish-brown forewings that are somewhat streaked. Eggs are oval and yellowish white.

Identifying the Injury (fig. 15b, c).— The first sign of infestation is rapid wilting and dying of seedling terminals and branch tips. Holes 4 to 6 mm in diameter are found in tender shoots. Splitting the infested shoot will reveal a tunnel, frass, and a gray larva.

Biology.-Overwintering larvae pupate in April and May, and moths emerge from May to June. Females deposit 500 to 600 eggs on herbaceous hosts that hatch in a week. Larvae complete feeding in July, and **moths** emerge in August. Second generation larvae feed until fall and overwinter in their tunnels. There may be one to two generations per year. Infestation of sycamore tree typically occurs when heavily infested herbaceous hosts mature or are harvested, causing the larvae to migrate to other succulent hosts.

Control.-Preferred crops like corn or millet should not be planted next to sycamore nurseries. Chemical controls may be required.

Figure 15--(a) Larvae of *O. nubilalis*; (b) terminal being killed by larval tunneling; (c) young stems with entrance holes, frass, and tunnel.

TRUNK BORERS

Columbian Timber Beetle, *Corthylus columbianus* Hopkins

Importance.-The Columbian timber beetle occurs from Massachusetts south to Florida and west to Kansas. Beetles bore into the trunks of trees of all sizes. Beetle attacks do not seem to affect tree health directly, but they provide entry points for canker and other diseases. Damage can degrade the lumber by as much as 25 percent.

Identifying the Insect (fig. 16a).— Adults are 3.6 to 4.0 mm long, reddish brown to black, cylindrical ambrosia beetles. Eggs are white, translucent, shiny, and oval. Larvae are white, legless, C-shaped, and about 4 mm long.

Identifying the Injury (fig. 16b, c).— Sap and fine frass oozing out of small round entrance holes in the trunk are evidence of injury. Radiating brown stains in log ends are evidence of damage in sawlogs. In lumber and veneer, defects consist of small, black, round holes surrounded by elongated brown stains.

Biology.-Adults overwinter in bark niches around the base of host trees. Beetles emerge in May and June and begin excavating brood galleries on host trees. Completed galleries consist of primary, secondary, and tertiary channels with 1 to 20 brood cells (cradles). Eggs are deposited singly in each brood cell. Both larvae and adults feed on ambrosia fungi that grow on gallery walls. Brood emergence occurs in 6 to 7 weeks. There are two to three generations per year.

Control.-Few natural enemies have been identified, and no direct controls have been developed.

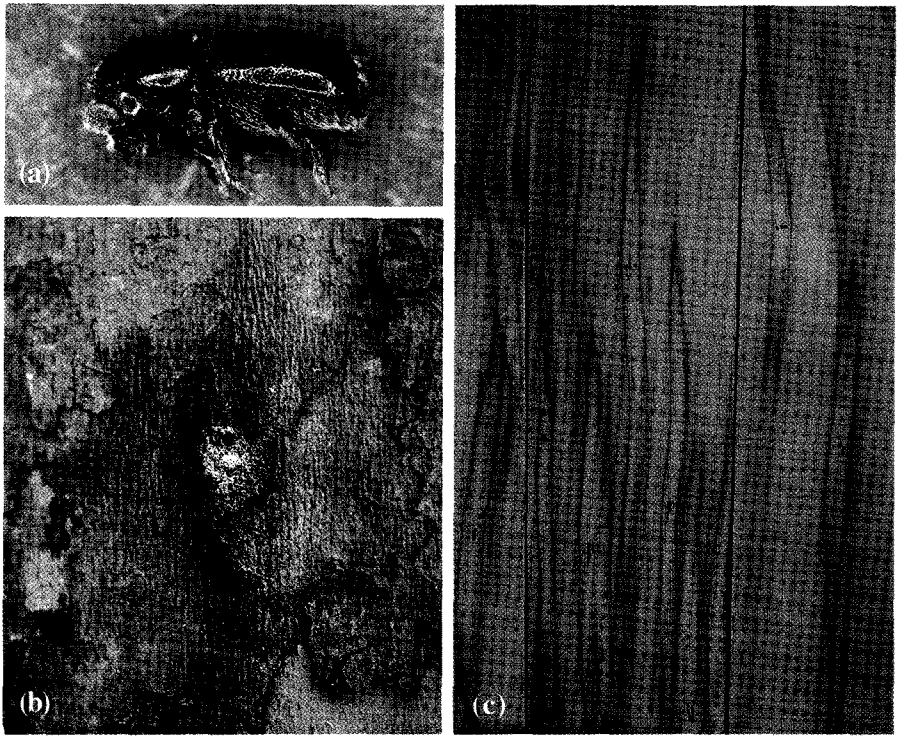


Figure 16—(a) Adult of C. *columbianus*; (b) tiny entrance hole with frass and stain; (c) stained flagworm defects in lumber.

Flatheaded Borers, Flatheaded appletree borer, *Chrysobothris femorata* (Olivier); Pacific flatheaded borer, *C. mali* (Horn)

Importance.-These borers are widely distributed: *C. femorata*, throughout the United States into Canada and Mexico; and *C. mali*, through the Western States. They make extensive galleries under the bark and often girdle and kill newly transplanted trees.

Identifying the Insects (fig. 17a, b).-Larvae are yellowish white, legless, and 18 to 25 mm long. The thoracic segments are broadened, which gives the appearance of large, flat heads. Adults are flattened, metallic-hued beetles (7 to 16 mm long), marked with gray spots in C. *femorata* and coppery spots in *C. mali*. Eggs are yellowish white, flattened and disclike.

Identifying the Injury (fig. 17c).— White, frothy sap oozes from cracks in the bark. Tunnels under the bark are broad, irregular, and packed with powdery frass. The bark of infested trees may be heavily scarred by larval burrows and oval exit holes of emerging beetles.

Biology.-Adults begin emerging in March and are present until fall. Females deposit about 100 eggs each in small groups in bark crevices. Eggs hatch in 8 to 16 days. Larvae feed in the cambium until late summer, then tunnel radially into the sapwood to overwinter. In spring, the larvae pupate for 8 to 14 days before the adults emerge. Generation time varies from 1 to 2 years.

Control.-Cultural practices that promote tree vigor help minimize attacks. Weakened and dying trees should be removed to eliminate breeding sites.

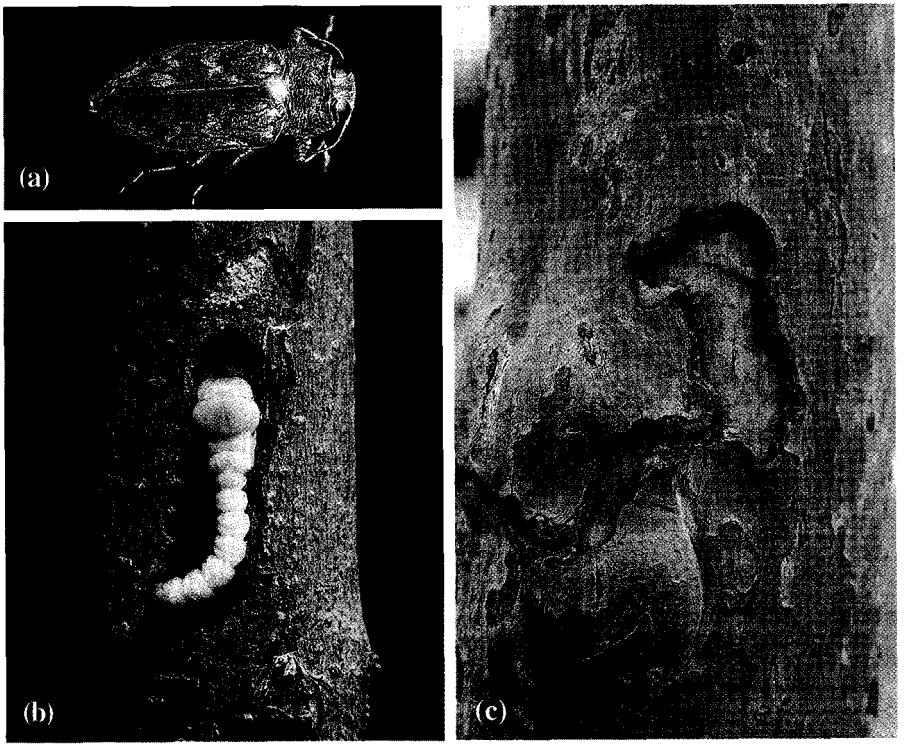


Figure 17-(a) Adult of C. *femorata*; (b) bark removed to expose larva; (c) larval burrow in bark.

MINOR TRUNK BORERS

Ambrosia Beetles, *Xylosandrus* spp., ***Xyleborus*** spp., ***Platypus*** spp.

Some ambrosia beetles attack healthy trees, but most prefer weakened, injured, or dying trees and fresh-cut logs (fig. 18). They bore into the sapwood and reduce tree and log values for wood products; some spread fungal pathogens. Larvae feed on a moldy fungus called ambrosia that adult females culture on the gallery walls. Small piles of boring dust or strings of compacted frass may be present on the bark. There are two or more generations per year. Adults can be trapped with pheromones. Logs should be processed promptly.

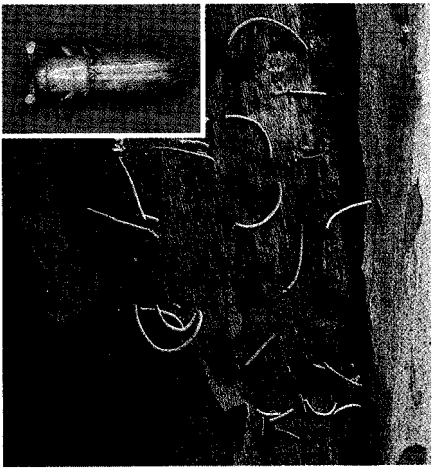


Figure 18-Adult of l? *compositus* (inset) and strings of frass.

American Plum Borer, *Euzophera semifuneralis* (Walker)

Larvae vary from dark pink or reddish gray to dusky green, with a dark-brown head and thoracic shield. They are about 25 mm long when full grown (fig. 19). The American plum borer is widely distributed throughout the United States, Canada, and parts of Mexico. Weepy sap spots appear on the bark, followed by accumulations of reddish frass in bark crevices (fig. 19). Lifting the bark will expose larval burrows, frass, larvae, and white, silken cocoons. This borer prefers trees in poor health, especially those with mechanical injuries to the bark and canker diseases. Good cultural practices help minimize infestation. Direct controls may be needed to protect valuable trees.

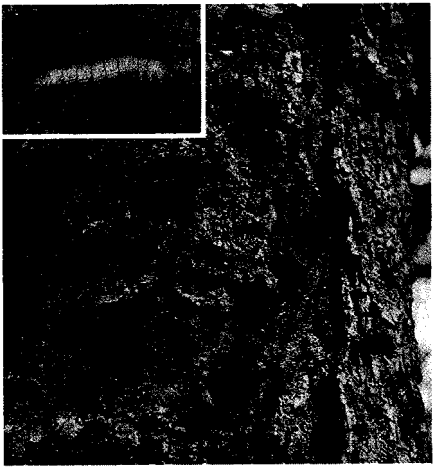


Figure 19-Larva of *E. semifuneralis* (inset), frass, and burrows.

ROOT INSECTS

Whitefringed Beetles, (Boheman), ***G. minor*** (Buchanan), ***G. peregrinus*** (Buchanan), and G. *fecundus* Buchanan

Importance.-Whitefringed beetles were introduced into Florida in 1936 and have spread north to Virginia and west to Louisiana. They feed on over 300 plant species. On young sycamore trees, the larvae destroy both tap and lateral roots. Damage may occur in new nurseries and first-year plantations established on sites with heavier soils not well suited for sycamore production.

Identifying the Insects (fig. 20a, b).-Adults are dark-gray, 9-mm-long beetles with a white fringe along the outer margins. Full-grown larvae are yellowish white, C-shaped, legless, and 12 mm long with a pale head. Eggs are oval and pale yellow.

Identifying the Injury. (fig. 20c).— Damaged plants become chlorotic and may die; injured survivors appear yellow and unhealthy. Excavation will reveal root injury. Larvae can be found in the top 12 to 24 cm of soil. Adults may be seen resting around the bases of plants.

Biology.-Overwintering larvae begin pupating in April, and adults emerge from May to October. All adults are females, each of which deposits up to 1,500 eggs in the soil in masses of 11 to 14. Eggs hatch in 11 to 30 days, and larvae feed on plant roots. There is one generation per year. Adults cannot fly, but the insect is easily spread by moving infested plants, soil, or equipment.

Control.-Commercial traps are available to monitor infestations. Fallowing heavily infested soils will reduce populations.

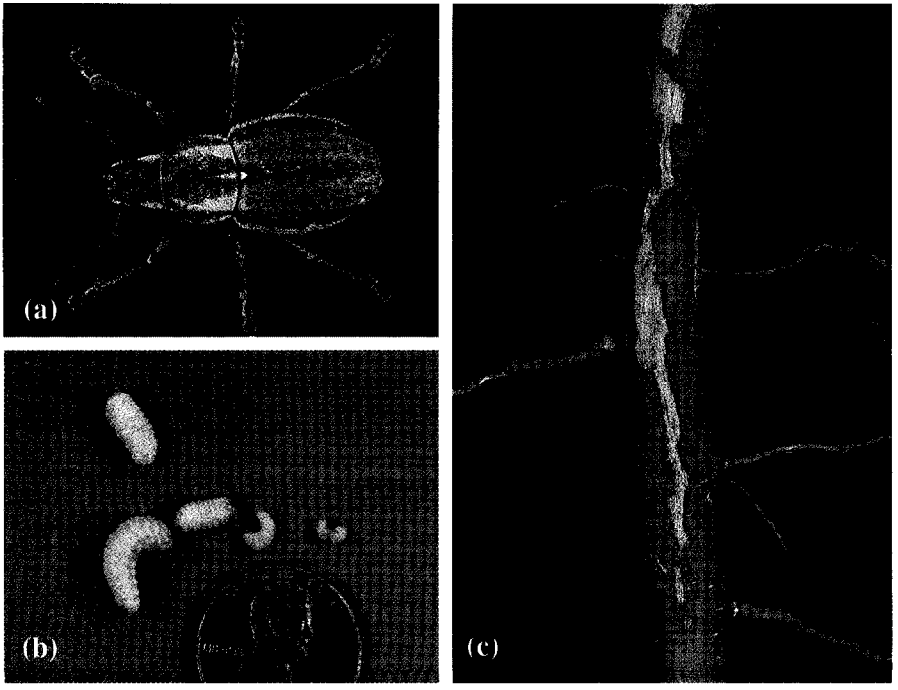


Figure 20—(a) Whitefringed beetle; (b) larvae; (c) larval feeding injury to roots of sycamore seedling.

SEEDLING DISEASES

Cylindrocladium Root Rot, Morg.

Importance.-Sycamore seedlings and other southern hardwood species are susceptible to Cylindrocladium root rot, especially in nurseries where seedlings are grown close together (fig. 21a).

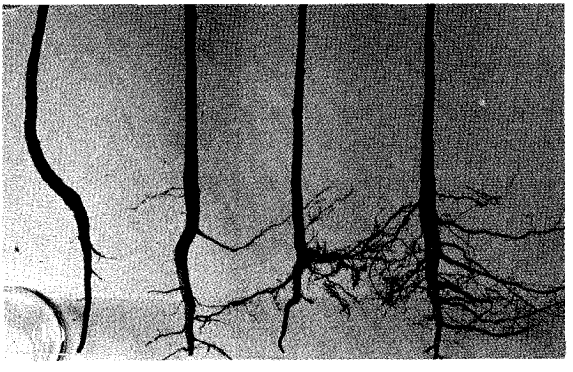
Identifying the Disease.-Infected seedlings may be killed by this disease or will exhibit a combination of symptoms: damping-off, root rot, hypocotyl rot, leaf spots, leaf blight, stem lesions, twig dieback, and wilting. Affected roots turn black, shrivel, and die (fig. 21b). Aboveground symptoms are favored by warm, moist conditions such as those that exist during summer irrigation by overhead sprinklers.

Identifying the Fungus.-The fungus produces pinpoint-sized, brown microsclerotia on dead roots, leaves, and stem lesions. Tiny white tufts of conidia appear on surface lesions. Yellow-orange perithecia (0.4 mm) may form on dead leaves and bark under moist conditions.

Biology.—Conidia produced on stem and leaf lesions are spread by wind and splashing rain to other susceptible seedlings. Microsclerotia released into the soil may survive for years, and, during moist conditions, germinate to infect roots.

Control.-To prevent spread of inoculum and minimize conditions that favor the fungus, avoid overhead watering in the summer. Plant seedlings further apart to promote vigorous growth and reduce seedling susceptibility. Remove diseased seedlings, and improve soil drainage on moist sites. High-hazard sites may require soil fumigation in the fall or spring to reduce inoculum in the soil.

Figure 21-(a) Sycamore seedling survival in the center and right rows is poor due to root rot, compared to that of the two rows on the left.



(b) Sycamore seedlings with root damage (left), and normal roots (right).

FOLIAGE DISEASES

Anthracnose-Leaf Blight, *Apiognomonia (=Gnomonia) veneta* (Sacc. & Speg.) Höhn.

Importance.-(See p. 31, Anthracnose-Twig Canker and Shoot Blight).

Identifying the Disease.—Anthracnose-blighted leaves have irregularly shaped, tan necrotic patches that run along the midrib and larger veins (fig. 22a). Necrotic patches often coalesce and span the area between veins. Lesions also form on petioles and along leaf margins. Repeated infections throughout the growing season can cause severe defoliation (fig. 22c).

Identifying the Fungus.-Colorless, one-celled conidia are produced in pinhead-sized, cream-colored acervuli on the bottoms of diseased leaves along veins and the midrib.

Biology.—Conidia produced on fallen leaves or on the bark of diseased twigs germinate and infect new leaves as hyphae grow along veins and the midrib into the petiole and twig. Leaf infections are favored by cool (16-20 ºC), wet weather. Repeated infections can occur throughout the growing season under favorable weather conditions, which, in the South, are common in the fall.

Control.-Wet conditions favor foliar infections. Sycamore in plantations may be protected by increasing the space between rows to ensure air movement. Landscape trees may be protected from initial infections by applying a contact fungicide when buds begin to swell and, again, 10 to 14 days later. Injections of systemic fungicides offer protection as well (fig. 22b). Disease resistant varieties should be planted if possible. There is no practical control for this disease in forests.

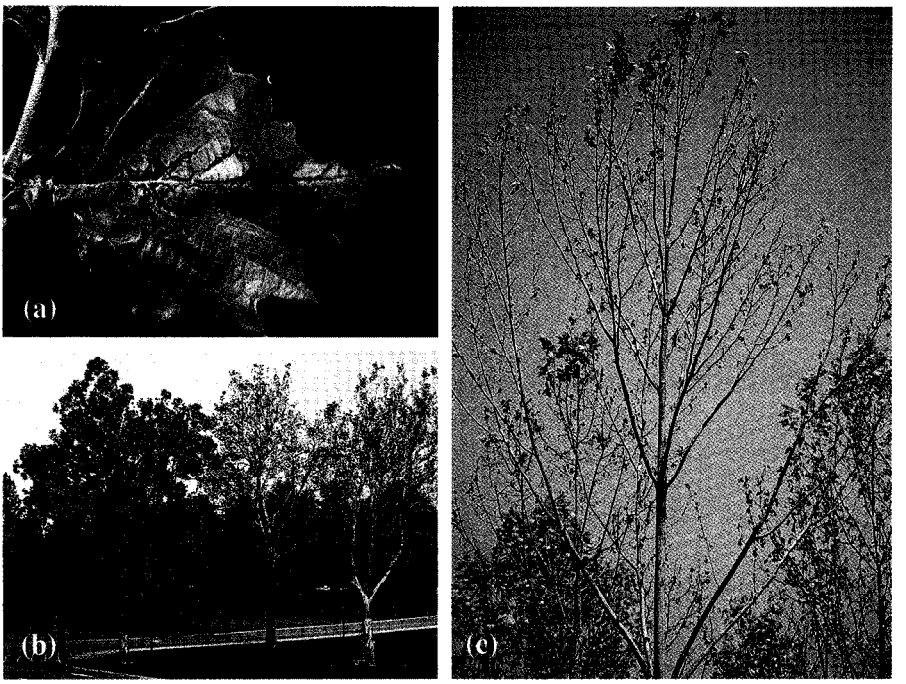


Figure 22-(a) Tan, necrotic patches along main veins of a leaf; (b) a systemic fungicide protected the sycamore on the left for 3 years compared to the two trees on the right; (c) severe defoliation from a heavy anthracnose infection.

Powdery Mildews, *Microsphaera penicillata* (Wallr.:Fr.) Lév. or *Phyllactinia guttata* (Wallr.:Fr.) Lév.

Importance.-Powdery mildews are common throughout the range of sycamore trees and are most damaging on younger, smaller trees in ornamental, nursery, or orchard settings. They do not cause significant damage in forests.

Identifying the Disease.-These fungi are named for the powdery white or, as they age, gray mycelia they produce on upper and lower leaf surfaces (fig. 23a). Infected leaves are often stunted, buckled, or cupped (fig. 23b). Mycelial mats may entirely cover young leaves or may occur as irregularly-shaped blotches (0.5 to several cm) on larger leaves.

Identifying the Fungi.-Young mycelial mats will have only the conidial stage of the fungus, which produces colorless spores. Older colonies may have spherical, brown-black cleistothecia (0.1 to 0.2 mm) with distinctive appendages that aid in identification. In warmer areas, cleistothecia may not form.

Biology-Initial infections are from spores that overwintered on fallen leaves or in buds. Infections begin on young shoots and expanding leaves but rarely on mature leaves. Conidia are spread on air currents and can germinate on dry plant surfaces. Disease buildup is favored by warm, dry days and cool nights.

Control.-Because powdery mildews grow superficially on leaves, they are easily controlled on ornamental trees with organic contact fungicides or sulfur dust. Disease occurrence may increase with activities that stimulate or prolong the occurrence of new growth; e.g., fertilizing and cultivating. Control in forests usually is not needed.

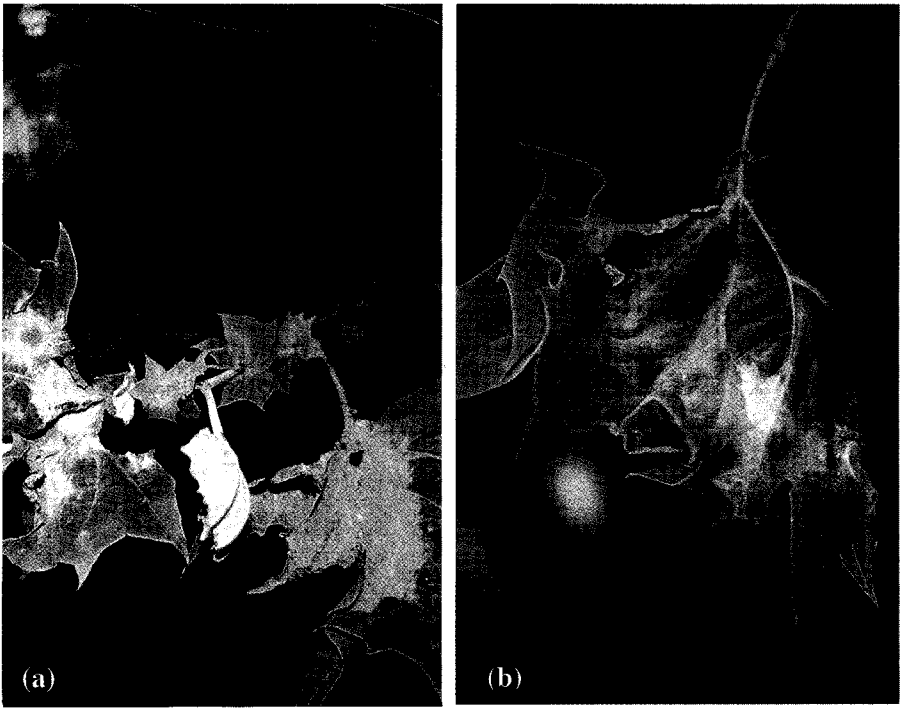


Figure 23-(a) White and gray mycelial mats of powdery mildew fungus on leaves in foreground; uninfected leaves in background; (b) leaf distortion and cupping caused by powdery mildew.

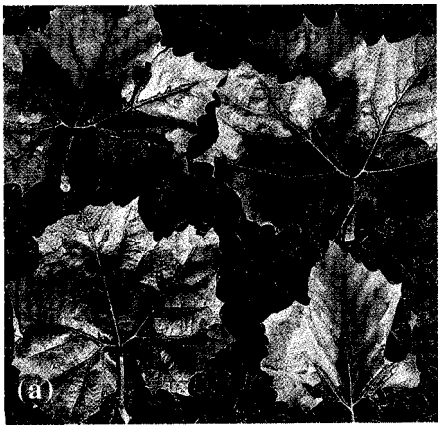
Importance.-Planted and wild sycamores are probably affected throughout the Southeast. Bacterial leaf scorch has been found in plantation sycamore in Virginia, Kentucky, Illinois, Georgia, North Carolina, South Carolina, and Alabama and in the wild in Mississippi, Louisiana, and Texas. The disease is becoming important as more is learned about its pathogenicity and distribution.

Identifying the Disease.-Olive-drab leaves appear in midsummer. Leaves later appear scorched as tissues along leaf margins and between veins turn brown (fig. 24a). Symptoms advance from older to younger leaves on a branch; scorched leaves curl upward and stay attached until fall (fig. 24b). Leaf scorch appears first on one branch, or a group of branches in one part of the crown, and moves through the crown in later years. Branch dieback may be worsened by secondary infections of such fungi as ***Botryosphaeria rhodina*** (p. 30). Bacterial leaf scorch may be mistaken for anthracnose (p. 22), which mainly affects young leaves during cool, wet periods. In some plantations, branch dieback, progressive decline (p. 26), and death occur within 5 to 7 years.

Identifying the Bacterium.—*Xylella* ***fastidiosa*** can be identified with a microscope. Otherwise, five to seven 2-cm-long sections of symptomatic leaf petioles, from three branches per suspect tree, can be submitted to a State cooperative extension lab for an ELISA test to determine if this bacterium is in the tissue.

Biology.-Xylella ***fastidiosa*** occurs only in xylem tissue where it blocks water conduction. The bacteria are transmitted from plant to plant by xylem sap-feeding insects such as treehoppers. Cold limits bacterial growth, but leaf scorch seems to be enhanced by hot, dry weather.

Control.-Xylella *fastidiosa* has a wide host range, which makes it hard to control directly by removing other hosts, or, indirectly, by trying to control insect vectors. Maintaining tree health by irrigating and fertilizing ornamental and plantation trees may delay disease onset and prolong the life of infected trees.



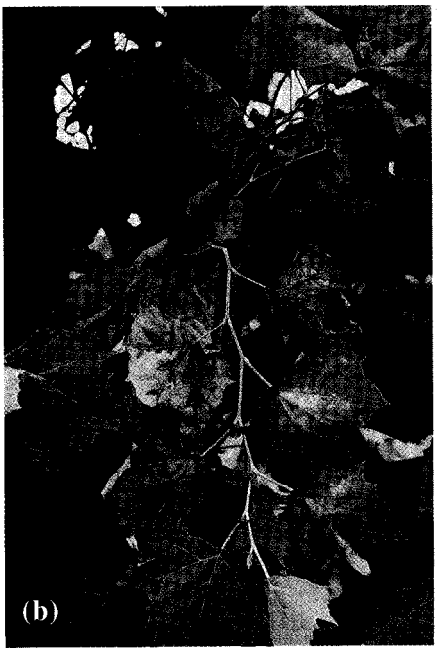


Figure 24-(a) Variation in leaf scorching caused by the leaf scorch bacterium; (b) leaves look scorched and cup upwards; older leaves are affected before younger leaves.

Minor Leaf Spots and Blights, *Mycosphaerella platanifolia* (Cooke) EA. Wolf, ***M. stigmina-platani*** EA. Wolf, ***Septoria platanifolia*** Cooke in Revenel, and ***Phloeospora multimaculans*** Heald & EA. Wolf

Importance.-Leaf-spotting fungi are generally of little importance to tree health. Severe infections that trigger early leaf abscission may have some effect on growth, but the main consequence is to the tree's appearance.

Identifying the Disease.—*Mycosphaerella platanifolia* and ***M. stigmina-platani*** leaf spots appear as unevenly round, tan spots (0.1 to 1 cm) with red-brown halos that may coalesce into larger, irregularly shaped lesions (fig. 25). Leaves infected by ***P. multimaculans*** develop unevenly round or angular, brown to purple spots ***(1*** to ***3*** mm). ***Septoria platanifolia*** produces brown, circular spots that later develop gray centers with dark halos. Spots typically develop on the upper surfaces of leaves. The lower surfaces of leaves infected by ***M. stigmina-platani*** may have a diffuse, sooty film.

Identifying the Fungi.-Ascospores of both ***Mycosphaerella*** species are two-celled. The conidia of the ***Cercospora*** or ***Stigmina stages*** are multiseptate. Pycnidia of ***P. multimaculans*** grow on the lower surfaces of leaves and produce colorless, cylindrical, slightly curved conidia with one to four' septations.

Biology.-Initial infections of ***Mycosphaerella,*** the sexual stage of the first two fungi, occur in early spring from spores produced in fruiting bodies on fallen leaves. Subsequent infections occur as asexual conidia from the ***Cercospora*** or ***Stigmina*** stages are moved by wind or rain splashing. Conidia of *S.* ***platanifolia*** and *P.* ***multimaculans*** are spread by wind and rain from pycnidia that form on the leaf spots.

Control.-Leaf spots typically do not warrant control on ornamental or forest trees because they are of minor consequence to tree health However, organic fungicides are sometimes used to control severe outbreaks.

Figure 25-Mycosphaerella leaf spots.

WILT, DECLINE, AND DIEBACK

Acremonium Wilt, *Acremonium (=Cephalosporium) diospyri* (Crandall) W. Gams

Fungus.-Initial infections by conidia likely occur through bark wounds made by insects, animals, or storms.

Injury-Brown leaves appear on one to several branches in spring. The disease develops progressively causing twig dieback, defoliation, and pale-yellow, stunted foliar regrowth (fig. 26). Acremonium wilt is favored by hot weather (≥ 30 °C). Wilted sycamores are susceptible to infection by *B. rhodina* (p. 30).

Control.-Acremonium wilt is mainly a problem in urban areas of east Texas. It has been controlled experimentally by spraying leaves and trunks with fungicides.

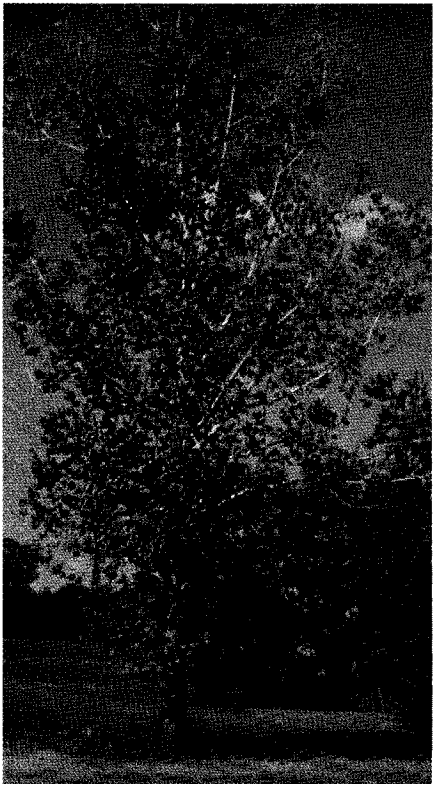


Figure 26—Sycamore tree with Acremonium wilt.

Sycamore Decline and Dieback, various causal agents

Importance.-Sycamore decline, sometimes called dieback, has been reported since the 1950's across the Southern United States. The recurrence of this problem has led some companies to curtail or halt commercial plantations.

Identifying the Disease.-Sycamore decline typically appears as foliar necrosis and branch dieback in tree crowns throughout a plantation (fig. 27a). Individual crown symptoms include sparse foliage, dead branches, and scorched leaves (fig. 27b, c). Similar symptoms can be caused by canker fungi such as C. *fimbriata f. platani* (p. 28), *B. rhodina* (p. 30), and *P. scabra* (p. 33), or the bacterium *X. fastidiosa* (p. 24), which often is associated with sycamore decline.

Identifying the Causal Agents.—The combination of environmental and biological agents contributing to sycamore decline may vary. Soil type, seed source, weather (temperature and precipitation extremes), time of planting, and plant culture can affect or trigger decline events. Specific pathogens and insects that attack declining trees are described elsewhere in this guide.

Biology.-Sycamore decline results from a combination of environmental and biological stresses and subsequent attacks by opportunistic pests. An abiotic factor, e.g., soil type or drought, will predispose a tree or stand of trees; and another abiotic or biotic factor, e.g., freezing temperatures or insect defoliation, will trigger a decline that results in mortality from various diseases and insects.

Control.-There is much to learn about sycamore decline. Planting clones with some disease resistance on sites that are well suited for sycamore and avoiding unnecessary wounding may be the best way to prevent sycamore decline.

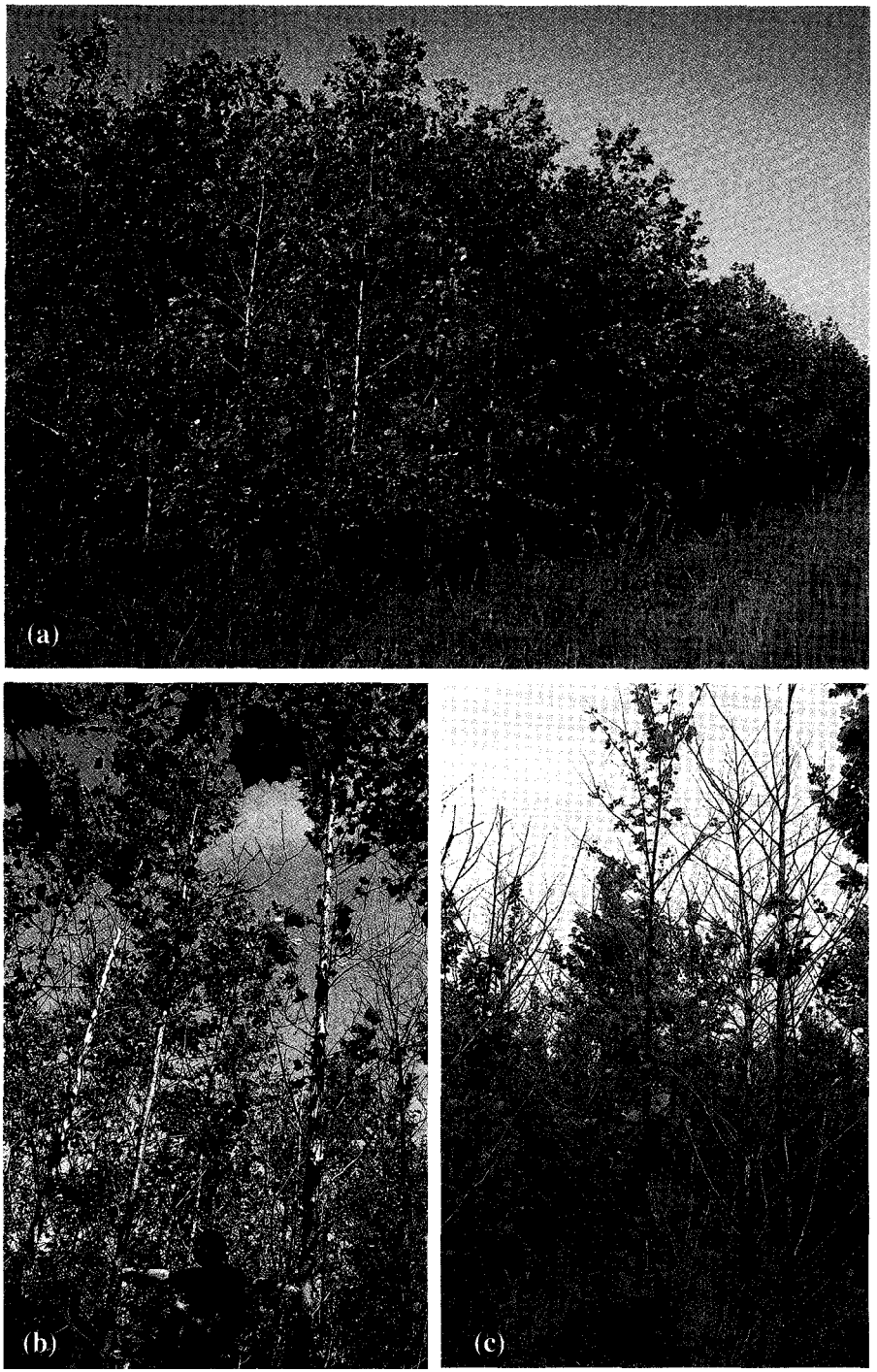


Figure 27-(a) Sycamore decline, expressed as leaf scorching, thin crowns, and branch dieback, in a S-year-old plantation in southern Alabama in August. *Xylella fastidiosa* and *Botryosphaeria* cankers were present in this stand; (b) Trees inside the stand in (a) showing branch dieback and sparsely foliated crowns; (c) dieback and epicormic branching in a 4-year-old plantation. Note the exposed, inactive canker, likely *Botryosphaeria*, on the tree at center.

CANKERS

Canker Stain, *Ceratocystis fimbriata* f. *platani* (Ellis & Halst.) J.M. Walter

Importance.-Canker stain is a deadly disease that occurs on sycamore and London planetree from New York to Georgia and west to Missouri. It poses a threat to natural stands and plantations throughout the South.

Identifying the Disease.-Canker stain is hard to detect early in its development, especially under older, scaly bark (fig. 28a). It may not be noticed until symptoms appear in the crown. Long, purplish-black, lens-shaped cankers form on stems and large branches. Cankers expand laterally about 9 cm per year and lengthen up to 3 m per year. Growth follows the wood grain, often resulting in a helical-shaped canker (fig. 28b). Phloem, cambium, and sapwood mortality cause parts of the crown to wilt suddenly and then die (fig. 28e). In the South, older cankers are often colonized by *L. theobromae* (p. 30).

Identifying the Fungus.-Conidia are produced on initial infection sites and in well-colonized tissue. Black perithecia with long (1 mm) necks produce hat-shaped ascospores. Diseased sapwood has brown-black, wedge-shaped staining that is evident in stem cross sections (fig. 28d).

Biology.-Both spore types are sticky and are spread by humans and insects. The fungus can infect even the smallest wound that exposes cambium or sapwood.

Control.-To prevent spreading canker stain to healthy trees, tools used to prune diseased landscape trees should be sprayed with a solution of rubbing alcohol and 50 percent laundry bleach. Wound dressings are of little value. Early detection and removal of diseased trees in plantations can reduce losses. "Sanitation cuts" of diseased stands should precede planting sycamore trees in adjacent areas.

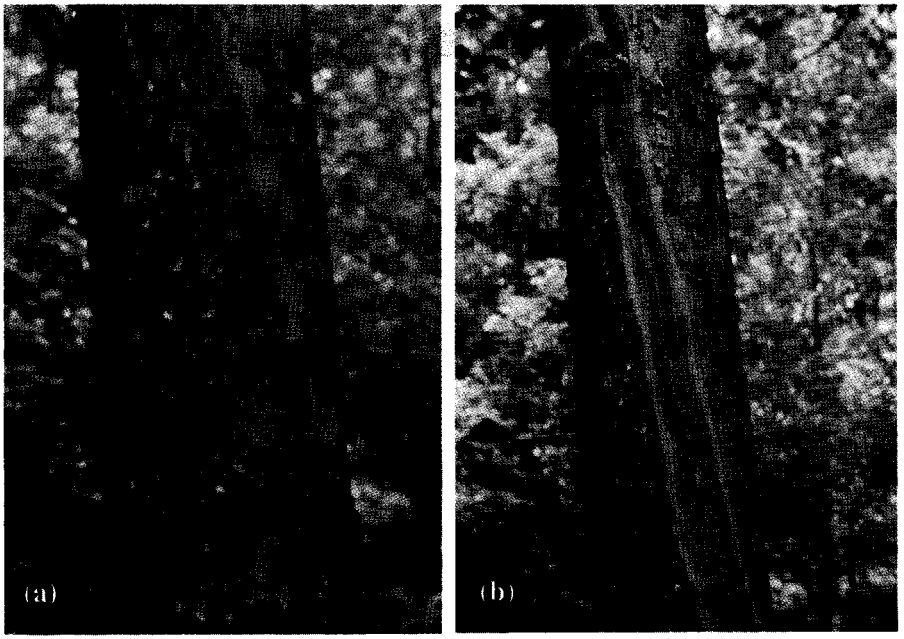


Figure 28-(a) Diagonal line from top center to lower right of bole defines right margin of a canker stain canker; (b) the same canker shown in (a) after removing the bark;

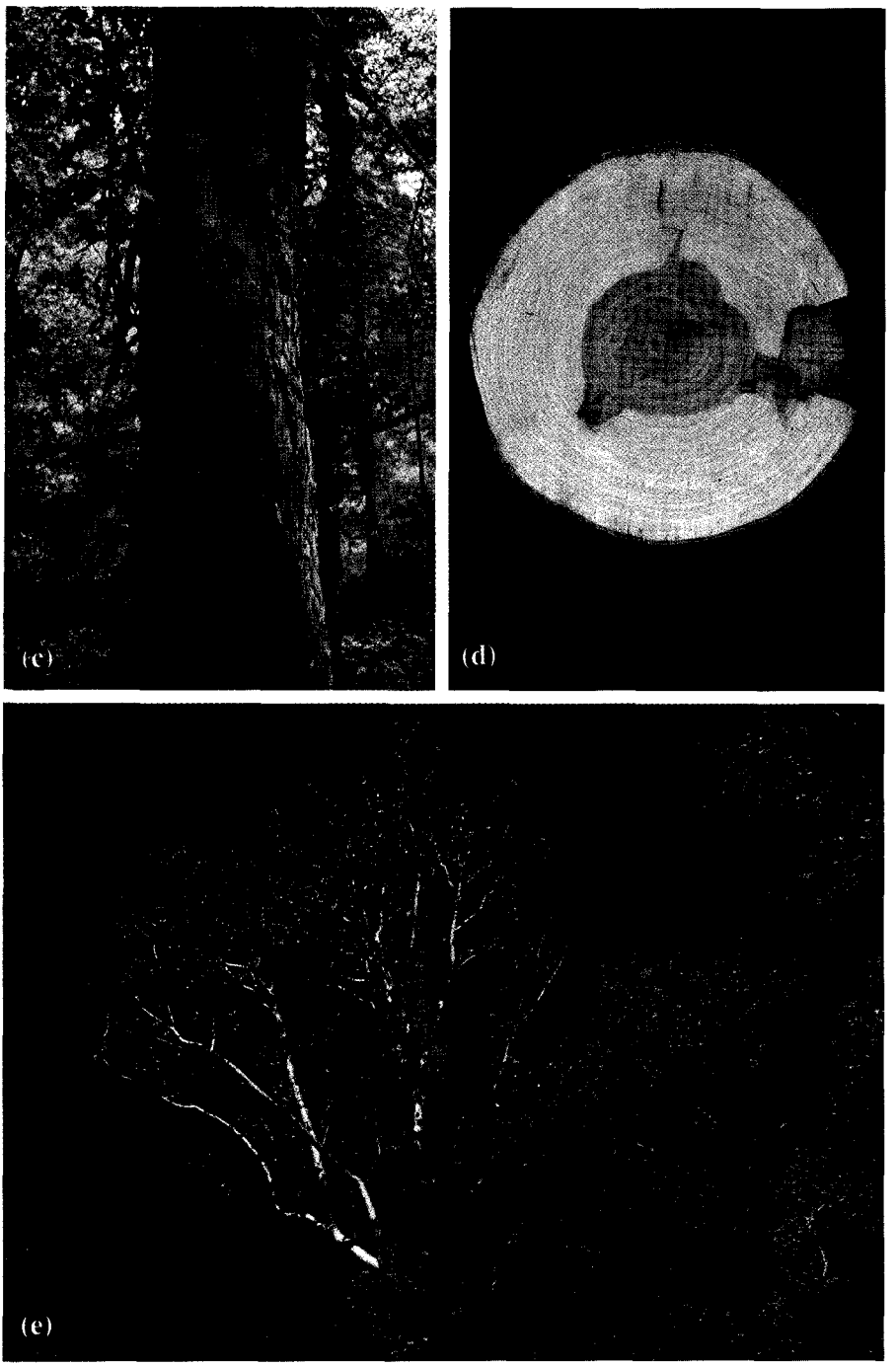


Figure 28 (continued)-(c) Canker stain canker several years old with decay and woodpecker holes; (d) wedge-shaped, dark staining extends from the dead cambium into the sapwood; (e) mature sycamore with crown dieback resulting from canker stain disease.

Botryosphaeria Canker, *Botryosphaeria rhodina* (Cooke) Arx

Importance.-This fungus attacks many species of woody and herbaceous plants worldwide. In ***the South, B. rhodina*** causes cankers, dieback, and mortality in natural stands and plantations.

Identifying the Disease.-Cankers, ranging in length from a few centimeters to several meters, form on twigs, branches, and main stems. Young and active cankers may be hard to see until sections of bark die revealing canker margins and fruiting bodies breaking through the bark (fig. 29a). Old, inactive cankers appear sunken and are typically surrounded by a callus ridge (fig. 29b). Dieback occurs above plant parts girdled by a canker.

Identifying the Fungus.-The asexual form of the fungus, *Lasiodiplodia* ***(=Botryodiplodia) theobromae*** (Pat.) Griffon & Maubl.) occurs more commonly than ***Botryosphaeria rhodina.*** Many black, pinpoint-sized pycnidia occur in groups, sometimes in rows, aligned with the wood grain. As the fungus advances in the sapwood, it causes a dark stain that can be seen beneath the bark and in cross sections of the stem.

Biology.-Conidia typically enter wounds made by cultivating, harvesting, or insects. Canker formation and disease development are enhanced by stress from drought, poor site conditions, or other diseases such as a wilt or canker stain (p. 28). Cankers grow faster, and seedlings are killed more quickly at warmer temperatures (30-35 "C).

Control.-Promoting tree vigor by planting sycamores on good sites and avoiding dry, sandy sites should reduce the incidence of ***Botryosphaeria*** cankers. Pruning ornamental sycamores and thinning or harvesting plantations (where regeneration is by coppice growth) should be done in the fall and winter (temperatures ≤ 20 °C) when the fungus is less active.

Figure 29-(a) Active *Botryosphaeria* canker on a sycamore stem; (b) inactive *Botryosphaeria* canker surrounded by callus on a sycamore stem.

Anthracnose-Twig Canker and Shoot Blight, *Apiognomonia (=Gnomonia) veneta* (Sacc. & Speg.) Höhn.

Importance.-Anthracnose is one of the most important diseases of sycamores and *Platanus* species worldwide. It occurs in sycamore trees throughout North America. Severe defoliation in consecutive years can weaken trees, making them susceptible to attacks from other agents and even causing death.

Identifying the Disease.-This fungus causes cankers on branches, blighting of twigs and shoots, and blighting of leaves (p. 22), which can, in some years, cause near total defoliation. Newly emerged leaves and young shoots are killed in early spring, often following cold weather, which causes the symptoms to be mistaken for frost damage (fig. 30a). Repeated shoot dieback can cause an angular branch pattern in older trees as shoots from lateral buds replace dead terminals. Cankers (3 to 8 cm long) form on small branches (fig. 30b), and those that do not girdle a branch in a year have callous ridges at the margins.

Identifying the Fungus.—Colorless, ascospores, which have two unequal cells, are released in spring from black perithecia on fallen leaves. Conidia are produced in small cups on dead leaves in spring and in small (0.5 to 0.9 mm) black pycnidia in the bark of twigs.

Biology.-Cankers form in the dormant season when temperatures are warm enough for fungal growth. Within 2 weeks after bud break, temperatures above 15 °C favor healthy shoot development, whereas temperatures below 12 °C slow shoot growth and favor the killing of shoots and twigs. The antbracnose fungus probably enters sycamore trees through their leaves; canker formation and shoot blight occur in subsequent years.

Control.-(See p. 22).

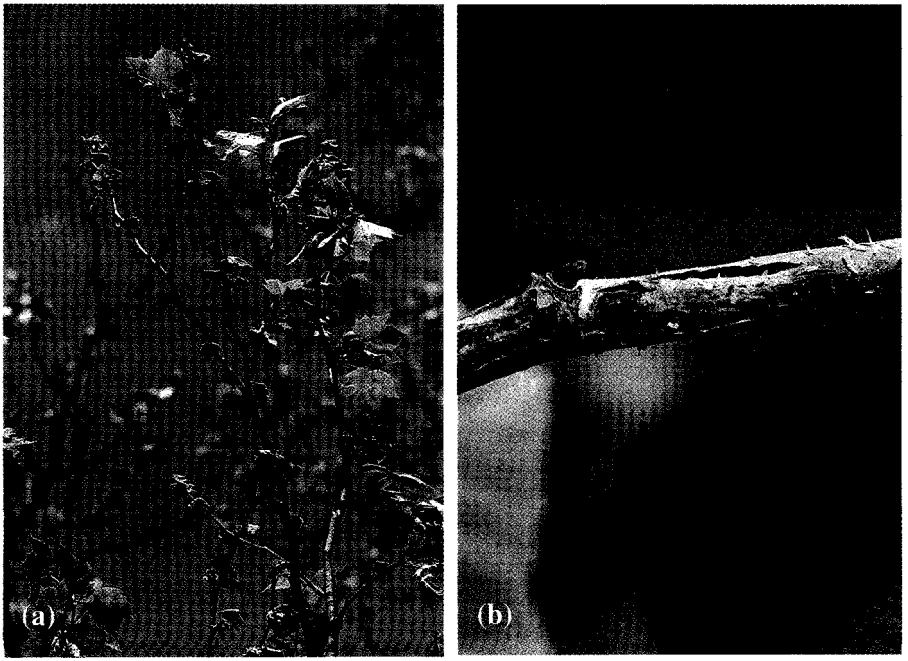


Figure 3&(a) Shoot blight, caused by sycamore anthracnose, can be mistaken for frost damage; (b) branch canker, with a callus ridge, from a sycamore anthracnose infection.

Hypoxylon Canker, *Hypoxylon tinctor* (Berk.) Cooke

Importance.-Hypoxylon *tinctor* is a fairly common saprophyte of dead sycamores and other hardwood species. The fungus occasionally produces cankers on live sycamores, taking advantage of trees in "decline" or under stress. In Georgia, it has been associated with cankers caused by the canker stain fungus *Ceratocystis fimbriata f. platani* (p. 28).

Identifying the Disease.-Irregularly defined, somewhat inconspicuous cankers tend to follow the wood grain, occurring mostly on the main stem and larger branches (fig. 31a). Older, decayed cankers may have holes from insect borers or woodpeckers (fig. 31b).

Identifying the Fungus.-The dark-brown to black fungal stromata (1 to 5 cm x 2 to 30 cm) may be evident through sloughing bark or may be partially concealed by bark (fig. 31c). Ascospores are produced in tiny cavities embedded in the hard surface of the stromata.

Biology.-The occurrence of *H. tinctor* seems to be associated with extensive thinning in natural stands, where other fungal pathogens and sun scald may be weakening trees. Infection by wind-blown or rain-splashed ascospores probably occurs through wounds in the bark.

Control.-H. *tinctor* apparently is less able to infect healthy, vigorously growing trees. Therefore, maintaining good tree vigor and minimizing bark wounds should prevent cankers caused by this fungus.

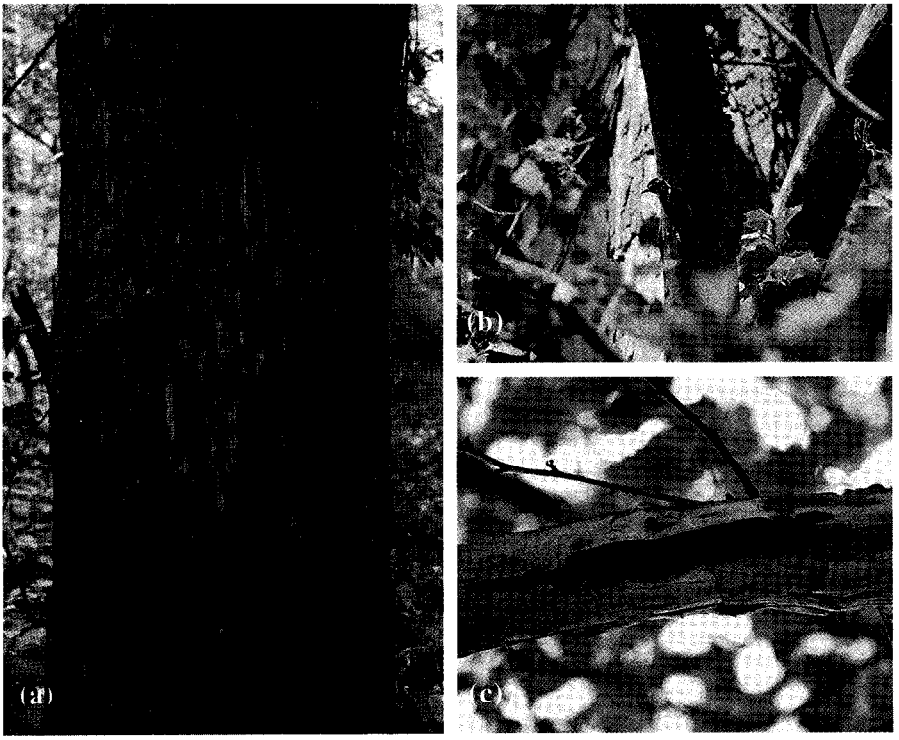


Figure 3 l-(a) ***Hypoxylon*** canker with bark removed to reveal fungal stromata; (b) dead, decaying limb showing dark fungal stromata and a woodpecker using the limb as a nesting site; (c) closeup of *H. tinctor* fungal stromata.

Miscellaneous Cankers, *Phomopsis scabra*, (Sacc.) Traverso; *Dothiorella* sp.

Importance.-These fungi cause cankers that are generally less of a problem than the canker fungi mentioned earlier in this guide. *Phomopsis scabra* and *Dothiorella* sp. can cause serious dieback and mortality when environmental conditions weaken the host.

Identifying the Disease.—*Phomopsis scabra* can cause cankers ranging from 10 cm to 1 m in length and may be mistaken for cankers caused by *Botryosphaeria rhodina* (p. 30). Cankers of both fungi are usually associated with dead buds, terminals, or lateral branches (fig. 32). At first, cankers may go undetected until the disease has progressed enough to cause small, off-color leaves, branch dieback, or tree death. Cankers will become dark and sunken after 1 to 2 growing seasons.

Identifying the Fungi.-Both fungi form spores in small, light-colored, flask-shaped fruiting bodies (usually pycnidia) formed on host tissue. *Phomopsis scabra* conidia are colorless, spindle-shaped, or slightly curved single cells. *Dothiorella* spores are colorless, one-celled, and oval.

Biology.-Phomopsis scabra cankers seem to develop readily at temperatures below 24 °C. *Growth* of *Dothiorella* cankers slows during the growing season allowing callus tissue to form. Spores of both fungi are spread by wind, rain, insects, and mechanical means. They enter through **wounds.**

Control.-Damage from these fungi can be reduced by preventing wounds and promoting tree vigor by planting on good sites.

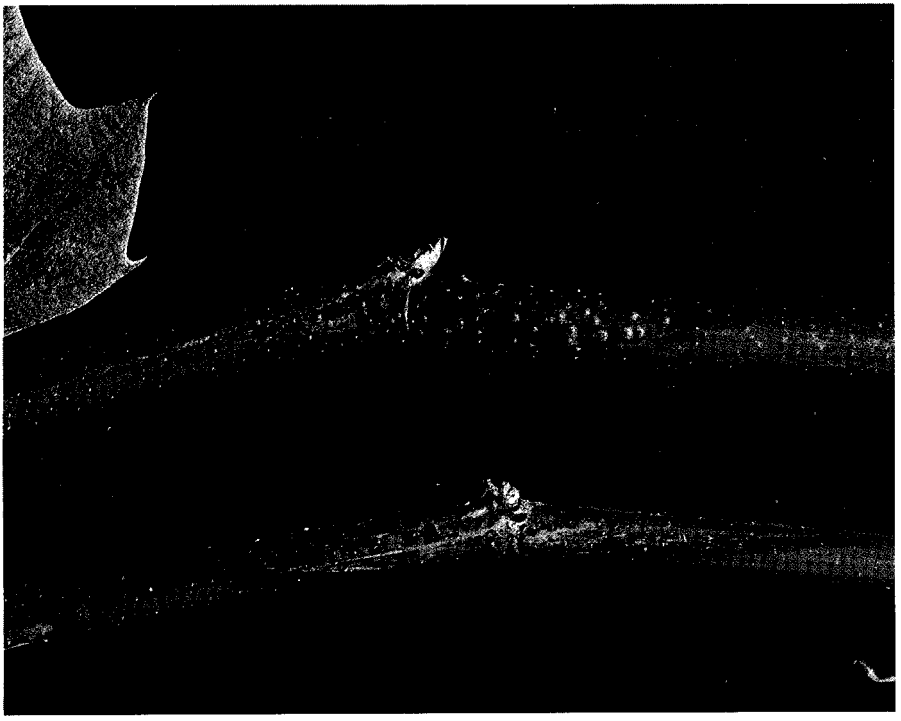


Figure 32—*Phomopsis* cankers on branches of a site-stressed sycamore.

ROOT AND BUTT ROTS

Armillaria Root Rot, *Armillaria tabescens* (Scop.) Dennis, Orton & Hora

Importance.-Armillaria root rot is one of the most common and damaging diseases of many hardwood forest and shade trees in North America. However, it occurs less often on sycamores than on other hardwood species.

Identifying the Disease.-Trees exhibit a loss of vigor and gradual decline, yellowing of foliage, growth reductions, premature leaf drop, and branch dieback. In severe cases, and, given enough time, *A. tabescens* can kill a tree.

Identifying the Fungus.-Following rains, clusters of *A. tabescens* may form at the base of diseased trees or from their roots. The mushroom is honey colored to brown, with white gills and a round cap that is 4 to 15 cm in diameter (fig. 33a). White, perforated fungal mats that form beneath the bark at the root collar, or on roots, are diagnostic (fig. 33b).

Biology.-The fungus survives as mycelium in the roots and stumps of dead trees from which it spreads to adjacent trees. Trees weakened by mechanical wounding or stressed by other pests are more susceptible to attack.

Control.-Prevention is difficult because the fungus is prevalent in woody debris in the soil and has a wide host range. Wounding of tree trunks or severing roots with cutting tools or heavy equipment should be avoided. Minimize stress to landscape and shade trees by promoting tree vigor through watering during periods of drought and fertilizing during the growing season. Roots and stumps of trees killed by *A. tabescens* should be removed to reduce sources of inoculum that could infect surrounding trees. Control other insect and disease pests that can reduce vigor and weaken resistance to infections.

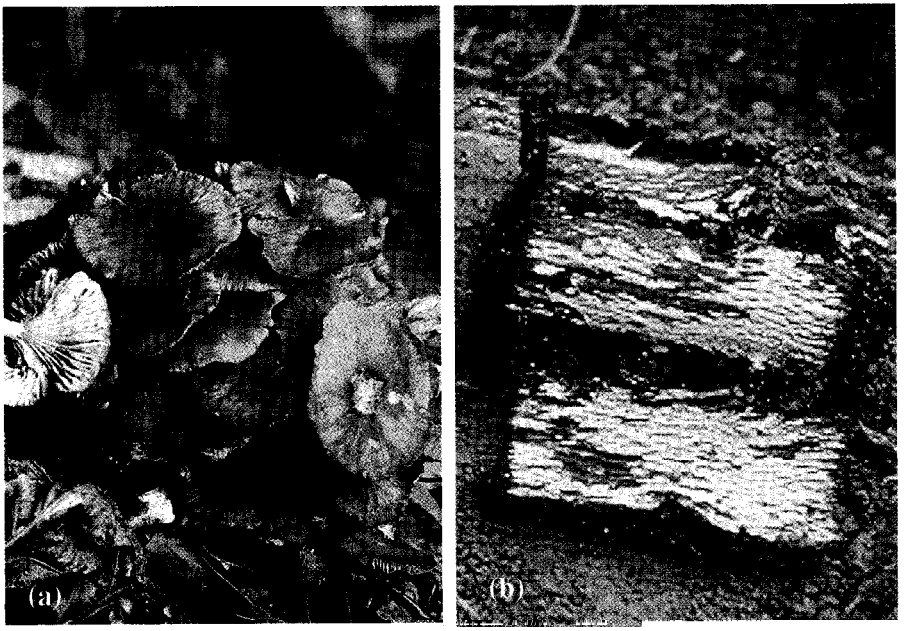


Figure 33-(a) Mushrooms and (b) mycelial mats of Armillaria tabescens.

Hericium Butt Rot, *Hericium erinaceus* (Pers.:Fr.) Murr.

Importance.-Hericium butt rot most commonly occurs in oaks, but it is also found in many other hardwoods throughout the Eastern United States, including sycamore, beech, birch, hickories, maples, and persimmon trees.

Identifying the Disease.-The fungus causes a white, soft, and spongy rot of heartwood in the butt and lower bole of the tree. Decayed wood eventually disintegrates leaving a cavity in the center of the tree. Because external cankers are not formed in the outer bark, no evidence of the disease is visible except for seasonal fruiting bodies.

Identifying the Fungus.-Large (up to 30 cm wide), soft, white, and fleshy fruiting bodies form on the boles of living trees, singly or in clusters, during the rainy autumn and winter months. They are initially round and smooth on all surfaces, but develop long, pendant "teeth" on the lower surface and gradually turn yellowish with age (fig. 34).

Biology-Spores of the fungus, released from fruiting bodies on infected trees, germinate and infect trees through fire or logging scars, stem cracks, and branch stubs near tree bases. Fruiting bodies form after extensive decay of the heartwood has occurred.

Control.-Hericium butt rot is best controlled when thinning stands by preventing wounds and broken branches on residual trees caused by logging equipment, skidding logs, and falling trees. Preventing fire scars is also suggested.

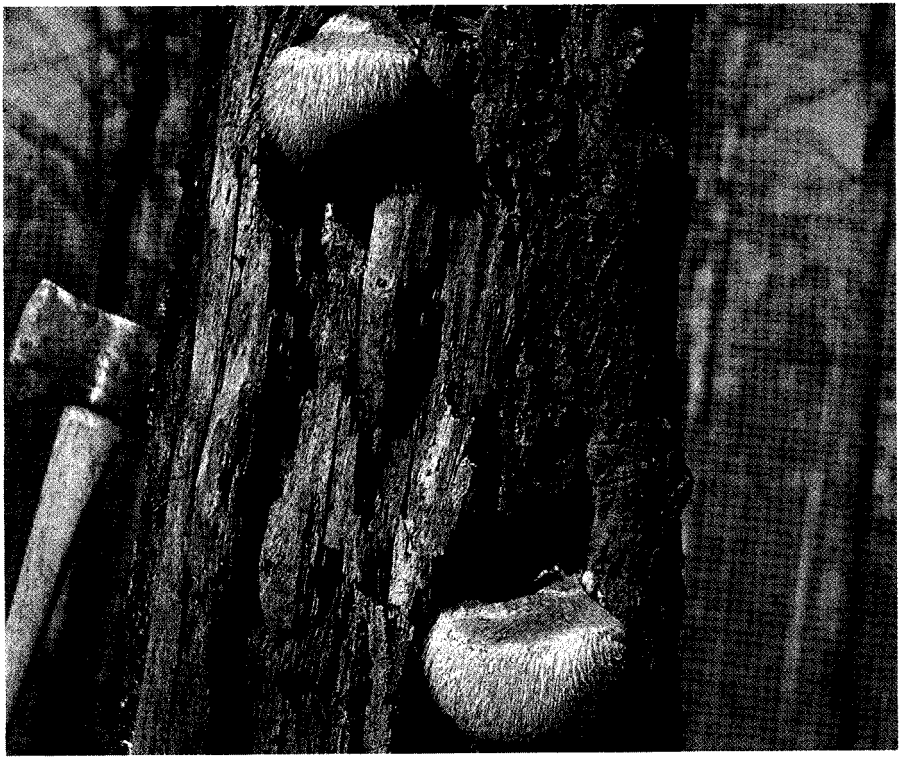


Figure 34—Fruiting bodies of ***Hericium erinaceus*** on a fire-scarred sycamore.

Oxyporus Root Rot, *Oxyporus latemarginatus* (Durieu & Mont.) Donk

Importance.-Oxyporus root rot causes decay of roots and root collars in sycamore, cottonwood, and many other hardwoods in the South.

Identifying the Disease.-Few diagnostic symptoms are known for this disease. Young trees exhibit reduced annual growth, stunting, and high mortality, whereas older trees often survive several years. The fungus causes a spongy white rot of the sapwood and enlarged cankers on the outer bark.

Identifying the Fungus.-The fungus invades the sapwood of roots as well as the wood behind fire scars in the lower bole, forming white mycelial mats and dirty white to pale yellow fruiting bodies at the soil line of dying or recently killed trees. The fruiting bodies are active for one season (fig. 35). Soil around diseased roots and the root collar may become infested, forming a white crust of mycelial strands on the soil surface at the stem base.

Biology.-Oxyporus *latemarginatus* colonizes and survives on dead wood or roots in the soil from which it invades small feeder roots of healthy trees. It then spreads to the root collar, colonizing the outer and inner bark, cambium, and sapwood.

Control.-Trees are predisposed to attack during warm weather, especially when the soil is waterlogged, or when feeder roots are wounded mechanically or by fire. The disease can be managed by preventing fiie and mechanical wounding to roots and the lower trunk and by maintaining adequate soil drainage. Tree vigor should be maintained by watering, fertilizing, and controlling weeds. If possible, soil with infested dead wood should be removed.

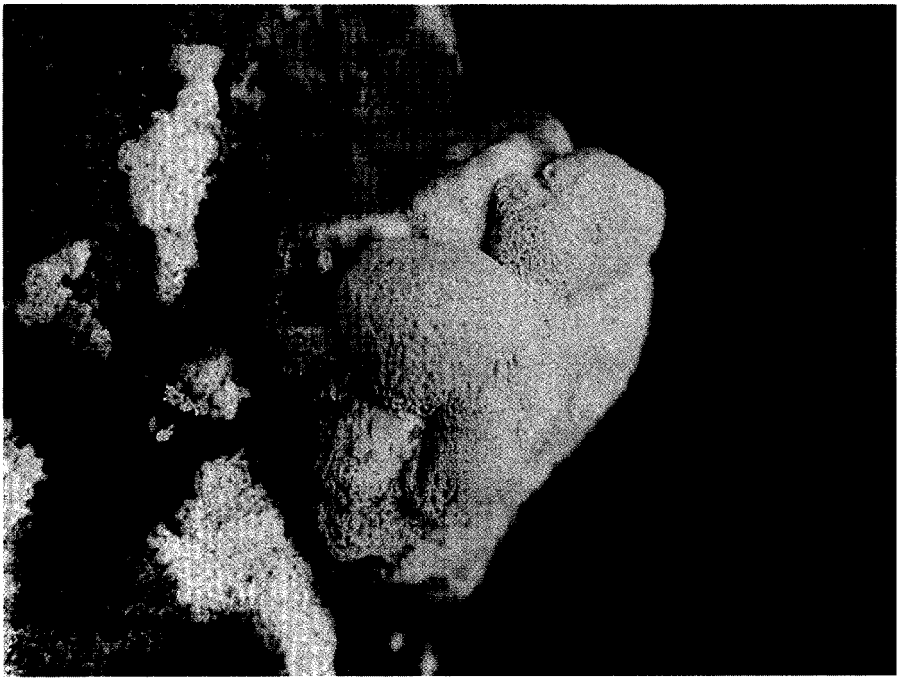


Figure 35-Fruiting body of *Oxyporus latemarginatus* on a young sycamore stem.

Ganoderma Butt Rot, *Ganoderma lucidum* (Curtis:Fr.) P. Karst.

Importance.-This fungus is one of the most commonly observed causes of butt rot in southern hardwoods. A true pathogen, it is often responsible for premature death of residential and landscape trees. It can kill large trees and frequently causes decay in declining trees.

Identifying the Disease.—***Ganoderma lucidum*** causes a white, spongy soft rot of sapwood and heartwood in the roots and lower bole. Diseased trees eventually lose vigor, bear undersized leaves and dead branches, and sometimes have wilted or yellow leaves. However, fruiting bodies may form at or near the ground on apparently healthy trees.

Identifying the Fungus.-The upper surface of ***G. lucidum's*** large, reddish-brown fruiting bodies usually has a shiny, varnished look and a leathery texture (fig. 36a). The fruiting bodies may form singly or in overlapping clusters at ground level or on the lower bole of sycamores. The margins are white, becoming a tawny yellow with age. The lower surface of a fruiting body has pores. Brown spores released from fruiting bodies often form a dustlike coating on grass, bark, or the fruiting bodies themselves.

Biology.-Ganoderma lucidum infects trees through wounds on roots or the lower bole caused by tools, lawn mowers, and falling trees or limbs. The decay's lethal effects occur when living cells in the sapwood are killed. A decay column may form for many years before sufficient damage causes visible symptoms in the crown. Fruiting bodies eventually form and may occur repeatedly during the summer months. Living trees with decay in the roots or lower bole are subject to windthrow (fig. 36b).

Control.-This disease is best controlled by preventing mechanical wounds to the lower bole and roots. Care should be taken not to injure landscape trees, especially when using heavy equipment to clear land when preparing sites for home building.

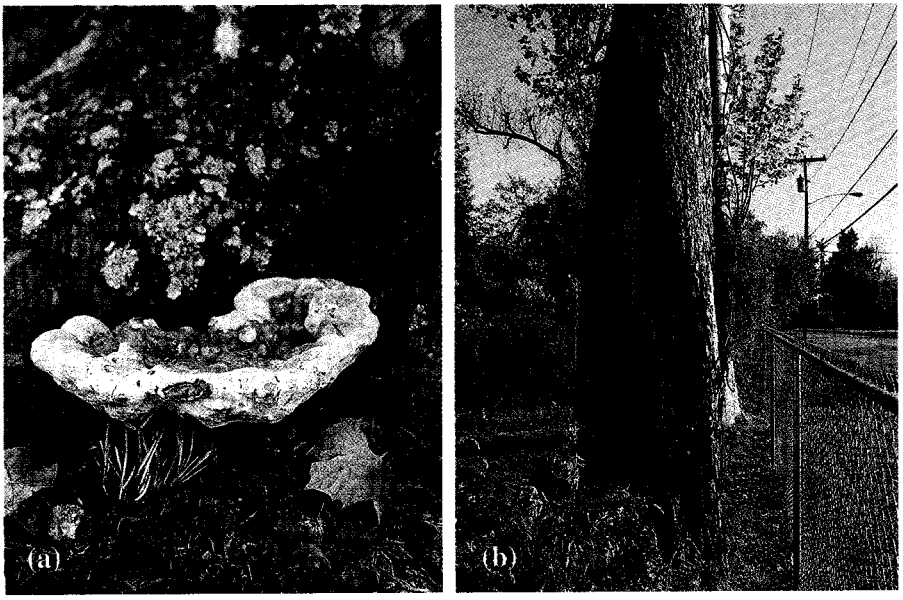


Figure 36—(a) Note the glossy, red-brown top and stalk of this G. *lucidum* fruiting body; (b) advanced decay in this canker, along with insect and bird damage, poses a hazard.

Scytinostroma Root Rot, *Scytinostroma (=Corticium) galactinum* (Fr.) Donk

Importance.-Seedlings of sycamore and other southern hardwoods such as sweetgum, white oak, and nuttall oak are very susceptible to Scytinostroma root rot. The pathogen may kill young seedlings within a month to a year after infection. Fortunately, the disease is not common in southern sycamores.

Identifying the Disease.-The fungus causes a white rot of roots in the collar and lateral roots of the taproot. Lateral roots may decay and, in severe cases, separate from the taproot. Infected seedlings may be dwarfed, have thin crowns, yellowing or dead leaves, and exhibit reduced vigor or decline prior to death. Dead leaves usually remain on the plant after death.

Identifying the Fungus.—*Scytinostroma galactinum* produces thick, white fungal mats on the surfaces of the root collar and roots below the collar (fig. 37). Fungal mats are visible below the soil line when soil is removed from the base of a tree. Fruiting bodies of this fungus are very small and inconspicuous, forming from fungal mats on the roots and root collar.

Biology.-Scytinostroma galactinum infects trees through wounds at the root collars of seedlings. Lateral and feeder roots often are killed. The fungus can then survive on dead roots and stumps and spread to living roots. Spores from fruiting bodies also may produce hyphae that infect seedlings.

Control.-Sycamore seedlings and saplings are most susceptible to this disease. Care should be taken to prevent the mechanical wounding of the root collar and lateral roots of seedlings. Removal of diseased seedlings will help minimize the fungus' spread to healthy seedlings, but no controls are feasible in natural stands.

Figure 37—White mycelial mats on roots and root collars of young sycamore (top) and cottonwood (bottom) trees.

PARASITIC PLANTS

Mistletoe, spp.

Importance.-Extensive infections and mortality are not common in sycamore trees. Infections usually occur in openly grown trees. ***Phoradendron*** plants are commonly used as greenery in Christmas decorations.

Identifying the Injury.-An affected branch may have a gall or swelling at the site of infection, and multiple infections may retard growth. Stunting and dieback may occur beyond where the mistletoe plant is attached to its host.

Identifying the Parasite.-Mistletoe has stout, woody, green stems and dark-green, leathery leaves (fig. 38a). It is seen most easily in winter growing on scaffold and minor branches and twigs of the host (fig. 38b). The plant has opposite branching, inconspicuous flowers, and produces white berries in the fall and winter.

Biology.-Mistletoe is a **perennial** evergreen plant that grows on tree branches from which it draws water and nutrients. Its seeds are covered with a sticky, gelatinous coating and are spread by birds and animals. Seeds germinate where they lodge on young branches, and a rootlike structure penetrates the branch and produces a mistletoe plant. One species, *P. serotinum,* affects many broadleaf tree species in the South and East but is limited by temperature in its northern range (Kansas to New Jersey). Several other species of ***Phoradendron*** occur in the West.

Control.-Control of mistletoe in sycamores is normally not needed but can be done by cutting the host branch at least 30 cm below the point of infection.

Figure 38-(a) Closeup of a mistletoe plant; (b) mistletoe infections in a mature sycamore.

AIR POLLUTION AND CHEMICAL INJURIES

Air-Pollution Injury

Sycamore trees are sensitive to ozone, sulfur dioxide, and fluorides, which are released from point-source industrial plants. Consequently, injuries from airborne pollutants often occur near these plants. Airborne pollutants may also cause damage to trees for some distance downwind of the source. Pollutants damage plant foliage by oxidative processes that interrupt normal physiology. Symptoms include stippling, interveinal and marginal chlorosis, and general bleaching of leaves (fig. 39a). Reducing point-source emissions is the only known control. Drought stress (fig. 39b) and some pathogens (e.g., p. 24), can cause leaf symptoms that may be mistaken for air-pollution injury.

Chemical Injury

Sycamore trees are sensitive to several agricultural pesticides, including herbicides and fungicides that are commonly used to control pests in field crops. Clomazone and phenoxy compounds like 2,4-D, are examples of herbicides that can cause chemical injuries when they drift during aerial applications. At higher concentrations, these materials produce symptoms of leaf distortion, curling, and chlorosis (fig. 39c, d). Solvent carriers in fungicide sprays can damage sycamores. Damage from pesticide spray drift can be avoided by carefully planning applications and spraying during periods of low wind.

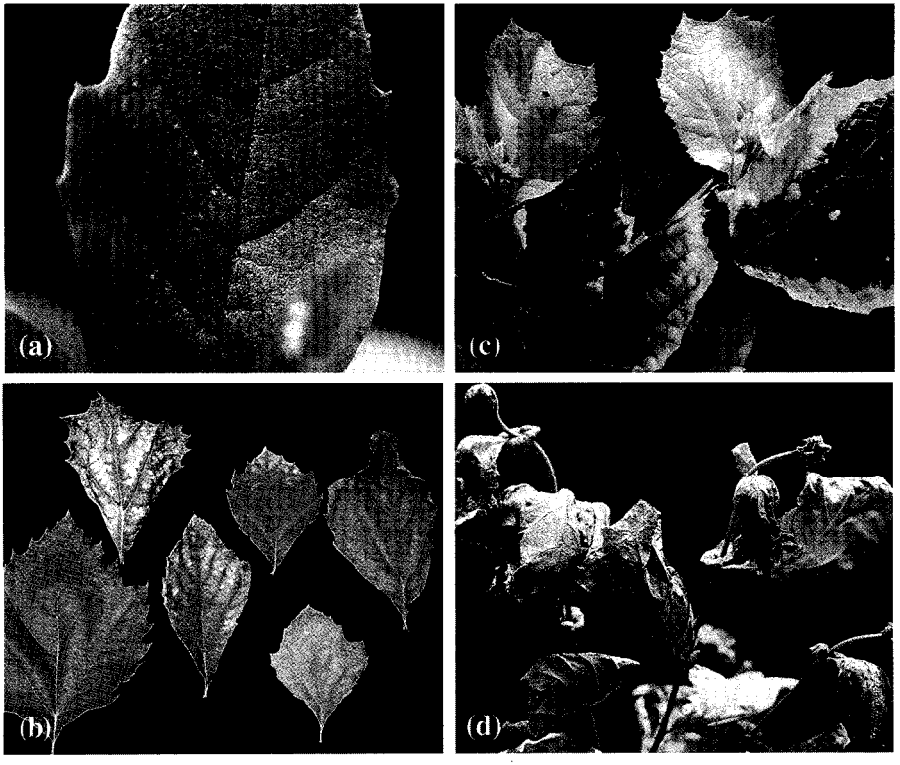


Figure 39-(a) Tan flecking caused by ozone injury; (b) interveinal necrosis from drought stress; (c) bleaching of leaves caused by the herbicide clomazone; (d) cupping, curling, and necrosis of leaves caused by the herbicide 2,4-D.

MAINTAINING TREE HEALTH

Because healthy trees are less susceptible to attack and injury by insects and diseases, sycamore plantings should be managed to optimize vigor. Seedlings and saplings that become stressed when planted "off site" or on marginal sites, and become further weakened by drought or other factors, are sometimes devastated by disease. The following cultural practices, singly or in combination, are suggested to promote and maintain good tree health in forest stands, plantations, nurseries, shelterbelts, and ornamental plantings:

1. Plant sycamore in deep, well-drained, loamy soils with a good supply of ground water such as alluvial soils, terrace soils, and fertile sites in coves and lower slopes. Site selection is the single most important factor in maintaining tree health and minimizing losses from diseases and insects.

2. Where possible, avoid planting sycamores on abandoned old-field sites with well-developed, impermeable hardpans, especially those that have been badly eroded and leached.

3. Use only vigorous planting stock (of adequate size and free of root and stem diseases) produced in nurseries that strictly follow recommended practices for growing, lifting, storing, and handling seedlings and cuttings.

4. When it is available, use planting stock from improved selections grown in sycamore seed orchards or from a locally adapted seed source. (Some research has shown that plants from seed sources north of a planting site are more severely damaged by certain canker diseases than those from seed sources south of the planting site.)

5. Ensure that trees receive sufficient water, nutrients, and sunlight through irrigation, fertilization, proper spacing, and other intermediate stand-management practices, such as timely thinning and crop-tree release cutting.

6. Use sanitation practices such as pruning, removing dead and symptomatic branches, and raking, discing under, or removing diseased and insect-infested leaves. Such practices reduce buildup of overwintering fungal inoculum and hibernating insects in plant debris that can cause new pest problems the following year.

7. Prevent or minimize injuries by harvesting and cultivation equipment, fire, or other sources that can create entry points for canker fungi, wood-decay fungi, and insect borers.

8. If pruning must be done, schedule it for the dormant season when fungi are inactive and less likely to colonize fresh wound sites. Always sterilize pruning tools with a solution of 50 percent laundry bleach and water before moving to the next tree.

9. Losses from canker diseases may be reduced substantially by early detection and shortened cutting cycles. However, when a shorter cutting cycle is not possible, cankered trees should be felled and destroyed or removed to minimize disease spread. Sanitation cuts of unmerchantable stands containing canker diseases are recommended when adjacent sites are to be planted in sycamore.

10. Managers should learn to identify serious diseases such as canker stain. Identification errors can result in premature and unneeded salvage harvest or failure to harvest trees that will die or be-

come unmerchantable before the next cutting cycle.

11. Strictly follow label guidelines when using herbicides around ornamental plantings and shade trees as well as in nurseries and young plantations. Adequately shield young trees from direct contact or spray drift. When used improperly, herbicides can injure young sycamore trees.

12. Examine plantings regularly for disease symptoms and the first signs of insect feeding. Early detection will allow for the greatest number of pest-management options.

13. Insect pheromones and traps are available commercially for monitoring a number of species. Determining local, seasonal abundance can help establish the need for control and proper timing of insecticide application.

14. For information on pesticides or additional assistance with sycamore pests, contact your State Forester, county extension agent, or the nearest office of the USDA Forest Service, State and Private Forestry, Forest Health Protection.

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GLOSSARY

acervulus(-i): a saucer-shaped fungal structure embedded in host tissue in which conidia form.

ascocarps: the sexual fruiting bodies of Ascomycetes.

Ascomycetes: a large group of fungi characterized by producing spores in a sac-like structure (ascus).

ascospores: sexual spores of Ascomycetes.

basidiocarps: the sexual fruiting bodies of Basidiomycetes.

Basidiomycetes: a large group of fungi characterized by producing spores on a club-like structure (basidium).

basidiospores: sexual spores of Basidiomycetes.

bole: the main trunk of a tree.

butt: the lower bole of the main stem.

callus: a protective tissue that forms to cover wounds on stems and branches.

cambium: a thin layer of meristematic cells between the bark and wood.

cankers: a definite localized necrotic lesion of the bark and cambium.

cleistothecium(-ia): roundish ascocarps of powdery mildews, typically with appendages, in which ascospores form.

conidium(-ia): an asexual fungal spore.

damping-off: a disease of seedlings that causes rotting of the hypocotyl and prevents shoot emergence, or causes a new shoot to fall over.

dieback: the gradual dying of a tree crown usually from the top down and from the outside in.

ELISA test: enzyme-linked immunosorbent assay; a test that detects a specific molecule, usually a protein, consistently associated with a certain organism.

elytron (a): hard leathery forewing of beetles.

frass: wood fragments mixed with excrement produced by insect larvae.

hair pencil: tuft of long upright parallel setae (hairs).

hypha(-e): a fungal filament.

inoculum(-a): the spores, mycelium, or other propagules of a pathogen that initially infect a host.

microsclerotium(-ia): a firm, often rounded, compact mass of fungal hyphae that are packed together to form a resistant structure.

mycelium(-ia): a collection of hyphae that make up a fungus body.

necrotic: composed of dead cells.

perithecium(-ia): flask-shaped ascocarps in which ascospores are formed.

saprophytic: the ability to grow on dead plant tissue.

sapwood: the outer, water-conducting wood of the tree stem.

sporodochium(-ia): a cushion-shaped stroma covered with conidiophores.

stroma(-mata): a mass or mat of hyphae in or on which fruiting bodies form.

Leininger, T.D.; Solomon, J.D.; Wilson, A.D.; Schiff, N.M. 1999. A Guide to major insects, diseases, air pollution injury, and chemical it-jury of sycamore. Gen. Tech. Rep. SRS 28. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 44 p.

This booklet will help nurserymen, forest woodland managers, pest control operators, and homeowners to identify and control pest problems on sycamore trees. The major insect and disease pests of sycamores in the Eastern United States are emphasized. Descriptions and illustrations of the pests and the damage they cause are provided to aid in identification. Brief notes are given on biology and control to aid in predicting damage and making control decisions.

Keywords: Bacteria, biology, borers, control, defoliators, fungi, identification,

The Forest Service, United States Department of Agriculture (USDA), is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives—as directed by Congress—to provide increasingly greater service to a growing Nation.