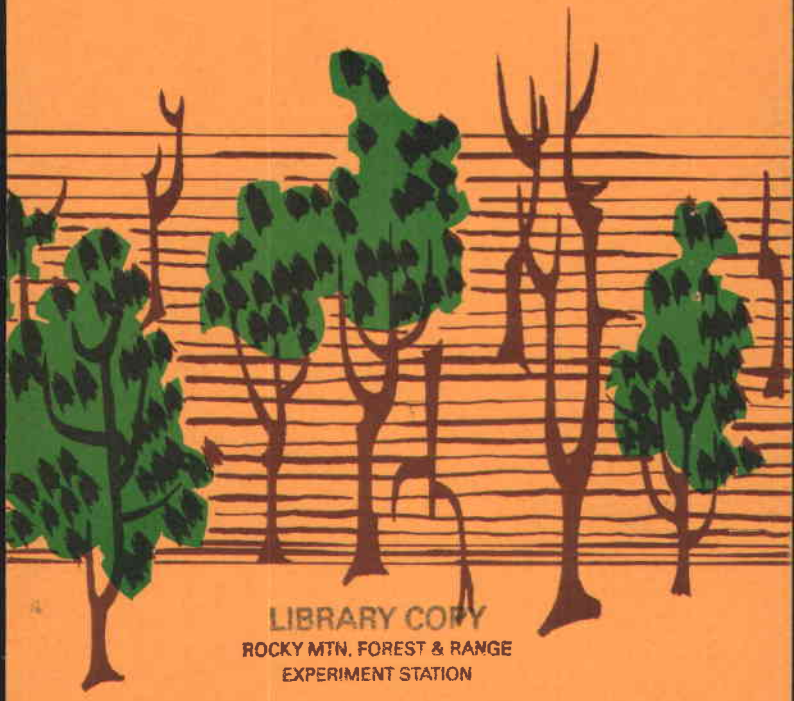
U.S. Department of Agriculture
Forest Service General Technical Report SO-8

INSECTS and DISEASES of COTTONWOOD



Southern Forest Experiment Station
and
Southeastern Area, State and Private Forestry
Forest Service, U.S. Department of Agriculture
1975

U. S. Department of Agriculture
Forest Service General Technical Report SO-8

Insects and Diseases of Cottonwood

R. C. Morris
T. H. Filer
J. D. Solomon
F. I. McCracken
N. A. Overgaard
M. J. Weiss

Southern Forest Experiment Station
and
Southeastern Area, State and Private Forestry
Forest Service, U. S. Department of Agriculture

1975

INSECTS

DISEASES

INSECTS AND DISEASES OF COTTONWOOD

R. C. Morris, T. H. Filer, J. D. Solomon,
F. I. McCracken, N. A. Overgaard, and M. J. Weiss [1]

Insects and disease organisms are a continuing threat to cottonwood (*Populus deltoides* Bartr.), especially during the tree's first 5 years. The danger is intensified in large plantings of a single species and age because rapid buildup of damaging agents can occur. This booklet will help forest nurserymen and plantation managers identify and control pest problems. The major insects and diseases are illustrated; and information on their importance, signs of infestation, biology, and natural control is presented. Brief mention is made of other pests which may be of local or sporadic concern.

A list of registered chemical controls is also provided. This list is subject to change as new materials are approved, and revisions will be made available at periodic intervals.

For further information, contact your State forester, county agent, or the nearest office of State and Private Forestry, U. S. Forest Service.

[1] Morris, Filer, Solomon, and McCracken are stationed at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station in cooperation with the Mississippi Agricultural and Forestry Experiment Station and the Southern Hardwood Forest Research Group. Overgaard and Weiss are members of the Forest Pest Management Group, Southeastern Area, State and Private Forestry.

COTTONWOOD LEAF BEETLE

Chrysomela scripta F.

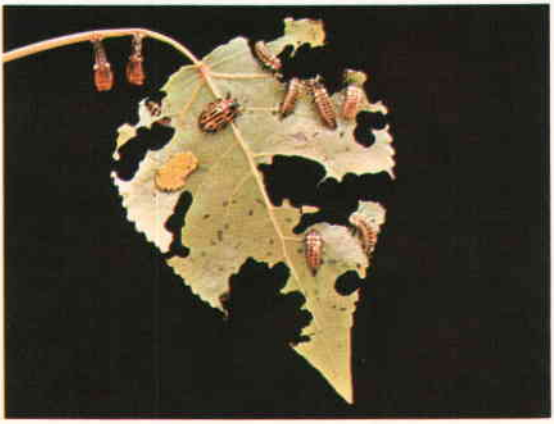
The cottonwood leaf beetle is one of the most serious pests of young trees in nurseries and plantations and occasionally causes severe damage in natural stands. In the nursery, the insect stunts height growth and reduces the yield of cuttings. First- and second-year plantations are weakened by early defoliation and may be overtopped by weeds. Continuing partial defoliation through the summer reduces tree growth and vigor. Serious damage occurs at the end of the growing season, when heavy populations feed on terminal tissues and buds, killing as much as 10 inches (25 cm) of the terminals. Lateral buds sprout below the injured terminals, and branches may grow above the dead terminal even before the season ends. These branches grow rapidly the next year, resulting in multiple-forked tops that have little potential for the production of quality wood for logs and pulpwood.

Often the sudden appearance of ragged foliage near branch ends and terminals of young cottonwoods will announce a leaf beetle attack. Some leaves will have brown patches where young larvae ate the green tissues. On other leaves, only the veins and midrib will remain. Heavy damage results in dead, black terminals from which the leaves and tissues are eaten. Other signs of the leaf beetle are black droppings on leaves and the unmistak-

Terminal killed by cottonwood leaf beetle.

able, pungent odor the larvae release when disturbed.

Adult beetles are oval, yellow, and about ¼ inch (6 mm) long with slender black markings on their wing covers. Egg clusters are bright yellow, and newly hatched larvae are black. As they develop, they turn brown, and prominent white scent gland spots appear along their sides.



Cottonwood leaf beetles.

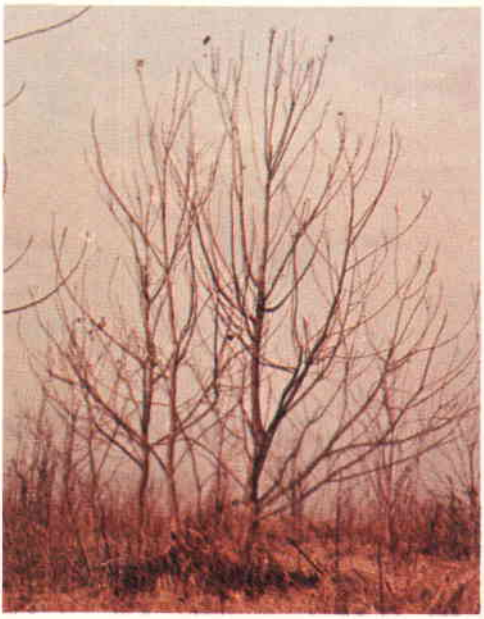
Adults spend the winter under fallen leaf debris or in clumps of weeds. In early spring they emerge and feed on unfolding leaves or on tender bark at the tips of twigs. The female lays a cluster of 15 to 75 eggs on the undersides of leaves. The newly hatched larvae feed side by side and skeletonize the leaves. Older larvae feed separately and consume the entire leaf except for the larger veins. At maturity they attach themselves to leaves, bark, or to weeds and grass beneath the trees to pupate. In 5 to 10 days they emerge as adult beetles. There are several generations per year, each lasting about 35 days.

The spring generation of the leaf beetle may be greatly reduced by the red lady beetle *Coleomagilla maculata,* which feeds on the eggs and pupae. However, as the season progresses, the ladybugs disperse to feed on aphids and other prey and do not affect later broods of leaf beetles. Several predaceous bugs feed on leaf beetle larvae, and a parasitic wasp also attacks them. Effective chemical controls are available.

COTTONWOOD TWIG BORER
Gypsonoma haimbachiana Kft.

The cottonwood twig borer, one of the most destructive insects of young trees, occurs throughout the host species' range from Ontario to the Gulf of Mexico and west to the Great Plains. Larval feeding in the terminal tissues prevents normal elongation and may kill the growing tip. The stunted terminals are rapidly overtopped by vigorous, undamaged laterals, resulting in a tree top with two to six forks. Later, one fork may assert dominance and become a new terminal, but a crook usually develops where the new terminal originates. Heavily damaged trees may be stag-headed bushes of little value.

Stunted terminals and short brown tubes of silk and borings near leaf bases indicate twig borer damage. Lateral branches overtop the terminal, which persists as a short stub in the forked top. Small, red swollen areas along leaf veins and midribs show where newly hatched larvae fed in the



Twig borer damage in 3-year-old tree.

vein tissues before molting and entering the branch and terminal tips.

Adults moths are ash grey and have a wingspan of ½ inch (12 mm). The forewing has a dark grey base and a dark spot on its outer tip. Full-grown larvae are ½ inch (12 mm) long and pale in color with a brown head.

Brown frass tubes at borer entrances.

Moths emerge from cocoons in April or May. Females deposit eggs singly or in small groups on the upper surface of leaves along the midrib and veins. Newly hatched caterpillars feed in the midrib or vein until their first molt, then move to the base of the first developing leaf and tunnel into the tender shoot. When they are fully grown, they move down the trunk and spin thin cocoons in bark crevices or in litter under the trees.

Successive generations—as many as five in Mississippi—develop through the summer; and with each generation the twig borer population increases. By September there may be 20 or more larvae of 4 different ages in a 15-inch (38-cm) cottonwood terminal. Winter is spent as tiny second-stage larvae in shelters of silk and trash in old entrance scars near branch ends, under corky ridges below leaf bases, or near leaf buds. In spring the small larvae migrate to the new shoots and complete their growth.

Natural controls of the twig borer include the potter wasp (*Eumenes* sp.), which preys on larvae, and other parasites and predators of the eggs, larvae, and pupae. These are inadequate for protecting nurseries and plantations from serious economic loss; therefore, chemical controls may be needed.

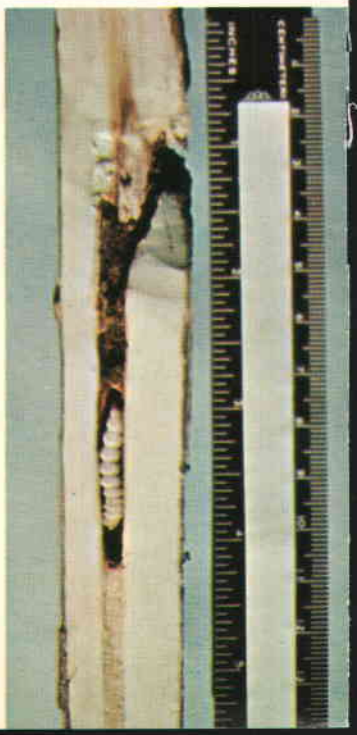
CLEARWING BORERS

Paranthrene dollii dollii (Neum.)
and *P. tricincta* (Harris)

Two clearwing borers prevalent in the Southern United States cause serious losses in cottonwood plantations and nurseries. *P. dollii* damages the tree base, and weakened trees may break off at the ground. *P. tricincta* attacks terminals, and breakage can occur at the entrance hole 18 to 24 inches (45 to 60 cm) below the terminal tip. The borer holes also provide infection sites for stem canker diseases caused by a complex of fungi.

Nursery plants become infested during their first year. Populations build up during the second and third years in the stools left after cuttings are harvested. Heavily infested stools cannot support vigorous growth from sprouts, and large stems break off and die before cuttings are harvested. Borer attacks also develop in the basal third of the shoots, and cuttings made from this material are rejected. As many as 10 percent of the cuttings produced may be damaged and discarded.

Clearwing borer, entrance (left) and stem sectioned to show larva and gallery (right).



Early signs of clearwing attack are sap flow from entrance holes and borings (frass) pushed out by the caterpillar. These signs will appear at the base of young trees infested by *P. dollii* or about a foot below the tip of terminals and branches attacked by *P. tricincta*. As the larvae grow, their galleries enlarge, and piles of frass accumulate at the tree base. A swelling of the stem may indicate the presence of *P. tricincta* in a terminal. When the terminal breaks off, the borer will be in the stub below the break. Evidences of adult emergence are brown pupal skins protruding from the exit holes. Infested trees will be drilled by woodpeckers feeding on the caterpillars during the winter.

Borer damage and frass at base of young cottonwood.

The adult of *P. dollii dollii* has narrow, dark brown forewings and partly transparent hindwings. Its wingspan is about 1¼ inches (32 mm). The body is brown, and orange crossbands bordered with yellow and dark brown mark the thorax and abdomen. The eggs are dark brown and oval. White to pinkish larvae with brown heads attain a final length of 1 to 1¼ inches (25 to 32 mm).

The adult *P. tricincta* has blue-black forewings, nearly transparent hindwings, a black body with three lemon yellow crossbands in the female and two in the male, and a wingspread of about 1 inch (25 mm).

The life cycles of both species are similar. The female lays eggs in bark crevices, especially near trunk scars. The larvae molt fives times while tunneling in the wood and pith and then prepare pupal cells at the gallery ends. Larvae overwinter in the galleries and pupate in early spring. Adults emerge in April, leaving the empty pupal skins protruding from their exit holes. Adult emergence peaks again in August, indicating two generations per year. There is, however, considerable overlapping; and larvae of several stages can be found in the trees during the late summer and fall.

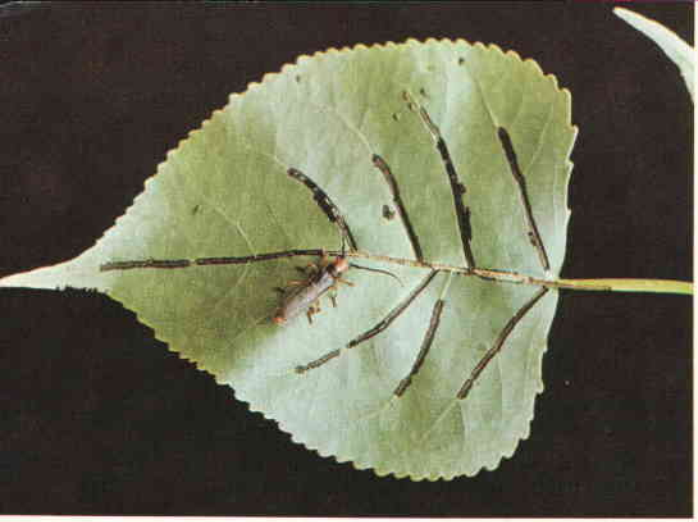
Control.—There are no effective natural controls. Woodpecker predation reduces populations in nurseries and plantations but may aggrevate the damage by providing oviposition sites and additional entries for canker fungi. Sanitation measures in nurseries, especially burning infested cull stems, tips, and stools, will help hold down borer populations. Control chemicals are listed in the insert.

BRANCH BORERS
Oberea schaumii LeConte and *O. Delongi* Knull

Two branch borers attack cottonwood and other poplars throughout much of the United States. Although both species may occur together, *O. delongi* is more prevalent in the South, and *O. schaumii* is more common further north. Small stems and branches are tunneled and sometimes weakened so that breakage occurs. Terminal breakage often results in crooked trunks, forking, and heavy branching.

Egg niches, the earliest signs of attack, may remain in evidence on stems and branches for several weeks. Later, frass protrudes from the entrance, particularly during attacks of *O. schaumii; O. delongi* ejects little frass. Infested stems may appear swollen. This symptom is most noticeable with *O. delongi,* which causes some stems to become greatly enlarged and gall-like. The adults typically feed on the midribs and branch veins of the leaves; such feeding is conspicuous and indicates stem infestation.

Oberea delongi **attacks in cottonwood branches.**



O. delongi **adult feeding on cottonwood.**

The adults are elongate long-horn beetles. *O. schaumii* ranges from ½ to ⅝ inch (12 to 16 mm) in length; *O. delongi* is slightly smaller. Both species are variable in coloration. In *O. schaumii* the thorax is yellowish to orange with four dark, smooth spots; the wing covers vary from yellowish to black. In *O. delongi* the thorax varies from yellowish orange to black, and the wing covers are black. The larvae of both species are legless, narrow, and yellowish white. Larvae of *O. schaumii* reach a length of ½ to 1 inch (12 to 25 mm); those of *O. delongi* reach ⅜ to ⅝ inch (10 to 16 mm). The pupae of both species are yellowish white.

Adult beetles emerge from April to June and feed on the foliage before laying eggs in niches gnawed in the bark. *O. schaumii* selects stems and branches up to 1½ inches (38 mm) in diameter, but *O. delongi* prefers smaller stems (usually current year's growth) up to ½ inch (12 mm) in diameter. The eggs hatch in about 2 weeks, and the larvae begin tunneling down the center of the stem. Pupation occurs within the gallery. Adults cut circular holes to exit. The life cycle of *O. schaumii* varies from 1 to 3 years; that of *O. delongi* is 1 year.

Branch borer damage is usually kept at low levels by natural enemies. Woodpeckers, particularly downy woodpeckers, have been observed to destroy large numbers of *O. delongi* larvae in some stands. Larval diseases kill many borers during some years.

COTTONWOOD BORER

Plectrodera scalator (Fab.)

The cottonwood borer is a pest throughout the Southeastern States. It attacks the root collar and main roots. Young trees may be girdled or so structurally weakened that breakage occurs. Severe damage has been observed in young natural stands growing on sandy soils along the Mississippi River.

Light brown, fibrous frass is sometimes ejected from bark openings at or slightly above the ground line and accumulates in piles at the base of the tree. But since most attacks occur at or below the ground line and most larvae tunnel downward, infestations often go unnoticed unless breakage occurs. However, when the soil is removed from the root collar and shallow roots, wounds filled with protruding frass can be found in the bark. Also, because of their large size and conspicuous color, the adult beetles are easily spotted while feeding and ovipositing during the summer.

Lateral root with larva and gallery of cottonwood borer.

Adult cottonwood borer.

The adult is a large, robust, long-horn beetle ranging from 1 to 1½ inches (25 to 38 mm) in length and ⅜ to ½ inch (10 to 12 mm) in width. The body is black with white cross-stripes. A strong spine is located on each side. The antennae are about as long as the body in the female and slightly longer in the male. The eggs are elliptical, white, and about ⅛ inch (3 mm) long. The larvae are legless, elongate, moderately robust, and yellowish white; they reach a maximum length of 1¼ to 1½ inches (32 to 38 mm).

Adult beetles emerge during late spring and summer and begin feeding on the bark of tender cottonwood shoots. To oviposit, the female digs away the soil at the base of the tree to a depth of ⅜ inch (10 mm) or more, cuts a niche in the bark, and deposits one or more eggs. Upon hatching, the larvae mine downward in the inner bark, later tunneling into the wood. Taproots of small trees may be completely hollowed. In large trees, some larvae excavate irregular cavities and others produce long tunnels. Portions of the mines or galleries may be packed with excelsior-like frass. Pupation occurs within the gallery. The new adult chews through the pupal chamber and digs its way to the soil surface to escape. A life cycle is completed in 2 years.

Since most grubs are below the ground line, they are well protected from both predators and parasites. Woodpeckers capture a few larvae exposed above the ground line. Although a fungus disease has been found, it does not appear to be common. Extended flooding will kill many larvae. Damage can usually be kept to a minimum by planting on good sites and utilizing cultural practices that maintain a vigorous, healthy stand.

POPLAR BORER
Saperda calcarata Say

The poplar borer is a serious pest of cottonwood and other poplars throughout the United States and Canada. It attacks the trunks of trees 3 years and older. Clusters of larvae tunneling close together may riddle portions of the trunk. Woodpecker excavations and decay fungi further weaken damaged stems. Badly infested trees may be so structurally weakened that wind breakage occurs. The value of infested trees sawn for lumber may be greatly reduced.

The most conspicuous early sign of attack is the appearance of sap spots on the trunk. Later, oozing sap mixed with fine frass is extruded through small openings in the bark. Although attacks may occur singly, they are typically clustered. After the bark is mined by a cluster of larvae, it begins to split or break irregularly as radial growth progresses. As the larvae grow, the frass becomes fibrous and excelsior-like. Coarse frass is usually conspicuous in large quantities at gallery entrances, lodged in bark crevices, and in piles around the base of the tree. Woodpeckers frequently excavate several holes in the wood and remove much of the loose bark in the vicinity of a larval cluster. Scars resulting from overgrown attacks remain for several years.

Trunk attacked by poplar borers. Note frass on ground and woodpecker holes above attack area.

The adult is a long-horn beetle, elongate, moderately robust, and ranges from ⅞ to 1⅛ inches (22 to 30 mm) in length. The body is grayish blue and heavily stippled with fine brown dots and yellowish spots. The antennae are about as long as the body. The eggs are slender, creamy white, and about ⅛ inch (3 mm) long. The larvae are legless, elongate, cylindrical, yellowish white, and 1⅛ to 1⅜ inches (30 to 35 mm) long. The pupae are yellowish white.

Poplar borer in sectioned cottonwood trunk.

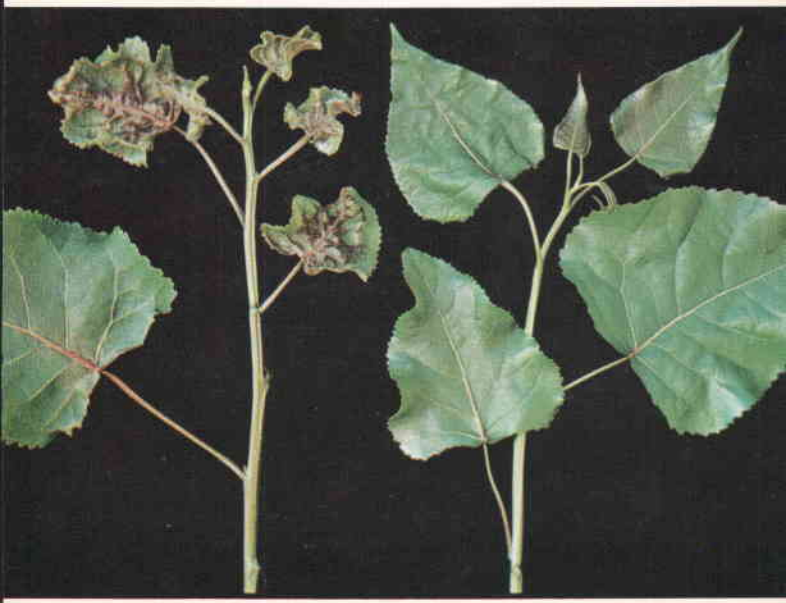
Adult beetles appear during late spring and early summer. After feeding on the tender shoots of young cottonwood they mate and begin laying eggs in niches cut in the bark. Eggs hatch in 2 to 3 weeks, and the larvae begin mining beneath the bark. Later, they tunnel into the sapwood and heartwood and produce extensive galleries. The larvae overwinter behind frass plugs within the galleries. The pupal stage lasts 2 to 3 weeks. The new adults exit through the gallery entrances. Two years are required for the life cycle.

Parasites, predators, and disease help keep infestations in check. Considerable natural mortality also occurs among eggs and early instars because of heavy sap flow, which is enhanced by high soil moisture and tree vigor. Woodpeckers destroy many grubs in some stands and are probably the most important natural enemy once the larvae have established galleries in the wood. Brood trees, scarred by repeated attacks and harboring heavy populations of borers, should be removed to prevent or reduce spread to uninfested trees.

COTTONWOOD LEAF CURL MITE
Aculus lobulifera Keifer

Attacks by leaf curl mites seriously reduce growth and vigor of young cottonwoods in nurseries and plantations. Mites feed on terminal foliage and stems, causing stunting and malformation of leaves, terminal tips and buds as well as the loss of immature foliage. The pest has been observed in cottonwood throughout most of its commercial range.

Leaf damage symptoms appear in early summer and intensify as the hot, dry weather continues. Heavily attacked leaves become stunted with red veins and crinkled, purplish-green blades, which are brittle and curled. The petioles become scaly and brown. Terminal shoots are also stunted, scaly, and brown. Small, developing leaves commonly break off, leaving several inches of the terminal shoot leafless.



Typical foliage and stem damage by leaf curl mites. Normal foliage on the right.

Leaf curl mites are minute, four-legged, and straw-colored; they look like dust flecks on the leaves. They develop two alternating forms: hibernating mites and foliage-feeding mites, the primary form. The majority of the mites perish with leaf fall; but a few find hibernation shelters in bark crevices, branch scars, and at the base of the trunk. Early the next spring, the hibernating mites leave their shelters, feed on green tissues, and lay eggs, which produce primary forms on the new foliage. The primary mites multiply rapidly; and all stages, eggs to adults, are found together on the foliage and tender terminals. Heavy populations develop during dry periods, especially from June through August and in October.

Heavy rains disseminate mite populations, and new growth with normal foliage may follow; however, this pest may reappear with dry weather in the fall. No other natural controls are known. Some improved cottonwood clones show evidence of possible resistance, and these are being investigated further. Artificial controls are available and may reduce populations significantly.

VICEROY BUTTERFLY
Limentis archippus (Cramer)

The viceroy butterfly is a common defoliator in cottonwood plantations throughout the United States. During most of the growing season, caterpillars feeding on leaves are of little concern; but later when few new leaves are being formed, caterpillars eat tender terminal tissues and buds, killing 8 to 10 inches (20 to 25 cm) of the terminals. New growth from lateral buds results in multiple-forked crowns the next year. These malformed trees will produce less pulpwood, saw logs, and veneer than healthy trees. The viceroy is normally not a serious pest in nurseries.

The first signs of attack are caterpillars on ragged, partly eaten leaves near branch ends. Late in the season, damaged terminals turn black and die. During the winter, leaf petioles fastened to the branch by silk will have small tubes of rolled leaf blade in which small caterpillars are hibernating.

The orange and black adult resembles the monarch butterfly but is smaller. It has a narrow black line across the hindwings and one row of white spots in the black marginal band of the wings. The full-grown caterpillar is about 1½ inches (38 mm) long and has a large, bilobed, pale green head. The body is olive green and white or brown and white. Two barbed, club-shaped, brown tubercles on the thorax are topped by two smaller tubercles armed with spines.

Eggs are laid on the leaves. The solitary caterpillars each consume several leaves during their growth. The full-grown larva secures itself to a leaf stem or branch and changes to a shiny brown and white chrysalis (pupa) from which the adult butterfly emerges after a few days. Two generations per year are recorded, but more may occur in the deep South.

In late fall, a small caterpillar fastens a leaf petiole to the branch with silk and then cuts away all but the base of the leaf blade. This part of the blade is rolled and fastened into a short tube in

Larva of viceroy butterfly.

which the ½-inch (12 mm) long caterpillar spends the winter. In spring, the caterpillar emerges and feeds on new leaves.

No natural controls are known.

POPLAR TENTMAKER
Ichthyura inclusa Hbn.

The poplar tentmaker occurs from southern Canada to the Gulf of Mexico and west to Colorado. It may seriously defoliate young trees in nurseries and plantations, especially during the first year. Height growth is stunted, resulting in fewer cuttings from nursery stock. Stunted plantation trees may be overtopped by weeds.

Attacks are announced by the presence of tents made of one or more leaves lined with silk and harboring the caterpillars.

Brownish-grey adult moths have three white lines across each forewing and a crest of brown hairs on the thorax. The wingspread is about 1 inch (25 mm). Caterpillars are dark brown with four yellow lines on the back and a bright yellow line on each side. They reach 1½ inches (38 mm) in length when fully grown and have black tubercles on the first and eighth abdominal segments.

Larva of poplar tentmaker and tent on cottonwood leaf. (Picture courtesy of R. F. Anderson, Duke University.)

There are two or more generations in the South. Adults appear in the spring and again in midsummer. Eggs are laid in clusters on the undersides of leaves. The larvae feed from May to October, then crawl to the ground and pupate in loose cocoons during the winter.

Parasites and predators usually control tentmakers in natural stands, but rapid build-ups can occur in plantations before the problem is recognized

LEAFHOPPERS

Cicadellidae homalodisca coagulata (Say),
Oncometopia orbona (Fab.),
Cuerna costalis (Fab.),
and *Aulacizes irrorata* (Fab.)

Four species of large leafhoppers injure young cottonwood trees by piercing plant tissues with their mouth parts and sucking the juices. Heavy feeding removes large quantities of sap from the trees, and this loss of sap can be especially harmful during dry periods in midsummer, when foliage is heavy. In addition, three of the four leafhoppers are known vectors of the virus causing Phony Peach Disease and may carry other viruses to cottonwoods.

There is an obvious sign of leafhopper activity: leaves below the feeding sites may be wet by fluid squirted from the leafhoppers.

Adult leafhoppers are about ½ inch (12 mm) long, bullet-shaped, and have strong jumping legs. The two species most common in midsummer are *H. coagulata,* which is brown, and *O. orbona,* which is blue with orange markings.

All four species spend the winter as adults or occasionally as nymphs under trash and debris in woodlands and along ditchbanks. In spring they become active, leave the woods, and feed on a variety of plants. Later they move to preferred herbaceous plants. Females lay eggs in clusters between the upper and lower leaf surfaces. The nymphs feed on various hosts during their development through five stages to the adult form.

Homalodisca coagulata **on cottonwood terminal.**

No natural controls are known, but there are some approved chemical controls.

OTHER INSECTS

The pests described below are usually not serious threats to cottonwoods. However, large populations occasionally build up in limited areas or on individual trees and cause considerable damage. Normally natural controls are sufficient, but to suppress periodic buildups in localized areas, artificial controls may be required.

The first four insects are moths. The adults are inconspicuous and do no damage, but the larvae feed on cottonwood.

Blotch leafminers, Paraleucoptera albella.—This insect probably occurs throughout the commercial range of cottonwood. Eggs are laid in clusters of 3 to 12 on the upper leaf surface. Groups of small, white larvae tunneling between the upper and lower leaf surfaces consume the green tissues and cause conspicuous brown blotches. Periodic heavy infestations may destroy half the total leaf surface and reduce growth of young cottonwoods. Full-grown larvae leave the mine and spin small white tent cocoons at leaf margins.

Serpentine leafminers, Gracillariidae.—The tiny, flat larvae construct winding mines in leaf blades and consume the green tissues. Their attacks late in the season are often noted, but their damage is usually negligible. Mature larvae spin small, flat-topped, white cocoons in curved leaf margins.

Leaf rollers, Tortricidae.—Pale green larvae about ¼ inch (6 mm) long fold over leaf margins and tips, fastening the edges with silk to form shelters in which they feed. Late in the season, new leaves may be conspicuously attacked, but damage to the tree is minor.

Epidermal miner, Marmara sp.—Tiny larvae mine immediately beneath the epidermis in phloem tissues and do not damage cambium or xylem. Larval mines appear as meandering brown lines on the smooth bark of 1- to 2-year-old trunks and branches. The injury is probably insignificant, but its presence can cause rejection of cuttings subject to quarantine examination for shipment.

Aphids or plant lice (Aphididae).—These small sucking insects are widely distributed and often cause local damage. Most forms suck the sap from leaves and tender terminal tissues. While feeding, they exude droplets of honeydew, which attract ants. Sooty mildew develops on leaves and tips covered with honeydew, and serious growth retardation may result. Other aphids feed on bark in the spring, injuring the bark and cambium. Others cause the formation of galls on leaf petioles, where they are feeding, and may cause premature leaf fall.

Night-feeding leaf beetles, Metachroma sp.—These beetles appear sporadically and can damage new plantings by killing tender new leaves, terminal tips, and buds. Adults are brown and smaller than cottonwood leaf beetles. In Mississippi they appear after mid-May and disappear after mid-June. They hide during the day and feed at night, cutting many small holes in the leaves. Older leaves remain, but new leaves turn black and drop off; terminal tips also turn black and die. The larvae are root feeders, and little is known of their biology.

Leaf curl midge, Prodiplosis morrisi Gagne.—Maggots of a fly midge feed in the tightly rolled margins of developing cottonwood leaves and damage the tender tissues, causing them to turn black and die. The leaves cannot develop and usually drop off. Some may appear stunted and crinkled, with only their tips developed normally. Attacks typically occur in June and can slow the growth of first-year plantings. Heavy rains reduce outbreaks, and normal foliage development follows.

A host of other insects also attacks cottonwoods. Most are inoccuous and appear infrequently. Some are capable of building to damaging levels in large plantings. Such outbreaks can occur without warning and should be reported promptly so that potential damage can be anticipated and minimized.

CANKER DISEASES

Canker diseases cause losses of about 20 percent during the first season in plantations established with unrooted cottonwood cuttings. Cankers are most severe on poor sites and under conditions of environmental stress.

Septoria musiva Peck. is considered the pioneer organism. *Fusarium solani* (Mart) Snyder & Hans., *Cytospora chrysosperma* Fr., *Phomopsis macrospora* Kobayshi & Chiba, and *Botryodiplodia theobromae* Pat. usually invade the small Septoria cankers. Although these fungi are secondary in the ecological succession, they singly or collectively cause mortality.

Septoria stem canker on young cottonwood.

The four fungi are indigenous to most areas and can infect nursery stock by means of wind-borne spores. They overwinter as mycelia or spores on cottonwood cuttings stored for spring planting. No fruiting structures are associated with *F. solani*.

Phomopsis macrospora **producing tiny, yellow strings of spores.**

The other three fungi produce inconspicuous, tiny, flask-shaped fruiting structures, which protrude through the epidermis and produce numerous spores. When these infected cuttings are planted, they may leaf-out and appear healthy; but many die before developing a root system. Mortality is increased by environmental conditions that limit plant growth or cause plant stress.

Inoculum enters older trees through wounds or insect borings. Cankers on stems of 2- and 3-year-old trees are easily detected. They usually develop in fall and by spring are 3 to 6 inches (7.5 to 15 cm) in diameter. On vigorous trees, cankers are arrested during the growing season and usually callus over. On slow-growing trees, cankers can girdle the stem, and leaves above the cankers will wilt but do not drop until late summer. The stem below the cankers may remain green until fall when it dies back to the root crown. Often such trees develop root sprouts the following spring.

Cytospora canker girdling 3-year-old cottonwood.

On trees older than 4 years, cankers usually develop in the crown. Yeast, bacteria, and other microorganisms quickly invade the sap flow from the cankers and cause a fermentation. Foresters refer to the unsightly wounds as "crud cankers." Generally cankers do not girdle the tree, but wind breakage occurs at the wound.

Extreme care should be taken to select only healthy, canker-free cuttings for planting. Proper storage and handling of cuttings will minimize losses. Cuttings should not be allowed to dry out and should be stored at 34 to 40° F until time of planting. Cultivation of 1-year-old plants reduces competition for moisture and nutrition by weeds and thus reduces losses from cankers. Preliminary results show that improved clones may have resistance to *Septoria*, the pioneer organism in the canker complex.

Fusarium canker on 4-year-old cottonwood.

Septoria leaf spots.

SEPTORIA LEAF SPOT

Septoria musiva Peck causes leaf spots as well as the cankers described earlier. The disease is common throughout the United States, parts of Canada, and Argentina. It is a serious threat to nurseries because it provides entry for other disease organisms. In plantations it reduces growth by causing premature defoliation.

Septoria musiva overwinters in fruiting bodies in fallen leaves or branches. In spring, during periods of high humidity, spores are shot into the air. They infect new leaves at bud break. Leaf spots develop 1 to 2 weeks later. Spots first appear as depressed black flecks. Under favorable moisture conditions, flecks increase in size. Spots merge on leaves with multiple infections, and as much as 50 percent of the leaf tissue can be affected. As the dead tissue dries, it fades to light tan or white in the center. Three or 4 weeks after initial infection, spore-producing pycnidia appear as small, black, inconspicuous flecks in the centers of leaf spots. Spores from these pycnidia spread the infection to other cottonwoods.

Control measures would be economically justified in nurseries but probably not in plantations. After cottonwood cuttings are harvested from nursery beds, all debris should be removed or plowed under to destroy infected plant parts and to prevent new shoots from being infected in the spring. Native poplars in or near nurseries should be removed to prevent infection by airborne spores.

OYSTER MUSHROOM ROT

Pleurotus ostreatus (Fr.) Quel., the oyster mushroom, decays both sapwood and heartwood of several broadleaf tree species throughout the world. Because of its wide occurrence and its ability to attack both root and stem of cottonwood, it is potentially dangerous to cottonwood plantations.

White fungus mycelium of Pleurotus ostreatus **on decayed roots.**

Presence of sporophores (fruiting bodies) on trunks indicate infection. These are 2 to 6 inches (5 to 15 cm) broad, fleshy, smooth, shiny or satiny when dry, and white to grey in color. The cap is convex, with or without an off-center stalk, and has gills on the lower surface where spores are produced. Spores are carried by wind to other areas where they germinate readily under favorable conditions. The fungus enters trees through wounds in stems or roots. A white, flaky rot results. Trees with infected root systems show top symptoms characteristic of root disorders, i.e., a growth decline, unthrifty condition, and a thin crown. Diseased trees do not compete well with adjacent trees, become suppressed, and die within a few years.

Pleurotus ostreatus **fruiting body.**

This disease can be reduced by avoiding wounds to the root system and basal stem of trees. Removal of infected trees and wood debris harboring the fungus would also help reduce its spread.

LUCIDUS ROOT AND BUTT ROT

Polyporus lucidus Leys. ex Fr. causes rot in roots and the basal stem of hardwood trees in the United States, Europe, the Phillippines, other parts of Asia, and North Africa. The fungus has been observed on cottonwood cuttings but not on established trees. However, since inoculum will be present in many sites intended for cottonwood, infection of established cottonwoods is anticipated.

Polyporus lucidus **fruiting body on decayed cutting.**

If attacked, cottonwood would probably develop moderate to slight disease symptoms such as thin crowns and stunted foliage. Later, sporophores will be produced on or near the base of infected trees in late summer or fall.

These mushroom-shaped sporophores are a glossy reddish brown with a white, round margin. The undersurface is whitish with numerous small pores. The stalk is also glossy, dark red. Sporophores vary from 1 to 6 inches (2.5 to 15 cm) high and from 1 to 10 inches (2.5 to 25 cm) in diameter. Brown microscopic spores are released from the fine tubes in the undersurface of the sporophore cap. These spores are carried by wind and germinate on wood debris, stumps, or open wounds on living trees. As the fungus grows, it can penetrate the root system or collar of nearby susceptible trees. The wood decay is a soft, spongy, white rot with black spots.

No practical control is known for this disease. However, avoiding mechanical injuries to roots and tree bases, avoiding sites with known infections of natural stands, or removing infected trees helps reduce infections.

Typical P. lucidus **fruiting bodies growing above diseased roots.**

CLITOCYBE ROOT ROT

Root rot caused by *Clitocybe tabescens* Bres. occurs on many woody plants in the Southeastern States and elsewhere throughout the world. The disease has been observed in cottonwood plantations, but its full impact on this species has not yet been assessed.

First noticeable symptoms may be a decline of the crown and yellowing leaves, which fall prematurely or remain small and scant. On small trees, all foliage may die. White, fan-shaped mycelial fungus mats may form on the roots and root collar, causing decay. These mats extend upward between bark and wood and cause rot in both heartwood and sapwood.

Root system decayed by Clitocybe tabescens.

In fall dense clusters of yellow-brown mushrooms develop at the base on the infected tree. These mushrooms are 4 to 6 inches (10 to 15 cm) high and have a broad, brown, scaly cap ½ to 2/3 inch (12 to 17 mm) in diameter and whitish gills. They

produce wind-borne spores that germinate on exposed tissue of living or dead trees. The fungus spreads through the roots of infected trees and penetrates living roots of adjacent, healthy trees through root grafts or wounds.

Suppressed or off-site trees are apparently most subject to attack. Thus, the best control is to maintain a vigorous stand through site selection, spacing, and thinning. Site preparation should include removal of all roots that might harbor the fungus. Removal of infected trees may be of value in young stands; however, care must be taken to avoid spreading fungus inoculum.

C. tabescens **fruiting bodies above diseased roots.**

CORTICIUM ROOT ROT

White root rot, or Corticium root rot, caused by *Corticium galactinum* (Fr.) Burt. attacks numerous woody and herbaceous perennial species in the United States, Europe, the West Indies, and Japan. Only a few cases of this disease have as yet been observed on cottonwood in plantations, but it is potentially destructive because of its wide occurrence and ability to spread from tree to tree.

Infected trees may only appear unthrifty with thin crowns. However, foliage may turn brown suddenly and die, accompanied by death of twigs and main stem. The sporophore appears on the root surface as a white or cream-colored layer of fungal growth without definite form or features and may persist for some time. The exposed sporophore surface may appear dry and cracked. Spores are wind disseminated. Under favorable conditions, they germinate and invade dead woody tissues or may even invade living root tissues. The fungus then spreads through the tissues, killing living cells and decaying the wood. Wood of affected roots often shows concentric spots, and roots may appear knotted or gnarled. Diseased trees occur singly or in small randomly located groups.

There are no practical control measures for this disease. However, avoiding sites where native stands are known to be infected and removing diseased trees from plantations are beneficial measures. Care should be taken so that pieces of infected roots or other inoculum are not spread to other areas. Replacement of plantation trees killed by this disease is generally not effective.

Corticium galactinum **fruiting bodies on decayed roots.**

MELAMPSORA LEAF RUST

Leaf rust caused by *Melampsora medusae* Thum causes economic losses in nursery stock throughout the geographic range of cottonwood. Above latitude 40°, rust may cause premature defoliation in plantations. This defoliation not only causes growth losses; it weakens the trees and predisposes them to other pathogens, which cause cankers and mortality.

Cottonwood leaves are infected in early spring by wind-borne spores produced on conifers or by spores that overwintered on cottonwoods in frost-free areas. The first evidence of the disease is small yellow spots (masses of spores) on the lower leaf surfaces. These rust spores can be blown to new leaves and cause additional infections. If humidity is high, infection may spread until the entire leaf is covered by yellow spores. Defoliation usually occurs when rust covers over 50 percent of the leaf. Late in the season, the disease is easily detectable by the vast amount of rust spores, which give the leaves a dusty yellow color.

Rust-resistant clones developed by the Southern Forest Experiment Station in Stoneville, Mississippi, are available through several State forest nurseries. Stoneville clones 75 and 92 are not defoliated by rust and should be favored in areas when summer defoliation occurs.

Melampsora rust spores.

Alternaria leaf blight.

ALTERNARIA LEAF AND STEM BLIGHT

Leaf and stem blight caused by *Alternaria tenuis* Nees occurs in the United States, Canada, and Mexico. It was first reported on cottonwood in North Dakota in 1918. It now appears to be an important disease in nurseries and plantations. Losses among unrooted, green-tip cuttings in mist beds can be as high as 65 to 95 percent.

The fungus overwinters as mycelia on plant debris. In spring wind-borne spores are carried to new leaves; they germinate within 1 to 2 hours when relative humidity is 100 percent and temperature is between 40 and 95° F. The spore can penetrate epidermal tissue of young leaves and stems, but it usually enters through leaf margins and insect wounds, turning tissue brown. Within 5 to 7 days, mycelia have formed, and new spores are being produced. The infested area now appears as a sooty, irregularly shaped blotch.

Rotation and sanitation of nursery planting beds will reduce incidence of this disease by eliminating fungus which overwinters on plant debris. Early spring cultivation of stool beds to turn-under plant debris will greatly reduce subsequent infections.

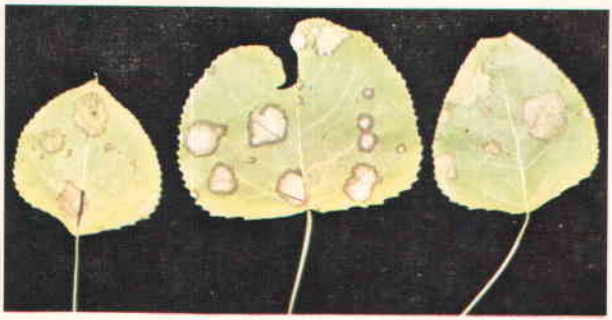
MINOR LEAF DISEASES

Several fungi cause leaf diseases on cottonwood throughout its geographic range. Leaf spot diseases may become epidemic during a wet spring and summer. Although the unsightly leaves and excessive leaf fall can be spectacular, they usually cause only minimal growth loss. A leaf disease is a serious problem only when more than half the leaf surface is infected or defoliation removes more than half the leaves. Heavy infections for several successive years can predispose the tree to other pathogens, which could cause death.

The most common fungi which cause damage are *Taphrina populina* Fr., *Phyllosticta* sp., *Cercospora populina* E. & E., *Colletotrichum gloeosporioides* Penz. These fungi overwinter on fallen leaves or twigs. In early spring spores are produced which infect leaves, causing death of leaf tissue. The affected area may be as small as a pinpoint or up to several inches in diameter. It can appear as a spot, ring, blotch, anthracnose, leaf curl, or leaf blister. Often more than one leaf disease is present on a single leaf.

Sanitation reduces the possibility of epidemics by reducing the amount of inoculum. In most cases, the disease is sporadic, and epidemics do not occur annually. If heavy defoliation occurs in successive years, chemical control may be needed to reduce subsequent infections.

Leaf blister caused by Taphrina populina.



Phyllosticta ring spot.

Leaf spot caused by Cercospora populina.

Anthracnose caused by Colletotrichum gloeosporioides.