

INSECT AND DISEASE PESTS OF SOUTHERN HARDWOODS

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Insects and diseases seldom kill southern hardwood trees in managed stands, but they cause major economic losses by lowering wood quality and reducing tree growth. In discussing the most important insects and diseases of southern hardwoods, let us consider first those that attack natural hardwood stands and then those associated with plantation culture.

NATURAL HARDWOOD STANDS

Insects

In natural stands, trunk borers are economically the most serious insect pests. The larvae construct galleries in the trunks of living trees, causing the greatest damage in the lower portion (Beal 1952, Hay and Wootten 1955). The quality of the butt log, which is potentially the most valuable portion of the tree, is greatly reduced. Oaks suffer more damage than other hardwoods in the South (Hay and Wootten 1955, Putnam et al. 1960). Wood value is greatly reduced by the holes, but little physical weakening or growth loss occurs. In addition to the damage resulting from the galleries of the large trunk borers, secondary damage around holes is caused by wood-rot fungi, by carpenter ants, and by woodpeckers preying on the grubs (Morris 1965, Solomon 1969). High-quality veneer and furniture-grade lumber cannot be cut from borer-damaged trees. Mill-grade studies (Morris 1964) showed that insect-caused defects in the trunks of living southern oaks resulted in lumber de-grade and loss averaging about \$20 M b.m. Such losses applied to the approximately 3 billion board feet of oak lumber sawn annually in the South indicate 60 million dollars' worth of damage per year.

The carpenterworm, Prionoxystus robiniae, is probably the most important borer of oaks in the Midsouth. Larvae hatch from eggs laid in bark crevices and bore into tree trunks. They spend up to 2 years constructing galleries, which often exceed 6 inches long and 1/2 inch in diameter before adults emerge (Solomon 1968). Similar damage in living oak trees is caused by two long-horn beetles, the red oak borer (Enaphalodes rufulus) and the white oak borer (Goes tigrinus).

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Dr. J. D. Solomon of the Southern Hardwoods Laboratory, Stoneville, Mississippi, is doing research that may lead to a biological method for controlling carpenterworms. Work now is aimed at identifying the chemical that attracts male to female carpenterworm moths. Practical application awaits its identification and synthesis.

Two large trunk borer species attack cottonwood. The cottonwood borer, Plectrodera scalator, attacks the root crown just below the ground surface. Trees on good sites withstand this damage and show little sign of injury (Morris 1965). The poplar borer, Saperda calcarata, attacks trunks of living trees 4 years old and older. The poplar borer population per tree increases with time regardless of tree site, but damage is more severe on poor sites. Serious lumber degrade or tree breakage can result from heavy concentrations of larvae, woodpecker predation, and introduced decay fungi.

Ambrosia beetles cause shothole, flagworm, and pinworm defects in most oaks, hickories, basswood, sycamore, walnut, and maple. Most ambrosia beetles attack weakened trees or freshly felled logs. A few, such as the Columbian timber beetle (Corthylus columbianus) and some Xyleborus and Platypus species, attack living trees and cause flagworm damage. These insects do not weaken the wood but the small holes and streaks of stain prevent its use for furniture stock, veneer, or bourbon staves. The stumpage value of sound flagworm maple is about \$15 less per thousand board feet than undamaged stumpage (Morris 1965). However, if sold as a specialty wood, such as paneling, it can bring a higher stumpage price than undamaged wood.

Economical control of borers in natural stands by chemical means is almost impossible at present. Possibilities include the use of sex attractants in biological control programs, sanitation practices during logging operations to remove weakened and dying trees, and favoring species best suited to each site. Morris (1964) showed in his oak degrade study that insect damage and degrade were greatest on poor sites.

Damage by defoliators constitutes another major type of insect injury to natural stands of southern hardwoods. The forest tent caterpillar, Malacosoma disstria, is the principal hardwood defoliator in the Midsouth; it defoliated over 500,000 acres per year of water tupelo in Louisiana and Alabama during 1970 and 1971. Except for a potential 3.5 million acres of riverbottom lands in Louisiana and Alabama where it is a serious threat to the gum forests, this insect is distributed throughout the southern forest in endemic numbers which normally cause no noticeable damage.

The tent caterpillar has one generation per year which develops in the spring when the host trees begin their new growth. In Louisiana and Alabama caterpillars appear near the end of March. By late April a heavy population will have completely defoliated the tupelo gums. By late June the trees re-leaf. This loss of rapid growth during 3 months in the spring is the main damage to water tupelo and blackgum. Studies with these species show that such defoliation reduces stem growth by at least 40 percent for the year. In sweetgum, however, repeated defoliation causes dieback and some mortality.

Nachod and Kucera (1971) reported that during 1970 heavily defoliated tupelos on 477,000 acres in Louisiana refoliated in October instead of June. Such a long delay in refoiliation has never before been reported for tupelo. The loss in growth for 1970 must have been nearly 100 percent, and if the pattern is repeated for several years these trees will probably die. The reason for this abnormal pattern of refoiliation after a forest tent caterpillar attack is unknown. This situation should be observed for the next several years.

The persistence of epidemic populations of forest tent caterpillars in these tupelo ponds and flooded areas of Louisiana and Alabama is believed due to flood water (3 to 10 feet) flowing through these areas when larvae are active (Morris 1965). In most other areas, such as the Lake States, natural enemies reduce the epidemic populations in a few years. Many active natural enemies of the tent caterpillar have been found in flooded areas of Alabama and Louisiana, but the populations remain small. Apparently the parasites normally overwintering on the forest floor drown or are flushed from the tupelo swamps.

Increasing prices for tupelo veneer and lumber may necessitate control measures in these areas. Special care will be required with control measures in these fish and wildlife habitats.

Research has uncovered two promising biological control agents, a polyhedrosis virus and a bacterium, Bacillus thuringiensis. While biological control agents, which are highly desirable, are being developed, interim control measures that do not harm the environment are required. Non-pollutant insecticides presently are being field-tested in Alabama by Abrahamson and Morris of the Southern Hardwoods Laboratory; results so far have been promising. Dylox^R, Diazinon^R, and Lannate^R are all highly effective against the forest tent caterpillar in dosages of 12 to 24 ounces per acre of concentrated material. Further testing with Dylox this year gave excellent control. These ultra low volume carbamate and organic phosphate insecticides are aerielly sprayed in quantities small enough to not harm any fish or wildlife in the area. They break down within a short time and do not build up or remain in the ecosystem as do the persistent chlorinated hydrocarbons.

The gypsy moth (Porthetria dispar), while not yet established in the South, is moving southward and may be expected in some areas within the next 5 years (Knauer 1971). The gypsy moth, a native of Europe and Asia, was introduced into the United States in 1869 and has defoliated forests in the New England area for 100 years. Today it occurs in nine Northeastern States and is moving south and west. The use of less efficient insecticides in place of DDT and the rising popularity of family camping and travel trailers are responsible for the increased rate of dispersal into the West and South (Knauer 1971).

Gypsy moth caterpillars feed on a large variety of hardwood foliage including aspen, apple, birch, oak, willow, blackgum, and hickory. They generally do not feed on ash, walnut, sycamore, or yellow-poplar. In the North the gypsy moth produces only one generation per year, but in the warmer climate of the South a second generation may be possible.

Knauer points out that gypsy moths cause both economic and esthetic damage. Repeated defoliation reduces growth and vigor and kills trees, and completely defoliated mountainsides have little esthetic appeal. When the gypsy moth enters a new area the potential exists for a population explosion because natural enemies are not yet established. Thus, large areas of hardwoods in the South may be completely defoliated within a few years.

The most promising material for control of the gypsy moth is "disparlure," a synthetic sex attractant recently developed by the Agricultural Research Service. In recent tests, disparlure has effectively competed with virgin females in attracting male moths. In field tests, disparlure has been effective for attracting male moths and for confusing them so they cannot find a female with which to mate. However, it has been stressed that many more experiments lie ahead before disparlure can be considered a practical control method. The ULV insecticide sprays that control the forest tent caterpillar may also be of value for gypsy moth control.

Other insects that sporadically defoliate southern hardwoods include the fall webworm, the variable oak leaf caterpillar, and the walkingsticks. The fall webworm (Hyphantria cunea) causes little growth loss because it defoliates late in the year after most growth has taken place. But aesthetic loss can be great along scenic routes and in parks, and the quality of nut crops may be affected. The variable oak leaf caterpillar (Heterocampa manteo), saddled prominent caterpillar (Heterocampa guttivitta), and oak worm (Anisota stigma), and a walkingstick (Diapheromera femorata), defoliated over 1.5 million acres in northwestern Arkansas during 1970 (Kucera et al. 1970). Oaks in both the red and white oak groups were the most heavily defoliated species. There are two periods of defoliation during the summer and, although the impact on these trees is not well known, it could be serious since 2 successive years of defoliation can cause branch dieback and tree mortality (Kucera et al. 1970). Most of the trees affected are not of high commercial value, and the larger more vigorous trees in the area are seldom defoliated. Caterpillars falling on people, roads, and walkways have been a serious nuisance (Kucera et al. 1970).

Insects also disperse various tree disease organisms. Perhaps the best known example of an insect vector is the European elm bark beetle (Scolytus multistriatus), which transmits Dutch elm disease. Another example is the leafhopper that transmits the virus disease phloem necrosis of American elm. In the North the Nitidulid sap-feeding beetles are vectors of the oak wilt disease. Nitidulids also kill small patches of cambium while feeding on the inner bark, thereby causing bark and stain defect in oak lumber and veneer (Morris 1965). This type of injury is caused mainly by bacteria or yeasts that are always associated with these beetles.

Diseases

In natural stands in southern bottom lands, decay and associated defects cause more volume loss than all other diseases of hardwoods combined. Butt rot, any decay at the base of a living tree, is the most serious type of decay. Most of the fungi that cause rot enter through dead branch stubs and bark wounds or openings resulting from fire and logging. Old wounds, hollows, swollen areas, flat faces, and fungal conks are indicators of possible internal defects or decay. The extent of damage is difficult to determine and depends upon the extent of initial tree damage, tree species, fungus species involved, and length of time since damage occurred. The major butt rot fungi in southern hardwoods are Pleurotus ostreatus, Hericium erinaceus, Polyporus fissilis, P. sulphureus, and P. lucidus.

The conks of these fungi are produced on diseased trees at various times during the year. Pleurotus ostreatus frequently produces fruiting bodies during the winter months, whereas Polyporus hispidus sporophores usually appear between July and October.

Canker rots, which may appear at any point on the tree, are especially serious in red oaks, but also occur on some white oaks, hickory, honeylocust, and other species. Polyporus hispidus, Poria spiculosa, and Irpex mollis are primarily responsible for these canker rots. These fungi enter the tree via dead branches, and the remnant of an old branch stub is almost always evident near the center of the canker. Hispidus cankers are from one to several feet long and the trunk in the canker area is usually spindle shaped. Rusty red conks usually appear on the canker face in the summer or fall. In contrast, rough circular swellings with depressed centers are characteristic of spiculosa cankers. Conks of this fungus ordinarily do not grow on living infected trees but develop on decayed logs. Irpex cankers are more irregular in shape than the other two. The swollen area will have several sunken areas, with white conks and fungus material occurring near the sunken areas.

Great numbers of microscopic spores are produced by conks of the decay and canker fungi. As many as 300,000 spores/cu.ft. of air have been trapped under P. hispidus conks in a period of 1 minute (McCracken and Toole 1969). Conks may produce spores for 21 days or more. Pathologists agree that these decay fungi are primarily spread by means of air-blown spores, but germination of spores of most species has not yet been observed. Recent studies have clarified environmental effects on time and amount of spore production. Spore dissemination and germination studies are presently being undertaken. A knowledge of how infection occurs, when it occurs, conditions necessary for infection, and distances spores can travel will aid greatly in the development of sound procedures to control decays.

Sweetgum blight, serious on bottom land sites during periods of drought, has become endemic in the South in recent years. Adequate soil moisture on these sites is believed responsible for the lessening of this disease.

Sycamore anthracnose disease has become epidemic in some areas of the South. The defoliation and twig blight are caused by Gloeosporium nervi-sequum (McCracken and Filer 1971). Infection occurs only at the proper temperature and humidity in the spring and occasionally in the fall. Volume growth loss resulting from defoliation is unknown. Although McCracken has not observed mortality resulting from this disease, severe defoliation for 3 or more successive years could kill the affected trees. Control of this disease is possible, but generally is neither necessary nor economically feasible.

Dutch elm disease and phloem necrosis are primarily responsible for dead and dying elms in the South. Since flagging or browned leaves are symptoms of both diseases, it is difficult to distinguish one from the other where both diseases occur in the same area. Dutch elm disease occurs mainly in the North but is moving further South each year. There is no practical control for either disease, but their spread can be checked by controlling insect vectors.

NURSERIES AND PLANTATIONS

With increasing emphasis now being placed on growing hardwoods in plantations, insects and diseases that attack pure stands are becoming more important. Plantation culture of cottonwood is further advanced than that of any other southern hardwood and most of this discussion will center on cottonwood, but work has been done on several other species.

Insects

Insects that cause relatively minor damage in mixed stands can cause severe damage in nurseries and large pure plantings. Cottonwood is the only southern bottomland hardwood that has been planted extensively enough to indicate problems that can be anticipated in large plantations. Experience gained in cottonwood nurseries and plantations is detailed below. Although other tree species are not mentioned, insect problems larger than those experienced in mixed stands should be anticipated in plantations.

The two large trunk boring beetles mentioned in the discussion of natural stands also are a problem in young cottonwood plantations. The cottonwood borer can so weaken first-year nursery and plantation trees at the ground-line that they will break off in high winds. Losses could be very heavy if a large population builds up in the year after planting. Poplar borer damage is similar in 4-year-old and older plantations as in natural stands of cottonwood.

Another borer that has become a problem in young plantings is the cottonwood clearwing borer (Paranthrene dollii). This insect is especially troublesome in 2- and 3-year-old root stocks in nurseries that produce cuttings. Clearwing borers overwintering in the stools left after cuttings are taken and attack new sprouts the following year causing breakage and loss of the cuttings. Another trunk and branch borer that is showing up in large numbers in some cottonwood plantations in the Mississippi Delta is an Oberea species,

probably O. schauimi. Attacks can cause stem breakage but we do not know what losses will occur if the population of this insect continues to build up in large plantations.

The cottonwood twig borer, Gypsonoma haimbachiana, injures terminal shoots of young cottonwoods. The adult is a small moth similar to the pine tip moth. It infests branch and terminal tips of trees of all sizes, but the greatest damage is to 1- to 3-year-old trees (Morris 1967). The larvae tunnel into and feed on tender tips, stunting growth of the twig, killing the terminal bud, or both. This damage is not as severe on fast- as on slow-growing trees. On some poor sites the cottonwood twig borer has reduced cottonwoods to multi-stemmed shrubs. Because of the rapid growth of young cottonwood and overlapping generations of the cottonwood twig borer, systemic insecticides seem better than surface sprays for control of this insect.

A tractor-drawn subsoil applicator developed by Abrahamson places granular systemic insecticides in the ground. The chemical is placed from 6 to 18 inches deep near the roots of the trees. No handling of the chemical is required except for placing it in the applicator hopper. With this treatment method, neither the operator, wildlife in the area, nor beneficial insects come in contact with the chemical. Tests have shown that a carbamate material, carbofuran, is an excellent systemic insecticide for cottonwood trees when placed in the soil near their roots. Carbofuran effectively controls not only the cottonwood twig borer, but also the cottonwood clearwing borer and the cottonwood leaf beetle. Carbofuran does not seem to move very far in the soil, so there is little chance of polluting any water sources that would be near a treated plantation or nursery. This is one of the most promising chemicals for control of plantation insects where pollution and hazard are prime considerations.

Two other twig borers (Paranthrene tricincta and Oberea delongi) in cottonwood sometimes damage terminal shoots, but they usually attack the branches and do not cause serious damage to the tree.

The cottonwood leaf beetle (Chrysomela scripta) has developed into the most serious pest of young cottonwood trees. Before large plantings were established, the leaf beetle was present in endemic numbers that very seldom built up to epidemic proportions. It has built up more and more each year and, in the last few years, has become epidemic in the spring as well as in the late summer and fall in cottonwood plantations and nurseries. The tender leaf and stem tissues are consumed and the terminal bud may be damaged. Six to ten inches of the terminal are often killed. In addition to a growth loss, dieback of the terminal is followed by forking of the tree when growth resumes. Both larval and adult leaf beetles feed on foliage, and they are capable of producing up to eight generations per year.^{2/} The more vigorously

^{2/} Personal communication, Robert Head, Mississippi State University.

the tree grows, the more damage that can be expected from the leaf beetle, especially in the fall of the year. These beetles are held in check during most of the year by a number of parasites and predators, particularly a ladybird beetle (Colleomagilla maculata) which feeds on eggs and larvae. This insect reduces the spring epidemic but its numbers decline and it cannot control the fall outbreak of the leaf beetle. Artificial control may be necessary during heavy build-ups, but special care must be taken with a spring or early summer spray program. If ladybird beetles are also killed, serious outbreaks of the leaf beetle may recur throughout the summer. Carbofuran systemic insecticide soil applications have shown great promise in controlling the leaf beetle without any disastrous effects on non-target organisms. Research is being continued on this method of control.

Last year 65,000 adult and larval leaf beetles were sent to the Insecticide Evaluation Laboratory of the USDA Forest Service at Berkeley, California, to test the effectiveness of promising new ultra-low-volume insecticides. This year we hope to field-test two of the most promising insecticides (Dursban^R and Diazinon^R) on the leaf beetle. Hopefully, the systemic insecticide carbofuran will control the leaf beetle economically during the first year and possibly during the first half of the second year. Presumably, ULV sprays would only be used when systemics are not working, as during extremely dry spells, and then only if the trees are being heavily damaged and beneficial insects are not multiplying to protect them.

During times of low moisture, Eriophyid mites and leafhoppers can become a problem on young cottonwood trees. They greatly reduce tree vigor and cause a growth loss. The mites, Aculus lobulifera, are associated with a leaf-curl disorder (Morris 1967) that appears to be a phytotoxic reaction of the leaves to the feeding mites. These problems are reduced by a heavy rain.

There are other minor insects on cottonwood trees that are not problems now but may be in the future. Large single species plantations are just what an insect needs for an outbreak if other factors are right.

If we create large even-aged plantations of single species, we must expect epidemics of many insect pests and we must be prepared to control them either chemically or biologically. Any control measure must be thoroughly researched to learn its effects on beneficial insects, its pollution potential, its hazard to humans, fish, and wildlife, and its control of the insect pest itself.

Diseases

One of the most important and common nursery problems is damping-off, the decay near the soil line and death of young seedlings caused mostly by Rhizoctonia, Pythium, and Fusarium. If seedlings die before they emerge, the disease is called pre-emergence damping-off; mortality after emergence above

the ground is termed post-emergence damping-off. Pre-emergence damping-off is difficult to detect and is frequently attributed to poor seed. Post-emergence damping-off is characterized by a gradual wilting of the seedling, which remains upright until it breaks off near the soil line. The severity of damping-off is affected by temperature, moisture, and soil pH.

Root rots in the nursery are commonly caused by such fungi as Phymatotrichum omnivorum, Cylindrocladium scoparium, Armillaria mellea, and Fusarium oxysporium. Some can be avoided by proper selection of nursery site. Leaf diseases such as shothole, top blights, and wilts can also cause considerable losses in nurseries. Dr. T. H. Filer, Jr., Southern Hardwoods Laboratory, Stoneville, Mississippi, is currently doing research on the control of nursery and plantation diseases.

Annual application of fungicide to the soil or seedbed sterilization is generally recommended for hardwood seedling nurseries. Seed treatment and protective spraying of seedlings are also necessary.

Serious and widespread disease outbreaks have not been observed in southern hardwood plantations to date, but a few diseases could become serious. Sycamore anthracnose, previously discussed, is one example. Cottonwood leaf rust caused by Melampsora medusae is another. It has caused premature defoliation of some cottonwood clones in early autumn. Many orange-yellow pustules containing urediospores develop on the leaves prior to defoliation. The disease spreads from tree to tree by the urediospores.

Stem cankers could also become important. Septoria canker occurs on cottonwood, and the same fungus also causes a leaf spot. Cankers weaken stems and result in breakage. Large quantities of cuttings have been culled as a result of this disease. Botryodiplodia theobromae has been shown to cause a stem canker of sycamore. This fungus requires an injury point and is probably spread from diseased to noninfected trees by insects.

Any hardwood that is extensively planted can be expected to develop both insect and disease problems that are not evident in natural stands. These problems may be held in check most of the time by natural agents. Management should try to favor these natural controls and increase their effectiveness. However, epidemics of insect pests and pathogens will break out in single-aged stands from time to time, and artificial controls will be needed to augment the natural controls. Intensive management of each tree species will require intensive management of its insects and diseases.

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