FOREST HEALTH

THREATS TO SOUTH CAROLINA'S FORESTS

South Carolina
Forestry Commission

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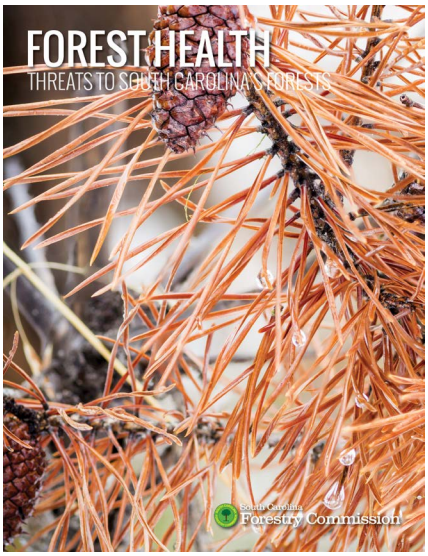

Forest Health: Threats to South Carolina's Forests, published by the South Carolina Forestry Commission, August 2016

This forest health manual highlights some of the insect pests and diseases you are likely to encounter in South Carolina's forests, as well as some threats that are on the horizon. The South Carolina Forestry Commission plans to expand on the manual, as well as adapt it into a portable manual that can be consulted in the field. The SCFC insect and disease staff hopes you find this manual helpful and welcomes any suggestions to improve it.

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Photo by Robert L. Anderson (USDA Forest Service, Bugwood.org)

DISEASES
OF STEMS, BRANCHES & TRUNKS

BEECH BARK DISEASE

Overview

This disease was first reported in Europe in 1849. The disease appeared in Nova Scotia in about 1920 and began to spread south and west. In 1929 it was first detected in Massachusetts. It has advanced along the Appalachian Mountains and is now found as far south as North Carolina and Tennessee. The beech scale, *Cryptococcus fagisuga*, damages the bark of infested beeches, allowing fungi in the genus *Neonectria* to infect the wounds. Both organisms are required for beech bark disease to occur. A native scale insect, *Xylococcus betulae*, which attacks a variety of tree species, can facilitate infection by *Neonectria* fungi, but to a lesser extent than the exotic *Cryptococcus fagisuga*. This disease is a serious threat to mature beech trees.

Hosts

Beech bark disease only infects mature beeches (genus *Fagus*). Young trees and sprouts from stumps are not affected.

Signs/symptoms

The woolly white beech scale only colonizes larger stems and branches, often starting on the north sides of trees. The fungus infects the tree through the wounds caused by feeding scale insects, killing the inner bark and resulting in an expanding orange-margined canker. Weeping wounds will appear when the fungus begins its infection. Orange fruiting bodies (perithecia) will form around the dead spot, especially in cool, wet autumns. The foliage of the tree becomes reduced in size, sparser and chlorotic.

Disease cycle

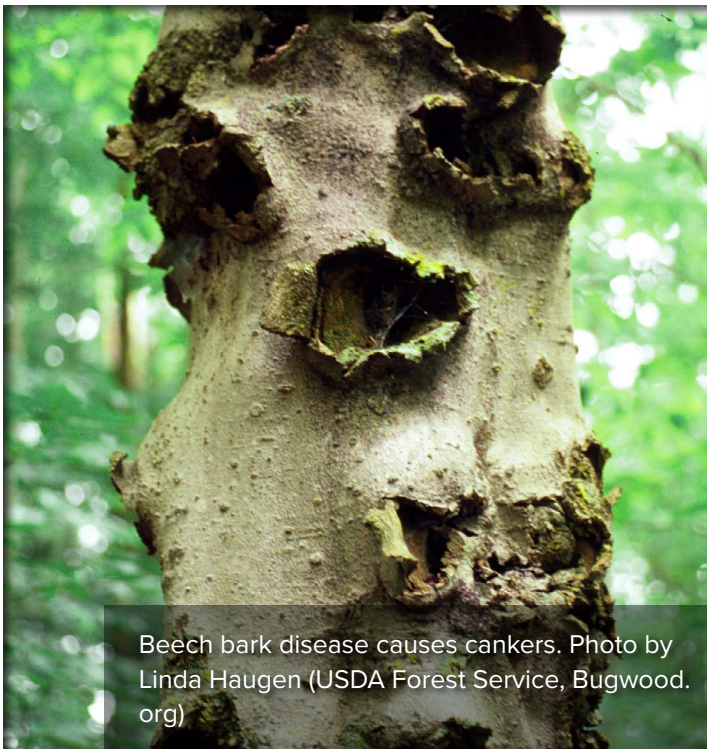
The beech scale, *Cryptococcus fagisuga*, feeds on the bark, creating a wound. Fungi in the genus *Neonectria* (*N. faginata* and *N. ditissima*) invade the wounds and create cankers. Spores are produced in orange-red fruiting bodies that form clusters on the bark. The fruiting bodies mature in the fall and release their spores in moist weather to be dispersed by the wind. Cankers continue to form, eventually killing the tree. The wood of infested trees may be weakened and can be blown over by stronger winds.

Timeline

The distinctive orange fruiting bodies of the fungus are produced in cool, wet weather in the fall. The insect can be found all year, but eggs and crawlers, the juvenile dispersal stage, are found in the mid to late summer.

Range

So far, beech bark disease has not been reported in South Carolina, but it is found in the mountains of neighboring North Carolina.



Beech bark disease causes cankers. Photo by Linda Haugen (USDA Forest Service, Bugwood.org)

An American beech has Cryptococcus on its trunk. Photo by Joseph O'Brien (USDA Forest Service, Bugwood.org)

Management

Trees that die back and produce sprouts appear to be resistant to scale attack. Infected and dying trees can be removed to reduce inoculum. Appropriate insecticides — systemic, if available, and properly timed horticultural oils — can be effective at controlling the scale insects, but timing and coverage is key; time applications to coincide with crawler populations in the mid to late summer.

FIRE BLIGHT

Overview

Fire blight is a bacterial disease caused by the bacterium *Erwinia amylovora* that infects apples, pears and some other members of the Rosaceae family. Fire blight dramatically reduces fruit yields in infected trees (blossoms abort). Systemic infections that reach the roots or graft junction often kill the trees.

Hosts

Fire blight only infects members of the Rosaceae family. Pears are most susceptible, but apples, loquats, crabapples, quinces, hawthorns, cotoneaster, pyracantha and raspberry can also be infected.

Signs/symptoms

Infected flowers darken, wilt and shrivel, finally turning black, as if they have been scorched. Lesions appear on fruit, leaves and green shoots. Cankers can also form on branches and stems.

Disease cycle

Leaves, flowers and fruit may be infected by rain splash, insect vectors (including honey bees visiting flowers) and by infected tools. Wounds caused by hail often allow entry of the bacteria.

Timeline

This disease is most severe in warm, wet years, particularly in the spring when the hosts are blooming. The bacteria is dormant when temperatures are low.

Range

Fire blight is native to North America.

Management

Once the bacteria enters the vascular system of the host, it can be transported to the roots of the tree, usually resulting in the death of the tree. Pruning infected branches at least one foot below the symptoms can prevent or slow the spread, but pruning can induce watersprouts or midsummer growth, making trees susceptible to further infections. Pruned branches should be removed from the site and destroyed to avoid spreading the disease. Similarly, application of nitrogen fertilizers will induce growth and should be avoided. Antibiotics have been applied to prevent infections, but this has resulted in some strains of fire blight developing resistance to antibiotics. There has been some success inoculating stems/blossoms with innocuous bacteria or yeasts that outcompete the pathogen. Application of fertilizers or other practices that stimulate new growth should be avoided, as this can increase infection.

An apple tree has symptoms of fire blight. Photo by Robert L. Anderson (USDA Forest Service, Bugwood.org)

FUSIFORM RUST

Overview

This is the most common fungal disease in southern pines and has resulted in millions of dollars in losses in timber. The rust fungus, *Cronartium quercum*, causes this disease. Infected trees grow slower and are susceptible to wind damage and attack by bark beetles. Fusiform rust can cause mortality on young pines. Although still prominent in the southern landscape, fusiform rust is less of a problem thanks to breeding and selection of resistant or tolerant pines.

Hosts

This is a serious disease of slash and loblolly pines, though pitch and pond pine are also infected. Longleaf pines are moderately resistant, and shortleaf pines are very resistant.

Signs/symptoms

Infection results in spindle-shaped swellings on stems and branches, deforming trees and reducing growth. Orange spots (spores) form on the canker in the cool, wet weather in spring, and these spores go on to infect oak foliage.

Disease cycle

Like many rust fungi, it requires an alternate host to complete its life cycle. Common alternative hosts include, water oak, willow oak, laurel oak, blackjack oak, southern red oak, and turkey oaks. Orange spores form on the underside of foliage of alternate hosts, building up inoculum. Approximately a week later brown spores form on the underside of the foliage. These brown spores can survive for several months on the foliage or in the leaf litter until conditions are ideal for basidiospore formation (60° - 80° F and high humidity). The basidiospores infect needles, young shoots and areas with thin bark on the pine hosts. The fungus produces growth regulators that induce gall formation in the stem. The orange spores that form on the gall allow the fungus to reproduce sexually. The resulting spores cannot infect a pine and can only develop on the foliage of the alternate hosts.

Timeline

The orange sexual spores are produced on the galls on pines in early spring. Infection of oak foliage soon follows. Infection of pines by basidiospores is most common in late spring and early summer.

A young pine has fusiform rust. Photo by USDA Forest Service (Region 8, Bugwood.org)

Range

This fungal pathogen is found in the southeastern U.S., from Maryland to Florida and west to Texas and Arkansas.

Management

Genetically improved pines are resistant or at least tolerant to fusiform rust and should be planted. Areas that are known to have historically high incidences of fusiform rust should be avoided as planting sites. Infected limbs should be pruned to keep the infection from getting to the trunk. Fertilization and other practices that stimulate growth can increase infection and should be avoided.

HYPOXYLON CANKER OR DIEBACK

Overview

Various species of *Hypoxylon* fungus cause this disease. Most species of fungi in the genus *Hypoxylon* are strictly saprophytic, decaying the bark and wood of trees and

A dying oak has an early stage of a stromatal mat on its bark. Photo by David Jenkins (SCFC)

shrubs that have been stressed by other factors, including heat, drought, root injury, toxic chemicals or other disease. *Hypoxylon* can often be found as a latent colonist on healthy oaks ready to take advantage of sick trees. Oaks killed by oak wilt fungus can be rapidly colonized by *Hypoxylon* fungi. *Hypoxylon* depletes starch and sugars found in the sapwood, depriving the oak wilt pathogen of the nutrients it needs for colonization and sporulation. This competition is much more important in areas where oak wilt is spread through root grafts than by insect vectors. This disease is a secondary invader that is usually an indicator of other stressors weakening the tree.

Hosts

Hypoxylon canker or dieback infects a variety of hardwoods, especially oaks.

Signs/symptoms

Infected trees often produce stromata beneath the bark. Stromata usually appear a year after drought or other severe stress. Infected trees die soon after production of the stromatal mat in the cambium layer. Oaks in the red oak group are more susceptible than oaks in the white oak group. As the disease progresses, the tree becomes stressed, and the foliage may yellow and/or wilt. Pressure from the stromatal mat on the decayed inner bark may cause the outer bark to peel off, often in large strips. Infection by *Hypoxylon* fungi results in a light brown discoloration of the sapwood, followed by a yellow decay with black zone lines. Stromatal mats are thin and tan to gray. Powdery conidia produced in the tan stage may be released as a cloud if the stroma is disturbed. *Hypoxylon* prefers warm climates.

Disease cycle

Hypoxylon is probably omnipresent, spores waiting for trees to weaken. As soon as the tree's defenses are down, *Hypoxlon* causes rapid decline.

Timeline

Symptoms of this fungus can be found throughout the year.

Range

Hypoxylon canker or dieback is cosmopolitan and found throughout South Carolina.

Management

Once you see the *Hypoxylon* spore mats it is too late. The best prevention is maintaining good tree health by providing adequate water, space, and nutrients; avoid nitrogen-rich fertilizers.

PITCH CANKER

Overview

The fungus *Fusarium circinatum* causes pitch canker. Infection by this fungus results in resin-soaked cankers on the inner bark and outer sapwood of many pine species. Infections can cause deformities, reduce growth and kill branches and occasionally the entire tree. The fungus needs a wound to enter the tree and will use pruning wounds, mechanical damage or insect feeding to this end. In the southeastern U.S. this disease usually limits itself, but in coastal California the disease progresses continuously. Although some Monterey pines are tolerant or even resistant, most are susceptible. Monterey pines are the most widely planted forest tree in the world, so the potential for this disease is devastating.

Hosts

This disease infects all species of southern pine.

Signs/symptoms

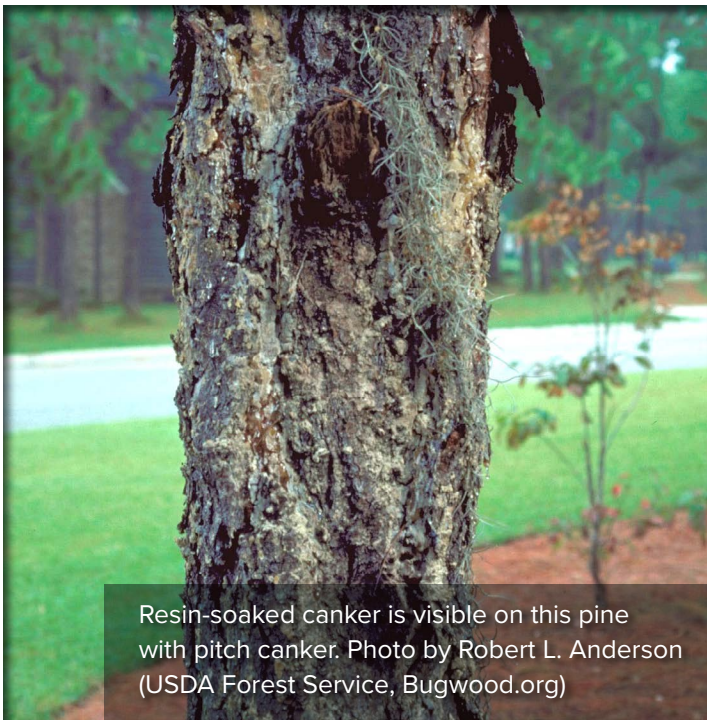
The main symptom of this disease are resin-soaked cankers, usually starting near the top of the tree. Dying back of the highest or terminal branches is common. Branches, the trunk and exposed roots may be discolored under the bark. Infection proceeds from the tips of the branches down, causing needles to turn brown. Symptoms most commonly appear in the winter. Infected trees often are also infected with fusiform rust.

Disease cycle

Bark, cone and twig beetles may all carry the disease to new hosts, but spores can also be moved by air and rain splash. Moisture is probably necessary for infection. The pathogen progresses faster at higher temperatures and grows poorly at temperatures below 50° F (10° C). In the southeastern U.S., pitch canker epidemics usually follow episodes of wounding (bad weather that damages the bark or pruning). The disease usually runs its course and peters out. Infections in California appear to be continuous, perhaps because insects are a main vector there. The canker spreads, girdling and killing branch tips. This disease can result in reduced seed germination.

Timeline

Infection can occur at any time of the year in the southeast,



Resin-soaked canker is visible on this pine with pitch canker. Photo by Robert L. Anderson (USDA Forest Service, Bugwood.org)

Flagging of terminals is present on an infected pine. Photo by Robert L. Anderson (USDA Forest Service, Bugwood.org)

but is most common in cool, wet weather and after weather that damages the trees, allowing fungal spores to enter. Symptoms are most visible in the spring and fall.

Range

Pitch canker occurs throughout the southeastern U.S. and along coastal California.

Management

Many trees infected with pitch canker disease can recover and often show resistance in later outbreaks. Removing symptomatic branches, if the disease is limited in extent, can eliminate the disease from the tree. However, re-infection can occur, especially if the disease is well established in a stand. Application of nitrogen-rich fertilizers can exacerbate pitch canker disease and should be avoided.

WETWOOD/SLIME FLUX

Overview

This is an infection caused by a variety of common soil-borne bacteria and yeasts, often facultatively anaerobic, that cause the limbs or trunk to be water-soaked. It attacks the sapwood and heartwood of the tree. In rare cases wetwood can disrupt vascular transport, resulting in limb dieback. Wetwood is common, but most trees can survive wetwood infections with little reduction in their fitness. In fact, infection with bacteria that cause wetwood often protect the tree from more damaging fungal infections due to

anaerobic conditions and a high pH. Although the bacteria that cause wetwood do not cause decay, products made from wood that has been infected with wetwood bacteria are more susceptible to termites, carpenter ants and rot-causing fungi. Also, products made from infected wood do not hold paint well.

Hosts

Wetwood is common in elms (*Ulmus* spp.), but also in many other species, including oaks, maples and many more. It occurs in conifers as well.

Signs/symptoms

It often has a sour smell, and a variety of bees, wasps and other insects are attracted to the fluid. The methane produced is odorless, but flammable.

Disease cycle

The bacteria or yeasts gain access to the sapwood and heartwood through wounds. To digest the cellular contents of the wood, these microorganisms secrete enzymes that cause cells to leak their contents. The infected wood becomes saturated with the released water and cell elements, raising the pH. The excess water creates an anaerobic environment where most wood-rotting fungi can't survive. The anaerobic respiration of the bacteria and yeasts produces methane. The pressure built up by the increasing volume of methane can cause the bark to split.

Timeline

Bacterial activity increases in warmer weather, resulting in increased methane production and splitting of the bark.

Range

This condition is cosmopolitan.

Management

Management is not required. Avoiding wounds to the trunk and roots will reduce the chances that bacteria can enter and begin the process.

A maple tree has wetwood leak. Photo by David Jenkins (SCFC)

DISEASES OF ROOTS

ARMILLARIA ROOT ROT

Overview

Various fungi in the genus *Armillaria* cause this disease. The fungi in this genus can grow on living, decaying and dead plant tissue. *Armillaria* is particularly long-lived, existing as an endemic part of hardwood forests throughout the world.

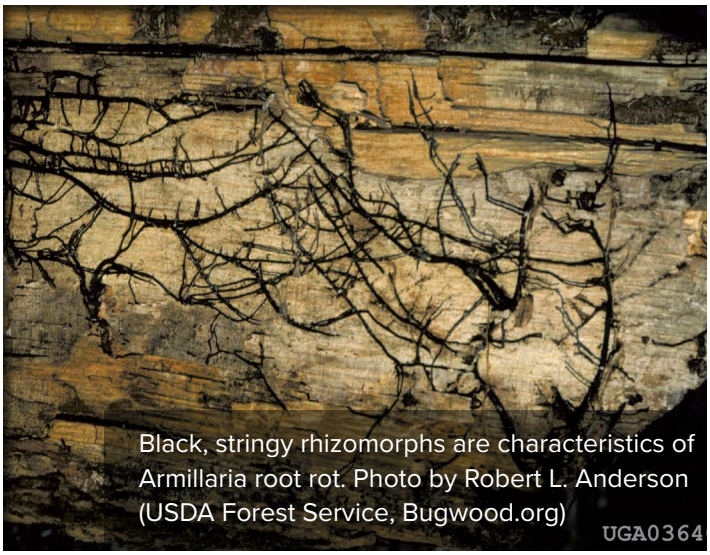
Hosts

This disease infects hardwoods and conifers. In hardwoods this fungus generally behaves like an aggressive saprobe, causing little damage until the tree is stressed by drought or defoliation. However, *Armillaria* can be pathogenic to healthy conifers.

Signs/symptoms

Symptoms of this disease are reduced terminal growth, especially apparent in infected conifers, dieback of twigs and branches (most apparent in hardwoods), chlorotic needles, stunted foliage, premature fall coloration, resin production at the base of infected conifers and stress crop of cones or fruits. The mycelia glow in the dark. Soft, white mycelial fans can be seen under the bark of living trees. These mycelial fans may leave distinctive impressions long after the tree is dead and the mycelia are gone. The black, stringy rhizomorphs of *Armillaria* are characteristic of this disease.


Armillaria mushrooms are located at the base of an infected tree. Photo by David Jenkins (SCFC)


Black, stringy rhizomorphs are characteristics of Armillaria root rot. Photo by Robert L. Anderson (USDA Forest Service, Bugwood.org)
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Disease cycle

Much of the research on *Armillaria* was conducted when they were all considered one or a few species. Now that we know there are at least 40 species worldwide, it is unclear how much of the known biology is applicable to multiple species, especially their capacity to attack vigorous trees, a characteristic that probably varies quite a bit from species to species. All species of *Armillaria* can survive 50 years or more feeding saprophytically on stumps and other woody substrates in the soil, infecting trees planted on that site. In fact, wood, particularly tree roots, is the principle source of inoculum. Especially virulent species are able to penetrate intact bark on trees. Rapid fungal growth allows it to escape developing periderm tissue meant to contain it. It also produces chemicals that break down secondary compounds produced by the tree to control fungal growth. *Armillaria* can spread to healthy trees from the roots of infected trees

via root grafts and rhizomorphs. The mushrooms produce spores that are dispersed by the wind to new sites. *Armillaria* infections have consistently occurred in fruit orchards planted on land cleared of hardwoods where *Armillaria* can be endemic.

Timeline

Infections can occur year-round. Symptoms may be easier to see during the active growth stage of trees in spring and summer. Fruiting bodies of *Armillaria* are most commonly found in the fall.

Range

Armillaria species are cosmopolitan in range and native species occur in the southeast.

Management

Prescribed burns, stump treatment, fertilization, and wide spacing do not remove spores or reduce infection rates. Removing stumps reduces spore inoculum in the soil. Planting resistant species and maintaining tree vigor are management strategies to combat *Armillaria*. Antagonistic fungi, such as *Trichoderma* spp., that are able to control other pathogenic diseases are not very effective against *Armillaria* because of its production of antibiotics to fend off competitors.

HETEROBASIDION/ANNOSUS ROOT DISEASE

Overview

This disease is known by different names, depending on the age of the forester. Although most foresters call it annosus root rot, older foresters call it *Fomes*, and the youngest call it *Heterobasidion* disease. The fungus *Heterobasidion annosum* is the causal agent. This root-rot is the most prevalent fungal disease of pines in the southeastern U.S. after fusiform rust. It is most common in recently thinned pine plantations that are at least 18 years old.

Hosts

All pines and members of the *Pinaceae* are susceptible, but infection is not as common in spruce, fir and cedar.

Signs/symptoms

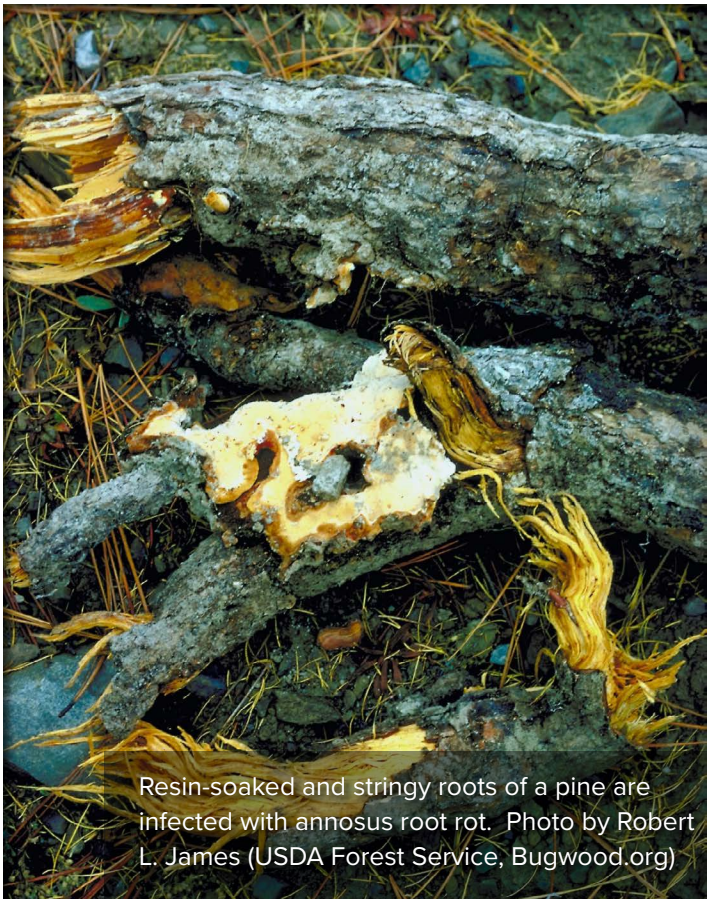
Crowns will thin and needles will be stunted, discolored and tufted at the shoot tips. Often, dead trees will have green needles through winter, disguising the infection. Because they have lost structural support, these otherwise apparently healthy trees may fall over, and that is the first indication that annosus may be a problem. Roots of infected trees will be resin-soaked, and stringy white rot can be seen on wind-thrown trees. In late winter or early spring, rubbery conks, or fungal fruiting bodies, may appear at the base of the tree, sometimes under the duff layer. These are not as durable as many conks and are easily destroyed and may not be visible. Mortality caused by annosus root rot will be spotty, clustered in several spots in the stand.

Disease cycle

The fungus invades stumps of freshly cut trees and spreads to adjacent trees through interconnected root systems (root grafts). The large roots at the base of the tree are decomposed, reducing uptake of water and nutrients, as well as reducing their anchorage, making them more susceptible to wind-throw.

Timeline

Spores are most commonly produced in the fall or winter in South Carolina, so sites in the "annosus belt" should be thinned in the summer (July and August).



Resin-soaked and stringy roots of a pine are infected with annosus root rot. Photo by Robert L. James (USDA Forest Service, Bugwood.org)

Rubbery conks appear at the base of a tree with Heterobasidion. Photo by Minnesota Department of Natural Resources (Bugwood.org)

Range

This disease is native to North America and cosmopolitan in temperate climates.

Management

If thinning must be done in the winter months, stumps should be treated as soon as possible (within 24 hours) with borax to prevent infection. *Phlebiopsis gigantea*, another saprophytic fungus that commonly colonizes old stumps, has been shown to outcompete annosus growth on new stumps and may play a role in future biocontrol of annosus root-rot. Plantations on old agricultural land and very sandy loam soils are very susceptible to annosus root-rot. Replanting on a harvested site does not pose a significantly higher risk in the southeastern U.S. because the spores do not last more than five or six years in our climate. The trees are still too young, and their roots are not interconnected at this age, so, although there may be limited die-off of seedlings adjacent to or on top of infected stumps, most trees will remain healthy.

LUCIDUS ROOT AND BUTT ROT

Overview

This white rot fungus is common in weakened or stressed hardwoods in the southeastern U.S. The fungus *Ganoderma lucidus* is the causal agent.

Hosts

This fungus is common in many southern hardwoods, including oaks, maples, hackberry, ash, sweetgum, locust, elm, mimosa and willows.

Signs/symptoms

Infected trees can decline over a period of years before dying, or the decline may be rapid. Conks, or fruiting bodies, are produced from exposed roots or from the butt of the infected tree. The fruiting bodies have a stem with yellow to reddish colored caps. The undersurface is white and porous. Conks are persistent and tough. Twigs show reduced growth, and the foliage may be sparse, smaller than normal and chlorotic (yellow). Infected roots are white and spongy with black flecks or dark lines.

Disease cycle

Stressed or wounded trees are most often attacked by *Ganoderma lucidus*. Airborne spores infect wounded tissue, spreading up into the butt of the tree and/or down to the roots. Infection of healthy trees can occur through root grafts.

Timeline

Fruiting bodies of *Ganoderma lucidum* are most common from late summer to early spring, but are persistent and may be found all year.

Range

This fungus is cosmopolitan.

Management

Avoiding wounds to the base of the tree prevents colonization by the fungus. Maintaining tree vigor through irrigation and fertilization can reduce infections, as well as promote rapid wound healing. Removing infected trees can prevent the spread to healthy trees.

A fruiting body of Ganoderma lucidum is at the base of this infected tree. Photo by David Jenkins (SCFC)

PHYTOPHTHORA ROOT ROT/LITTLE LEAF DISEASE

Overview

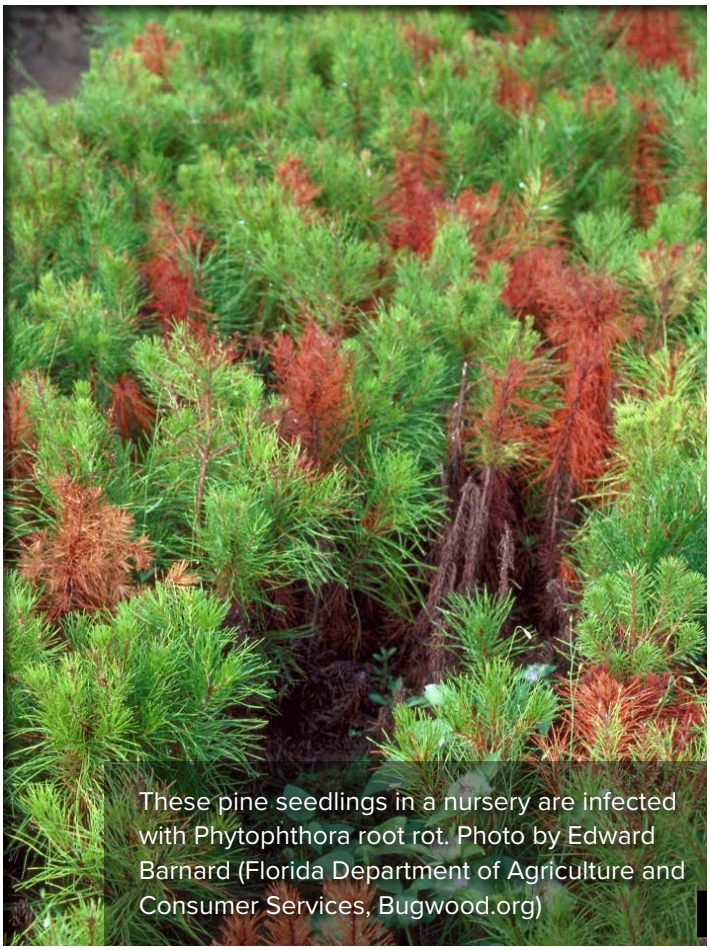
The watermold *Phytophthora cinnamomi* and other *Phytophtora* spp. are the causal agents. This watermold is prevalent in trees and shrubs whose roots remain wet for long periods of time. The roots are destroyed, interfering with water and nutrient uptake, eventually killing the infected tree. Although *Phytophthora* and other water molds are common in soils in the southeastern U.S., they are most damaging to trees planted on sites with poor drainage and low levels of essential elements.

Hosts

This disease infects hardwoods and conifers; shortleaf pine is very susceptible, especially when planted in nitrogen-poor soils. Oaks and dogwoods are also very susceptible.

Signs/symptoms

In most hosts, the first symptoms of root infection by *Phytophthora* spp. are nutrient deficiencies and drought stress, chlorotic foliage, shortening of needles in pines and reduced shoot growth. As the disease progresses in shortleaf pines, the crown looks thin and tufted; older needles will drop, leaving the shorter tufts. Branches begin dying in the lower crown and move up through the crown. In shortleaf pines growth is dramatically reduced and an abundant crop of small cones with mostly sterile seeds. The bark near the soil surface may be darkened, and the wood will be discolored to a reddish-brown.



These pine seedlings in a nursery are infected with Phytophthora root rot. Photo by Edward Barnard (Florida Department of Agriculture and Consumer Services, Bugwood.org)

Disease cycle

Phytophthora spp. can survive in the soil as spores for many years if moist conditions are common. The disease can be spread through splashing rain, irrigation water and runoff water, as well as through contaminated soil and equipment. Spread is most common in early spring or late fall during cool, wet weather, but symptoms are more likely to appear during stress. In shortleaf pines and other pines, the disease usually occurs in trees that are at least 20 years old. Trees can die within a year of infection or may hang on for more than a dozen years, but most trees die within six years. The watermold infects the rootlets, reducing uptake of nutrients. The symptoms are more pronounced in nitrogen poor soils and when plant pathogenic nematodes and/or the watermold *Pythium* is/are present.

Timeline

Spread of spores is most common in wet springs or autumns.

Range

Phytophthora root rot is cosmopolitan.

Management

Phytophthora is common in soils in the southeastern U.S., and most healthy pines can tolerate and overcome damage to the roots by the watermold. Planting in poor soils should be avoided. Sites with poor drainage and high soil moisture favor infection by *Phytophthora*. Heavily eroded soils, very firm or compacted soils, and subsoil mottling (grays and browns) are all indicators of a high-hazard site for *Phytophthora*. Avoid planting in these sites unless some remediation practices are put in place to improve the soil. Infected trees should be removed. Soil preparation, breaking up any hard-pans or compacted soil, and interplanting nitrogen-fixing species (*Robinia* or *Lespedeza*) can improve soil drainage and increase available nitrogen, making symptoms less dramatic.

Photo by Joseph O'Brien (USDA Forest Service, Bugwood.org)

DISEASES

VASCULAR

DUTCH ELM DISEASE

Overview

This fungal disease had an enormous impact on landscape trees in the eastern U.S. where elm trees had been an important component. In many of these neighborhoods, dead elms were replaced with ash trees, only to subsequently become infested with emerald ash borer. The fungi *Ophiostoma ulmi* and *O. novo-ulmi* cause this disease. It has had a devastating effect on the North American landscape, killing many American and European elms.

Hosts

Elms native to North America and Europe are very susceptible to Dutch elm disease, while elms native to Asia, the origin of the fungus, are tolerant to resistant.

Signs/symptoms

Since the fungus causes susceptible trees to block up the vascular system with tyloses and gums, symptoms are very similar to those caused by drought. An isolated region of the crown will wilt and turn yellow and then reddish-brown before dying. Larger portions of the crown will wilt in response to the spreading of the pathogen. Removing the bark on symptomatic branches or stems will reveal a dark brownish-purple streaking in the outer sapwood. Cross sections of infected elm stems will show dark stains in the outer vascular tissue. Elms infected through root grafts usually succumb more rapidly than trees infected by bark beetles.

A cross section of an elm branch infected with Dutch elm disease shows vascular streaking. Photo by Fabio Stergulc (Universita di Udine, Bugwood.org)

Disease cycle

This disease is transmitted by bark beetles and root grafts. Two species of bark beetle transmit this fungus in North America; *Scolytus multistriatus* is the smaller European elm bark beetle, and *Hylurgopinus rufipes* is the native elm bark beetle. Note that the "smaller European elm bark beetle" is actually bigger than the native elm bark beetle. These beetles feed on the tender bark of healthy trees, often in branch crotches, and infections vectored by beetles usually start there and spread. They reproduce in the trunks of dead or dying trees. Adults emerging from infected trees can then transmit the fungus to healthy trees when they feed.

Timeline

The vectors are active in the growing season. The wilt symptoms appear in the summer to early fall.

Range

Dutch elm disease is known from Europe, eastern North America and New Zealand.

Management

The vector insects are attracted to wounds, so pruning should be restricted to the winter when these beetles are not active. Removing diseased trees before elm beetles can transmit the fungus to new trees can slow the spread. Breeding has resulted in resistant varieties of elm. Although this disease occurs in the southeastern U.S., it is not reported very often. It may be that you are left with resistant trees, or the inoculum is low.

LAUREL WILT

Overview

Laurel wilt is an exotic fungus, *Raffaelea lauricola*, transmitted by an Asian ambrosia beetle, *Xyleborus glabratus*. However, native *Xyleborus* spp. can also transmit the fungus and may be more important in delivering it to some hosts, such as avocado. Populations of native Lauraceae (red bay, pond spice, sassafras) are being killed off. Populations of red bay have experienced nearly 100 percent mortality in some areas of coastal South Carolina and Georgia.

Hosts

Infection is limited to members of the Lauraceae, including red bay (*Persea borbonia*), sassafras, pond spice (Litsea aestivalis), which is rare, and spicebush (*Lindera benzoin*). It can also infect camphor trees, but the symptoms are much milder. There are many trees and shrubs called bays, but only those in the Laurel family are susceptible to laurel wilt.

Signs/symptoms

The fungus grows on the walls of galleries excavated by the exotic ambrosia beetle, *Xyleborus glabratus*. Susceptible trees respond by blocking vascular tissue with tyloses and gums, but this cuts off the transportation of water, resulting in rapid wilting and dying of the tree. Signs of the insect include small, round entrance holes on stems and branches of wilted and dead trees, tubes of sawdust emerging from dead trees (although these can easily be removed by wind or rain), and sawdust at the base of the tree. Symptoms of infection include changes in leaf color from green to olive-green and then to reddish-brown, dying and wilting. Dead leaves stay on the tree in red bay but fall quickly in sassafras. Death ensues weeks or months after infection. Sapwood is discolored dark purple or black in infected and dead trees.

A cross section of a sassafras stem has vascular staining. Photo by David Jenkins (SCFC)

Laurel wilt disease killed this red bay tree. Photo by David Jenkins (SCFC)

Disease cycle

Female *Xyleborus glabratus* beetles are attracted to volatiles emitted by laurel hosts and bore tunnels into the wood. They carry spores of the fungus *Raffaelea lauricola*, which grows on the walls of the excavated tunnels. Adults and larvae feed on the growing fungus. Susceptible trees respond to the fungus by forming tyloses, which are outgrowths of the xylem tissue, and producing gums that are meant to prevent the spread of the fungus to other parts of the plant. These blockages become extensive, preventing the transport of water and minerals from the soil to the foliage and the leaves begin to wilt and die. Female *Xyleborus glabratus* are attracted to volatiles, including ethanol given off by weakened trees, as well as the odor of the fungus, and move in on infected trees. Other ambrosia beetles are also attracted to the weakened trees, but because they are not usually attracted to healthy trees they are not an important means of transmission in forest settings. *Xyleborus glabratus* females tend to prefer larger trees, but as these die off, they will begin infesting smaller trees.

Timeline

The beetles are most active in the spring and summer, and that is when their signs are most visible. Symptoms in the red bays can be found all year long, but in sassafras they are better seen during the growing season.

Range

Since its discovery in 2002, this disease has spread rapidly throughout the southeastern states, particularly in coastal areas.

Management

For culturally valuable trees, there is a fungicide available. Otherwise, the best method of slowing the spread is to destroy (burn or chip) infested wood.

OAK WILT

Overview

Oak wilt is the most devastating disease of oaks in the eastern U.S. (Minnesota to Michigan and Pennsylvania, south along the Appalachians and west to Arkansas with extralimital outbreaks in Texas). The fungus *Ceratocystis fagacearum* causes oak wilt. This disease has not been described outside of the U.S.

Hosts

All oaks are susceptible, but those in the white oak group (*Quercus alba*, *Q. prinus*, *Q. michauxii*, *Q. bicolor*, *Q. stellata*) tend to be more tolerant than those in the red oak group (*Q. rubra*, *Q. falcata*, *Q. velutina*, *Q. laevis*, *Q. laurifolia*, *Q. phellos*, *Q. nigra*, *Q. coccinea*).

Signs/symptoms

Symptoms of infected oaks can differ quite a bit between these two groups and between regions (south versus north). Infected oaks in the red oak group usually succumb more quickly than oaks in the white oak group, which often have light symptoms and survive. In fact, this fungus has been used as a selective "herbicide" to remove oaks in the red group from land where they are unwanted. Infected oaks in the red oak group show foliage wilting and drop over the entire crown and no progressive branch dieback. Short-lived sprouts emerge but quickly dieback. Dark longitudinal streaks in the vascular tissue of the outer growth ring are often seen. The fungus multiplies in the tree's vascular system, shutting down water transport in the xylem tissue. This results in symptoms similar to those caused by drought. Symptoms often show up in the upper crown, changing color and wilting. Leaf tips begin to brown and progress inward, often leaving an abrupt border between dying tissue and green tissue. Mats of gray mycelium with raised black centers form on the surface of the wood and on the inner surface of the bark, especially in infected oaks of the red oak group. Formation of mats may be delayed until the following spring if the wilt begins in summer. These fungal mats are rarely seen in South Carolina and may cause fissures in the bark. Fungal mats have a fruity odor and are very attractive to sap beetles.

Disease cycle

Wounds caused by wind damage or mechanical damage associated with construction or pruning can be entry points for spores and beetles carrying the spores. The fungus most commonly spreads to neighboring trees through root-grafts, resulting in a center of dead trees surrounded by wilting trees. Oak bark beetles (*Pseudopityophthorus minutissimus* and *P. pruinosus*) and sap beetles can also transmit fungal spores to healthy trees, but only if sporulating mats are produced, which is rare in South Carolina and other warmer regions. Spores are produced for only a brief period after a tree dies.

Timeline

The fungus does not do well in high temperatures (>90° F), causing it to die in the smaller branches and stems of the tree in the summer. However, it does remain viable in the trunk and roots. The insect vectors are most active during the growing season.

Symptoms of oak wilt are visible on this oak. Photo by Joseph O'Brien (USDA Forest Service, Bugwood.org)

Range
So far, this disease is only found in North America. It is especially common in the Midwestern states and in Texas. In South Carolina it is most common in sandy soils where root grafts between oaks are more common.

Management
In the southeastern U.S., infections typically peter out. If management is required, the roots of infected trees need to be separated from those of healthy trees using a vibratory plow or trencher. Pruning should be avoided during the spring and summer when the insect vectors are most active. Reducing sporulation by drying the dead wood, for instance by deep girdling of the trunk soon after diagnosis, will also slow the spread of the disease.

SUDDEN OAK DEATH

Overview
Sudden oak death is a potentially devastating disease caused by Oomycete (watermold), *Phytophthora ramorum*, that has been detected in plant nurseries in South Carolina. This disease has caused massive die-off of native oak species in California and Oregon. Because oaks are such an integral part of eastern forests, sudden oak death has the potential to be devastating ecologically.

Hosts
This disease has an enormous host range but only causes serious damage in oak species. Of eastern oak species, red oak appears to be the most susceptible.

Signs/symptoms
Although called "sudden oak death," it usually takes several years for an infected oak to die. Cankers develop in inner bark and the outer portion of the sapwood, rapidly expanding to girdle the trees. Black or reddish liquid can often be found oozing from the cankers, staining the bark. The crown begins to die back. Infected trees often host secondary insects and pathogens, including ambrosia beetles, bark beetles, two-lined chestnut borers, Hypoxylon canker, and Armillaria root rot.

Disease cycle
Like all watermolds, *Phytophthora ramorum* produces more spores and is more mobile in humid conditions, especially overly-wet soils. The spores can multiply on the foliage of a number of non-oak hosts without killing these hosts. These foliar infections are an important source of inoculum to spread infections. Spores may be spread through rain splash, water, movement of infected plant material and movement of infected soil. Although the pathogen can spread from intact bark cankers on infected oak hosts, it does not usually do so, and oaks are probably only infected when exposed to spores produced on the foliage of nearby hosts.

Timeline
Infection can occur at any time of the year, but is a bigger threat in cool, wet weather and at sites with poor drainage.

Range
Currently, this disease is restricted to northern California

These oak trees have succumbed to sudden oak death. Photo by Joseph O'Brien (USDA Forest Service, Bugwood.org)

and Oregon, but the fact that many hosts show no detectable symptoms means that movement of nursery stock could easily bring this disease to the oak forests of the east. Most of the oak species common in the eastern U.S. appear to be susceptible.

Management

Currently, there are no management options for infected trees. Infections can be prevented by not moving potentially infected plant material. Soil amendment with fungi that are antagonistic to *Phytophthora* spp., such as *Trichoderma* spp., may become a management option in the near future.

THOUSAND CANKERS DISEASE

Overview

The fungus *Geosmithia morbida* vectored by the walnut twig borer, *Pityophthorus juglandis*, a beetle native to Arizona, California and New Mexico, cause thousand cankers disease. It is thought that the beetle and fungus are native to southwestern U.S. The beetle and fungus have usually been found together, but this is not always the case. Arizona walnut (*Juglans* major), a tree native to the region where the beetle and fungus are normally found, appears to be resistant to the disease, only succumbing when they are stressed or weakened. Plantings of black walnut in the southwest began to die off in 2001. Originally attributed to drought, walnut twig beetles and the fungus were shown to be the cause. In 2010 the disease and beetle were found in black walnut trees in Knoxville, Tenn., for the first time. Infestations can be transported in a single piece of walnut wood.

Hosts

This disease only infects trees in the genus *Juglans*, but black walnut appears to be the most susceptible. Black walnut is a valuable forest tree and timber tree.

Signs/symptoms

Symptoms include thinning crowns, stunted and undersized foliage, flagging of branches, chlorosis and wilting of foliage, and brown wilted foliage that remains on the tree. Infected trees often sprout shoots in response. Individual branches die in the upper crown and spread downward. The bark must be stripped away to see the cankers, which are associated with the beetle galleries. Infected branches often have many exit holes packed closely together. Symptoms may not be visible for 10-20 years after the original establishment.

Disease cycle

Beetles prefer to attack stressed trees. Male and female beetles emit aggregation pheromones that attract other beetles. Fungal spores are introduced by adult beetles when they construct their galleries. As the fungus grows, it produces cankers that disrupt the transport of nutrients throughout the tree.

Timeline

Infections are only likely to occur in the spring and summer when the vector insects are active. Symptoms may be most apparent when trees are actively growing.

Range

Besides being found in all western states, thousand cankers disease has also been reported in Indiana, Ohio, Maryland, North Carolina, Tennessee, Virginia and Pennsylvania. This disease has not been reported in South Carolina.

Management

The only management options are identifying and removing infected trees and restricting movement of infested wood to slow the spread.

Cankers are under the bark of a walnut tree infected with thousand cankers disease. Photo by Ned Tisserat (Colorado State University, Bugwood.org)

Photo by Chuck Bargeron (University of Georgia, Bugwood.org)

INSECT PESTS

BARK BORERS

BLACK TURPENTINE BEETLE

Overview

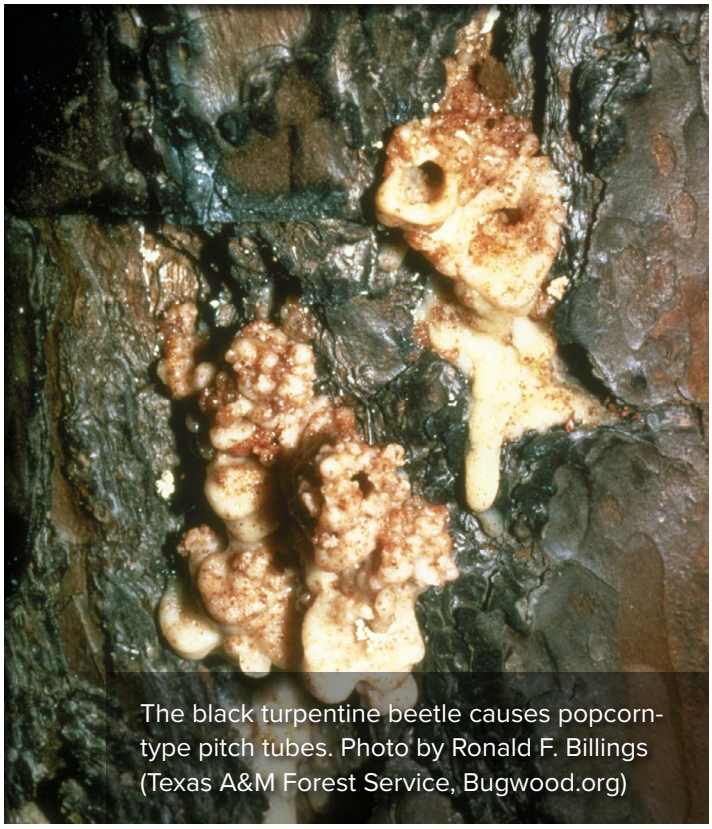
The black turpentine beetle, *Dendroctonus terebrans*, is rarely the primary cause of tree death, but will take advantage of weakened trees.

Hosts

Southern pines, particularly loblolly (*Pinus taeda*) and slash (*P. elliottii*), are the hosts, but shortleaf pine (*P. echinata*) and longleaf pine (*P. palustris*) are also attacked.

Signs/symptoms

This bark beetle attacks the lower 6 feet of the trunk, producing white pitch tubes resembling popcorn. It is the largest of the pine beetles (5-10 mm in length) and constructs large cave-like galleries in the bark that may etch onto the sapwood.



The black turpentine beetle causes popcorn-type pitch tubes. Photo by Ronald F. Billings (Texas A&M Forest Service, Bugwood.org)

Life cycle

Black turpentine beetles are attracted to smoke and turpentine and often turn up in forests that have been burned or thinned. The stumps and buttress roots of freshly cut pines are very attractive to the black turpentine beetle, but they will also move into living trees. The females excavate large galleries, laying eggs as they go. The larvae feed gregariously on the bark. It may take 10-16 weeks to go from an egg to an adult. Two or three generations occur each year in South Carolina.

Timeline

Adults, eggs and larvae can all be found overwintering under the bark of infested trees. Adults and larvae are active during the growing season.

Range

The black turpentine beetle is native to North America and ranges from central Atlantic and southern states. It has been recorded as far north as New Hampshire.

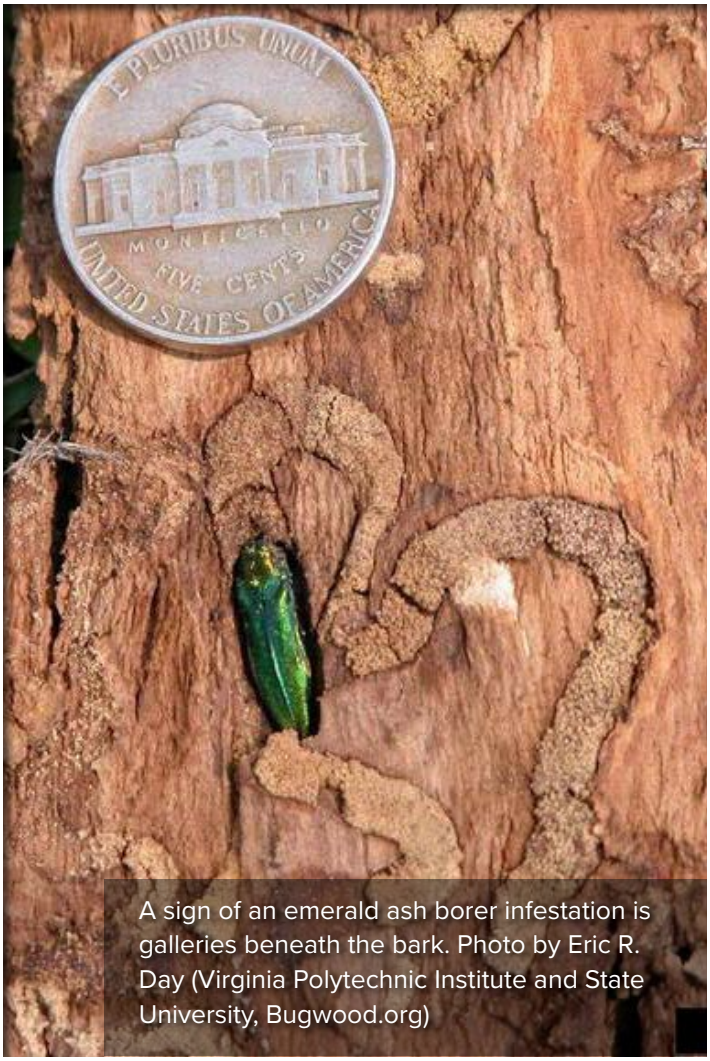
Management

Good silviculture practices go a long way in keeping this beetle at bay.

EMERALD ASH BORER

Overview

The emerald ash borer, *Agrilus planipennis*, is the most destructive insect pest of ash trees in North America, decimating ash trees in urban and forest environments.



A sign of an emerald ash borer infestation is galleries beneath the bark. Photo by Eric R. Day (Virginia Polytechnic Institute and State University, Bugwood.org)

Hosts
This insect pest attacks all native ash trees (*Fraxinus* spp.) and has been recorded from fringe trees (*Chionanthus virginicus*), both in the olive family. Manchurian ash is resistant, and there are hybrids between native ashes and Manchurian ash that are tolerant or even resistant.

Signs/symptoms
Adults are approximately 8.5 millimeters (0.33 inches). Symptoms include epicormic growth (shoots emerging from the base of the tree) and reduced foliage and chlorotic foliage. Signs of infestation include bark splitting, galleries beneath the bark and D-shaped emergence holes in the bark. Heavily infested trees often attract woodpeckers that feed on the larvae and the prepupae.

Life cycle
Adult emergence generally coincides with full bloom of black locust trees in the spring. The adults feed on ash foliage and lay eggs on the bark. The larvae chew through the bark into the phloem and cambium of the tree where they feed and develop. Infestations usually start high in the trees, moving down the trunk as the population of borers grows. Larval feeding in the phloem reduces the transport of nutrients and water, causing the tree to decline. Eventually, the feeding galleries girdle the tree, killing it.

Timeline
Adults emerge in the spring and, like most *Agrilus* spp., nibble on the foliage of their ash hosts. They mate, and the females oviposit in crevices in the bark. In cold environments or very healthy trees, it may take two years for a larva to mature to an adult.

Range
This buprestid beetle is native to Asia, but has invaded the northeast and Midwest of North America. It is steadily moving southward. Isolated populations have been recorded in the Upstate of South Carolina.

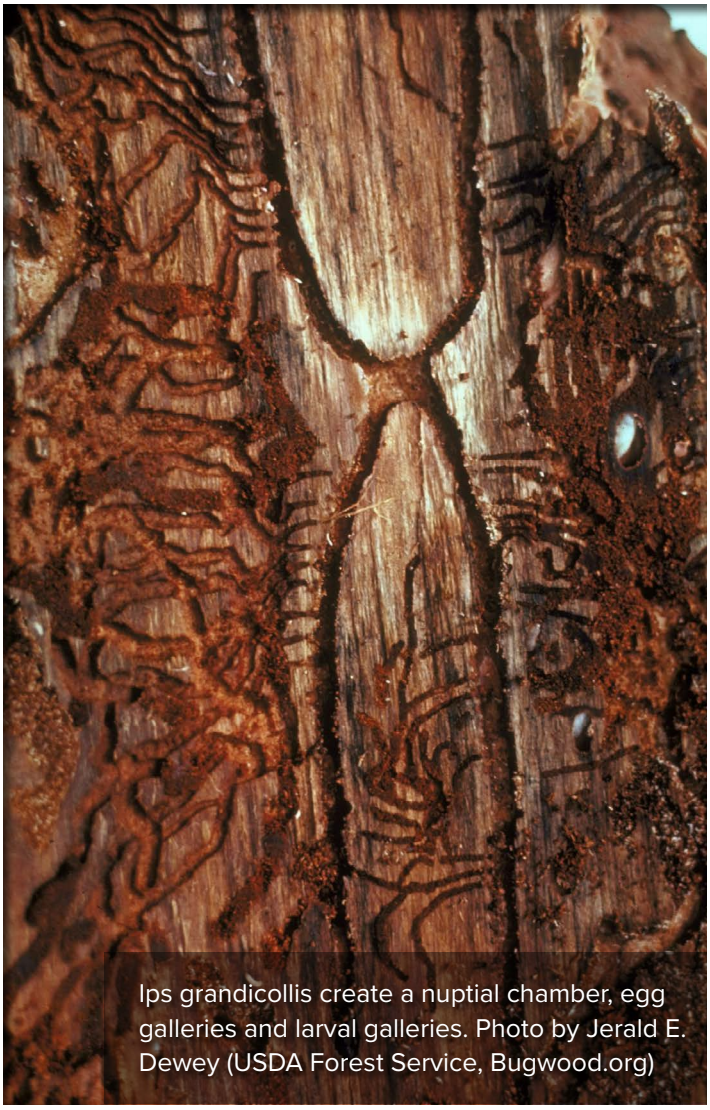
Management
There are systemic insecticides available to protect "high-value" trees.

IPS BEETLES

Overview
Although relatively common, *Ips* engraver beetles are not usually a threat to forest health. Their presence usually indicates something else wrong with the tree. Various scolytid beetles in the genus *Ips*, including *I. calligraphus*, *I. avulsus* and *I. grandicollis*, are the causal agents. Infestations are limited to dying or injured trees or recently cut trees.

Hosts
Ips engraver beetles attack pines (*Pinus* spp.) and spruce (*Picea* spp.). They will also occasionally attack larch (*Larix* spp.) and firs (*Abies* spp.).

Signs/symptoms
Most *Ips* engravers excavate egg galleries that are of more or less uniform width. The larval galleries radiate from these main galleries and expand as the larvae grow.



Ips grandicollis create a nuptial chamber, egg galleries and larval galleries. Photo by Jerald E. Dewey (USDA Forest Service, Bugwood.org)

The adults are very distinctive, most easily recognized by the concave posterior of the elytra surrounded by tooth-like projections.

Life cycle

Adults and larvae overwinter in galleries in the bark of host trees. Adults emerge in spring to attack susceptible trees. Unlike in *Dendroctonus*, it is the males in *Ips* that excavate the initial entrance hole to the bark and form the nuptial chambers. Multiple females mate with the male and form individual egg galleries radiating from the nuptial chamber, resulting in the "I", "Y" or "H" forms characteristic of Ips galleries. Eggs laid at regular intervals hatch into larvae that feed in galleries radiating from the egg galleries and that expand as the larvae grow. A new generation is produced approximately every two months during the growing season.

Timeline

Adults and larvae are active throughout the growing season. Activity is limited by cold weather.

Range

Beetles in the genus *Ips* are found throughout the Northern Hemisphere.

Management

Good silviculture practices that keep the forest and trees healthy keep trees from succumbing to *Ips* beetles.

SOUTHERN PINE BEETLE

Overview

The southern pine beetle is the most destructive insect pest of southern pine forests. The causal agent is the bark beetle species Dendroctonus frontalis. The generic name, Dendroctonus, means "tree destroyer," and the southern pine beetle has lived up to that reputation. It has destroyed thousands of acres of pines and continues to be the most significant threat to southern pine forests.

Hosts

Southern pines, particularly shortleaf pine (Pinus echinata) and loblolly pine (P. taeda), are the preferred hosts. Longleaf pine (P. palustris) is tolerant of southern pine beetles, but still susceptible to attack.

Signs/symptoms

Early in the infestation, popcorn-sized pitch tubes will be seen on the trunk; they may be high up the trunk, requiring binoculars to see. The female excavates S-shaped galleries that overlap. The needles will change from yellow to orange as the infestation progresses. Ambrosia beetles, Ips beetles and other secondary insects will begin to arrive, producing pale sawdust at the base of the tree. The beetles are 2.5 to 4 millimeters long and construct distinctive serpentine galleries.

Life cycle

Multiple overlapping generations (probably six or seven in South Carolina) of the southern pine beetle occur in the southern U.S. Female beetles seek out suitable, usually weakened, trees. She begins constructing an oviposition gallery and is soon joined by a male. They release pheromones that, combined with the chemicals released by the wounded tree, attract more bark beetles. Once a

host is completely colonized, the beetles begin to release a pheromone that keeps other beetles away. The larvae and adults feed on the phloem tissue of the tree, girdling the tree. Adult female beetles introduce a fungus that grows in the galleries. The fungus, Entomocortium, concentrates nitrogen from the cambial cells, increasing the growth of the beetles. Adult beetles may also introduce mites, which introduce the blue stain fungus, Ophiostoma minus. The blue stain fungus competes with Entomocortium, and larval growth of southern pine beetles is reduced in areas with blue stain fungus. Adults, larvae and eggs overwinter in infested trees, emerging in spring as adults to seek out new hosts. In outbreaks populations are so large that they are able to attack healthy trees and overcome their defenses, destroying thousands of acres of pines.

Timeline

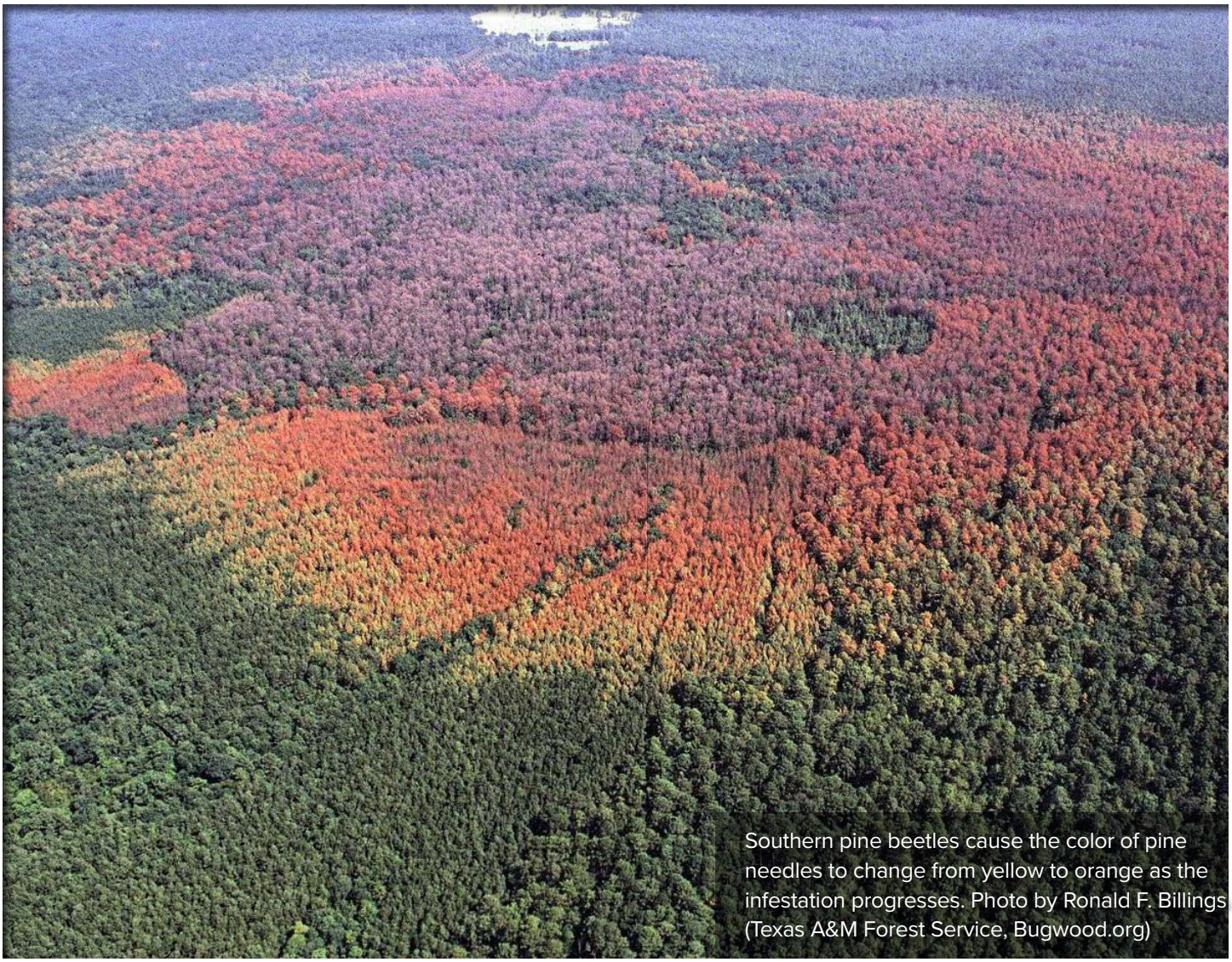
The southern pine beetle can be active all year in warm temperatures, but in South Carolina they emerge in early spring and are active through late fall. Historically outbreaks have occurred roughly every seven to 10 years.

Range

The southern pine beetle is native to North and Central America and ranges from New Jersey southwest to the Ohio Valley, south to Arizona, Texas and Mexico and Central America, and east to Florida. Only in the last decade has the southern pine beetle been recorded as far north as Long Island, New York.

Management

Management practices go a long way toward preventing southern pine beetle outbreaks. Thinning when appropriate or planting at wider spacing keeps pines from competing for light and space, resulting in healthier growth. Tolerant species, such as longleaf pine, can be planted in appropriate areas. Historically, outbreaks have been associated with drought.



Southern pine beetles cause the color of pine needles to change from yellow to orange as the infestation progresses. Photo by Ronald F. Billings (Texas A&M Forest Service, Bugwood.org)

TWOLINED CHESTNUT BORER

Overview

Generally, the twolined chestnut borer, *Agrilus bilineatus*, attacks declining or stressed oaks. Oaks that have suffered from drought, trunk and/or root injury, soil compaction and heavy defoliation by caterpillars are all vulnerable to attack by twolined chestnut borers. Attacked trees have typically died after two or three years of infestation. The larvae will overwinter in a burrow in the outer bark in a doubled-over position. The twolined chestnut borer, usually a secondary invader, is often associated with oak decline.

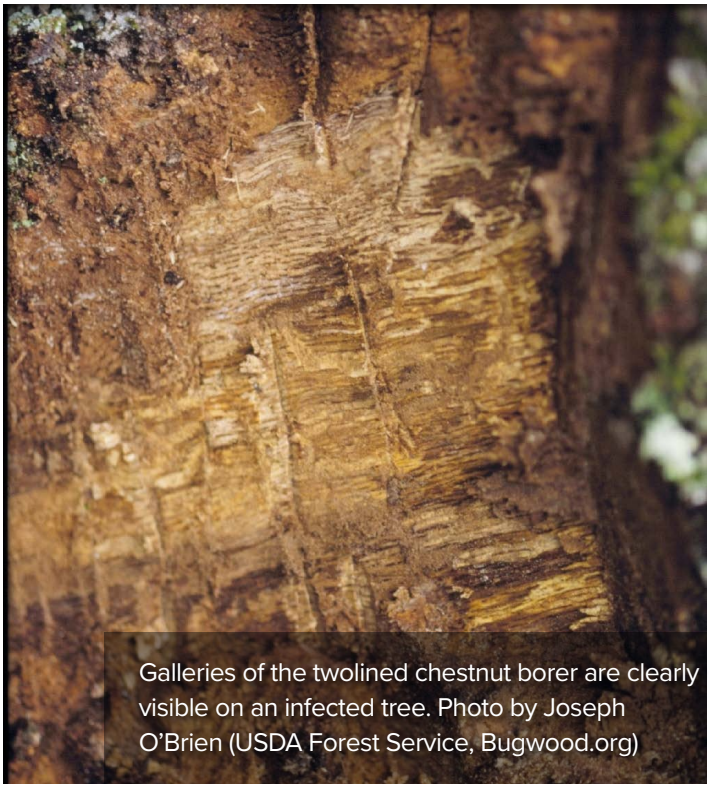
Hosts

When chestnuts (*Castanea dentata*) were common, this beetle attacked them, but now that chestnut trees are very rare, the twolined chestnut borer attacks oaks, which are related to chestnuts. Oaks commonly attacked include white oak (*Quercus alba*), scarlet oak (*Q. coccinea*), northern pin oak (*Q. ellipsoidalis*), bur oak (*Q. macrocarpa*), chestnut oak (*Q. prinus*), northern red oak (*Q. rubra*), post oak (*Q. stellata*), black oak (*Q. velutina*) and live oak (*Q. virginiana*).

Signs/symptoms

Adult beetles are slender black beetles 6 to 13 millimeters long with two yellow stripes along their elytra. The white larvae have the distinctive flat head of buprestid beetles and are about 25 millimeters when fully mature. Two sclerotized spines are visible at the terminal of the abdomen. These spines are also found on the larvae of the emerald ash borer, but few other borers have them. The adults tend to attack the crown first, moving downward in subsequent years of the infestation as the population grows. Foliage wilts and turns brown in the first year of the attack. The D-shaped exit holes will not be present the first year, but

Larvae of the twolined chestnut borer have the distinctive flat head of buprestid beetles. Photo by David Cappaert (Bugwood.org)



Galleries of the twolined chestnut borer are clearly visible on an infected tree. Photo by Joseph O'Brien (USDA Forest Service, Bugwood.org)

larvae and galleries will be common in the crown. The foliage will stay on the tree, falling off in the winter. Other phloem borers will begin to attack the tree as well. The exit holes will become more abundant as the populations of twolined borers infest lower parts of the tree. The larvae excavate meandering galleries through the phloem and the xylem, blocking the flow of nutrients and water. These galleries are clearly visible on the sapwood of infected trees.

Life cycle

Adults are active from spring until late summer. Adults feed on the foliage of their hosts trees, moving to branches and the trunk to mate. Eggs are laid in clusters in cracks in the bark. Larvae hatch between one and two weeks later.

Timeline

Pupae overwinter in cells in the sapwood and sometimes in the bark. Adults emerge in the spring and lay eggs in the bark of their hosts through spring and summer. Larvae take two years to mature.

Range

This native insect ranges from the Dakotas south to Texas and east to the Atlantic and Gulf coasts.

Management

Maintaining healthy trees goes a long way to keeping this borer out of oaks stressed by drought or defoliation.

Photo by David Jenkins (SCFC)

INSECT PESTS

WOOD BORERS

AMBROSIA BEETLES

Overview

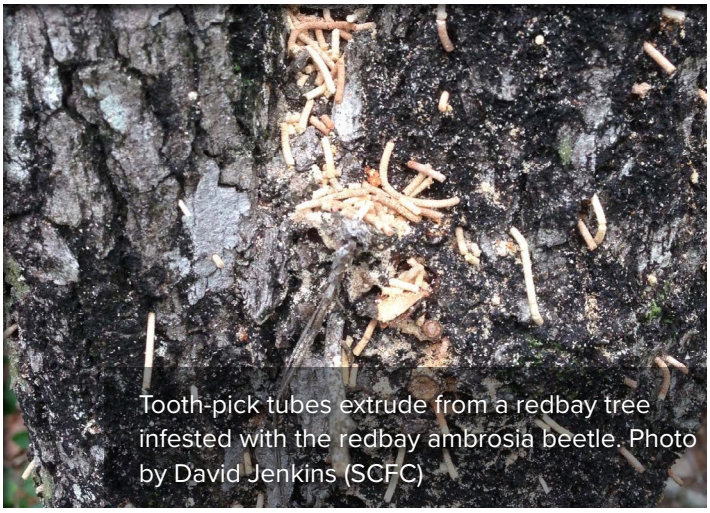
Beetles in the Platypodinae and Scolytinae subfamilies are the causal agents. Unlike the related bark beetles that limit their excavations to the bark, ambrosia beetles tunnel into the sapwood. However, they usually attack unhealthy or dead wood and are rarely a problem. They often move into trees that have been weakened by other pests or diseases. There are few exceptions. The redbay ambrosia beetle and the granulate ambrosia beetle are known to infest healthy trees.

Hosts

Ambrosia beetles have a variety of different hosts, including hardwoods and conifers. Although a few species have broad host ranges (granulate ambrosia beetle and the black twig borer), most attack a limited range of related species.

Signs/symptoms

Because ambrosia beetles need their tunnels free of sawdust to grow their fungus, they push the very fine, usually white sawdust out of their burrows. The sawdust can form toothpick-like extensions from the host and accumulate at the base of the tree. Pin-hole sized entrance and exit holes will be numerous in heavily infested trees. Tunnels are stained dark blue or black by the ambrosia fungus.



Tooth-pick tubes extrude from a redbay tree infested with the redbay ambrosia beetle. Photo by David Jenkins (SCFC)

Pin-hole sized boring damage will be present in heavily infested trees. Photo by W.H. Bennett (USDA Forest Service, Bugwood.org)

Life cycle

All ambrosia beetles excavate galleries in host trees and introduce a fungus that adult and larval beetles feed on. Although some species (redbay ambrosia beetle, the granulate ambrosia beetle and the black twig borer) attack living and healthy trees, most attack dying, recently cut trees, logs and stumps. Often their fungus cannot grow unless trees are sick. Except for rare cases, ambrosia fungi do not decay wood; most of them lack the required enzymes to do so. Ambrosia beetles require high humidity to successfully cultivate their fungi. Seasoned timber is not attacked. Their tunnels and fungal stains degrade lumber. In the South, trees cut in the summer that are left for more than two weeks can be severely damaged. Ambrosia beetle galleries can be distinguished from the galleries of other borers by their uniform diameter throughout, the absence of refuse in the galleries and the stain on their walls.

Timeline

Ambrosia beetles are active throughout the growing season, but are most active in the spring.

Range
Ambrosia beetles are cosmopolitan, but especially diverse in the tropics and subtropics.

Management
Management is usually not required. Infested trees can be removed and destroyed.

BLACK TWIG BORER

Overview
The black twig borer is similar to other ambrosia beetles in many respects, but *Xylosandrus compactus* is one of the few species that attacks living and healthy hosts and has a broad host range. Damage is generally cosmetic, though infestations by the black twig borer have resulted in economic damage to avocado and to coffee.

Hosts
The black twig borer has more than 200 host species, including hardwoods and conifers.

Signs/symptoms
The black twig borer infests twigs that are about 3/4 of an inch (2 centimeters) thick or less, resulting in wilted and dead foliage at the end of the infested branch within weeks of the infestation. The infested branches have small circular entrance holes made by the females that initiated the brood chamber.

Life cycle
Females excavate burrows in the pith of stems and lay eggs. In smaller branches there is generally a single female, but larger branches may accommodate more females. Males are flightless and are only found in the brood chambers. Adults and larvae feed gregariously on the ambrosia fungus cultivated on the chamber walls.

An adult female Xylosandrus compactus excavates burrows in the pith of stems and lays eggs. Photo by Pest and Diseases Image Library (Bugwood.org)

Timeline
Females attack twigs in early spring, and infestations continue throughout the growing season.

Range
This beetle is found throughout the tropics. It was first reported in North America in Ft. Lauderdale, Fla., in 1941 and has since expanded its range to include the Gulf states and north to Georgia, South Carolina and North Carolina.

Management
Management is not usually required, but removing and destroying infested branches can reduce the number of beetles that can infest adjacent trees.

GRANULATE AMBROSIA BEETLES

Overview
Like *Xyleborus glabratus*, the vector of laurel wilt, the scolytid beetle *Xylosandrus crassiusculus* is in the tribe Xyleborini. All members of this tribe have the head completely hidden by the pronotum when viewed from above. The flightless male is half as big as the female and looks dramatically different. Because of their large host range these can be very important pests in yard trees and nurseries. There is some indication that unhealthy trees or seedlings are more likely to be attacked.

Hosts
It has been recorded from over 200 species of trees, shrubs and vines, including sweetgum, Australian pine (casuarina), peaches, cherries, dogwood, aspen, crape myrtle, redbud, beech, locust, magnolia, Chinese elm, persimmon, tulip poplar, oaks and walnut are hosts among many others, but this beetle does not attack conifers.

Signs/symptoms
Like most ambrosia beetles, this beetle produces extruding tooth-pick-like frass tubes.

Life cycle
The beetles are most active in the spring, when females bore

Granulate ambrosia beetles are most active in the spring. Photo by Pest and Diseases Image Library (Bugwood.org)

into twigs and branches of their hosts, usually closer to the ground. Females inoculate the galleries with a fungus that blocks the vascular system of the tree and can eventually kill it. It is this fungus that the adults and larvae feed on. Adults, eggs and larvae can be found together in the tunnel system excavated by the female. Adults can become quite abundant when they swarm at dusk in the spring and have a fluttering flight. They are attracted to ethanol and may find their way into your beer if you are out on a spring afternoon.

Timeline

The adults make their attacks in the spring but usually stay in the tunnels of infested trees with the larvae for the remainder of the growing season.

Range

This beetle is a native of Asia and was first detected in the U.S. in Charleston, S.C., in 1974. Currently, it is found in the southeastern U.S., Hawaii, Indiana and Oregon.

Management

Contact pesticides can be applied at the bottom foot or so of the trunks of susceptible trees, or physical barriers can be used. Infested trees can be destroyed by a chipper to reduce the population.

SAWYER BEETLES

Overview

Longhorned beetles in the genus *Monochamus* are the causal agent. *Monochamus titillator* is very common in pine forests of eastern and southeastern North America. Like most longhorn beetles, sawyer beetles attack dead or dying wood. The structural damage these beetles cause to felled pines is extensive and are the primary reason that loggers have to remove logs soon after cutting them. Sawyer beetles can also harbor pine nematodes which, when introduced into living trees, can kill them. These beetles are important ecologically in speeding up the breakdown of woody material. The galleries excavated by the larvae weaken the wood and facilitate further breakdown by fungi and other organisms.

Hosts

Conifers are the hosts, especially pine species.

Signs/symptoms

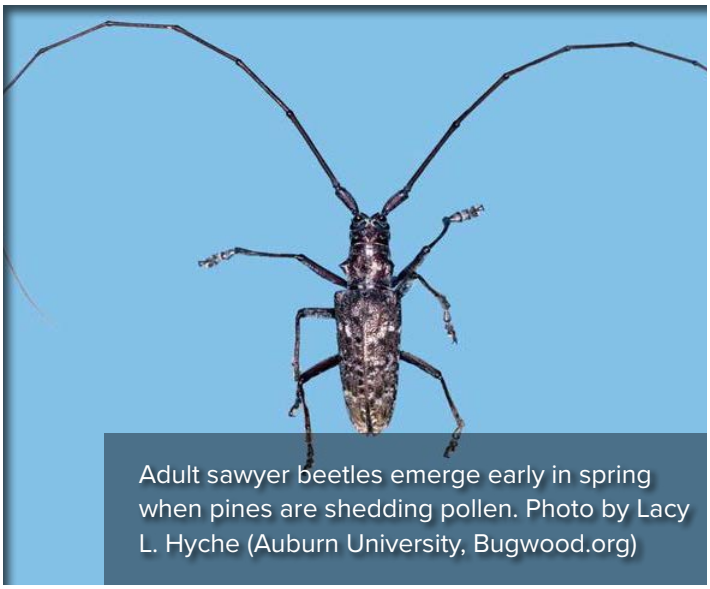
The larvae are large in the later stages (40 millimeters or 1.6 inches) and can be found under the bark of dead pine trees. The feeding galleries are filled with coarse shredded frass.

Life cycle

Adult beetles emerge early in spring, usually when pines are shedding pollen. They chew oval pits through the bark of trees that have died within the last year and lay several eggs in each pit. The early instar larvae bore below the bark for about a month and half. As older larvae they enter the wood and excavate a deep U-shaped cell through the sapwood and heartwood, plugging the entrance with fibrous frass. The larva pupates in this cavity and, in the South, emerges the next spring.

Timeline

Adults are active in the spring, and larvae chew through the wood during the growing season. They pupate overwinter and emerge the following spring.



Adult sawyer beetles emerge early in spring when pines are shedding pollen. Photo by Lacy L. Hyche (Auburn University, Bugwood.org)

Range

The southern pine sawyer is native to eastern North America and is found throughout the Southeast.

Management

Rapid harvesting of logs soon after they have been cut or harvesting trees in the winter when the adults are not active can keep harvested pines from being damaged. Debarking logs or storing them in water also prevents infestation.

SIREX WOODWASP

Overview

Sirex noctilio (Hymenoptera: Siricidae) is native to Eurasia and northern Africa where it is a secondary pest of stressed pines. Siricid wasps are not endemic to the southern hemisphere where *Sirex noctilio* is a pest of pine plantations. The lack of competition from other siricid woodwasps and the absence of pathogens and predators probably allows *Sirex noctilio* to be more damaging in the southern hemisphere. It is the most commonly intercepted exotic woodwasp detected in solid wood packing materials at U.S. ports of entry.

Hosts

This woodwasp attacks many species of pine. North American species of pine that have been planted in the southern hemisphere have been severely attacked by this wasp.

Signs/symptoms

In the early stages of infestation, foliage wilts dramatically. As feeding progresses the foliage becomes more chlorotic, finally resulting in brown, dead needles. Resin beads may dribble from the oviposition sites, which tend to be focused around mid-bole. Galleries caused by the feeding of the larvae are packed with fine sawdust. Emerging adults leave round exit holes that range in size from 1/8 to 3/8 inch in diameter.

Life cycle

Unlike native woodwasps, which only attack dead and dying trees, *Sirex noctilio* can attack living pines. Females are attracted to stressed pines. They use their ovipositor to drill into the outer sapwood and inject a mucilaginous

Adult sirex woodwasps are most active in the late summer. Photo by Vicky Klasmer (Instituto Nacional de Tecnologia Agropecuaria, Bugwood.org)

gel and a wood decaying fungus, *Amylostereum areolatum*, along with eggs. Both the fungus and the gel are toxic to the tree. Larvae tunnel through the wood feeding on the fungus. It takes the larvae 10 or 11 months to mature. Mature larvae pupate close to the bark surface and emerge as adults after three weeks.

Timeline

Like our native woodwasps, adult *Sirex noctilio* are most active in the late summer when they are on the wing looking for hosts. Larvae can be found in different stages of growth throughout the year.

Range

This woodwasp is native to Europe, Asia and northern Africa, where it is a minor pest of pines. It has been introduced accidentally throughout the southern hemisphere, including New Zealand, Australia, South Africa and South America. It has since invaded North America, expanding out from the Great Lakes region to New York, Pennsylvania, Vermont, Ohio and Michigan. Its rate of spread is relatively slow. At its current rate, it will reach the southeastern United States in 2050. However, transportation of wood could expand its range much faster.

Management

Good management practices, particularly thinning trees, can keep trees healthy and reduce their chances of being attacked by *Sirex noctilio*.

Photo by A. Steven Munson (USDA Forest Service, Bugwood.org)

INSECT PESTS

DEFOLIATORS

BAGWORMS

Overview

Caterpillars in the moth family Psychidae are the causal agents. There are many species of bagworms, most of which are of minor importance to forests and ornamental species. However, some species can be troublesome on cedars and junipers, especially in landscape trees.

Hosts

The evergreen bagworm, *Thyridopteryx ephemeraeformis*, attacks many species of hardwoods and evergreens, but is an important defoliator of cedars and junipers.

Signs/symptoms

Defoliation is the often the first thing homeowners notice. Looking closely at the trees will reveal brown spindle-shaped bags that may have caterpillars in them or may already be abandoned.

Life cycle

The life cycles of bagworms vary by species. Females of most species cannot fly. The males, which are strong fliers, mate with the female and die. The females may lay their eggs on their host. The evergreen bagworm, however, dies with her eggs still in her abdomen. Larvae hatch out and make a small silk case in which it will live. As it feeds it incorporates dead foliage and other material to camouflage the case.

Timeline

The evergreen bagworm dies with the eggs in her body in the fall, and the eggs overwinter. In spring the larvae hatch out and begin feeding on their hosts. Applications of pesticides, if needed, are most effective at this time while the larvae are still small.

Range

Bagworms are found all over the world. The evergreen bagworm is found throughout the Eastern U.S. and across to the Gulf states.

Management

Management is not usually necessary. The bags can be picked off of the host manually. Pesticides containing *Bt* specific to caterpillars can be very effective and have a light footprint on the environment.

An abandoned bagworm case hangs from a tree. Photo by David Jenkins (SCFC)

CANKERWORMS

Overview

The fall cankerworm, *Alsophila pometeria*, and the spring cankerworm, *Paleacrita vernata*, are the causal agents and are both caterpillars in the inchworm family, Geometridae. Like most defoliators, cankerworms are usually not a threat to tree health unless defoliation occurs repeatedly and/or is combined with another stressor, such as drought. The city of Charlotte, N.C., has had severe outbreaks over the years and has resorted to pesticide application and banding of trees. This is usually not required, but the sheer number of caterpillars can be astounding.

Hosts

Both moths have broad host ranges, including elms (*Ulmus* spp.), ash (*Fraximus* spp.), birch (*Betula* spp.), hackberry (*Celtis* spp.), oak (*Quercus* spp.), willows (*Salix* spp.), walnut (*Juglans* spp.) and many more. Willow oak (*Quercus phellos*) in urban environments seems to be especially susceptible.

Signs/symptoms

Severe defoliation is the most common symptom. The caterpillars may dangle on silk threads under their host trees.

Life cycle

Females of both species are wingless and must crawl up their host trees to lay their eggs. The fall cankerworm typically emerges in November or December, crawls up a host tree and calls the male with pheromones. She then lays her eggs in clusters on the stems. The females of the spring cankerworm emerge from their pupation sites in the spring. Eggs of both species hatch in spring and feed on the tender foliage. Mature caterpillars move to the ground to pupate.

Timeline

Adult females of the fall cankerworm emerge from pupation in the fall (November and December). Those of the spring cankerworm emerge in the spring (March or April). Caterpillars of both species feed in the spring and move to the soil to pupate in early summer.

Range

The spring cankerworm is native to North America and

Caterpillars of the fall cankerworm, Alsophila pometeria, feed on foliage. Photo by E. Bradford Walker (Vermont Department of Forests, Parks and Recreation, Bugwood.org)

can be found from the east coast (Nova Scotia in Canada south to Georgia) and west to Texas. The fall cankerworm has much the same distribution, but extends to Alberta in Canada and south to Colorado and Texas.

Management

Although defoliation can be severe, there is usually no need to treat trees. Some cities, for instance, Charlotte, N.C., have opted to put bands of sticky material around the trunks of some trees in the fall. This prevents the fall cankerworm adult female from ascending the trunks and, if there is any sticky stuff left, the spring cankerworm adult, too.

EASTERN TENT CATERPILLAR

Overview

The eastern tent caterpillar, which are caterpillars of the moth *Malacosoma americanum*, was the most important defoliator of eastern forests before the gypsy moth came along. Outbreaks are reported to occur roughly every 10 years. Although the caterpillars can completely defoliate trees, trees usually recover and refoliate within a month. However, repeated defoliation can weaken the tree, leading to secondary pests.

Hosts

The webs of this caterpillar are most commonly seen on wild cherry in the Southeast, but it also likes apple, ash, birch, blackgum, redgum, willow, witch hazel, maple, oak, poplar, peach and plum.

Signs/symptoms
The most distinctive trait of this caterpillar are the webbing nests in the crotches of their host trees in spring.

Life cycle
Throughout its range the eastern tent caterpillar only has one generation year. The nocturnal moths glue their egg masses to stems on the upper crown branches. The eggs are covered with a cement that protects them from desiccation and freezing, although extreme temperatures can kill the eggs. The eggs hatch in winter or spring. The caterpillars lay silk trails that lead from a central location to branches where they feed gregariously.

Timeline
Eggs hatch in the late winter or early spring and feed on the tender young foliage through mid-summer when they pupate.

Eastern tent caterpillars lay silk trails that lead to branches where they feed. Photo by David Jenkins (SCFC)

Range
Eastern tent caterpillars are found throughout the eastern region of North America and west to the Rockies.

Management
Management is usually not necessary. Forest tent caterpillars have many natural enemies. Even in outbreak years with severe defoliation, most trees can recover.

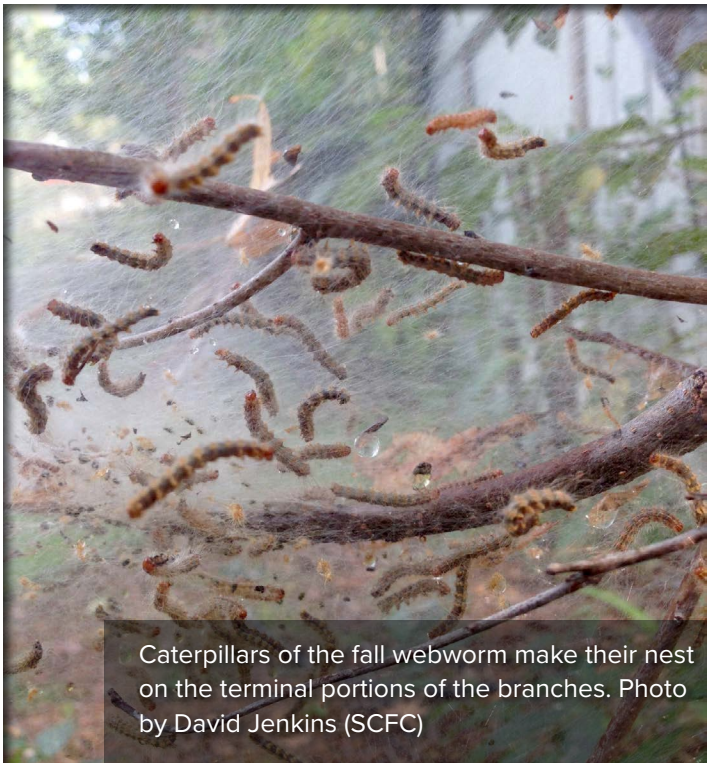
FALL WEBWORMS

Overview
Fall webworms, which are caterpillars of the moth *Hyphantria cunea*, are native to North America and Mexico and are one of the few insect pests in Europe that were introduced form North America. Fall webworms cause more cosmetic damage than anything, although they can defoliate young trees, dramatically slowing growth.

Hosts
Many species of hardwoods are attacked ,and there are regional preferences for the hosts attacked; In South Carolina fall webworm is commonly found on sweetgum and persimmon, but in the Ohio Valley American elm, maples and hickory are preferred hosts.

Signs/symptoms
Webbing is made by the caterpillars and is always located on the terminal portions of the branches.

Life cycle
There are two races of *Hyphantria cunea* that interbreed, and these races differ in color and behavior. The blackheaded race has a black head and distinct black dots along the dorsum (back) of the caterpillar. The redheaded race has a red head and yellow or orange dots along the dorsum. However, you will usually see their distinctive nest of webbing before you see the caterpillars. There are two or three generations a year in South Carolina. Female adults begin laying their eggs in the spring; the blackheaded form lay eggs up to a month earlier than the redheaded form. Eggs are deposited underneath host leaves, covering them with hairs from the female's abdomen.



Caterpillars of the fall webworm make their nest on the terminal portions of the branches. Photo by David Jenkins (SCFC)

Timeline
Nests begin to appear in the late summer and early fall.

Range
This moth is native to North America and ranges from Canada south of 55 degrees latitude to Mexico. It has also been accidentally introduced to Europe and Asia (parts of China, the Korean peninsula and Japan).

Management
Management is usually not required. Nests may be removed manually or pruned from trees for aesthetic purposes.

FOREST TENT CATERPILLAR

Overview
Forest tent caterpillars are of the moth *Malacosoma disstria*. Outbreaks of the forest tent caterpillar in the spring can cause extensive defoliation, especially in hardwood bottoms. Although the caterpillars can completely defoliate trees, trees usually recover and refoliate within a month. However, continued defoliation can stress the trees, making them susceptible to other pests and diseases.

Hosts
The adult moth prefers to oviposit on oak, sweetgum, tupelo and maple, but the larvae have been found feeding on a variety of species.

Signs/symptoms
Extensive defoliation of hardwoods, especially river bottoms, is a sign of forest tent caterpillars.

Life cycle
Throughout its range the forest tent caterpillar only has one generation year. The nocturnal moths glue their egg masses to stems on the upper crown branches. The eggs are covered with a cement that protects them from desiccation and freezing, although extreme temperatures can kill the eggs. The eggs hatch in winter or spring. The caterpillars lay silk trails that lead from a central location to branches where they feed gregariously.

Timeline
Eggs hatch in the late winter or early spring and feed on the tender young foliage through mid-summer when they pupate.

Range
Forest tent caterpillars are found throughout the eastern region of North America.

Management
Management is usually not necessary. Forest tent caterpillars have many natural enemies. Even in outbreak years with severe defoliation, most trees can recover.

Larvae of the forest tent caterpillar crawl up a tree. Photo by Steven Katovich (USDA Forest Service, Bugwood.org)

GYPSY MOTH

Overview

Intentionally imported into the U.S. in 1869 to investigate its potential for silk production, the moth *Lymantria dispar* soon escaped and became one of the most important defoliators of deciduous forests in the northeastern U.S. and southeastern Canada. Efforts to control it using pesticides and biocontrol have slowed its spread. There is also the Asian gypsy moth, the same species as the European moth, but the females of the Asian gypsy moth can fly. Although gypsy moth defoliation rarely kills a tree outright, continued defoliation weakens the tree and makes it susceptible to other pests or diseases.

Hosts

The caterpillar attacks a broad range of deciduous trees, particularly oak, sweetgum, maple, elm, apple trees and many others. If outbreaks are especially severe, older larvae may attack pines and spruces. Species that are usually avoided by the European gypsy moth include ash, tulip poplar, sycamore, butternut, black walnut, catalpa, dogwood, holly, cedars, locusts, junipers, balsam firs, horse chestnut/buckeyes, azaleas, mountain laurel and rhododendron.

Signs/symptoms

Severe defoliation in outbreak years can make it seem like winter. You can hear the caterpillars feeding and the ground will be covered with frass. You can also hear the frass falling.

Life cycle

Moths mate in the late summer. Only the males can fly; the female, although winged, is gravid with eggs and unable to fly and has to climb up the trunk of host trees to lay her egg masses. The eggs hatch in the spring, and the larvae feed on the new foliage. Feeding continues until mid-summer when the mature larvae pupate.

Timeline

The larvae are active from spring until mid-summer. The adults emerge in the late summer and mate, and the females lay their egg masses.

Range

Although egg masses and isolated individuals have been occasionally found in South Carolina, the gypsy moth has not established in South Carolina. It ranges from the northeastern states west to Wisconsin and Michigan and south to Ohio, West Virginia and Virginia. Isolated populations appear in North Carolina from time to time.

A female gypsy moth deposits an egg mass on a tree. Photo by Steven Katovich (USDA Forest Service, Bugwood.org)

Management

Concerted efforts to control gypsy moth have included broadcast application of pesticides, including insect-specific viruses, *Bt* and the use of parasitoids. Egg masses may also be placed on vehicles or firewood and be transported considerable distances. Vigilance for egg masses can help slow the spread. Tree banding, often used to control cankerworm, can be effective in keeping female adults from reaching the top of a tree to oviposit or keep larvae from moving into a new host tree.

PINE SAWFLIES

Overview

The larvae of various non-stinging wasp species in the Diprionidae family are the causal agents, including the redheaded pine sawfly (*Neodiprion lecontei*), European pine sawfly (*Neodiprion sertifer*) and blackheaded pine sawfly (*Neodiprion excitans*). Although pine sawflies may reduce the growth of defoliated seedlings, they are not considered a major pest. They usually feed on the older needles, causing little damage, but larger populations will remove all of the foliage. They get their name from their saw-like ovipositor which they use to make slits in pine needles and insert their eggs.

Hosts

All of the pine species found in the southeastern U.S. can be attacked by sawflies. Norway spruce, deodar cedar and larch have also been reported as hosts but are not preferred.

Larvae of redheaded pine sawfly (Neodiprion lecontei) feed on pine needles. Photo by Gerald J. Lenhard (LSU, Bugwood.org)

Signs/symptoms

Defoliation is usually apparent after the larvae have matured and moved on. If the larvae are present, they are usually gregarious and respond to disturbance by raising their heads and tails. Younger larvae feed only on the edges of the needles, leaving the central tissue which rapidly dries out and wilts. Older larvae eat the entire needle. Eggs may discolor the needles.

Life cycle

Eggs are deposited in slits made by the female with her ovipositor. The eggs hatch in the spring (European pine sawfly), and the larvae feed gregariously. Mature larvae pupate in tough brown cocoons. There are at least two generations of the red headed sawfly in South Carolina. Some species overwinter as eggs laid in the fall (e.g. European sawfly), while others overwinter as mature larvae in silk cocoons in the leaf litter or shallow soil.

Timeline

These insects overwinter as eggs in/on the needles or as mature larvae in the soil (e.g. redheaded pine sawfly). The adults and larvae are active from spring until late fall.

Range

Conifer sawflies are restricted to the Northern Hemisphere.

Management

Management is usually not required. If populations are very high, pesticide applications timed early in the year when larvae are younger and most susceptible can be helpful. Natural enemies normally keep populations of sawflies in check. A number of wasp parasitoids lay their eggs in the larvae. Larvae are also consumed by predators, including assassin bugs, carabid beetles and birds. Mice eat many of the pupae.

PINE WEBWORMS

Overview

Pococera robustella, a moth in the Pyralidae family, is the causal agent. The pine webworm is a common defoliator of pines in the eastern U.S. Infestations are more common on 1- or 2-year-old seedlings, but larger

seedlings and branches of mature pines may become infested. The damage is largely cosmetic, which is important for Christmas trees and ornamental pines. Rate of growth may be reduced in very young seedlings.

Hosts

Various pines are the hosts, including eastern white pine (*P. strobus*), loblolly (*P. taeda*), longleaf (*P. palustris*), pitch pine (*P. rigida*), Scots pine (*P. sylvestris*), shortleaf (*P. echinata*), slash (*P. elliotii*) and Virginia pine (*P. virginiana*).

Signs/symptoms

The most conspicuous sign of this defoliator is the conglomeration of brown granular frass (insect excrement) and pine needles bound together with silk webbing. This nest may contain multiple caterpillars between 8 and 18 millimeters long. Seedlings and shoots that have been infested will be missing needles, and there will be stubs of partially consumed needles.

Life cycle

Two or three generations of pine webworm can occur each year in South Carolina. Adults are active from spring until autumn with most flight occurring in June. Females oviposit eggs singly or in masses of up to 15 or 20 on the surface of the needles. Young larvae are needle-miners, feeding on the vascular tissue within the needle. Older larvae construct a shared nest on a main branch or stem. Larvae clip needles and bring them back to the nest to feed on them. Mature larvae migrate to the soil and pupate there.

Timeline

Adults and larvae are active from spring through autumn.

Range

The pine webworm has been reported from the eastern regions of North America, from southern Canada to Wisconsin and Minnesota and south to Florida.

Management

Management is not usually required. Natural enemies, including various wasps, flies and predatory insects, usually keep pine webworm populations below outbreak levels.

A pine webworm nest with frass, needles and silk and silk webbing cover a branch of a pine tree. Photo by Steven Katovich (USDA Forest Service, Bugwood.org)

Photo by Tom Coleman (USDA Forest Service, Bugwood.org)

INSECT PESTS

PIERCING

HEMLOCK WOOLLY ADELGID

Overview

Hemlock woolly adelgid (*Adelges tsugae)* has dramatically reduced stands of eastern and Carolina hemlock in the Appalachians.

Hosts

Eastern and Carolina hemlocks, as well as many ornamental hemlock cultivars, are hosts.

Signs/symptoms

Symptoms develop gradually over three to seven years. Foliage of infested branches will be chlorotic. Foliage will dry up and fall off of the tree. Little or no new shoot growth is produced. The crown will thin, and individual branches will start to die back from the bottom up. The sedentary adult adelgids are coated with a woolly, white wax and aggregate on the undersides of branches. When crawlers are present they can be detected by shaking an infested branch over a white piece of paper; the crawlers appear as small black dots moving on the paper.

Life cycle

In its native Asia, the hemlock woolly adelgid has a complex life cycle where it alternates between hemlocks and spruce. Spruce native to North America are not suitable for the development of some life stages, so this insect only attacks hemlocks here. In the spring, two forms are produced, a winged form and a wingless form. In North America the winged forms do not reproduce and do not survive to infest a host. The non-winged forms produce crawlers between March and May. The crawlers are mobile and look for a good feeding site at the base of a needle. They can also be transported by the wind, people, and on the feet of birds. Once attached to feed, the crawler becomes sedentary and does not move for the rest of its life. In June or July the sedentary juveniles become adults, which are also sedentary and are covered with woolly sacs containing eggs. Another crawler stage emerges from these eggs and seeks out suitable feeding sites. These insects remain attached through the winter, producing eggs in February.

Timeline

The highly visible woolly adults appear in early spring. Crawlers are active in late spring and early summer. White, woolly residue is often visible year-round.

Range

This is an exotic insect native to Asia. It is found throughout the native range of hemlock in eastern North America.

Management

Chemical control is effective and may be used for high-value trees. Insecticidal soaps and horticultural oils are effective on small trees if thorough and timed to cover crawlers and juveniles. Systemic insecticides have been very effective, protecting trees for several years.

A Carolina hemlock has hemlock woolly adelgid on its stems. Photo by David Jenkins (SCFC)

INSECT PESTS

Photo by Lacy L. Hyche (Auburn University, Bugwood.org)

SEEDLING & TWIG

PALES WEEVIL

Overview

The weevil species *Hylobius pales* is the causal agent. This weevil can be a serious pest in recently planted pines and in Christmas tree plantations.

Hosts

The adults of this weevil attack most of our native pines, spruce, firs, hemlocks, junipers and cedars.

A pales weevil adult feeds on the stem of a pine seedling. Photo by USDA Forest Service (Northeastern Area, Bugwood.org)

Signs/symptoms

Light infestations will have resin-filled holes in the bark. Heavy infestations will have patches or coalescing patches of barkless seedlings, usually with white, crystallized resin. Needles above this girdling damage will turn brown and die. Adults also feed on the terminal branches of larger trees, resulting in flagging needles.

Life cycle

Adults can be found in the Southeast throughout the year. Adults feed on the bark of their hosts. High populations will girdle seedlings, killing them. The adults are attracted to recently cut pine stumps, laying their eggs in the roots of these stumps. The larvae feed on the phloem, making irregular tunnels that engrave the wood. Larvae that hatched in spring will typically emerge in late summer of the same year. This cohort of adults may cause damage by feeding on seedlings, but they will not oviposit until the spring of the following year. Adults may live two years or more. Adults are nocturnal, feeding at night on the bark. During the day they return to the leaf litter or other hiding places.

Timeline

Adults, which are the damaging stage, can be active all year in South Carolina and other southern states. Larvae feed through the summer and emerge as adults in the late summer. Females may oviposit throughout the summer, but eggs laid after spring often will not emerge as adults until the following spring.

Range

The pales weevil is native to eastern North America.

Management

Delaying planting for nine to 12 months is the cheapest and most effective method of avoiding seedling loss.

Seedlings in areas that have been cleared within the last six months, particularly clear-cuts made at the end of summer, are especially prone to damage by pales weevils and the pitch weevil.

TIP MOTHS

Overview

Pine moths in the genus *Rhyacionia* are the causal agent, particularly the Nantucket tip moth, *R. frustrana*. The Nantucket pine tip moth and other tip moths bore into growing shoots of pines. Although this moth rarely kills trees, infestations can dramatically reduce the value of the wood as a result of the deformities caused.

Hosts

Southern pines are attacked, especially pines in plantation that are five years old or younger. Although longleaf, slash and eastern white pine are said to be tolerant, they can be attacked when populations of tip moths are high.

Signs/symptoms

Attacks are usually limited to trees 5 years old or younger and that are shorter than 12 feet tall. Needles on infested stems will lose their color and turn brown. Shoots die and then curl over. Terminal shoots and rapidly growing main laterals are preferred areas of attack. Adjacent laterals will compete for dominance, giving trees a deformed appearance with multiple stems or leaders. Splitting open dead shoots will reveal a hollow feeding cavity in the center of the shoot. In some shoots you will find the caterpillar; younger caterpillars have pale bodies and black heads, while fully grown larvae have light brown to orange-red bodies.

Tip moths attacks are usually limited to trees 5 years old or younger. Photo by USDA Forest Service (Bugwood.org)

A tip moth has caused damage to shoots of this tree. Photo by A. Steve Munson (USDA Forest Service, Bugwood.org)

Life cycle

The pupa overwinters in killed shoots and emerges in the spring as a moth in late winter or early spring. Females lay their eggs at the base of needles or in bud scales. Young larvae may feed on the needles and surface of young shoot growth before moving to the shoot tip to begin mining through the buds or stem tissue. The mature caterpillars pupate at the bottom of the mined shoot. There are multiple generations (three to five) of this moth in South Carolina.

Timeline

Adults emerge from infested stems in late winter or early spring and go through several generations during the summer. Larvae can be found feeding in the stems throughout the growing season.

Range

The Nantucket pine tip moth is found from New York south to Florida and west to Texas.

Management

Management is usually not required unless infestations are severe. Young trees often recover with minimal deformation. Pesticides may be used to protect high-value trees or to preserve aesthetic value. Applications must be properly timed to coincide with the youngest stages of the moth.