Pocket Identification Guide to

FOREST PESTS and TREE DISEASES

of the Southeastern United States

Edward L. Barnard, Dave Treadway,
Geetha S. Iyer, Jason A. Smith,
Jeffrey Eickwort

UF UNIVERSITY of FLORIDA
IFAS Extension

Photographs courtesy
Robert L. Anderson, Edward L. Barnard, Ronald F. Billings, Andrew J. Boone, Jerald E. Dewey, Wayne N. Dixon, L.D. Dwinell, Jeffrey Eickwort, Jiri Hulcr, Lacy L. Hyche, Gerald J. Lenhard, Albert (Bud) Mayfield, James R. Meeker, A. Steven Munson, Keumchul Shin, Jason A. Smith, James Solomon, Michael C. Thomas, the Connecticut Agricultural Experiment Station Archive, the Pennsylvania Department of Conservation and Natural Resources – Forestry Archive, the Pest and Diseases Image Library, and Bugwood.org.

Illustrations
Geetha Iyer

Design
Michele Linette Wood
UF/IFAS Information and Communication Services

UF | UNIVERSITY of FLORIDA
IFAS Extension

Contents

Introduction

Forests in natural, urban, and plantation settings in the southeastern United States are a source of numerous ecological and economic benefits. Consequently, forest health is a matter of regional and national concern. Healthy forests are sources of clean air and water, wood products, wildlife, recreation opportunities, and various goods both tangible and intangible. Insects, fungi, bacteria, birds, worms, and even humans interact with trees in forests in ways that may facilitate their growth or stress, weaken, or kill them.

Learning how to identify pests, pathogens, and diseases of trees is a first step towards protecting them from harm. The *Pocket ID Guide* provides basic information concerning a number of common insect pests and tree diseases that impact forests in the southeastern United States. The guide also addresses potential benefits and disadvantages of having pests and diseases in a forest, as well pointing out prospective management strategies to control them.

The *Pocket ID Guide* may be used as technical resource, a handy field guide, and as a memory aid to the identification of forest pests and tree diseases. It may also be used as a teaching tool in classrooms. The *Pocket ID Guide* complements other forest health educational resources developed by the University of

Florida's School of Forest Resources and Conservation (SFRC) and the Florida Forest Service (FFS). These resources include:

- ***What Is a Healthy Forest? A Supplement to Florida Project Learning Tree***
  This supplement to the Project Learning Tree (PLT) Pre K–8 Environmental Education Activity Guide is a module on forest health for Florida students in grades 5 and 7, containing modifications and extensions to thirteen existing PLT activities as well as five new activities.
- ***Beyond the Trees: A Systems Approach to Understanding Forest Health in the Southeastern United States***
  This high school module on forest health is a set of six lesson plans for educators in the Southeast to convey forest health concepts to students using a systems thinking framework.

Visit the University of Florida's SFRC Extension website to access these resources at **http://www.sfrc.ufl.edu/extension/ee/foresthealth/.**

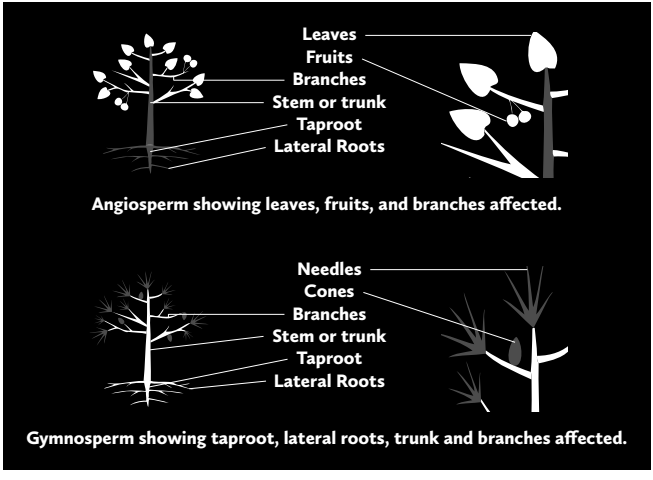
How to use this guide

Although the *Pocket ID Guide* is arranged in book format, each page may be detached and used separately as a flash card. There are helpful images on the fronts of the cards, and explanatory text on the backs.

Text material includes common and scientific names of insect pests, pathogenic organisms, and impacted tree species. Information is also provided concerning the significance of these pests and pathogens in natural, urban and plantation settings,

together with helpful management strategies to minimize pest and disease impacts. Some of the material included in the *Pocket ID Guide* is of an advanced or technical nature. Accordingly, unfamiliar terminology on each card is found within parentheses in bold small caps to the accompaniment of simplified explanations.

The images on the card fronts include photographs of a forest health issue as well as icons signifying the type and part of a tree the issue occurs on. The icons may be used as a key or sorting tool for teaching purposes, to make groups of similar pests and diseases. There are two basic icons, representing broadleaf plants and trees (**ANGIOSPERMS**) and conifers (**GYMNOSPERMS**). The tree icons are lighter, with white portions representing the parts of the tree that each forest health issue occurs on, as shown below.



Tree health may be affected by various stressors including insects, fungi, bacteria, parasitic plants, and humans. Grouping insect pests and tree diseases into meaningful categories for study or understanding is a somewhat arbitrary process and can be highly technical, based on scientific classification of organisms, or simplified into groups according to the parts of plants or trees affected by such organisms. The *Pocket ID Guide* is broadly organized along the latter lines. You will find in the *Contents* that cards are arranged into three sections: Forest Insect Pests (cards 11-44); Tree Diseases (cards 45-108); and Other Issues (cards 109-122). The first two sections are further subdivided into categories of foliage, stem, and root pests or diseases.

Forest Insect Pests


A

Cottonwood Leaf Beetle

Species: *Chrysomela scripta*.

Family: Leaf beetle family (Chrysomelidae).

Hosts: Cottonwoods and other poplars (*Populus* species), willows (*Salix* species), and alders (*Alnus* species).

Significance: This beetle is a common defoliator. It is not usually a problem in forests, but outbreaks sometimes occur that can reduce growth and damage the form of small trees in poplar plantations, and may be an aesthetic issue in urban landscapes.

Recognition: The first sign is often ragged foliage with brown, skeletonized patches near the ends of branches and tops of trees. This is followed by the loss of entire leaves and possibly dead, black ends of twigs.

Biology: Adults overwinter in bark crevices, leaf litter, and duff, emerging in early spring to feed and lay eggs. Larvae hatch and feed first on undersides of leaves, later eating all but largest veins. Pupae hang from leaves, bark and other surfaces on and around the tree. There can be up to seven generations per year.

Management: Cottonwoods are often protected from this pest by natural predators such as ladybird beetles. Consider approved insecticide application when necessary, ideally upon larvae of the first generation in spring.

A. *Cottonwood leaf beetle eggs, larvae, pupae, and adults with feeding damage on a cottonwood* (P. deltoides) *leaf.*


A
5 cm
B
C
2.5 cm
D

Eastern Tent Caterpillar

Species: *Malacosoma americanum*.

Family: Lappet moth family (Lasiocampidae).

Hosts: Preferred hosts are trees and shrubs in the rose family (Rosaceae), including cherries (*Prunus* species), and apples (*Malus* species).

Significance: These caterpillars are common defoliators in the spring and early summer. Severe defoliation over repeated years may reduce growth and increase stress, but trees usually refoliate and recover.

Recognition: Hairy blue, white, black, and orange caterpillars form large silk tents in the crotches of tree branches—rather than covering entire branches like the fall webworm. Adult moths are brown and nocturnal. Egg masses are shiny black, encircling pencil-sized twigs on the host tree.

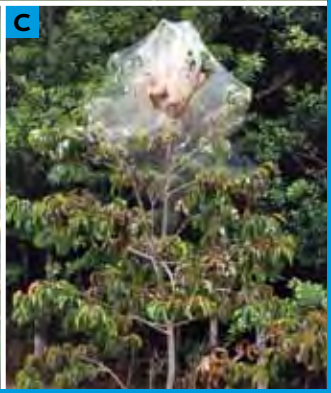
Biology: Caterpillars hatch and begin feeding in early spring, when the host's leaf buds start to open, from eggs deposited by adult moth the previous year. The silk tents spun by the caterpillars serve as protection from predators and weather.

Management: Outbreaks are usually controlled by natural enemies within one or two years. Prune out and destroy twigs with egg masses and tents. Consider insecticide treatment (such as Bt) on young caterpillars.

A. *Caterpillar (larva).*
B. *Egg mass on twig.*
C. *Adult moth.*
D. *Caterpillars in silk tent on branch fork.*


A


B


C

Fall Webworm

Species: *Hyphantria cunea*.

Family: Tiger moth family (Arctiidae).

Hosts: Many trees, especially hardwoods. Particularly common on pecans and hickories (*Carya* species), persimmon (*Diospyros virginiana*), and sweetgum (*Liquidambar styraciflua*) in the Southeast.

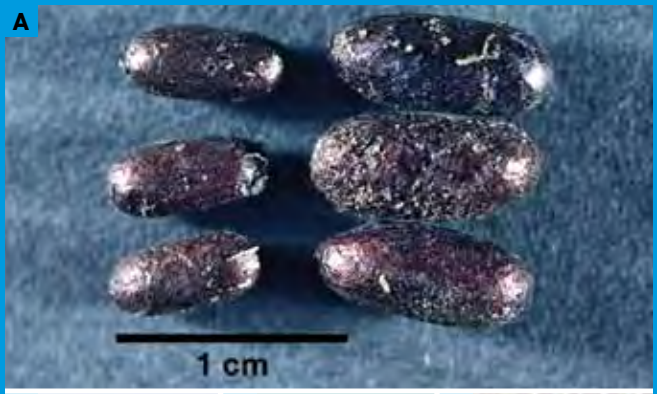
Significance: These caterpillars are common summer defoliators. While they are usually only an aesthetic problem, major or repeated defoliation may stress trees or reduce nut and fruit production.

Recognition: Large silk tents constructed by larvae cover entire branches and foliage—not just branch forks, like the eastern tent caterpillar. Larvae have long hairs when mature, light yellow to dark green bodies, often with a dark stripe down the back and yellow stripes on the sides. Larvae often skeletonize leaves. The adult moth is white, occasionally with black spots.

Biology: Females lay eggs in cottony masses beneath leaves. Larvae feed together within and around silk tent, and pupate in the soil or leaf litter.

Management: Usually no management is required. Prune out or disturb tents to allow predators to enter. Consider insecticide treatment, such as Bt, on young caterpillars.

A. *Adult moth depositing egg mass.*
B. *Caterpillars (larvae) on silk tent.*
C. *Fall webworm tent on tree.*


A
1 cm


B


C
2 cm


D

Pine Sawflies

Species: *Neodiprion* species.

Family: Conifer sawfly family (Diprionidae).

Hosts: Pines (*Pinus* species).

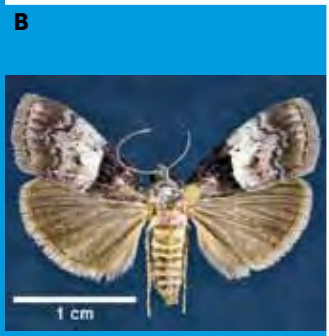
Significance: These insects are common defoliators of pine trees. Heavy defoliation, especially late in the year, can stress trees, leaving them susceptible to bark beetles and other problems.

Recognition: The larvae look similar to caterpillars, though they are not related to butterflies and moths. Larvae feed together in colonies on branches. Older needles are eaten first, giving trees a tufted appearance. Egg-laying (oviposition) leaves yellow spots along the needles.

Biology: The adult female saws slits in needles, in which she deposits her eggs. Larvae hatch and feed, first on outer needle tissues, then entire needles. Larvae pupate in duff, soil, or bark crevices. There can be one to four generations per year. Outbreaks can occur, commonly on an eight to ten year cycle.

Management: Natural predators normally keep populations low. Insecticides may be used to suppress outbreaks; however Bt products are not effective, because sawflies are not butterflies or moths.

A. *Sawfly pupal cases.*
B. *Partially defoliated pine with "tufted" appearance.*
C. *Redheaded pine sawfly larvae* (N. lecontei).
D. *Sawfly oviposition marks on pine needles.*



1 cm

Pine Webworm

Species: *Pococera robustella.*

Family: Snout moth family (Pyralidae).

Hosts: Pines (*Pinus* species).

Significance: These caterpillars are common defoliators of pines. Their feeding rarely causes serious harm, but reduces growth in very small trees and can be an aesthetic problem in Christmas tree farms or ornamental nurseries.

Recognition: Look for a brown mass of needles and excrement (frass) held together by silk webbing, found on small stems and branches, with nearby needles missing or partially eaten.

Biology: Adult moths lay eggs on pine needles in summer. Larvae hatch and construct webbing among pine needles, which they eat. When mature, larvae drop to the ground and pupate beneath the soil.

Management: Severe outbreaks are rare and usually controlled by natural enemies by the following year. Remove webbing by hand, or use approved insecticides, such as Bt, on high-value trees.

A. *Pine webworm larva.*
B. *Adult moth.*
C. *Frass-filled larval nest.*


A


B


C

Cypress Twig Gall Midge

Species: *Taxodiomyia cupressiananassa*.

Family: Gall midge family (Cecidomyiidae).

Hosts: Bald-cypress (*Taxodium distichum*) and pond-cypress (*T. ascendens*).

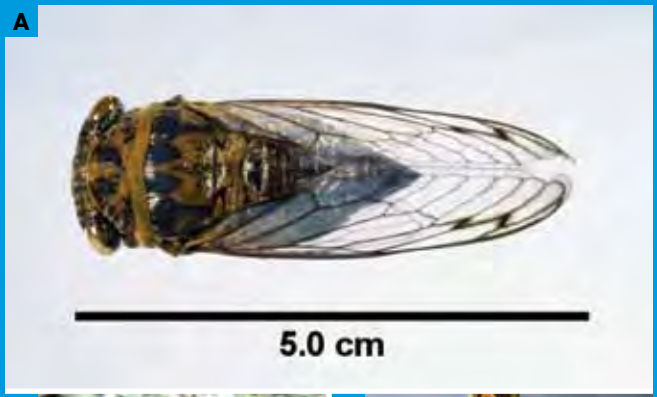
Significance: This insect induces swellings (galls) on bald-cypress and pond-cypress branches, affecting the trees' appearance, although not significantly harming their health.

Recognition: Small, elongate swellings, up to 3 cm long, grow on leafy branchlets. The galls start out pinkish and turn light green, but usually appear white due to a powdery coating covering them. Branchlets eventually die and the galls turn brown.

Biology: Adults lay eggs on new developing foliage. Larvae cause galls to grow, and feed in chambers within them. The larvae pupate in spring and emerge as adults from the previous year's fallen galls. There are two generations in Florida, and only one generation farther north.

Management: Collect and destroy fallen galls from fall to early spring. Insecticidal control is unnecessary and may harm the natural enemies which usually control large populations.

A. *Infestation on a bald cypress branch.*
B. *Developing gall.*
C. *Mature galls.*


A
5.0 cm


B


C

Cicadas

Species: Many species.

Family: Cicada family (Cicadidae).

Hosts: Many plants, particularly woody ones.

Significance: A common type of sap-sucking insect, the cicada's egg-laying behavior (oviposition) creates linear gouges in twigs, and may cause twigs to wilt and die. Adults of some species emerge in large numbers in periodic cycles several years apart.

Recognition: They are typically large insects, most 2-5 cm long, with long, clear wings that lay back when resting, and large eyes set apart on each side of the head. Most often cicadas are only noticed only due to their loud summer mating songs.

Biology: The adult female cuts a slit into the bark of a twig and lays eggs inside. After hatching, the young (nymphs) fall to the ground and burrow down to suck sap from roots. Adults may feed minimally, by sucking sap on twigs, or not at all. Most species take from two to eight years to mature underground, but some take thirteen or seventeen years, and emerge all at once in large numbers—so many that predators cannot possibly eat them all.

Management: Usually no management is necessary. During mass emergences, cover vulnerable plants to protect them from egg-laying damage.

A. *Adult dog-day cicada (Tibicen species).*
B. *Molted exoskeleton of a dog-day cicada.*
C. *Cicada egg-laying damage on a twig.*


A


B


C


D

Scale Insects

Species: Many species.

Superfamily: Scale insect superfamily (Coccoidea).

Hosts: Many plants.

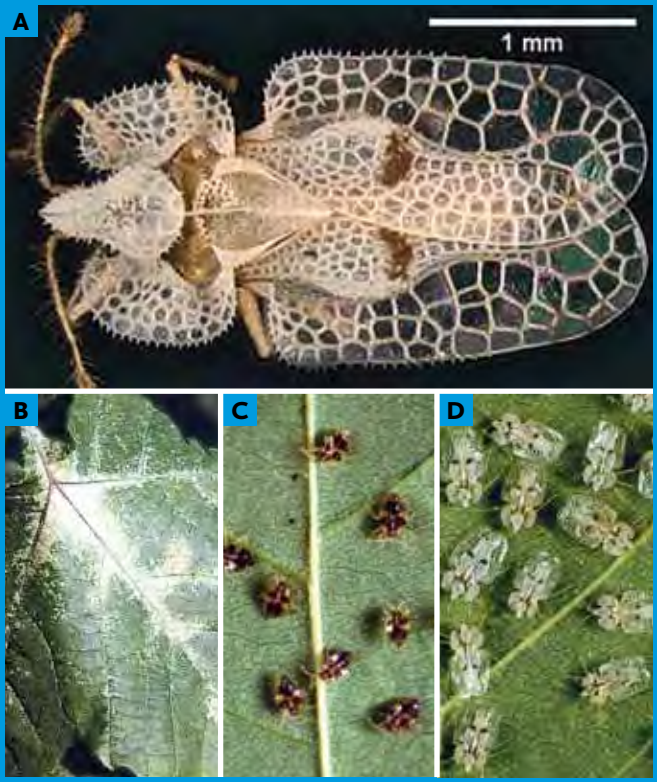
Significance: This is a large, common group of sap-sucking insects. Most are minor pests, but some, particularly exotic species, can cause reduced growth, dieback, or even death of trees.

Recognition: There are three main groups of scale insects—soft scales, armored scales, and mealybugs—and all highly variable in size and appearance. Female soft and armored scales are usually stationary when mature. Mature males are often winged. Soft scales and mealybugs are often detected by the presence of their sticky honeydew excretions, and by black sooty mold that grows on honeydew. Armored scales do not excrete honeydew.

Biology: This varies according to species. Scales have an immature, mobile (crawler) stage upon hatching that moves to feed on succulent new growth. All species feed on plant sap through a set of specialized straw-like piercing and sucking mouthparts (the rostrum).

Management: Control by natural predators and parasites can be effective in many cases. Insecticides, including insecticidal soaps and oils, are more effective on the crawler stages than adults.

A. *Kermes scale* (Kermes *species*) *on oak twig.*
B. *Obscure scale* (Melanaspis obscura).
C. *Oak lecanium scale* (Parthenolecanium quercifex) *on oak twig.*
D. *Wooly pine scale* (Pseudophilippia quaintancii) *on pine foliage.*


A
1 mm
B
C
D

Sycamore Lace Bug

Species: *Corythucha ciliata*.

Family: Lace bug family (Tingidae).

Hosts: Plane trees and sycamores (*Platanus* species), especially American sycamore (*P. occidentalis*).

Significance: Lace bugs are common pests of sycamores, though normally only an aesthetic problem. Multiple years of severe infestations, combined with other stresses, may sometimes contribute to tree death.

Recognition: Adults have lacey, flattened wings. The young (nymphs) look similar, but are smaller and wingless. The insects' feeding behavior leaves whitish spots on the upper leaf surfaces, and bronze stains and debris on the undersides of leaves. Heavy infestations can cause leaves to turn brown and fall off prematurely in the late summer.

Biology: Adults lay eggs near veins on the undersides of leaves in spring. Adults and nymphs suck plant juices from the undersides of leaves, and deposit varnish-like liquid droppings (frass). There may be three to four generations per year, and adults may overwinter in plant crevices.

Management: Populations are usually kept small by natural enemies. Promote good tree health and vigor to aid recovery from severe defoliation. Use approved insecticides to undersides of leaves when necessary.

A. *Close-up of adult sycamore lace bug.*
B. *Infested sycamore leaf with white spots on upper surface.*
C. *Nymphs on lower leaf surface.*
D. *Adults.*


A
1 mm


B


C

Ambrosia Beetles

Species: Many species.

Family: Weevil family (Curculionidae).

Hosts: Many woody plants.

Significance: Most ambrosia beetles only infest stressed, injured, dying or recently dead woody plants. An exotic species, the redbay ambrosia beetle (*Xyleborus glabratus*), carries a fungus that kills healthy trees in the laurel family (Lauraceae). All ambrosia beetles have a symbiotic relationship with one or more species of fungi that serve as their only food source.

Recognition: Look for small entrance holes in the bark. Fine, light-colored sawdust-like material is pushed out through these holes as the insect tunnels into the tree.

Biology: Adults tunnel directly through the bark into the wood (xylem) and introduce fungal spores carried with them. Adults and larvae feed only on the fungus growing on the tunnel walls, which also spreads through the wood. Larvae develop and pupate in the tree, and adults emerge to fly to new hosts.

Management: Promote good tree health to avoid infestation. Prevention is vital, since no treatment is known to be effective after beetle colonization.

A. *Adult redbay ambrosia beetle* (X. glabratus).
B. *Ambrosia beetles in chamber excavated in wood.*
C. *Tree stem infested with ambrosia beetles, pushing out sawdust "dowels" as they tunnel in. Sawdust collects at tree base.*


A


B


C

Black Turpentine Beetle (BTB)

Species: *Dendroctonus terebrans*.

Family: Weevil family (Curculionidae).

Hosts: Pines (*Pinus* species).

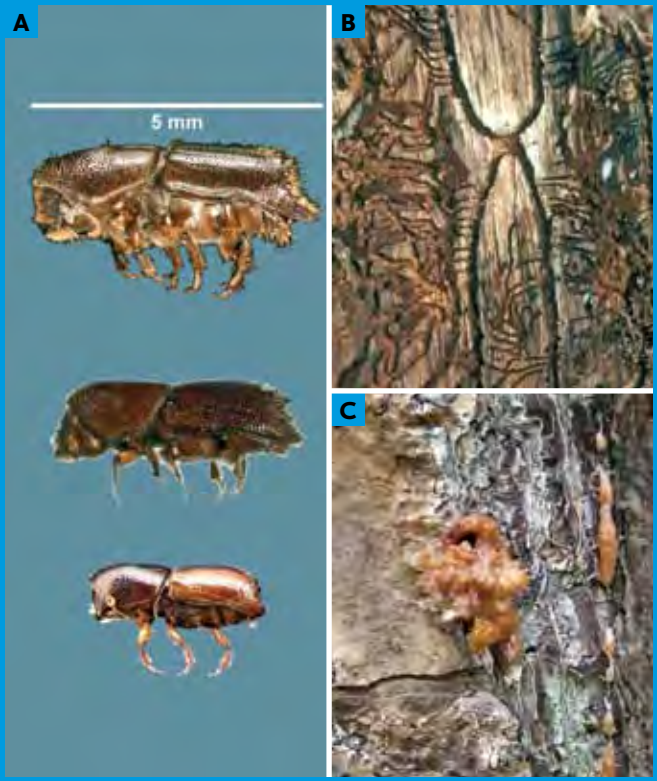
Significance: The largest of five common species of pine bark beetles in the southeastern United States, the BTB attacks stressed and injured pine trees, and may breed in cut pine stumps. BTB impact on a stand is usually minor, but can sometimes cause moderate or heavy tree mortality.

Recognition: Look for large, whitish or reddish clumps of sap (pitch tubes) near base of the tree, along with reddish-brown boring dust.

Biology: Adult females tunnel through outer bark into the lower tree trunk or root collar. Adults excavate egg tunnels (galleries), and larvae feed in the inner bark (phloem) until they pupate and emerge.

Management: Prevent infestations by promoting good tree health. Allow mild to moderate infestations to die out on their own. Protect single trees by spraying an appropriately labeled insecticide on lower trunk. Unlike attacks from *Ips* engraver beetles or southern pine beetles, trees can often recover from a mild BTB attack.

A. *Adult black turpentine beetle.*
B. *BTB larval feeding gallery.*
C. *BTB pitch tube on pine stem.*


A
5 mm
B
C

Ips Engraver Beetles

Species: *Ips avulsus, I. grandicollis*, and *I. calligraphus*.

Family: Weevil family (Curculionidae).

Hosts: Pines (*Pinus* species).

Significance: These three species of bark beetle are common pests of stressed, injured, dying or recently killed pines in the southeastern United States.

Recognition: Look for dime-sized resin clumps (pitch tubes), often in the middle of bark plates, where the beetle tunnels in. Reddish-brown boring dust collects in crevices and at base of tree. Needles of the entire tree turn yellow, then reddish, then brown. The inner bark shows I-, Y-, or H-shaped tunnels (galleries) where the beetles live.

Biology: Adult males tunnel into the inner bark and release pheromones to attract females and more males. Each male is joined by one to five females, which excavate egg galleries parallel to the wood grain. Larvae hatch and feed in the inner bark (phloem) until they pupate and emerge. Ips beetles also introduce bluestain fungi that spread into sapwood.

Management: Infestations are usually small and stop spreading on their own. Prevent infestations by promoting good tree health and vigor.

A. *Top to bottom:* I. calligraphus, I. grandicollis, I. avulsus *(adult beetles).*
B. *Typical H-shaped galleries.*
C. *Ips pitch tube on pine stem.*


A
1 cm
B

Pine Tip Moths

Species: *Rhyacionia* species.

Family: Tortrix moth family (Tortricidae).

Hosts: Pines (*Pinus* species).

Significance: The insect causes the death of the growing branch tips, often resulting in reduced growth and poor form, especially in young trees. It is more often a problem when trees are planted on an unsuitable or marginal site.

Recognition: Look for dying branch tips with reddish-brown or fallen needles, as well as resin beads and fine webbing on branch tips.

Biology: Female moths lay eggs on pine shoots in the spring. After hatching, larvae feed first on the outside of new growth. Later they tunnel into the shoot and gradually downwards for three to four weeks, hollowing out and killing the shoot until they pupate inside. There can be up to five generations per year.

Management: Plant pine species that are well-suited to the site. Trees become less susceptible as they mature and the forest canopy closes. Insecticidal control may be cost-effective for high-value trees or sites where the problem is severe and persistent. Time foliar sprayings to impact larvae before they tunnel into tree, or apply systemic insecticides in late winter or early spring.

A. *Adult Nantucket pine tip moth* (R. frustrana).
B. *Pine shoot killed by pine tip moth feeding.*


A
1 cm


B
1 cm


C

Reproduction Weevils

Species: Pales weevil (*Hylobius pales*), and pitch-eating weevil (*Pachylobius picivorus*).

Family: Weevil family (Curculionidae).

Hosts: Pines (*Pinus* species).

Significance: These weevils can cause heavy mortality in recently planted pines, especially when the area is planted soon after harvest.

Recognition: Adult beetles are rarely noticed, but up to 1.3 cm long, brown to black, with long snout-like mouthparts (proboscis). Pine seedlings show partial to complete debarking of stems or roots due to feeding damage.

Biology: Adults are attracted by odors from recently cut or disturbed pines. Females lay eggs in roots of cut or killed trees and larvae hatch to feed in inner bark (phloem). Adults feed on roots, shoots, and buds of live pine seedlings and trees in the area.

Management: Avoid seedling mortality by not planting on a site soon after it is harvested. If the site was harvested after mid-June, wait an additional year before planting to allow beetles to disperse.

A. *Pales weevil adult.*
B. *Pitch-eating weevil adult feeding on seedling.*
C. *Stem injury from reproduction weevil feeding.*


A
3 mm


B


C


D

Southern Pine Beetle (SPB)

Species: *Dendroctonus frontalis.*

Family: Weevil family (Curculionidae).

Hosts: Pines (*Pinus* species).

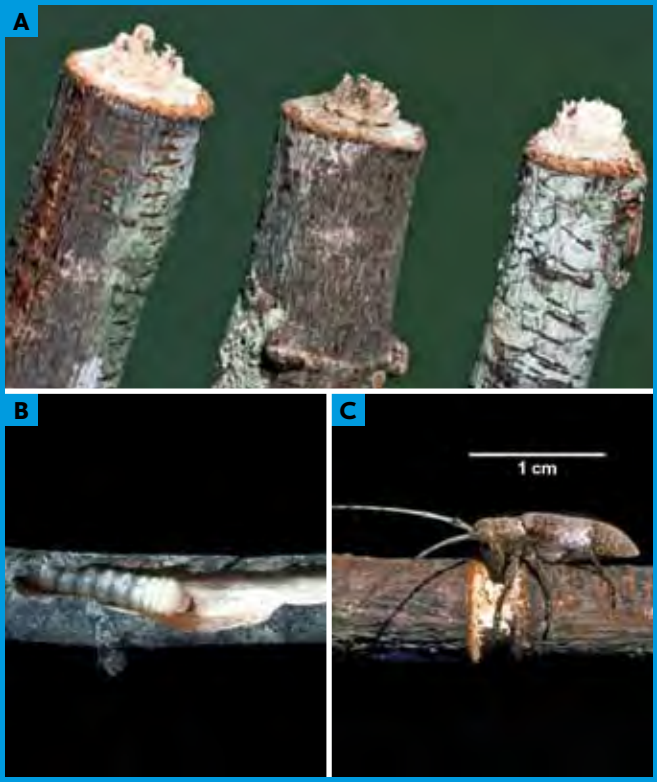
Significance: When populations are low, SPBs mainly attack weakened or stressed trees. However, during an outbreak, SPBs can kill hundreds of acres of apparently healthy pine trees.

Recognition: Look for small, whitish resin clumps (pitch tubes) in bark crevices, and for reddish-brown boring dust. There are winding S-shaped tunnels in the inner bark. Tree needles turn yellow, then reddish-brown.

Biology: Adult females first tunnel into trees and release pheromones to attract more beetles. A tree's defenses can be overwhelmed in a mass attack of many SPBs. Larvae feed and develop in the inner bark (phloem). SPBs introduce blue stain fungi that clog up the tree's vascular system, hastening its death.

Management: Promote healthy, resistant stands through thinning, competition control, and other silviculture practices. Cut and remove infested trees, in addition to a buffer strip of healthy trees, to halt the spread of active infestation spots.

A. *Adult beetle.*
B. *Aerial view of an active SPB infestation.*
C. *S-shaped tunnels (galleries) in inner bark.*
D. *Infested pine stem with pitch tubes.*


A
B
C
1 cm

Twig Girdler

Species: *Oncideres cingulata*.

Family: Longhorn beetle family (Cerambycidae).

Hosts: Preferred hosts include pecans and hickories (*Carya* species), oaks (*Quercus* species), persimmon (*Diospyros virginiana*), and Australian pines (*Casuarina* species).

Significance: A pest of pecan orchards, twig girdlers may weaken or distort the appearance of ornamental and shade trees.

Recognition: The beetle is almost 2 cm long with antennae as long as or longer than its body. Its egg-laying (oviposition) behavior causes twigs—about the thickness of a pencil—at ends of tree branches to die and sometimes fall to the ground. The end of a fallen twig shows a fairly neat, straight cut around its circumference.

Biology: In late summer, the adult beetle girdles a twig by chewing through the outer and inner bark, and lays eggs in a notch chewed into the dying portion. The larvae hatch and continue to live in the dead twig through the winter, feeding on the inner bark and wood until they pupate and emerge as adults the in the following summer.

Management: Collect and destroy the fallen twigs in the winter to reduce the population for the following year.

A. *Ends of twigs cut by twig girdler.*
B. *Twig cut open to show larva inside.*
C. *Adult beetle girdling a twig.*

Tree Diseases


A


B

Brown Spot Needle Blight

Pathogen: Fungus (*Mycosphaerella dearnessii*).

Hosts: Southern pines (*Pinus* species), especially longleaf pine (*P. palustris*).

Significance: Brown spot needle blight is regarded as the most serious disease affecting longleaf pine. It stunts and sometimes kills young, grass-stage pine seedlings.

Recognition: Look for small brown spots with distinct yellow margins on needles. Dead needles are often confused with symptoms caused by certain needle cast fungi, especially *Lophodermium* species.

Infection Biology: Spores, spread by wind and rain, are produced in two types of small, black fruiting bodies on symptomatic needles.

Management: Use fungicidal sprays to control the pathogen in nurseries or on ornamental stock. In forests, use genetically resistant stock or prescribed burns as control measures.

A. *Close-up of typical brown spots.*
B. *Severely diseased longleaf* (P. palustris) *seedling.*


A


B

Foliage Blights of Junipers

Pathogens: Fungi (*Cercospora, Passalora, Asperisporium,* and *Pseudocercospora* species).

Hosts: Many members of the cypress family (Cupressaceae), including *Juniperus, Cupressus, Taxodium, Thuja, Cryptomeria,* and *Sequoiadendron* species. Especially serious on Leyland cypress (x *Cupressocyparis leylandii*) in Florida.

Significance: Foliage blights are occasionally serious on ornamental and Christmas trees. They are deadly to Leyland cypress in Florida landscapes, but may be less of an issue further north.

Recognition: Look for progressive browning and loss of foliage beginning on lower branches next to the main stem, spreading upward and outward over time.

Infection Biology: Pathogens overwinter in diseased leaves. Asexual spores (conidia) are produced throughout the growing season, enhanced by warm temperatures, wet weather, and high humidity. Conidia are dispersed by wind or splashing water and infect young leaves through their breathing pores (stomata).

Management: Avoid unnecessary irrigation. Provide good aeration. Fungicides may be helpful in certain situations.

A. *Leyland cypress hedge with* Cercospora *foliage blight, showing symptom progression from base of tree upwards.*
B. *Close up of infected branchlet, showing symptom progression from base of branch outwards.*


A


B

Needle Casts of Pines

Pathogens: Many fungi, including *Ploioderma* species and *Lophodermium* species.

Hosts: Pines (*Pinus* species).

Significance: In most cases, the effects of needle casts on otherwise healthy trees are negligible.

Recognition: The disease is characterized by a red to brown, fire scorch-like effect on the needles of scattered pines in early spring, typically more prevalent on the lower portion of tree crowns.

Infection Biology: Microscopic spores (ascospores) are produced released from the fungi's fruiting bodies (hysterothecia) on symptomatic or dead needles. The spores are spread by wind and rain to infect young, emerging needles of susceptible pines during spring and summer. Infection symptoms appear during the following spring.

Management: Usually no management is required. Fungicides are useful for Christmas trees.

A. *Diseased needles on pine.*
B. *Elongated black hysterothecia on pine needles.*


A

Oak Leaf Blister

Pathogen: Fungus (*Taphrina caerulescens*).

Hosts: Many oaks (*Quercus* species).

Significance: The disease does not seriously impact trees and is primarily just a blemish.

Recognition: The fungus wrinkles and deforms leaves of susceptible oaks. Initially small, yellowish-green (chlorotic) spots with grayish undersides appear on new spring leaves. These develop into swollen areas (blisters) that often fall out of leaves leaving holes behind.

Infection Biology: The fungus forms tiny spore-producing fruiting sacs (asci) on the concave sides of blisters. Asci release spores into the wind, infecting newly emerging leaves. The disease may be especially severe during cool wet springs.

Management: Usually no management is required. Consider using carefully timed fungicides prior to bud break.

A. *Blistered oak leaves.*


A


B


C

Powdery Mildews

Pathogens: Many fungi in the Erysiphaceae family.

Hosts: Many broadleaf plants.

Significance: Powdery mildews cause reduced growth of their hosts and dwarfing and distortion of parasitized leaves.

Recognition: Mildews are most often distinguished by the presence of distorted leaves with powdery whitish coatings. Small yellow, orange, or black spherical fruiting bodies (cleistothecia) can sometimes be observed with a hand lens.

Infection Biology: Wind or rain disseminates spores that germinate and infect foliage on tender, newly emerging shoots of many hosts. On other hosts infections may begin and persist on mature leaves.

Management: There are no effective controls in forest situations. Use fungicides for ornamental trees.

A. *Superficial powder-like fungus growth on elm* (Ulmus *species*) *leaves.*
B. *Distortion of a sycamore* (Platanus occidentalis) *leaf infected by fungus.*
C. *Close-up of cleistothecia on elm* (U. alata) *leaf. Note the yellow to brown to black coloration as cleistothecia mature.*


A


B

Sooty Molds

Pathogens: Many saprophytic and dark-pigmented fungi.

Vectors: Members of the Homoptera order, including aphids (Aphidoidea) and scale insects (Coccoidea).

Hosts: Many plant species, including angiosperms and conifers.

Significance: Sooty molds are not problematic in and of themselves and are usually indicative of scale or aphid infections.

Recognition: Look for superficial dark blotches or coatings of fungal tissue on foliage and tender succulent growth. Also look for associated scale insects or aphids.

Infection Biology: Sooty molds are not plant parasites. They develop in honeydew, a sweet, sticky liquid excreted by aphids, scales and other sucking insect pests that feed on sap (phloem).

Management: Suppress aphids, scales or other pests that are excreting honeydew on which molds subsist. Loosen pests from the plant surface using horticultural oils, or use a water hose to wash them off.

A. *Superficial coating of sooty mold on pine* (Pinus *species*) *needles.*
B. *Superficial growth of sooty mold on broadleaf.*


A


B

Tar Spot

Pathogens: Many fungi, including *Trabutia quercina* on live oak, *Rhytisma acerinum* and *R. americanum* on maples.

Hosts: Live oak (*Quercus virginiana*) and maples (*Acer* species).

Significance: Most leaf spot pathogens are of minor importance. Their cosmetic effect on nursery stock may affect sales.

Recognition: Look for slightly raised, coal black spots (stromata) on leaf surfaces. These house the fungal fruiting bodies (perithecia). The distinctive stromata, round to irregular in shape, are definitive evidence of this disease. Stromata are surrounded by brown, dying (necrotic) leaf tissue that often tracks along the main veins.

Infection Biology: The fungal fruiting bodies release spores (ascospores) that initiate new infections when temperature and moisture are favorable.

Management: Usually no management is required. Consider fungicides or sanitization through removal of symptomatic and fallen leaves.

A. *On oak, black stromata (spots) containing fungal fruiting bodies.*
B. *Symptoms, signs and spore-producing structure on maple* (A. rubrum).


A
B
C
D

Annosum Root Rot

Pathogen: Fungus (*Heterobasidion irregulare*).

Hosts: Most conifers, especially pines (*Pinus* species).

Significance: The disease is considered among the most important and destructive of those affecting conifers in the north temperate regions of the world. It is particularly problematic in managed conifer stands.

Recognition: Look for thin-crowned, dead or dying, and windthrown pines, often in groups in the forest, typically three to six years after partial harvests, and sometimes longer in cooler climates. The fungus' fruiting bodies (basidiocarps) form bracket-shaped conks at infected tree or stump bases. Conks are leathery and brown on top, with white, porous undersurfaces.

Infection Biology: The pathogen is dispersed by airborne spores (basidiospores) produced in conks at the bases of infected trees and stumps. Infection is typically initiated as basidiospores land on fresh-cut stumps. The fungus grows into the stump, then through root-to-root contacts (grafts) into nearby standing trees. Crown symptoms develop when root decay reaches threshold levels.

Management: Prevent infections through silvicultural practices such as appropriately timed thinning on hazard sites, use of appropriately labeled chemical stump treatments, or application of competitive biological control agents.

A. *Fruiting structures (conks) at base of infected tree.*
B. *Early stage of resin soaking (resinosis).*
C. *Advanced stage "white stringy rot."*
D. *Resin-soaked root. Note soil clumped around root from leaked resin.*


A


B

Armillaria Root Rot

Pathogens: Fungi (*Armillaria* species).

Hosts: Many woody plants and trees.

Significance: These are commonly found fungi. They are typically opportunistic—colonizing roots of injured or physiologically stressed trees, causing decline, dieback and mortality.

Recognition: Trees exhibit decline, dieback and mortality. Look for clusters of tan-colored, gilled and fleshy mushrooms on or near affected trees at certain times of the year. The definitive sign of the pathogen is the fungal body, appearing as white sheets (mycelial felts) beneath the bark of infected roots and tree bases. Some *Armillaria* species produce distinctive black shoestring-like structures (rhizomorphs) in infected tissues and adjacent soil.

Infection Biology: Airborne spores are responsible for long range spread of the pathogen, infecting wounded trees and roots. Local spread occurs via root-to-root or stump-to-root growth of mycelia or rhizomorphs from infected roots or decaying stumps. The fungus can survive by feeding on dead tissues (as a saprophyte) in old stumps and roots for years.

Management: Avoid tree injury. Sanitize area by removing infected trees, stumps and roots.

A. *Cluster of mushrooms. Note gills under caps.*
B. *Fungus mycelial mat (felt) beneath bark of infected root.*


A
B

Butt Rot of Palms

Pathogen: Fungus (*Ganoderma zonatum*).

Hosts: Many palms (Arecaceae family).

Significance: Decline and death of infected palms is common. The disease can be problematic in ornamental plants.

Recognition: The first symptoms of the disease are foliage discoloration, wilting, and or defoliation. Fruiting bodies (basidiocarps) in the shape of bracket-shaped conks at or near the tree base are more definitive indicators of the fungus.

Infection Biology: The pathogen is disseminated by microscopic, airborne spores produced in the conks.

Management: Prevention is the key to control. Avoid planting in damp soil or dense shade. Minimize mechanical damage.

A. *Fungal fruiting bodies (conks) of* G. zonatum *at base of palm tree.*
B. *Stems conk on palm.*


A


B


C

Eastern Gall Rust

Pathogen: Fungus (*Cronartium quercuum* f.sp. *echinatae*).

Aecial Hosts: Shortleaf pine (*Pinus echinata*) and sand pine (*P. clausa*).

Telial Hosts: Oaks (*Quercus* species).

Significance: This pine gall rust is of little economic significance. Occasionally stem or branch breakage may occur where infections form.

Recognition: Distinct spherical or almost spherical swellings (galls) form on infected pine stems and branches. The galls may be accompanied by bushy, overgrown branches called witch's brooms. White to cream-colored spore-producing structures (aecia) appear on active gall surfaces in the spring or early summer and burst to release masses of striking yellow-orange spores (aeciospores).

Infection Biology: Aeciospores produced on pine galls are wind-disseminated and cause inconsequential foliage infections on the young leaves of several oak species. Spores (basidiospores) produced on oak leaves are airborne, causing new infections on young pine tissues.

Management: There are few practical controls in forest situations. In nurseries, appropriately registered fungicides should provide disease-free seedlings. Remove infected branches on trees.

A. *Distinct aecial pustules full of aeciospores.*
B. *Globose gall, typical of infection, with droplets of spores (pycniospores).*
C. *Ruptured gall showing bright yellow-orange aeciospores.*


A


B


C

Fusiform Rust

Pathogen: Fungus (*Cronartium quercuum* f.sp. *fusiforme*).

Aecial Hosts: Many pines (*Pinus* species), especially loblolly (*P. taeda*), slash (*P. elliottii*), and longleaf pine (*P. palustris*).

Telial Hosts: Many oaks (*Quercus* species), especially red and water oaks.

Significance: This is the most serious disease affecting commercial pine production in the southern United States. Annual commercial timber losses are estimated to be in millions of dollars. It is primarily troublesome on loblolly and slash pines. Related rusts occur on other pines in other parts of the world.

Recognition: Infections are typically defined by spindle or fusiform-shaped swellings (galls) on pine branches or stems. Masses of bright yellow-orange blister-shaped fruiting bodies (aecia) appear on the surfaces of active galls in early spring. The aecia rupture and release powdery, yellow-orange spores (aeciospores).

Infection Biology: Aeciospores from pines infect new leaves of oaks; later spores produced on infected oaks re-infect succulent tissues of susceptible pines.

Management: Fungicides are effective in pine seedling nurseries. Destroy severely infected young stands and replant with genetically resistant pines or less susceptible species, such as longleaf pine. Careful removal of galled branches or cleaning of small stem galls may be useful in urban or ornamental situations.

A. *Stem galls on pine seedlings.*
B. *Gall with aecia on young slash pine stem.*
C. *Gall on longleaf pine branch.*


A


B


C

Gymnosporangium Rusts

Pathogens: Fungi (*Gymnosporangium* species).

Aecial Hosts: Apples (*Malus* species), hawthorns (*Crataegus* species), and others.

Telial Hosts: Red-cedars (*Juniperus* species).

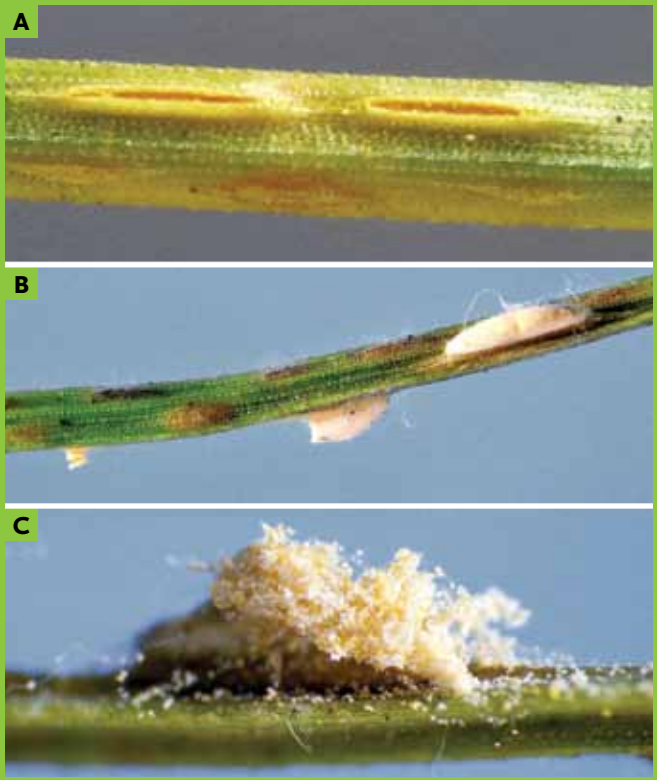
Significance: Gymnosporangium rusts are generally not major problems on junipers in the Southeast. They cause some concern on ornamental red-cedars, but may be more problematic on aecial host species such as apple, pear, or quince, whose fruit may become disfigured as a result of infection.

Recognition: Stem swellings (galls) form at infection centers on red-cedars. Mature, second year galls on red-cedars produce showy, gelatinous reproductive structures (telial horns) in wet spring weather. Leaf spots, petiole and twig cankers, and swellings, often with yellow-orange fruiting pustules (pycnia and aecia) appear on infected leaves and fruit of aecial hosts.

Infection Biology: Spores produced on aecial hosts induce infections on junipers. The gelatinous telial horns on junipers release spores (basidiospores) that infect susceptible tissues on the aecial hosts.

Management: Usually no management is required for junipers. Fungicides may be useful in some situations and for protection of aecial hosts.

A. *Galls with developing telial horns.*
B. *Gelatinous telial horns on mature galls (during wet spring).*
C. *Leaf spots caused by fungus on aecial host leaves.*


A
B
C

Needle Rusts of Pines

Pathogens: Fungi (*Coleosporium* species),

Aecial Hosts: Many pines (*Pinus* species).

Telial Hosts: Many members of the Asteraceae family, including asters (*Aster* species) and goldenrods (*Solidago* species).

Significance: Although widespread and occasionally unsightly, needle rusts are typically sporadic in occurrence and of little impact. Ornamental pines may appear unattractive, but infected pines rarely die.

Recognition: Papery-white fruiting pustules (aecia) form on infected needles in spring. These rupture, releasing yellow-orange spores (aeciospores). The appearance of ornamental trees may suffer temporarily.

Infection Biology: Aecia release spores and infected needles turn brown and fall from the tree. Aeciospores infect telial hosts, such as the goldenrod, and spores produced on these plants re-infect other pines. The disease's occurrence is affected by rainfall, temperature, humidity, populations of telial hosts, and genetic diversity in pine population.

Management: Usually management is neither cost-effective nor required.

A. *Early stage of aecia.*
B. *Aecial spore pustules.*
C. *Ruptured aecium releasing aeciospores.*


A


B

Southern Cone Rust

Pathogen: Fungus (*Cronartium strobilinum*).

Aecial Hosts: Slash pine (*Pinus elliottii*) and longleaf pine (*P. palustris*).

Telial Hosts: Many evergreen oaks (*Quercus* species).

Significance: This disease is of sporadic occurrence, but may destroy up to 50% of first-year cones in some slash pines, and so could be an issue in high-value pine seed orchards.

Recognition: Infected female pine flowers (strobili) take on a distinctive yellow-orange color and swell with fruiting pustules (aecia) early to mid-spring. By April and May the infected strobili display masses of brilliant yellow-orange spores (aeciospores) as the aecia rupture to release them. Infected cones are often swollen and misshapen.

Infection Biology: Airborne aeciospores infect the leaves of many evergreen oaks. In late winter and early spring, coincident with pollen receptivity in young female pine flowers, fruiting structures (telia) on oak leaves release spores (basidiospores) that result in new infections to young strobili.

Management: Some research suggests that appropriately timed fungicides may be helpful. Minimizing evergreen oak populations in and near seed orchards may also be helpful.

A. *Swollen, infected strobilus (right) next to healthy strobili.*
B. *Yellow-orange aeciospores on infected strobilus.*


A


B

White Pine Blister Rust

Pathogen: Fungus (*Cronartium ribicola*).

Aecial Hosts: Five-needled white pines (*Pinus* species).

Telial Hosts: Currants (*Ribes* species).

Significance: This is the most destructive disease of five-needled white pines in North America; however, it is not a major issue in the Southeast. The fungus is a non-native, introduced from Asia to North America in the 1900s on diseased planting stock.

Recognition: Look for slight, elongated, and often fissured bark swellings (cankers) on branches, and needle reddening and branchlet mortality past these infected areas. Whitish to yellow-orange blister-like fruiting bodies (aecia) are produced on actively infected bark tissues at certain times of the year. Rust-infected bark is often gnawed at by rodents and slugs.

Infection Biology: The aecia release spores (aeciospores) that are wind disseminated and infect the foliage of telial hosts, such as the currant. In late summer, the telial hosts produce fruiting bodies (telia) that release airborne spores (basidiospores) to infect pines through breathing pores (stomata) on the needles. The fungus grows into branches to initiate cankers.

Management: Prune lower branches to prevent the pathogen's spread to the main stem. Consider planting genetically resistant trees.

A. *Aecia on white pine stem infected with* C. ribicola.
B. *Spores of the rust fungus on telial host* (Ribes *species*).


A


B

Bacterial Leaf Scorch (BLS)

Pathogen: Bacterium (*Xylella fastidiosa*).

Vectors: True bugs (Hemiptera), including leafhoppers (Cicadellidae), and spittlebugs (Cercopidae).

Hosts: Many broadleaf hardwoods, including elms (*Ulmus* species), sycamores (*Platanus* species), and oaks (*Quercus* species).

Significance: BLS is widespread and common in many hosts, interacting with other biological and abiotic stress factors. BLS is associated with and considered by some to be a cause of tree decline and mortality.

Recognition: Affected trees exhibit copper, tan, or brown scorching along leaf margins and in the tissues between veins of otherwise green leaves. This is particularly visible in late summer or early fall. Leaf cupping or curling may occur in some hosts. Caution is advised in identifying BLS because similar leaf scorch symptoms may be caused by several other factors.

Infection Biology: The pathogen is vectored by various sap-sucking insects, such as sharpshooter leafhoppers and spittlebugs, which take up the bacterium and transfer it to other trees as they feed on sap (xylem). The bacterium proliferates in xylem cells resulting in vascular tissue blockage and subsequent leaf scorch symptoms.

Management: Control measures have not been extensively developed or tested, and may be unnecessary. Injections with certain antibiotics show some promise.

A. *Foliar scorch on sycamore showing leaf cupping.*
B. *Foliar symptoms on oak.*


A
B

Cylindrocarpon Galls on Red Mangrove

Pathogen: Fungus (*Cylindrocarpon didymum*).

Host: Red mangrove (*Rhizophora mangle*).

Significance: Mortality resulting from infections is considered minimal but the diseased trees are more susceptible to wind breakage.

Recognition: Swellings (galls) are visible on stems. These vary in size from 1 to 20 cm in diameter, depending on variables such as age and location on host. The bark on gall tissue surfaces is darkened and cracked or fissured.

Infection Biology: Infections seem to occur occur through breathing pores in the bark (lenticels) as opposed to wounds or insect feeding sites or galleries. Gall development is believed to be related to the production of indole acetic acid by the fungus. Mites may be capable of disseminating the pathogen.

Management: There are no known practical controls at present.

A. *Galls on stems of red mangrove.*
B. *Gall on branch.*


A
B

Cypress Canker

Pathogens: Fungi (*Seiridium* species), including *S. cupressi*.

Host: Leyland cypress (x *Cupressocyparis leylandii*).

Significance: The disease was first recognized in the western panhandle of Florida in 2003, but it is uncommon in occurrence in this region.

Recognition: Look for reddened foliage on some branches (branch flagging), and dying of entire branches. Stems and branches display longitudinal elongated wounds (cankers) that may be flattened, ridged, or contorted.

Infection Biology: *Seiridium* species are fungi that reproduce via asexual spores (conidia) produced in tiny saucer-like fruiting bodies (acervuli). The disease's development is facilitated by phytotoxins produced by the pathogens.

Management: Management is difficult. To decrease likelihood of infection, avoid movement of infected trees and grow trees in suitable environments.

A. *Canker, fissured bark, and resin exudation (resinosis).*
B. *Branch and foliage flagging on infected Leyland cypress.*


A
B

Hispidus Canker

Pathogen: Fungus (*Inonotus hispidus*).

Hosts: Oaks (*Quercus* species) and other Southern hardwoods.

Significance: This is a common disease that causes internal rotting of woody tissue (heartrot) as well as external trunk wounds (cankers). The fungus is one of a limited few that cause both cankers and heartrot. As a result the disease is often referred to as a canker rot. While the disease is not a big issue in forestry, it can be a problem in urban settings as weakened trees may be structurally unstable and hazardous.

Recognition: The cankers on trunks of infected trees are often vertically elongate, flat faces or sunken areas, typically bordered by distinct callus ridges. Fruiting bodies (basidiocarps), when present, are large, spongy, bracket-shaped conk structures ranging from yellow-brown to rust-brown in color. Old conks are dark brown or black and remnants of old conks are often found on the ground at bases of cankered trees.

Infection Biology: Infections occur primarily through dead branch stubs by means of aerially disseminated spores (basidiospores). Fungus activity begins as a heartrot that later extends to the trunk's living tissues (sapwood and cambium) causing the very visible external cankers.

Management: There is no known effective treatment other than removal of infected trees.

A. *Cankered oak trunk with fresh fruiting bodies (conks).*
B. *Cankered oak stem with the previous year's old, dark conk and fresh yellow conk below it.*


A
B

Hypoxylon Canker

Pathogens: Fungi (*Hypoxylon* species (now called *Biscogniauxia* species)).

Hosts: Many hardwoods, especially oaks (*Quercus* species).

Significance: These are secondary pathogens in most cases, following severe tree injury or drought stress.

Recognition: Depending on the stage of development or species, these fungi appear as dusty brownish sheets of asexual spores (conidia) or hard tan, silver-gray or black crusts (stromata) containing sexual fruiting bodies (perithecia) on trunks or limbs of affected trees. Tree decline and death causes bark to slough off from affected trees.

Infection Biology: Airborne or rain-splashed spores (ascospores) are produced in the crust-like stromata. They cause infection on susceptible hosts that are injured or stressed. Research indicates that these fungi may be harmless residents of bark tissues until trees are severely injured or stressed.

Management: Severely infected trees cannot be recovered. Remove infected branches. Do not stack infected wood near susceptible trees.

A. *Crustlike fungal stromata (black and silver-grey) on oak stem.*
B. *Dusty brown sheet of conidia on oak stem.*


A
2 mm


B


C


D

Laurel Wilt

Pathogen: Fungus (*Raffaelea lauricola*).

Vector: Redbay ambrosia beetle (*Xyleborus glabratus*).

Hosts: Members of the Lauraceae family, especially redbay (*Persea borbonia*).

Significance: The disease results in mortality to redbay and related species.

Recognition: Leaves wilt, turn brown and remain hanging on trees. Look for pitch tubes indicating presence of ambrosia beetles. The sapwood (xylem) of infected trees is discolored with streaks of black stain in the outer xylem rings.

Infection Biology: The fungus infects sapwood, restricting the flow of water. It is introduced into host trees by the non-native redbay ambrosia beetle, first discovered in Georgia in 2002. It has caused high levels of tree mortality in North and South Carolina, Georgia, Florida, Alabama and Mississippi.

Management: Discourage transport of redbay firewood. Bury, cover, burn, or chip affected host tree material at original site. Tree injections with the fungicide propiconazole may help prevent development.

A. *Dying redbay trees.*
B. *Sawdust-like frass "dowels" indicative of ambrosia beetle infestation.*
C. *Dark streaking/staining in outer sapwood.*
D. *Adult redbay ambrosia beetle.*


A


B


C

Oak Wilt

Pathogen: Fungus (*Ceratocystis fagacearum*).

Vector: Sap beetle family (Nitidulidae).

Hosts: Oaks (*Quercus* species), especially red and live oaks.

Significance: This is a lethal vascular wilt of oaks, especially red oaks, in 21 states, although it is not yet found in Florida. Interstate and international regulations are in place to prevent movement of the pathogen in timber products, nursery stock, and firewood.

Recognition: Leaves on infected trees turn dull green to bronze, with dying (necrotic) tissue along leaf margins, and sometimes water-soaking wilt. They later turn yellow to brown with the onset of death. Premature defoliation may also occur.

Infection Biology: Sap-feeding insects, such as Nitidulid beetles, are attracted to spore-producing fungal mats formed under the bark of infected trees. The beetles then transport spores to fresh wounds, such as caused by pruning scars, on healthy trees. This results in new infections. Local spread from tree to tree via root grafts is common.

Management: Prevent infections in certain urban scenarios by injecting systemic fungicides. Where possible, prevent root-to-root pathogen spread by deep trenching around local infection foci—this severs the root grafts between trees. Avoid pruning oaks in the spring.

A. *Veinal necrosis on live oak (not necessarily a definitive symptom).*
B. *Vascular staining in oak xylem tissue.*
C. *Bronzing on a red oak leaf.*


A
B

Perennial Nectria Canker (Target Canker)

Pathogen: Fungus (*Nectria galligena* (now *Neonectria galligena*)).

Hosts: Many hardwoods including oaks (*Quercus* species), maples (*Acer* species), ashes (*Fraxinus* species), birches (*Betula* species), elms (*Ulmus* species), sweetgums (*Liquidambar* species), magnolias (*Magnolia* species), dogwoods (*Cornus* species), and cherries (*Prunus* species).

Significance: This disease is not a major issue, although it can make individual trees vulnerable to decay organisms and wind breakage.

Recognition: Look for somewhat sunken wounds (cankers), often centered on branch stubs, and surrounded by distinctive annual ridges or rings of callus tissue that form target-like faces. Tiny red fruiting bodies (perithecia) may sometimes be seen on bark surfaces or crevices.

Infection Biology: Infections are spore-initiated at wounds or through branch stubs.

Management: Prune and remove damaged branches. Remove badly damaged trees that are at risk of falling.

A. *Target shaped, perennial canker on oak.*
B. *Tiny (<1mm) red perithecia on bark surface.*


A
B

Phytophthora Basal Cankers of Oak

Pathogen: Water mold (*Phytopthora cinnamomi*).

Host: Laurel oak (*Quercus hemisphaerica*).

Significance: The disease is scattered in occurrence. It may be lethal if a severe infection occurs on individual oaks. Symptoms are similar to those caused on oaks on the west coast of the United States by *P. ramorum*, the sudden oak death pathogen.

Recognition: Bark fissures and lesions exude clear to dark-colored sap on lower stems. Older branches may exhibit depressed bark surrounded by callus ridges (cankers). Infected trees may or may not exhibit signs of decline. Laboratory confirmation is essential for positively diagnosing the pathogen's presence.

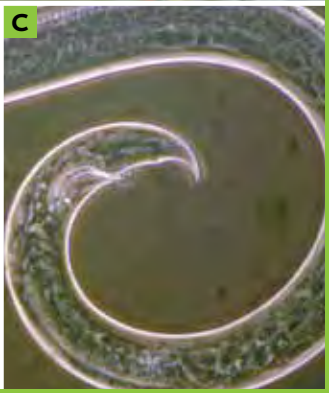
Infection Biology: *Phytophthora* species are often soil-borne pathogens. The disease has received little research attention.

Management: Trees with advanced cankers are not curable. Certain fungicides may be useful for high-value ornamental trees.

A. *Basal cankers showing callus ridges and bleeding (black stain).*
B. *Water soaked lesion in inner bark tissues.*


A


B


C

Pine Wilt

Pathogen: Pine wood nematode (*Bursaphelenchus xylophilus*).

Vector: Longhorn beetle family (Cerambycidae).

Hosts: Scots pine (*Pinus sylvestris*), Austrian pine *(P. nigra*), and white pine (*P. strobus*).

Significance: The pine wood nematode has gained considerable attention in recent years. Although initially thought to be an introduced species, recent evidence indicates otherwise. It is believed to be a secondary pest, working together with other microorganisms and stress to finish off trees.

Recognition: Look for fairly rapid foliage color changes from green to yellow-green to reddish or brown. The disease results in marked reduction of resin flow. Death comes rapidly.

Infection Biology: The nematodes reproduce rapidly in resin ducts of hosts. Longhorn beetle larvae develop and mature in infected pines. Mature beetles emerge from dying and dead trees in late spring carrying the dispersal stages of nematodes, which they transport to healthy trees.

Management: There are no practical control measures.

A. *Sawyer beetle* (Monochamus *species*) *which vectors the pine wilt nematode.*
B. *Dying scotch pine infected with pine wilt.*
C. *Pine wilt nematode.*


A


B


C

Pitch Canker

Pathogen: Fungus (*Fusarium circinatum*).

Hosts: Pines (*Pinus* species).

Significance: This disease is a potentially menacing problem in the artificial regeneration of pine plantations, sometimes causing unacceptable levels of mortality in first-year seedlings. It causes the death of terminal shoots and branches in larger trees resulting in their disfigurement.

Recognition: Look for characteristic reddening needles on infected terminal or lateral shoots (branch flagging). Sunken wounds (cankers) exude resin, and the wood within is also resin-soaked. Asexual fruiting structures (sporodochia) are sometimes observed in needle fascicle scars.

Infection Biology: Pitch canker infections are initiated by microscopic asexual spores (conidia) that germinate within and colonize mechanical or insect-caused injuries. Infections are most common during the late summer and fall with spore dispersal enhanced by the feeding activity of the eastern pine weevil, violent thunderstorms, and accompanying wind and rain. The fungus causes mortality of female pine flowers (strobili) and mature cones, as well as seeds.

Management: Prevent infections through good silvicultural practices. Use genetically resistant planting stock.

A. *Flagging tips of infected slash pines* (P. elliottii).
B. *Resin exudation (resinosis) from infected branch.*
C. *Spore producing structure (sporodochium) of the pathogen in needle fascicle scar.*


A

Red Heart of Pine

Pathogen: Fungus (*Phellinus pini*).

Hosts: Pines (*Pinus* species) and other conifers.

Significance: The fungus causes internal decay of woody tissue (heartrot) in old pines and other conifers. Decayed stems are a valuable habitat component for red cockaded woodpeckers (*Picoides borealis*) in the southern United States.

Recognition: Hoof or bracket-shaped annual or perennial fungal conks (basidiocarps) appear on trunks of old conifers. Conks may appear yellow-brown, rust-brown or dark brown, depending on their age and stage of development.

Infection Biology: Infection likely occurs when airborne spores (basidiospores) contact branch scars or stem wounds under suitable conditions of temperature and moisture.

Management: Once established, there is no control for this pathogen. In cases where quality timber is a goal, harvest older conifers prior to onset of substantial decay—this is called pathological rotation. Avoid mechanical damage in silvicultural and harvest operations.

A. *Close-up of a perennial* P. pini *fruiting structure (conk) showing at least two layers of old growth (brown tissue) with current year's fresh spore-producing layer (yellow).*

A

Stress-Related Dieback and Cankers

Pathogens: Many fungi, including *Botryodiplodia theobromae, Massaria platani, Dothiorella species, Phomopsis* species, and *Hypoxylon* species.

Hosts: Many hardwood plants.

Significance: These fungi are found everywhere, all the time. However, they don't appear to cause harm unless host trees are severely stressed by such factors as drought, freeze damage, sunscald, or mechanical injury.

Recognition: Look for localized branch and shoot mortality, typically working from the top of the tree downward. Also look for shrunken, discolored, and shriveled leaves, as well as thinning tree crowns. Elongated and sunken wounds (cankers) are often centered on branch stubs. Small, black pimple-like fungal fruiting bodies are produced in or on infected twig and branch bark. Crust-like sheets (stromata) of *Hypoxylon* (*Biscogniauxia*) species may occur on large branches and stems.

Infection Biology: Spores are spread by wind, splashing rain, insects, and sometimes humans.

Management: Plant trees on appropriate sites with adequate moisture and nutrients. Prune infected branches. Remove seriously damaged trees.

A. *Stress-related decline and dieback on a sycamore* (Platanus *species*).


A


B

Twig Blights of Junipers

Pathogens: Fungi (*Phomopsis, Kabatina,* and *Sclerophoma* species).

Hosts: Many members of the cypress family (Cupressaceae), including *Juniperus, Chamaecyparis, Cupressus,* and *Thuja* species.

Significance: This is a widespread, though not typically threatening, disease that can sometimes cause serious damage to nursery stock, ornamental trees, and Christmas trees under conditions of warm wet weather.

Recognition: Terminal shoots die, and foliage turns from red to gray. Small black fungal fruiting bodies (pycnidia) are produced within grayed dead tissues. These release spores (pycnidiospores) in tendrils when mature and hydrated. Infected twigs often curl, appearing like shepherd's crooks.

Infection Biology: Young, succulent host tissues are infected during periods of warm temperatures and wet weather by spores produced on and surviving in older symptomatic tissues.

Management: Fungicidal protection of high-value trees is sometimes useful. Avoid overhead irrigation and excessive moisture.

A. *Infection on red-cedar* (Juniperus virginiana). *Note progression of curled, dead tissue from branch tip inward.*
B. *Close-up of dead tissue with embedded pycnidia releasing pycidiospores in tendrils.*


A

Wetwood and Slime Flux

Pathogens: Many anaerobic and facultatively anaerobic bacteria.

Hosts: Many hardwoods, particularly elms (*Ulmus* species) and some oaks (*Quercus* species).

Significance: This causes water-soaked wood in stems, roots, and limbs and devalues saw logs and lumber. Unsightly slimy or frothy flux on ornamental trees causes concern, but is not particularly threatening.

Recognition: Look for water-soaked, stained, and malodorous wood tissues, generally in mature trees. Look also for discolored bark tissues where sap oozes, fluxes, or froths from bark fissures, wounds, or branch scars and flows downward, staining bark in vertical streaks.

Infection Biology: Wetwood bacteria enter wood tissues (xylem) through wounds and lesions, especially in the roots.

Management: There are no practical or recommended control measures.

A. *Discolored streak on bark as a result of from sap oozing from branch stub.*

Other Issues


A


B

Construction Damage and Catfaces

Cause: Fires and mechanical injury caused by construction equipment.

Hosts: All trees.

Significance: Trees subjected to root and stem injury or excessive changes in soil levels during development or home construction have wounds that may become entry points for secondary opportunistic infections or infestations. Many organisms, including fungi, bacteria, insects, may take advantage of the wounds to exacerbate and extend the primary injuries. This often results in dieback, decline, and ultimately death of affected trees. In some cases, wounds form scars called catfaces. Some catfaces reflect historic fire injuries. On old pines, they may be remnants of historical naval stores or turpentining operations. Catfaces may also hide serious structural weaknesses in some scenarios.

Recognition: Look for stem and root injuries, crown thinning or dieback. Watch out for changes in soil levels, as evidenced by exposed or injured roots, or a lack of root flare at the ground line around trees trunks. Be aware of development history in the area. Catfaces are often located on lower stems, as shallow depressions in the tree's circumference, with or without covering bark. Catfaces are bordered by raised ridges of callused or woody tissue as the tree attempts to grow over the injury.

Management: Avoid injuries and soil grade changes within at least the tree crown's drip-line to protect it from construction activities.

A. *Tree dieback after construction damage to roots.*
B. *A typical catface caused by turpentining operations.*


A

Leafy Mistletoes

Species: *Phoradendron* species, primarily *P. leucarpum* in the South.

Family: Mistletoe family (Santalaceae (also Viscaceae)).

Hosts: Many hardwoods.

Significance: Heavily colonized trees may be weakened, exhibit dieback of branches, and slowed growth, but are only occasionally killed by this parasitic plant. Damage may be exacerbated by drought.

Recognition: Look for distinct, often globose clumps of evergreen leafy plants attached to and growing in the crowns of susceptible hosts. They are most easily visible when the hardwood hosts are bare of leaves.

Infection Biology: Birds feed on mistletoe fruits, passing out sticky-coated seeds that adhere to tree surfaces. The seeds germinate, develop an attachment disc or holdfast, and subsequently penetrate host bark and wood tissues via a root-like system of cortical strands and sinkers (haustoria).

Management: Prune parasitized branches well behind mistletoe plants to assure removal of the haustorial system.

A. *Globose evergreen mistletoe plants in crown of oak* (Quercus *species*).


A

Lightning Damage

Abiotic Agent: Lightning.

Hosts: All trees.

Significance: Trees struck by lightning are often, but not always, killed.

Recognition: Fresh lightning strikes are recognized by jagged, longitudinal strips of split or missing bark along stems or branches. Severe hits may result in the shattering of branches and stems. Old, non-lethal longitudinal bark splits or seams may be recognized years later as elongated callus ridge on surviving trees.

Management: Severely damaged trees are often beyond salvage. Bark beetles often finish off lightning-damaged pines. Sophisticated lightning protection systems can be installed in high value trees. Such systems provide substantial protection if properly installed.

A. *Tree trunk showing lightning scar.*


A

Pine Chlorosis

Abiotic Agents: Nutrient deficiencies such as iron and manganese.

Hosts: Pines (*Pinus* species).

Significance: Affected trees often slowly decline and can succumb to secondary infestations of bark beetles. Death is often hastened by secondary insects, such as bark beetles. Winter chlorosis is a seasonal and non-threatening temporary condition.

Recognition: Pine needles gradually turn from off-color green to brilliant yellow.

Infection Biology: This is a physiological malady often related to deficiencies in iron (Fe) and manganese (Mn), usually associated with high soil pH levels, and complicated by over-watering issues in urban landscapes. High soil pH values also adversely affect the occurrence and nutrient-supplying function of certain highly specialized and beneficial mycorrhizal fungi associated with the roots of pines. Winter chlorosis is a seasonal issue related to nitrogen deficiency.

Management: Treatments are often costly, time-consuming, and futile. Avoid or minimize irrigation of pines. Use acid-forming mulches above roots, such as pine bark or pine needles.

A. *Yellowing (chlorotic) pines on left and on right. Compare to healthy, dark green pines in the middle.*


A

Witch's Brooms

Pathogens: Numerous organisms, including fungi, insects, mistletoes, mites, nematodes, phytoplasmas and viruses. Some may be caused by mutations.

Hosts: All trees.

Significance: A witch's broom is a disease or deformity in a woody plant, typically a tree, where the natural structure of the plant is changed. Structural instability and weakness at the point of deformity can result in breakage at this point.

Recognition: Look for a dense mass of shoots growing from a single point, with the resulting structure resembling a broom or a bird's nest.

Infection Biology: The plant hormone cytokinin interferes with bud regulation by another hormone, auxin. Usually auxin keeps the secondary, tertiary, and other apexes (growing tips) from growing too much, but cytokinin releases them from this control, causing these apexes to grow into witch's brooms. Such hormonal signals may be triggered by various organisms and mutations that attack the tree.

Management: Avoid improper pruning, which could leave a plant susceptible to disease.

A. *Witch's broom (dense cluster of shoots) in middle of tree.*


A


B


C

Woodpeckers

Species: Many species.

Family: Woodpecker family (Picidae).

Hosts: Many woody plants.

Significance: Most woodpeckers in the southeastern United States do not usually have negative effects on living trees, and are insect predators that can help control bark beetle and wood-boring insect populations.

Recognition: They are small to large birds that climb vertical trunks and branches of trees and hammer into bark and wood with their beaks. Feeding holes may be small or large, often removing bark. Nesting cavities have circular or oval entrance holes. The yellow-bellied sapsucker drills neat, horizontal rows of small holes.

Infection Biology: The yellow-bellied sapsucker is one species that often damages healthy trees, drilling rows of holes in trunks and branches to eat the inner bark (phloem), drink sap, and catch insects stuck in the sap. Most other species primarily forage for insects in and on the outer bark, and chisel into dead or dying trees and branches to eat insects in the wood and inner bark. All are cavity nesters, excavating nest holes in soft or rotten wood, usually of dead trees.

Management: The presence of beneficial woodpeckers can be encouraged by leaving dead trees as snags for foraging and nesting.

A. *Woodpecker feeding and nesting damage.*
B. *Red-bellied woodpecker* (Melanerpes carolinus).
C. *Feeding damage from yellow-bellied sapsucker* (Sphyrapicus varius varius).

UF | UNIVERSITY of FLORIDA
IFAS Extension