

Arizona Urban Tree Map Field Guide

INSECTS AND DISEASES

Identification of Insects and
Diseases in the Urban Forests of Arizona



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INTRODUCTION

The Arizona Urban Tree Map is a joint project of the Arizona State Forestry Division and USDA Forest Service. The main goals of the project are to 1) support communities throughout Arizona in conducting urban forest inventories and 2) compile a database of inventory information, local forest resource information, strategies for public involvement and a sustainable plan to enable long-term urban forest management.

This Insect and Disease Field Guide is one part of a packet of information that is designed to help communities perform urban tree inventories. The packet includes field guides for identifying trees commonly found in Arizona's urban forests; an instruction manual detailing how to perform an inventory and how to use all Arizona Urban Tree Map products; templates for collecting data; and this Insect and Disease Field Guide.

This Insect and Disease Field Guide is designed to be a single source document to help identify insects and disease agents commonly found in tree species most likely found in managed urban environments. It is

not an exhaustive list of every insect and disease species found in Arizona. For additional information on regional insect and disease agents, see the USDA Forest Service Field Guide to Insects and Diseases of Arizona and New Mexico Forests, at www.fs.fed.us/r3/resources/health/field-guide/index.shtml.

HOW TO USE THIS GUIDE

This guide is arranged according to threat type by alphabetical order of common name followed by scientific name in italics. Each disease and insect identification page has a simple design to make information easy to find. Common name is displayed at the top in bold with scientific name underneath in italics. Each page includes a section on Hosts (information on the types of trees that are common hosts to the insect or disease agent), Signs and Symptoms, Effects, and Similar Insects and Diseases (agents that present similar signs and symptoms).

This guide does include some technical terms. A list of technical terms and their definitions can be found in the Glossary (Pg. 16).



True mistletoe (*Phoradendron* species) Pg. 11L



Red ring rot, Red heart of pine (*Phellinus pini*) Pg. 14L

DIAGNOSING TREE STRESS

Diagnosing the source of stress on a tree can sometimes be difficult. It is likely that a combination of factors are working together to cause the decline of a tree over a period of many years. The growing environment of a stressed tree should be carefully evaluated to determine as many of the causal factors as possible. Check for proper planting depth and for girdling roots. The past history of the tree should also be reviewed. Previous applications of chemicals or salt, recent periods of drought, extremely cold or open winters, flooding and similar events can be important in evaluating sources of stress.

Symptoms of Stress

The symptoms of stress often develop slowly, more slowly than insect or disease symptoms. Some things to look for include: the appearance of abnormally small leaves, pale green coloration of leaves, unusually slow growth, premature development of fall leaf coloration, early leaf drop, dieback of twigs and branches, wilting of leaves and tender new growth, peeling bark, and presence of fungi protruding from stems and branches. Repeated

occurrence of these symptoms over a period of years is a good indicator that a tree is being subjected to some chronic stress influences.

Identifying Disease

Tree diseases develop slowly and are usually caused by fungi or bacteria. Symptoms of disease infections typically appear as leaf spots, blights, yellowing of leaves, or wilting. Proper recognition of tree disease symptoms requires familiarity with the “normal” appearance and growth of trees. Trees should also be examined regularly for signs of peeling bark, dieback of twigs and branches, and fungi growing out from the trunk or at the base of the trunk. Some diseases result in little lasting damage to trees while others become progressively worse and can eventually kill trees. The damage caused by diseases can be compounded if the tree is being affected by other stress factors such as drought. If a wilt disease or dieback of branches is occurring, the problem may be internal or below ground. In these situations, it is best to consult with a professional.

Identifying Insect Problems

Some insects can cause injury and damage to trees and shrubs. By defoliating trees or sucking their sap, insects can retard plant growth. By boring into the trunk and branches, they interfere with sap flow and weaken the tree structure. Insects may also carry some plant diseases. In many cases, however, the insect problem is secondary to problems brought on by a stress disorder or pathogen. *It is important to remember that most insects are beneficial rather than destructive.* They help with pollination or act as predators of more harmful species. Therefore, killing all insects without regard to their kind and function can actually be detrimental to tree health.





Bagworm
Oiketicus toumeyi,
Thyridopteryx ephemeraeformis

Host: A wide variety of more than fifty hosts from conifers to eucalyptus (eucalyptus is otherwise almost insect free in North America)

Signs & Symptoms: Silken larval cases (bags) that hang from twigs. Bags are .25 to 3" long, and are disguised using leaves from the host plant (creating different appearances based on host leaf types), hang from twigs. Adult bagworm moths (one inch long, brown, slender with transparent wings) are rarely seen because of their brief lifespan and nocturnal habit. Adult females are legless, wingless caterpillar-like creatures that never leave their larval case, waiting instead for males to find them.

Effects: Bagworms feed by popping their heads out of their protective cases. Damage to the tree host is localised and typically not extensive. Heavy infestations are rare.

Similar Insects and Diseases:
Thyridopteryx meadi specializes on creosotebush and would not be seen on tree species.



Fall webworm
Hyphantria cunea

Host: Willow, alder, ash, chokeberry, cottonwood, madrone

Signs & Symptoms: Large webs occur in host branches in the fall when larvae are feeding. There are two races: blackheaded/northern race (black head, yellowish or greenish body, dark stripe on back, long white hairs) and redheaded/southern race (red/orange heads, yellowish-tan body, brownish hair). The blackheaded/northern race predominates in the West. Adults are white with orange markings on their bodies and legs. Wings are approximately one inch in expanse and have some black spots.

Effects: Larvae feed on leaf surfaces or consume whole leaves causing minor defoliation in most forested situations. Can cause loss of visual quality in ornamental plantings.

Similar Insects and Diseases:
 Western tent caterpillar feeds in the spring, while fall webworm feeds in the fall.





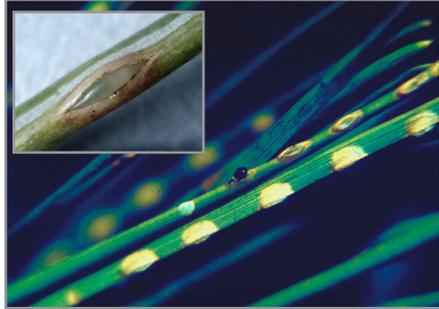
Pine/Conifer sawfly
Neodiprion species,
Zadiprion species

Host: Ponderosa and pinyon pines

Signs & Symptoms: Infested trees have sparse foliage and thin crowns. Eggs may be visible in slits cut in the edge of living pine needles. Larvae, which vary by age and species, are typically green/yellowish-green with shiny black, tan or orange heads. They occur in groups on older foliage consuming the outer needle tissue while leaving the central ribs intact (which later turn yellow-brown and break off). Older larvae feed singly and consume most of the needle. A papery cocoon covers pupae. Adults are broad-waisted wasps.

Effects: Pine sawflies in the Southwest typically attack open-grown trees or areas where pine is growing at a low density. In general, defoliation causes slower growth. Repeated defoliation can result in top-kill and tree mortality.

Similar Insects and Diseases: Pandora moth and pine butterfly larvae are dark, rough skinned and hairy while sawfly larvae are smooth and light green with shiny caps.



Tiger moth
Lophocampa ingens

Host: Ponderosa, white and pinyon pines

Signs & Symptoms: Larvae make large webs (tents) in upper branches of host trees and feed on foliage. Mature caterpillars (reddish brown to black with black and yellow tufts of hairs on their back) are approximately 1.5" long. Adult moths have dark forewings with white markings and white hindwings.

Effects: Larvae occur in groups in web tents, feeding primarily on young trees. They cause only minor defoliation that rarely results in permanent tree injury.

Similar Insects and Diseases: Western tent caterpillars are more likely to be found in hardwood species while tiger moths are more likely to be found in pines.





Western tent caterpillar
Malacosoma californicum

Host: Aspen, willow, cottonwood, mountain mahogany

Signs & Symptoms: Early season defoliator with damage typically occurring between May and June. Can cause moderate to complete defoliation. Large silken tents seen on branches with presence of larvae in and around the tents. Mature larvae are 1.5 to 2" long and usually quite hairy. Their heads are blue to black, body color patterns are varying mixtures of black, orange, and blue.

Effects: Repeated defoliation will result in sparse foliage, minor branch dieback, and in some cases, tree mortality.

Similar Insects and Diseases: Fall webworm feeds in the fall and *Malacosoma* in the spring.



Aphids
Aphididae, Adelgedae

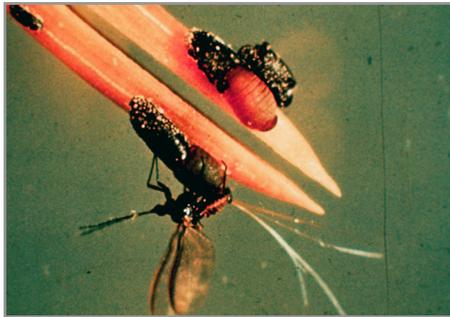
Host: Hardwoods and conifers

Signs & Symptoms: Aphids may be apparent or leaves may appear shiny from honeydew (a clear, sticky liquid that aphids excrete as they feed). Honeydew accumulates on foliage, twigs, trunks and on the ground. It attracts ants, and is a growth medium for sooty mold so the presence of either ants or mold can be an indicator of infestation. Aphids are small, soft-bodied insects that often occur in sticky clusters. They vary in color by species, from nearly colorless to green to black. Adults may be winged or wingless. Nymphs are wingless.

Effects: Dead spots, early leaf drop, yellowing of foliage, and/or reduced plant growth may occur depending on the species involved and the level of infestation. Honeydew accumulation can be a nuisance in an urban environment soiling streets, sidewalks, furnishings, cars and the soles of pedestrian's shoes.

Similar Insects and Diseases: Needle midges are flies resembling mosquitoes while aphids are soft, sticky and elliptical in shape.





Pinyon needle scale
Matsucoccus acalyptus

Host: Pinyon pine

Signs & Symptoms: A native sap-sucking insect that produces cotton-like masses of yellow eggs in the spring. The eggs are often found at root collars, in the crotches of branches or in the fissures of rough bark. Tiny black, bean-shaped nymphs emerge on leaves in fall (the scale). Winged males and wingless, wax covered, almost immobile females emerge as adults in April.

Effects: Infestations can cause needles to yellow and drop. Repeated attacks reduce new growth, stunt needles and predispose trees to attack by bark beetles. Small trees may be killed by severe outbreaks.

Similar Insects and Diseases: Some fungi cause needle cast but their 'scale' is embedded in needles and not external.



Spider mites
Oligonychus species

Host: Conifers and hardwoods including blue palo verde

Signs & Symptoms: Foliage may have discoloration (bronzing) or may appear scorched. Cast mite skins, webbing on foliage, eggs, and other mite activity may also be apparent. Adults are tiny greenish to reddish colored arachnids (eight legs rather than six found in insects) with black heads.

Effects: Spider mites use needle-like mouthparts to suck plant juices, causing spotting, yellowing, fading, and premature dropping of foliage.

Similar Insects and Diseases: Aphids are larger than mites and have six legs instead of eight. Leaf injury from environmental compounds may have similar symptoms (yellowing, spotting, or fading) but without evidence of insects.





Spittlebugs (Froghoppers)
Aphrophora species
Clastoptera species

Host: Oak, juniper, pines and southwestern dwarf mistletoe (a parasite of a parasite)

Signs & Symptoms: Discolored leaves and twigs. Conspicuous, spittle-like froth that surrounds the feeding nymphs, hiding them from predators and insulating them from heat and cold.

Effects: When abundant, feeding insects can cause discoloration and sometimes mortality of infested twigs.

Similar Insects and Diseases:

The juniper twig girdler, *Styloxus bicolor*, causes twig dieback and flagging on junipers, but may be distinguished from spittlebugs by careful inspection of affected twigs. The twig girdler bores inside the twigs, leaving them hollow.



Cooley spruce gall adelgid
Adelges cooleyi

Host: Spruce and Douglas-fir

Signs & Symptoms: A sap sucking bug that forms light green to purplish, cone-like galls (1.5 to 3" long) on spruce branch tips in late spring. The nymphs may be found inside the galls. In late summer/fall the galls dry and open. The nymphs emerge, and fly to Douglas-fir trees to complete their life cycle, feeding on the sap of new needles, shoots, and developing cones. Galls may persist on spruce branches for several years. Adult *A. cooleyi* are dark brown, covered with white, wooly wax.

Effects: In forest situations, the galls on spruce are unimportant. On ornamentals, galls are a concern because they kill branch tips and can stunt and deform trees. On Douglas-fir, infested needles turn yellow, become twisted and may result in defoliation.

Similar Insects and Diseases:

Damage on Douglas-fir resembles that caused by needle midges or needle cast. Midges are flies, rather than fuzzy white bugs. Needle cast is a fungal infection where the scale is embedded rather than on the leaf surface.





Pine tip moths
Rhyacionia species

Host: Ponderosa pine

Signs & Symptoms: Larval feeding causes pitch (protective sap) to flow from the injured tree. It is mixed with silk to create glistening pitch tents. Yellowed, hollowed out shoots appear on the host by midsummer. Pupae in yellowish silken cocoons are attached to tree root collars. Adult forewings (1" span) are irregularly banded with transverse bars of dark gray/black and brick-red scales. Larvae are orange with brown head capsules and are .5 to .66" long when fully developed. Yellowish green elliptical eggs are laid on needles.

Effects: Larvae mine the lateral and terminal shoots of ponderosa pine damaging growth buds. This causes slow growth, crooks, forks, multiple stems, and spike tops. Pine tip moths rarely kill established trees, but attacks can affect survival of newly planted seedlings.

Similar Insects and Diseases: Western pineshoot borer, but unlike a pine tip moth, their attack does not leave webbing, frass or scars and needles may wilt but remain green.



Pitch moths/Clear wing moths
Synanthedon species

Host: Pinyon, ponderosa pine, occasionally Douglas-fir and true fir

Signs & Symptoms: Presence of dying limbs and deformed bark. Sawdust-like frass (insect excrement and resinous tree exudate) marks the location of larval tunnel openings. Larvae are 1 to 1.5" long (at maturity) with a dark brown head and whitish/pink body that darkens before pupating. Empty brown pupal cases may be seen protruding from bark or on the ground. Adult clearwing moths have narrow front wings and wider transparent hind wings. They fly during the day or at twilight and are yellow and black resembling paper wasps or yellowjackets.

Effects: Larger branches, limbs, and trunks of young trees are attacked. Repeated attacks weaken and kill branches. The most severe damage is to trees under 20 feet, especially in urban areas. Rarely a problem for large trees or in the forest environment.

Similar Insects and Diseases: Bark moths (brown with dark spots) cause less pitch production because they feed on inner bark rather than pitch.





Bark beetles
Ips species, *Dendroctonus* species

Host: Ponderosa and pinyon pines

Signs & Symptoms: Fading tops of large trees or whole crowns in small trees are indicators of infestation. Adult bark beetles are small (.125 to .375" long) and black or brown. They are difficult to distinguish from each other but leave characteristic marks on trees including egg galleries found under the bark, engraving on sapwood, "shotgun" pattern holes in bark, pitch tubes (resemble crystallized honey) and accumulations of boring dust in bark crevices and at bases of trees.

Effects: Kill vast numbers of pine trees in short-lived outbreaks, often during drought years.

Similar Insects and Diseases: Other bark beetles which can be distinguished by a professional.



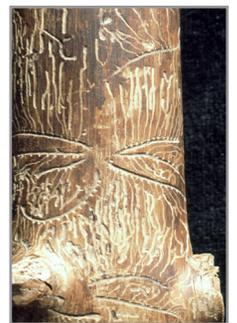
Twig beetles
Pityophthorus species
Pityogenes species
Pityoborus secundus

Host: Pinyon, ponderosa pine, other conifers

Signs & Symptoms: Fading needles on twigs and branches, twig and branch dieback throughout the crown. Tan sawdust is produced around the attack sites. Small, star-shaped egg galleries occur under bark of larger branches and small trunks.

Effects: Kills small twigs and branches of drought stressed or otherwise weakened conifers. Under favorable conditions they may kill small trees.

Similar Insects and Diseases: Other bark beetles which are larger (.25" long) and occur in large trunks. Twig beetles are smaller (.125") and are found in branches or in small diameter trunks.





Wood borers (long-horned beetles/round-headed borers, flat-headed/metallic woodborers)

Coleoptera:
Cerambycidae, Buprestidae

Host: Dead/dying conifers and hardwoods

Signs & Symptoms: Larvae/egg galleries found under bark of dead/dying trees, adults emerging through large holes. Roundheaded borers: Galleries with coarse boring material. Adults oblong with antennae often longer than body. Larvae cylindrical grubs with heads slightly larger in diameter than the body. Flatheaded borers: Galleries with fine boring dust. Adults flat, compact, often brightly colored (similar to species shown below). Larvae with first body segment behind head broader than following body segments.

Effects: Primarily attack weakened, dead or dying trees (a few species attack and kill apparently healthy trees). Often attack trees already infested with bark beetles and sometimes compete with them.

Similar Insects and Diseases: Bark beetles have narrow, uniform galleries while wood borer galleries vary in width.



Dwarf mistletoe
Arceuthobium species

Host: Ponderosa, bristlecone, pinyon, Apache, Chihuahua and southwestern white pine; Douglas-fir, white and subalpine fir; Engelmann, western, and blue spruce

Signs & Symptoms: Swollen branches and stems are apparent at infection sites, which may show either aerial shoots or well developed witch's brooms. Aerial shoots vary by species in size, color, and pattern of branching.

Effects: Decline of growth and vigor occurs when more than half the crown is parasitized. Most infected trees can survive for decades with smaller trees declining more rapidly than larger ones. Bark beetles often attack heavily infected trees, especially during drought. Infection has some benefits for wildlife; birds and small mammals may use plants for habitat and food.

Similar Insects and Diseases: Some fungi cause the formation of witch's brooms. Branches can be checked for aerial dwarf mistletoe shoots to distinguish broom symptoms caused by other pathogens or disorders.





True mistletoe
Phoradendron species

Host: Oak, mesquite, acacia, palo verde, ironwood, juniper, Arizona cypress, white fir, riparian hardwood species

Signs & Symptoms: Rounded clumps of thick green stems up to 3' in diameter (witch's brooms) are apparent growing out of the bodies of host trees. The plants have thick green leaves that are either oval, small and thin, or can be nearly leafless, depending on the species. In late fall to early winter small, sticky, white, pink or red berries (vary by species) may be present.

Effects: Infection and infestation often occur on larger trees where birds prefer to perch. True mistletoes are not aggressive pathogens and cause mortality only when water availability to the host is limited. Infected portions of some trees may exhibit galls on branches or burls in trunks. Branch dieback is associated with galls on some hosts.

Similar Insects and Diseases: Deformities caused by fungi can resemble those caused by mistletoe. Check for aerial mistletoe shoots.



Anthracnose
Apiognomonia veneta

Host: Arizona sycamore

Signs & Symptoms: *Apiognomonia veneta* is a species of fungus that infects sycamore trees. There are three phases of the disease: (1) Cankers (areas of dying tissue) on buds and twigs, (2) shoot blight following a period of cold spring weather and (3) leaf blight from direct infection of leaves. Foliar lesions have a characteristic pattern extending along the veins and in the interveinal tissue. Large irregular marginal lesions may also develop.

Effects: Anthracnose has aesthetic consequences for urban trees. Branch axes change direction due to terminal bud dieback causing crooked branches and unattractive clusters of twigs emerging from a common point on a branch.

Similar Insects and Diseases: Sometimes confused with frost injury. However, frost damage may affect several species in the same area while *Apiognomonia veneta* affects only sycamore trees.





Needle casts (and blights)

Elytroderma deformans, Lophodermella arcuata, L. cerina, Rhabdocline species

Host: White pine, ponderosa pine, pinyon, Douglas-fir

Signs & Symptoms: Needle casts, or blights, are diseases caused by fungi that result in discoloration and premature loss of needles. Following infection fungi produce fruiting bodies on needle surfaces. These bodies are shades of brown, often glossy and vary from ovoid to elongated by species. Affected needles change color becoming brown, red, straw colored, pallid green, or develop chlorotic lesions that progress to brownish-purple bands, depending on species of fungus and tree. Needles may remain green at the base while discolored at the apex.

Effects: Growth loss, defoliation, predisposition to attack by bark beetles. Repeated infection can kill trees. Severe damage occurs in Christmas tree plantations.

Similar Insects and Diseases: Winter damage, salt damage, and needle miners can resemble needle cast but close inspection will reveal fruiting bodies. Some needle cast fungi produce witches brooms that may be confused with mistletoe.



Cytospora canker

Cytospora chrysosperma

Host: Aspen, cottonwood, alder and other riparian species

Signs & Symptoms: Necrosis of bark appears as an orange discoloration often accompanied by a brown liquid exudate. Inner bark turns from green to brown to black beginning to slough off after 2-3 years. Small, raised fruiting bodies appear embedded in and breaking through affected bark. Often numerous, these bodies give the appearance of coarse sandpaper. Fine, curly orange tendrils of spores project from the fruiting bodies if the weather is wet, otherwise orange-colored spore masses accumulate on the bark surface.

Effects: *C. chrysosperma* is the most common fungus found on aspen. It normally attacks stressed trees. Cankers may be annual, stopping growth after a season or may continue their spread until the tree is dead. Once a stem is girdled (killed all the way around), everything above that point dies.

Similar Insects and Diseases: Sooty canker, but the orange tendrils or spores produced by this fungus are quite distinctive and it lacks the lens-shaped, light-colored area and the barber pole design.





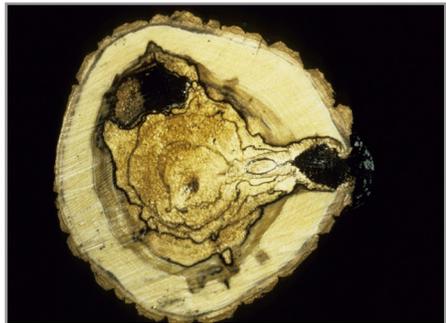
False tinder conk
Phellinus tremulae

Host: Aspen

Signs & Symptoms: Woody, hoof-shaped conks (the visible fruiting bodies of bracket/shelf fungi) occur on aspen trunks, typically at branch stubs or scars. They are brown to black, with a rough, cracked upper surface and tan to white pore surface. *P. tremulae* also produces hard, blackish sterile conks (no spores) at branch scars, giving the fungus its name. Yellowish-white, spongy decay is usually confined to a central core.

Effects: False tinder conk is the most common cause of aspen stem decay in the Southwest. It causes less mortality than other fungal diseases but can create hazard trees in recreation sites.

Similar Insects and Diseases: Other conk forming fungal infections but this species is the most likely to be found on Aspen.



Heart rots of oak
Inonotus dryophilus,
Phellinus everhartii

Host: Oak

Signs & Symptoms: Fungal diseases causing decay of wood at center of trunks and branches. Presence of conks (fruiting bodies) on the tree are an indication of heart rot. Two of the most common species to infect oaks are *I. dryophilus* and *P. everhartii*. The former produces an annual fruiting body that is up to 7 inches across. It is soft, light yellow, becoming rusty brown, and degrades quickly following spore dispersal. The latter (*P. everhartii*) produces a perennial conk that is convex and semicircular at first, becoming hoof-shaped with age. Can be more than a foot across; at first smooth, later woody and cracked; brown to gray, or black with a paler, smoother margin. Produces rusty brown spores. Branch stubs and injured trunks are the most common sites of infection.

Effects: Diseased heartwood softens resulting in structural weakness often resulting in breakage. By the time a conk is visible extensive damage has already been done to the tree.

Similar Insects and Diseases: Many fungi decay the heartwood of oaks; these are most common.





**Red ring rot,
Red heart of pine**
Phellinus pini

Host: Spruce, Douglas-fir, true fir, pine

Signs & Symptoms: Hard brown fruiting bodies (conks) are hoof-shaped to shelf-like. They have a brownish-black upper surface, furrowed concentric rings and a yellow-brown undersurface containing spores. Conks appear at branch bases, branch stubs, knots, wounds, and cracks. Decayed wood appears as a red to purple discoloration of the heartwood with included white pockets. This disease affects mostly older trees.

Effects: Thought to be the most common trunk decay fungus of conifers in North America. Decay is more extensive in old trees.

Similar Insects and Diseases:
None



Sooty canker
Encoelia pruinosa, Cenangium singulare

Host: Aspen

Signs & Symptoms: This fungal infection causes young cankers to appear as slightly sunken areas on otherwise normal bark. When dead bark falls off it reveals black (sooty), crumbly inner bark beneath which is a distinctive, black, feather-like pattern on the wood surface. Perennial cankers form a band of light gray bark that remains attached to annual growth rings giving the tree a barber pole appearance. Gray to black leathery cup-shaped fruiting bodies develop on the inner bark along the canker margin. The wood beneath the cankers is light gray.

Effects: *Encoelia pruinosa* can kill trees in 3 to 10 years. Found mainly on larger dominant trees older than 60 years, in middle elevational limits of aspen. Cankers are more common in disturbed stands.

Similar Insects and Diseases:
Cryptosphaeria canker can also produce dead inner bark with a soot-like appearance but produces a long, lens-shaped, light-colored area that lacks the barber pole design.





White pine blister rust
Cronartium ribicola

Host: Five-needled pines

Signs & Symptoms: Dead branches often in crown. Young stems/branches may have swollen or sunken areas with discolored margins. Older stems may have resinous, cankered regions. In spring, blister-like aecia (cup shaped fungal bodies) appear on cankered stems and release powdery whitish-orange spores.

Effects: Very few young trees survive infection (die within a few years). In older trees, rust often occurs in isolated branches or in the upper crown so that only part of the tree is killed. *C. ribicola* is the most costly conifer disease in North America.

Similar Insects and Diseases:
Endocronartium harknessii
(Western gall rust) infects two-needled pines.



GLOSSARY

Aecia: cup-shaped fungal bodies

Cankers: any of various plant diseases that causes open sores

Conspicuous: very easy to see or notice

Defoliation: to cause the leaves of a plant, tree, or forest to fall off

Deformities: a condition in which part of the body does not have the normal or expected shape

Discoloration: the process of changing to a different, less attractive color

Excrement: waste matter discharged from the body

Exudate: the slow escape of liquids out of a plant through pores, diseased or injured tissue, including gum, sap, resin, and latex

Galls: an abnormal outgrowth of plant tissue usually due to insect or mite parasites or fungi

Infestations: being invaded or overrun by pests or parasites

Larval: a distinct juvenile form many animals undergo before changing into a different adult form

Nocturnal: animal behavior characterized by activity during the night and sleeping during the day

Nymphs: a young insect that has almost the same form as the adult

Pupae: the life stage of some insects undergoing transformation

Sparse: thinly dispersed or scattered

Transparent: able to be seen through

PHOTO CREDITS

Cover: Sky Jacobs, *Quercus coccolobifolia*

Page 2: Tom Van Devender, *Pinus strobiformis*

Page 3L: Forest Images, 1 bagworm damage to conifer tree, 3 bagworm hanging from conifer stem, Eric R. Day, Virginia Polytechnic Institute and State University; Claire Dickson, 2 bagworm on tree trunk; Pennsylvania Department of Conservation and Natural Resources - Forestry Archive 4 bagworms on hardwood branch

Page 3R: Bugwood.org, 1 webworm infestation, 2 web close-up, 3 larvae consuming leaf, Lacy L. Hyche, Auburn University; Bugwood.org, 4 webworm damage, Ronald F. Billings, Texas Forest Service; Bugwood.org, 3-inset, Moth, Jerry A. Payne, USDA Agricultural Research Service

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