Scale Insects

Overview: Scale insects are some of the most destructive pests of shade trees and ornamentals, but few are serious forest pests. All scale insects pierce plant tissues and obtain nutrients by the ingestion of large amounts of plant sap. Localized injury may occur around feeding sites and serious damage or death may occur in heavily infested trees. All adult scales produce a waxy or shell-like covering. Many scale insects are often very inconspicuous (some scale coverings act as camouflage) making diagnosis of an infestation difficult (Fig 5). Others may produce an obvious waxy coating that is easily visible. There are hundreds of species of scale insects that feed on North Carolina trees and shrubs. However, each scale species usually infests only one (or a few) host species. Therefore, many scales are named for the specific host species on which they feed.

Causal Agent: Scale insects: Order Hemiptera, Suborder Sternorryncha, Superfamily Coccoidea

Hosts: Many species of conifers and hardwoods. Scale insects are usually very host specific.

Symptoms / Signs: Symptoms vary widely with the scale species, host, and host tissue attacked. The most common symptoms observed may include foliage spotting, speckling, chlorosis, curling, and/or wilting; as well as galls, distorted growth patterns, bark swelling, twig dieback, branch dieback, decline, and mortality.

Adult females are sedentary, wingless, and may lack distinctive divisions between the head, thorax, and abdomen. They are covered with a hard scale or waxy secretion, and can range from $^{1}/_{50}$ inch to ¼ inch long. Scale coverings can be flattened and shield-like (Fig. 3), spherical (Fig. 8), or anywhere in between. Wax coatings (frequently white) (Fig. 6) may simply be a thin transparent film (Fig. 7), but some species produce powdery bloom-like secretions. Adult males usually have wings, lack mouthparts, and are very active flying insects but are rarely observed. Nymphs are nearly microscopic and only mobile for a few days to a couple of weeks. After their first molt, they lose their legs, become sedentary, and begin to form a scale or wax covering. The best way to detect crawlers is to hold a white sheet of paper under an infested branch. Shaking the branch will cause the crawlers to fall onto the paper, where they may be visible as small moving dark specks.

In addition, like many other sap-sucking insects, some scales produce large amounts of honeydew (waste and excess plant sap that could not be processed by the digestive system) that drips down onto lower surfaces. Specialized fungi known as “sooty molds” grow on the honeydew, turning those surfaces dark gray or black (Fig. 2). Other insects, such as ants and wasps, may also invade the area to feed on fresh honeydew.

Life Cycle: Life cycles vary by scale species. Usually there are 1-4 generations per year in North Carolina. Most scales overwinter as late-stage nymphs. In the spring after maturation is complete, the eggs inside the adult female’s body mature within one to several weeks after fertilization. When the eggs hatch, the first stage nymphs (known as “crawlers”) search for feeding sites, or may spread to neighboring trees on the wind or by animal vectors such as birds and small mammals. Once a feeding site is located, the crawlers molt and become sedentary. Their long piercing-sucking mouthparts may penetrate deep into the plant to reach nutrient-rich sap. Feeding sites may be leaves, buds, twigs, or main stems depending on the scale species. It may take 2-8 weeks for nymphs to transform into fully mature adults. Populations can grow exponentially, resulting in heavy infestations in short periods of time, and are frequently cyclical.

Importance: Moderate. Most scales pose no serious threats to tree health. However, scales can be a serious nuisance on landscape trees and ornamentals. Gloomy scale can cause serious dieback or even death in many maple species. The tuliptree scale (Fig. 1) is a serious pest of yellow poplar that can cause branch dieback or death. The beech bark scale releases a potent toxin and carries a pathogen that threatens the survival of American beech. Lecanium scales are a very common pest of hardwoods, but rarely require control measures (Fig. 4).

Management: Chemical control options are available for high-value trees. Treatments are usually ineffective against adults. Therefore, applications of insecticides or horticultural oils must target crawlers when they are active. Close monitoring of crawler activity and repeated chemical applications are usually necessary for successful control.

Timeline: Species dependent. Life stages may overlap significantly. Crawlers are most active in the spring and fall.

Range: Statewide.


Fig. 1 Tuliptree scales

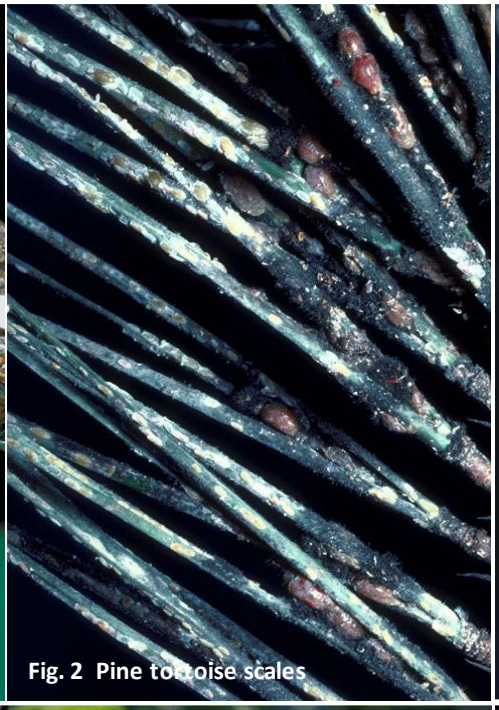
Fig. 2 Pine tortoise scales

Fig. 3 Obscure scale

Fig. 4 Lecanium scales

Fig. 5 Black scale

Fig. 6 Wax scales

Fig. 7 Green scales

Fig. 8 Soft scale

Aphids

Overview: Aphids are usually minor pests of hardwoods and conifers, however, a few can cause serious harm to landscape trees and ornamentals, while others can be serious pests in seedling nurseries. Some aphids act as vectors for viral or bacterial diseases, and most have the potential to become persistent and troublesome pests. All aphids pierce plant tissues and obtain nutrients by the ingestion of large amounts of plant sap. Localized injury may occur around feeding sites, and serious damage or death may occur in seedlings or young trees. Usually natural predators keep aphid populations under control, therefore, serious infestations are often observed following insecticide applications that adversely affect predatory insects. Aphids can feed on almost any plant tissue, but are most common on foliage and new growth. Aphids produce large amounts of honeydew resulting in sooty mold that can damage or degrade the beauty of ornamentals. Some aphids produce a woolly or waxy material that covers their body; others induce gall formation at the feeding site. There are hundreds of species of aphids, most of which are named for their host plants.

Causal Agent: Scale insects: Order Hemiptera, Suborder Sternorryncha, Superfamily Aphidoidea

Hosts: Conifers and hardwoods. Aphids are usually host specific; almost all plant species are attacked by one or more species of aphid.

Symptoms / Signs: Aphids weaken a plant by feeding on sap, or may transmit plant pathogens. Symptoms vary widely with the aphid species, host, and host tissue attacked. The most common symptoms observed may include foliage spotting, speckling, chlorosis, curling, and/or wilting; as well as distorted growth patterns (Fig. 6), galls (Fig. 7), bark swelling, twig dieback, branch dieback, decline, and mortality.

Aphids are small (1/64 - 1/4 inch long) pear-shaped insects (Fig. 1) that live in colonies (Fig. 2 & 5) on the leaves and new growth. They may be winged (Fig. 3 & 4) or wingless and vary widely in color, shape, and size. Some aphids produce alarm pheromones when threatened or disturbed, stimulating defensive responses (e.g. dropping to the ground, shaking aggressively) in their neighbors. Other aphids have wax glands in their abdomen that produce a woolly or waxy coating that may cover their entire body (Fig. 9).

Like many other sap-sucking insects, aphids produce honeydew (waste and excess plant sap that could not be processed by the digestive system) that drips down onto lower surfaces. Fungi known as “sooty molds” grow on the honeydew, turning those surfaces dark gray or black. Other insects such as ants and wasps may also invade the area to feed on fresh honeydew, and some ant species “farm” aphids for honeydew (Fig. 8).

Life Cycle: Life cycles vary considerably in different aphid species. Usually, aphids overwinter in the egg stage and hatch in early spring as plant growth resumes. Only wingless females are produced at first, which feed and reproduce without mating, resulting in a growing population of more wingless females. When the colony gets big enough, winged females are produced that fly to an alternate host plant species to feed and continue to reproduce without mating. Late in the season, winged forms return to the original host plant species where a generation of both males and females is produced; they mate and lay eggs before the onset of winter. Numerous overlapping life-stages can be found throughout the growing season.

Importance: Moderate. Most aphids cause little or no serious harm to host plants; however, large infestations can cause damage. Generally, aphids are a serious nuisance that degrade the appearance of landscape trees and ornamentals.

Management: Chemical control options are available and infested plants must be thoroughly treated. Contact insecticides and horticultural oils are usually ineffective against aphids with waxy protective coatings; systemic insecticides are sometimes effective in these cases. Aphids are notoriously difficult to control and nearly impossible to eradicate completely. An integrated pest management approach is usually the most effective. Predatory/parasitic insect populations usually keep aphid populations in check; insecticide applications that kill beneficial insects may result in aphid outbreaks.

Timeline: Species dependent. Life stages may overlap significantly. Active throughout the growing season.

Range: Statewide.


Fig. 1 Tobacco aphid
UGA1402117


Fig. 2 Aphid colony
5382116


Fig. 3 Green peach aphid
UGA1317037


Fig. 4 Giant bark aphid
UGA1150117


Fig. 5 Black cherry aphid
UGA2200052


Fig. 6 Leaf curl ash aphid
UGA3066042


Fig. 7 Woolly apple gall aphid
5361965


UGA5343048
Fig. 8 Ant feeding on honeydew


Fig. 9 Woolly alder aphid
UGA5062058

Gall-forming Insects

Overview: Many insects induce hypertrophies (a condition of abnormal rapid cell division and cell enlargement) in host tissues during feeding or to complete their life cycle. These hypertrophies are generally referred to as galls, and are caused by a wide variety of insects. Gall-forming insects release plant growth-regulating chemicals that alter normal plant growth and development. Most gall-forming insects are host species-specific and are often named for their host. Galls can be formed on virtually any host tissue including leaves, buds, flowers, cones, shoots, twigs, branches, and main stems. There are hundreds of gall-forming insects, most of which cause little if any serious harm to their host plants. However, because galls may be large and conspicuous, they often cause concern.

Causal Agent: Gall-forming insects include a number of insect and arachnid orders and families including aphids, phylloxerans, midges, adelgids, mites, pysillids, beetles, moths, sawflies, and wasps. Most often it is the immature stage of the insect that is responsible for gall production. Galls formed by gall wasps are among the most common galls observed.

Hosts: Most common in hardwoods. Most hardwood species serve as hosts to one or more gall-forming insects; galls are particularly common in oaks. Some conifers including pines, fir, spruce, and baldcypress (Fig. 9) are hosts to gall-forming midges and adelgids.

Symptoms / Signs: The causal agents of galls are usually not observed; larvae inside of galls are difficult to identify. Diagnosis is usually based on the gall symptoms and host species. Galls vary widely in size, shape, color, texture, and longevity and are determined by the host species, host tissue, and the causal agent. In general, galls are tissue swellings caused by rapid cell division and enlargement (gall midges in conifers also cause resin accumulation at their feeding sites, which contribute to gall swelling). Galls can be small leaf spots or bumps (e.g. eyespot galls on maple, dogwood, and yellow poplar (Fig. 1)), soft and fruit-like (e.g. oak apple galls (Fig. 2)), carpet-like (e.g. eriophyid galls (Fig. 4)), woody (e.g. many oak galls), ornamented (e.g. horned oak galls (Fig. 3)), spiny rose galls), fuzzy (e.g. hedgehog gall, woolly rose gall (Fig. 5)), cone-like (e.g. eastern spruce gall (Fig. 6)), well defined (e.g. nipple galls (Fig. 7)), deformed (e.g. many psyllid galls), or abnormal clusters of buds, shoots, or leaves (e.g. witches brooms (Fig. 8)). The variations are nearly endless.

Life Cycle: Life cycles vary considerably. Galls are produced by plant growth-regulating compounds (sometimes called plant hormones) released by larvae, but a few galls are caused by adult life stages (e.g. sawfly-induced galls). Additional resources should be consulted for specific information on gall-forming insects. The life cycle of a typical oak gall caused by a gall wasp is given below as an example.

Each gall-making wasp species utilizes only one or a few closely related tree species as a host; each gall maker creates a distinctive gall on its host. An interesting characteristic of many gall wasps is that they are heterogamous: the offspring differ significantly from their parents, but are identical to their grandparents. This is also referred to as alternating generations. The galls formed by alternating generations may be formed on different host tissues and look completely unlike those caused by the parent (Fig. 10 & 11). In fact, the offspring and their galls may look so unlike their parents that in many cases, entomologists have unknowingly described them as separate species. Many gall wasps overwinter as mature adults inside their galls. In the spring they emerge and lay eggs in suitable host tissue. Larvae rapidly develop; the plant growth-inducing chemicals they release cause rapid multiplication and growth of nutrient-rich cells surrounding the larval chamber on which they feed. Adults of the second generation emerge and lay eggs on the same host (but often different tissue). Larvae formed during this generation mature during the summer and fall but will not emerge until the following spring.

Importance: Low. Galls usually cause little if any serious harm to their hosts.

Management: Usually not required.

Timeline: Species dependent; active throughout the growing season.

Range: Statewide.


Fig. 1 Eyespot galls UGA2167004


Fig. 2 Oak apple galls UGA3056041


Fig. 3 Horned oak gall UGA1470114


Fig. 4 Eriophyid mite gall UGA1428105


Fig. 5 Mossyrose gall UGA1370042


Fig. 6 Eastern spruce gall UGA4836011


Fig. 7 Nipple galls UGA5203023


Fig. 8 Witches brooms UGA5188079


Fig. 9 Cypress gall UGA2109073

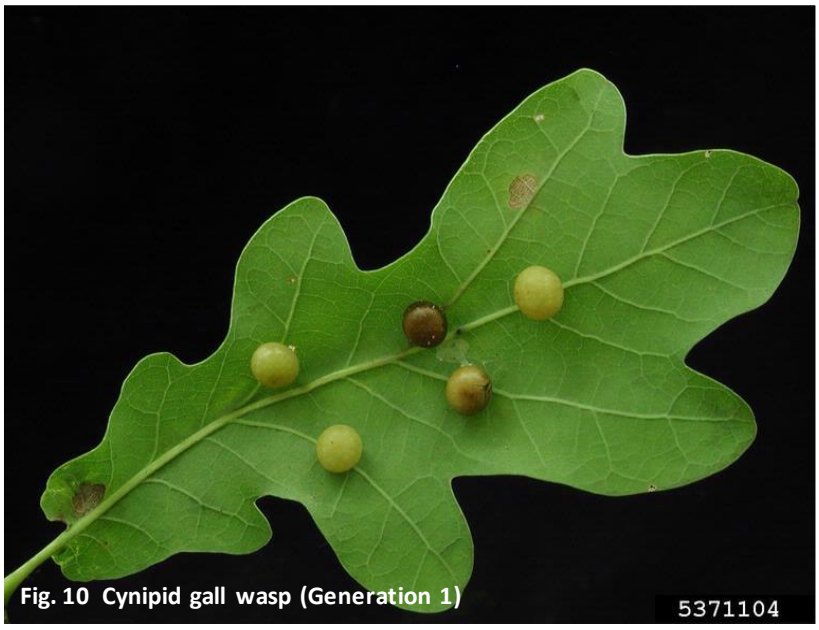
Fig. 10 Cynipid gall wasp (Generation 1) 5371104

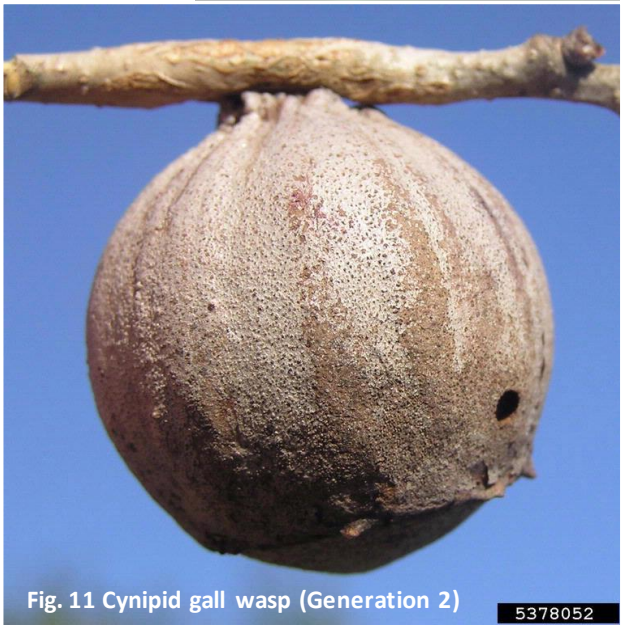
Fig. 11 Cynipid gall wasp (Generation 2) 5378052

Hemlock Woolly Adelgid

Overview: The hemlock woolly adelgid was first introduced to the eastern United States in the early 1950's from Asia. Since that time, it has spread throughout much of the natural range of our native hemlocks and threatens to eradicate virtually all hemlocks from our forests. The hemlock woolly adelgid is an aphid-like insect that feeds on nutrient-rich sap; large populations of the insect that heavily infest trees cause decline and eventually death over a period of three to seven years. There are many potentially disastrous consequences of losing mature hemlocks from our forests as they are critical for water and soil quality preservation, and are depended upon by many plant and wildlife species.

Causal Agent: Hemlock woolly adelgid (*Adelges tsugae*)

Hosts: Eastern and Carolina hemlocks; also hundreds of ornamental hemlock cultivars.

Symptoms / Signs: Symptoms develop gradually over a period of several years. The foliage on infested branches will begin to pale in color, often turning from dark green to grayish-green or gray. Needles will dry out and may fall off the tree within a few months. A new flush of needles may occur on some infested trees, but this is not necessarily an indicator of improving tree health. Infested trees put on little if any new shoot growth. Crowns will appear thin and individual branches may be killed starting in the bottom of the crown and spreading upwards (Fig. 3). Trees will usually die within 3-7 years of becoming heavily infested. In areas where the adelgid front has already passed through, large numbers of pale-gray snags line watersheds (Fig. 7).

Sedentary adult adelgids will be located on the undersides of branches (Fig. 1). Adults (< 1/16 inches long) (Fig. 8) are covered by a white woolly coating and are usually attached at the base of needles (Fig. 4). Heavily infested branches will look as if they have been sprinkled with snow (Fig. 2). The juvenile crawlers are nearly microscopic, but can be seen (when present) by shaking an infested branch over a white piece of paper; crawlers will appear as small black dots moving on the paper surface.

Life Cycle: The hemlock woolly adelgid has a complex life cycle that involves a number of life stages and an alternate host (spruce) in Asia. The life-cycle here in the U.S. is not as complex because our native spruce species are not suitable for the production/survival of certain life-stages of the insect. In spring, two life stages are produced at the same time: winged sexuparae and non-winged progrediens. *Note: Sexuparae do not survive or reproduce in North America.* Progrediens hatch as crawlers from late March through early May. Crawlers are mobile for several weeks and can be dispersed to new trees by wind, people, and animals (particularly birds). Crawlers quickly settle down and attach themselves to a feeding site at the base of a needle where they remain attached for the rest of their life. The adelgids have a long stylet (3 times the length of the insect) that penetrates deep into plant tissues and obtains nutrients from cells that store and deliver nutrient-rich sap to the rest of the tree. By June or July, the progrediens have developed into mature sedentary adults, and produce white cottony sacs of eggs that cover their bodies (Fig. 5). Another life-stage called sistens hatch from these progredien eggs in mid-summer. Sisten crawlers attach themselves to needle feeding sites within a few days of hatching. Sistens remain attached throughout the fall and winter; in February they produce white sacs of eggs that hatch into progrediens and sexuparae a few months later.

Importance: High. The hemlock woolly adelgid is a serious threat to our native hemlock species and ornamental varieties. There may be catastrophic consequences for ecosystems that depend on this important late-successional species.

Management: Chemical control options are available for high-value trees in the early stages of decline. Insecticidal soaps and oils can be sprayed onto small trees, but coverage must be thorough and timed accordingly to target susceptible crawlers and sedentary nymphs. Systemic insecticides are also available that can be injected into the tree or applied as a soil drench. Systemic insecticides are effective for up to three years and kill sedentary adults. Research to use predatory beetles introduced from Asia as biological control agents is currently underway.

Timeline: White and woolly adult adelgids first become visible in early spring. Crawlers are active in late spring and again for a short period during mid-summer. White woolly residue is usually visible year-round.

Range: Western North Carolina; isolated populations of hemlock throughout the rest of the state (Fig. 6).

Fig. 1 Infested branch

Fig. 2 Infested branches

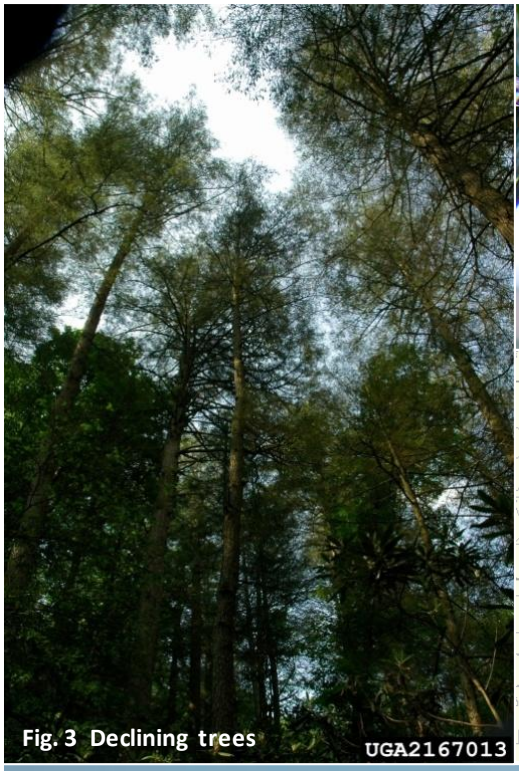

Fig. 3 Declining trees

Fig. 4 Adelgids on needles

Fig. 5 Eggs in egg sac

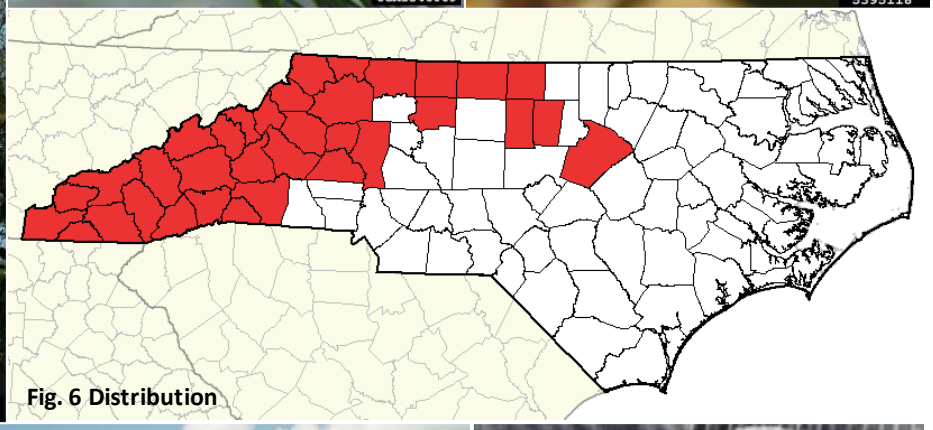
Fig. 6 Distribution

Fig. 7 Dying hemlocks


Fig. 8 Adult adelgid

Balsam Woolly Adelgid

Overview: The balsam woolly adelgid was first introduced to the northeastern United States in the early 1900's from central Europe. In the 1950's, the insect was introduced to the southeast, and now all natural fir stands in North Carolina are thought to be infested (Fig. 6). The balsam wooly adelgid is considered to be a serious threat to Fraser firs in forests, Christmas tree plantations, and seedling nurseries. The insects attach themselves to the bark of stems and twigs to feed; abnormal cell growth and swelling follow and prevent water conduction in the sapwood. Trees decline and die within 2-3 years of being attacked. The long-term ecological consequences of this pest in fir-dominated ecosystems are unknown.

Causal Agent: Balsam woolly adelgid (*Adelges piceae*)

Hosts: All North American true firs; eastern U.S. species include balsam and Fraser fir.

Symptoms / Signs: The most common symptom of trees attacked by the balsam woolly adelgid is abnormal swelling of infested tissues. This swelling is called "gouting" and is most common around buds, branch nodes, and on stunted shoots (Fig. 3 & 4). Gouting is most severe in trees that are only lightly infested for a prolonged period of time; the tops of these trees are usually killed first, and will often curl over. In more severe cases, adelgids will infest the main stem of the tree (Fig. 1); abnormal swellings resembling severely roughened bark may be present at feeding sites. When adelgids attack the main stem, trees are sometimes weakened to such a degree that gouting does not appear on other tissues. Foliage may become chlorotic, needles may fall off, and trees usually die within 2-3 years.

Adult adelgids are very small (< 1/32 inch long) and are covered by a thick mass of white, woolly, and waxy coating that protects both the adult and its eggs. The adults are easiest to find where they gather in high densities around buds, branch and twig nodes, and on the main stem especially where bark is roughened. Juvenile crawlers are nearly microscopic, but can be seen (when present) by shaking an infested branch over a white piece of paper; crawlers will appear as small black dots moving on the paper surface. After crawlers attach and begin to feed, they become flattened and wax-fringed.

Life Cycle: The balsam woolly adelgid has 2 ½ - 3 generations per year in North Carolina. Only female adelgids are present in North America, and they can reproduce without mating. Life stages widely overlap. Eggs hatch in spring and crawlers are mobile for several weeks; they are easily spread by wind and birds. Crawlers settle down and attach at feeding sites, such as bark lenticels and other natural openings. After the crawler's mouthparts pierce the bark and it begins to feed, the insect transforms (without molting) into an immature resting stage called a neosisten. Neosistens generally develop into adult sistens by the end of June, and for the next several weeks eggs are laid by the sedentary female adults. Eggs (Fig. 2) hatch within a few days, crawlers quickly attach to feeding sites, and transform from neosistens to adults in September and October. In warmer parts of the state, a partial third generation will develop. Neosistens are the only over-wintering stage.

Importance: High. The balsam woolly adelgid is a serious threat to our native firs. The long term consequences of balsam woolly adelgid-caused mortality are unknown. When the insect first colonizes a new stand, populations grow exponentially and high rates of tree mortality are observed. Natural regeneration follows, however, successive cycles of regeneration and mortality may cause significantly declining populations of firs over time (Fig. 6).

Management: Chemical control options are available for high-value trees (Fig. 5). Contact insecticides are most effective against the crawler stage in May-June or September-October. Insecticidal soaps and oils may be effective against wax-covered adults, but coverage must be thorough and timed to avoid burning the foliage. Chemical applications can reduce adelgid populations enough to allow natural tree defenses to overcome the remaining infestation. Many treated trees may remain free of adelgids for several years. Research to use predatory beetles introduced from Asia as biological control agents is currently underway.

Timeline: Crawlers are active in late spring and again for a short period during mid to late summer. Life stages overlap significantly, and evidence of white woolly adults can usually be seen year-round.

Range: High elevations in western North Carolina.

Fig. 1 Infested stem

Fig. 2 Eggs laid around a bud

Fig. 3 Twig gouting

Fig. 4 Branch gouting

Fig. 5 Chemical treatment

Fig. 6 Mortality and regeneration

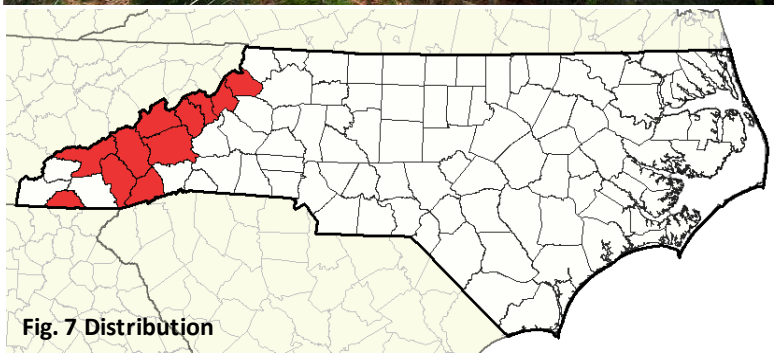
Fig. 7 Distribution

Pine Webworm

Overview: The pine webworm is considered to be a minor pest of southern pines. The pine webworm larvae primarily feed on young seedlings, but may attack larger saplings or even mature trees. Severe defoliation is uncommon; even heavy infestations of the pine webworm are not usually severe enough to kill the host, but heavily defoliated seedlings may have reduced growth and vigor. There are many species of web-spinning sawflies and pine false webworms similar in appearance and behavior; generally, the information provided below applies to all of these species.

Causal Agent: Pine webworm (*Tetralopha rubestella*).

Hosts: Southern pines including loblolly, longleaf, pitch, shortleaf, slash, Virginia, white pine, and others.

Symptoms / Signs: Symptoms include defoliation; early larval instars mine the needles whereas later instars clip and feed on the entire needle. Browning of mined/clipped needles may be observed. Growth reduction is possible when defoliation is severe.

Pine webworm infestations are unmistakable, but usually go unnoticed until after the larvae have disappeared and feeding is complete. Needle mining by early instars is difficult to detect. Larger larvae will form colonies within a silken web nest. As the larvae feed and mature, the nest becomes filled with small brown fecal pellets and clipped needles. The result is an unmistakable mass of frass and webbing wrapped around branches or clustered at branch crotches (Fig. 1 & 2). Nests range from less than 2 inches to more than 5 inches in diameter. The larvae when fully grown are approximately ¾ inches long, tan to yellow-brown or brown, with dark-brown longitudinal stripes (Fig. 3). Adult moths are rarely observed, but are drab or dark gray with darker forewings; wingspan is approximately 1 inch (Fig. 4).

Life Cycle: There are two generations per year in North Carolina. Pine webworms overwinter as pupae in the soil. The emergence of adult moths begins in May and continues throughout the summer. Adults mate and the females lay eggs in longitudinal rows on the needles of a suitable host; up to 20 eggs may be laid on a single needle. When larvae hatch, they spin a silken strand behind them, eventually entangling many needles. Young larvae mine the needles from within, but as they grow, they devour entire needles. Larger larvae will form colonies within a single silken nest; colonies may contain anywhere from two to more than 80 individuals. The feeding larvae fill the nest with frass and clipped needles. In September, the second generation of larvae drop to the ground and burrow into the soil to pupate.

Importance: Low. Pine webworms usually cause little if any significant damage. When severe infestations occur, young seedlings can be killed but usually growth reduction is the only result (Fig. 5).

Management: Usually not required. Pine webworm larvae are a preferred food of natural predators such as birds and rodents. There are also several species of parasitic wasps and flies that keep pine webworm populations in check.

Timeline: Emergence of first generation adults occurs in May. The first webs (from the current growing season) may be visible as early as June. Nest formation and feeding occurs throughout the summer. Pupation of the second generation occurs mid to late September. Nests from the previous growing season are persistent and may be visible year-round.

Range: Statewide.


Fig. 1 Pine webworm nest UGA1398117


Fig. 2 Pine webworm nest UGA3226091


Fig. 3 Pine webworm larvae UGA1178101


Fig. 4 Pine webworm adult UGA5190066


Fig. 5 Defoliated seedling UGA0590091

Pine Sawflies

Overview: There are over 100 species of sawflies in the U.S. whose larvae feed on the foliage of conifers; several occur in North Carolina including the redheaded pine sawfly, blackheaded pine sawfly, introduced pine sawfly, and the loblolly pine sawfly. Sawflies are not actually flies (Order Diptera), but rather they are a type of non-stinging wasp (Order Hymenoptera). They are called sawflies because they resemble flies and have a saw-like appendage that protrudes from their abdomen which is used to insert eggs into pine needles. Sawfly larvae are potentially serious defoliators of many pine species in North Carolina; heavy defoliation can lead to growth loss or mortality. Outbreaks of this pest generally do not warrant control measures, but sawfly activity should be closely monitored to prevent serious damage. This pest is most common in young plantings, but trees of all ages may be attacked. All species of sawflies in North Carolina are similar in appearance and biology; the redheaded pine sawfly is discussed below as an example.

Causal Agent: Redheaded pine sawfly (*Neodiprion lecontei*)

Hosts: Loblolly and longleaf pine are the preferred hosts; all southern pine species are susceptible.

Symptoms / Signs: Symptoms include defoliation. Early larval instars feed only on the outer edges of needles; partially consumed needles will turn brown and fall off and resemble fine straw hanging from the tree. Older larvae will consume the entire needle. Complete defoliation of pines is possible during severe outbreaks (Fig. 4 & 5).

Fully grown larvae are easy to identify; the larvae is approximately 1 inch long, pale to bright yellow, have four to six rows of black spots on the body, and a prominent red head (Fig. 1). Larvae often cluster together to feed (Fig. 2). Adults are rarely seen and resemble flies that are approximately ¼ inch long with four clear wings.

Life Cycle: There are usually two to three overlapping generations per year in North Carolina. Sawflies overwinter as pupae in the soil or leaf litter below the host tree. Emergence of adults occurs in the spring (emergence of some pupae is delayed for one to three years as a survival mechanism so that the population can survive should all larvae during a single growing season be killed). Females can lay eggs with or without mating (unmated females only lay eggs that produce males). Eggs are laid in rows of slits cut into needles; there may be more than a dozen eggs per needle and each female may lay more than 100 eggs in a cluster of needles (Fig. 3). Larvae hatch in approximately one month and begin to feed immediately. Feeding lasts for 3-5 weeks during which the larvae grow rapidly; larvae then drop to the ground and burrow into the soil to pupate.

Importance: Moderate. While the redheaded pine sawfly is usually a minor pest, when conditions are suitable, populations can grow rapidly and severe defoliation can occur. Outbreaks are particularly common in plantation settings where many host trees are available in close proximity. Seedlings and saplings are most commonly attacked and most severely impacted by defoliation. Trees greater than 12-15 feet in height are rarely attacked.

Management: Usually not required. Severe infestations usually subside naturally after 1 or 2 years, but populations of this pest should be monitored to avoid serious damage. Rapid population declines are usually due to predation by rodents, birds, and a viral disease that spreads rapidly through large populations. Chemical control options are available but are only effective against early instars. Because generations overlap considerably, larvae at all stages of development are usually present making successful treatment difficult. Often, by the time severe defoliation is detected it is too late to apply insecticides. The best option is to wait until the following year, monitor the new population, and treat early in the growing season if necessary.

Timeline: Emergence of adults occurs in the spring. Defoliation is usually noticed mid to late summer. Insecticides should only be applied in the spring or early summer when only young instars are present.

Range: Statewide.

Fig. 1 Redheaded pine sawfly larvae

Fig. 2 Redheaded pine sawfly larvae

Fig. 3 Adult sawfly laying eggs

Fig. 4 Defoliated pine plantation

Fig. 5 Larvae on defoliated seedling

Eastern Tent Caterpillar

Overview: The eastern tent caterpillar is a common native defoliator in the eastern U.S. Normally, the eastern tent caterpillar is only a nuisance or an aesthetic problem, but populations are cyclical and outbreaks occur on average at ten year intervals. During outbreak years, individual trees can be heavily infested and defoliated. Control is usually not necessary because trees can survive these occasional attacks and caterpillar populations soon decline.

Causal Agent: Eastern tent caterpillar (*Malacosoma americanum*)

Hosts: Cherries, apples, and crabapples are the preferred hosts. Other host species include ash, birch, blackgum, willow, maple, oak, aspen, peach, and plum.

Symptoms / Signs: Eastern tent caterpillars are so named for the silken tents which colonies of larvae construct. Tents usually begin in a branch crotch, and grow in size along with the caterpillars (Fig. 5 & 6). During heavy infestations, entire trees can be covered with webbing and trees can be completely defoliated. Fully grown larvae have black heads, are lightly covered by brown or yellow hairs, and can be up to 2 ½ inches long. Wavy yellow and blue lines run down the sides of the caterpillar on a black background; a row of blue and black spots run between these stripes (Fig. 1). Eastern tent caterpillar larvae are easily confused with the forest tent caterpillars, but differ in that they have a solid white line that runs down their back (forest tent caterpillars have white spots running down their back) (Fig. 2). Adult moths have a 2 inch wingspan, are reddish-brown or yellow-brown, and have two narrow white stripes running across each forewing (Fig. 3). Eggs are brown or black in color, cup-shaped, and laid in masses of several hundred individuals that are covered in a varnish-like protective coating. Egg masses are spindle-shaped, less than 1 inch long, and completely encircle small twigs (Fig. 4).

Life Cycle: There is only one generation per year. Egg hatch in spring coincides with bud-break of suitable host species. Caterpillars group together in a nearby branch crotch and construct a small silken tent from which they venture out to feed on new leaves. Caterpillars do not feed during cool and/or wet weather; rather they cluster together in their tents for protection. As caterpillars move about, they spin a silken thread behind them, so tents grow in size as the larvae move about branches to feed. Almost the entire leaf is consumed; only the midrib is left behind. Caterpillars become fully grown by late spring or early summer and leave the crown in search of a suitable location to spin a cocoon (usually on the trunk or other nearby vertical object). Adults emerge by the end of June or early July and lay eggs by mid to late summer. Populations are cyclical and outbreaks occur approximately every ten years.

Importance: Low. Heavy defoliation only occurs during outbreak years and usually causes little long-term damage to trees. However, severe defoliation (especially if it occurs in consecutive years) can weaken trees and make them susceptible to secondary insects or diseases.

Management: Control is usually not necessary. Trees usually produce new leaves by early to mid-summer. Insecticides are available to protect valuable fruit trees and ornamentals. Caterpillars can be picked from small trees by hand. Tents can be clipped off or gathered up and destroyed on cool rainy days when larvae are inside. Egg masses can also be located and clipped off of trees during the winter months.

Timeline: Emergence occurs in early spring; feeding occurs through late spring or early summer. Adults are active for several weeks during the summer. Trees usually produce new leaves by early to mid summer, leaving little evidence of infestations or defoliation.

Range: Statewide.

Fig. 1 Eastern tent caterpillar

Fig. 2 Eastern tent caterpillar

Fig. 3 Eastern tent caterpillar adult

Fig. 4 Egg masses

Fig. 5 Defoliated tree

Fig. 6 Tent in branch crotch

Forest Tent Caterpillar

Overview: The forest tent caterpillar is one of the most important native defoliators of hardwoods in the eastern U.S. Its name is misleading because the larvae of this species do not form a true tent (as compared to the eastern tent caterpillar), rather they form a flattened silk mat on the trunk or large branches. Populations are somewhat cyclical and major outbreaks occur on fluctuating intervals of 5-20 years. Occasionally, large acreages of trees can be defoliated. Consecutive years of defoliation by this insect can cause growth loss, decline, or even isolated mortality. However, trees are seldom killed and populations of the forest tent caterpillar are usually kept in check by parasitic insects and diseases, therefore control options are usually unnecessary.

Causal Agent: Forest tent caterpillar (*Malacosoma disstria*)

Hosts: Bottomland hardwoods including water tupelo, sweetgum, birch, ash, silver maple, oak, elm, cherry, and basswood. Sycamore, red maple, and conifers are avoided. If trees are completely defoliated and food is scarce, the larvae may descend and feed on shrubs and even herbaceous plants.

Symptoms / Signs: The forest tent caterpillar does not construct an obvious silken tent like the eastern tent caterpillar; rather they form a silken mat on the main stem or on large branches where they gather to rest or molt. Fully grown larvae have black heads, are lightly covered by light brown or yellow hairs, and can be up to 2 ½ inches long. Wavy yellow, orange, and blue lines run down the sides of the caterpillar on a black background. Forest tent caterpillar larvae are easily confused with the eastern tent caterpillars, but differ in that they have white keyhole shaped spots running down their back (eastern tent caterpillars have a white stripe along their back) (Fig. 1 & 2). Adult moths have a 1½ - 2 inch wingspan, are tan or yellow-brown, have a short stocky body, and have one or two brown stripes on each forewing (Fig. 4). Egg masses, which can contain over 300 eggs, are tan in color, covered in a varnish-like protective coating, encircle small twigs, and are squared (rather than tapered) at their ends (Fig. 5).

Life Cycle: There is one generation per year. Egg hatch in spring coincides with, or even precedes, bud-break of suitable host species. Early instars feed on leaf and flower buds, and they may even mine unopened buds if foliage is not available. Once leaves expand, older instars consume the entire leaf except the midrib (Fig. 7). Larvae feed in colonies and travel from branch to branch in single file along a winding path of silk laid down by the leading individuals. Colonies of young instars tend to feed in the upper crown (Fig. 3); as they mature they are more frequently found in the lower crown or on the trunk. Pupation occurs in late spring or early summer. Larvae descend out of the crown and spin yellowish cocoons wrapped in a folded leaf (Fig. 8); adults emerge approximately two weeks later. Moths, which are active in the late afternoon and throughout the evening, are highly attracted to lights. Eggs are laid in masses of 300 or more individuals on small twigs by the end of summer. Outbreaks of the forest tent caterpillar occur every 5-20 years and defoliation can be severe (Fig. 6). However, parasitic insects and diseases usually cause drastic population declines soon after large outbreaks occur. Therefore outbreaks rarely last more than a couple of years and hosts are rarely killed.

Importance: Low. Heavy defoliation only occurs during outbreak years and usually causes little long-term damage to trees. However, severe defoliation (especially if it occurs for three or more consecutive years) can kill trees or increases their susceptibility to secondary insects or diseases. Widespread mortality is rare because outbreaks usually subside within a couple of years.

Management: Control is usually not necessary. Trees usually produce new leaves by mid-summer. Insecticides and biological control products are available to protect valuable landscape trees and ornamentals. Caterpillars can be picked from small trees by hand. Natural diseases and parasitic insects keep populations in check and infestations rarely occur for more than a few consecutive years.

Timeline: Larvae hatch in early spring; feeding occurs through late spring or early summer. Adults are active for several weeks during the summer. Trees usually produce new leaves by mid-summer, leaving little evidence of infestations or defoliation.

Range: Statewide.

Fig. 1 Forest tent caterpillar

Fig. 2 Forest tent caterpillar

Fig. 3 Young larvae

Fig. 4 Adult

Fig. 5 Egg masses

Fig. 6 Defoliation

Fig. 7 Defoliation

Fig. 8 Cocoon

Fall Webworm

Overview: The fall webworm is a native defoliating insect that feeds on a wide variety of hardwoods, particularly landscape trees and ornamentals. It is not considered to be a serious forest pest, but numerous silk nests and defoliation can detract from the aesthetics of landscape trees. Complete defoliation can occur in heavily infested trees by the end of growing season, but this results in little long-term damage to the tree. Interestingly, the fall webworm was accidentally introduced to Europe and parts of Asia where it has become a serious pest of hundreds of species of trees and shrubs. Its name comes from the fact that its web-like nests, which are spun at the ends of branches as opposed to branch crotches (eastern tent caterpillar), become prominent on heavily infested trees in the late summer and early fall.

Causal Agent: Fall webworm (*Hyphantria cunea*)

Hosts: The fall webworm is found throughout the U.S. and its host preferences vary by region. In North Carolina, many species of hardwoods can be attacked, but preferred hosts are persimmon, pecan, sourwood, black walnut, and sweetgum.

Symptoms / Signs: There are two races/forms of fall webworms which differ in appearance and biology: the "black-headed race" and "red-headed race" are named for the color of the caterpillar's head. Moths are white with a wingspan of approximately 1 inch. Larvae may exceed 1 inch in length when fully grown and are covered in silky hairs. Young black-headed larvae are yellow-green or pale yellow and have rows of black tubercles (raised dots) along their backs (Fig. 1). As they mature, their color darkens slightly to yellow or green, and they develop a dark stripe down their back. Larvae of the red-headed race tend to be tan or orange in color with red or orange tubercles (Fig. 2). While both races form silken nests at the ends of branches, the webs of the black-headed race are thin and provide less protection than the smaller, more compact webs of the red-headed race. The nests enlarge as caterpillars feed. When approached or when branches containing nests are disturbed, caterpillars in the nest will all wiggle to ward off predators. Complete defoliation by the end of the growing season can occur and may be observed in trees with many nests (Fig. 8).

Life Cycle: There are two to three generations of fall webworm per year in North Carolina. Fully formed adults overwinter in cocoons in a sheltered location or in leaf litter. Moths of the black-headed race may emerge up to a month earlier than the moths of the red-headed race. Eggs are laid on the underside of suitable host leaves (Fig. 5) and hatch two weeks later; larvae initially feed on the soft tissues between leaf veins (Fig. 6 & 7). Larvae are gregarious; dozens of caterpillars can be found feeding within a single nest (Fig. 3 & 4). As the caterpillars feed, they spin a silken strand which accounts for the ever-expanding web around infested leaves and branches. Larvae mature in 4-6 weeks and drop to the ground to pupate in the soil or leaf litter. Many species of parasitic insects, predators, and pathogens suppress fall webworm populations; severe infestations rarely last more than a few years in an individual tree.

Importance: Low. Severe defoliation occasionally occurs but has little serious impact on tree health. Defoliation and the webs in particular, detract from the aesthetics of landscape trees and ornamentals. The fall webworm is not considered to be a serious forest pest, but it is often a serious concern to homeowners.

Management: Control is usually not necessary. Trees will produce new leaves the following year. Many species of parasitic insects, predators, and pathogens suppress fall webworm populations. Insecticides are available for severe infestations, but should only be applied when larvae and webs are small during the summer. If webs can be reached, they can be removed by pruning or can be pulled off with a forked stick; removed webs should be destroyed.

Timeline: Emergence of adults from cocoons occurs in spring; larvae first appear in early summer. Feeding proceeds throughout the summer and into the fall. Webs and defoliation are most prominent in late summer and fall.

Range: Statewide.

Fig. 1 Fall webworm (black-headed race)

Fig. 2 Fall webworm (red-headed race)

Fig. 3 Gregarious larvae in nest

Fig. 4 Silken nest

Fig. 5 Adult laying eggs

Fig. 6 Skeletonized leaf

Fig. 7 Defoliation

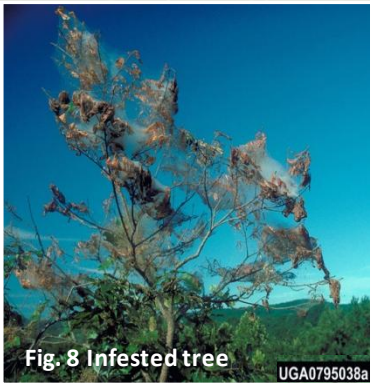

Fig. 8 Infested tree

Orangestriped Oakworm

Overview: The orangestriped oakworm is one of several closely related native moths that are important defoliators of oaks and several other species of hardwoods. Outbreaks and complete defoliation by these caterpillars occurs occasionally, but because feeding occurs late in the growing season, trees are normally not adversely affected. While trees in forested situations tend to be attacked more frequently, severe defoliation can detract from the appearance of landscape trees. Natural predators and parasites keep populations in check; therefore control measures for these pests are usually not required.

Causal Agent: Orangestriped oakworm (*Anisota senatoria*) and related species including the pinkstriped oakworm (*Anisota virginiensis*), spiny oakworm (*Anisota stigma*), and the greenstriped mapleworm (*Dryocampa rubicunda*).

Hosts: The orangestriped oakworm prefers to feed on oak species; it is particularly common on white oaks, scrub oaks, willow oaks, and pin oaks. It may also feed on maple, hickory, cherry, and hazelnut. The pinkstriped and spiny oakworms also feed on species of the red and white oak groups, whereas the greenstriped mapleworm prefers maples but will also feed on oaks.

Symptoms / Signs: Larvae of fully grown orangestriped oakworms are 2 inches long; their bodies are black with eight orange or yellow stripes running lengthwise down their backs (Fig. 1). Pinkstriped oakworms are green to brown with four pink stripes (Fig. 4) and spiny oakworms are tan to pink in color but lack stripes (Fig. 2). The greenstriped mapleworm is slightly smaller than the oakworms; it is greenish-yellow, has a red or black head, and seven green to black stripes running down its back (Fig. 3). All of these species have a pair of "horns" near their head and are covered in spines of varying size, numbers, and arrangements. Adult oakworm moths are stout bodied and short haired, range in color from red, yellow, pink, or orange, and have a small but obvious white dot on their forewing (Fig. 5 & 6). The mapleworm moth, called the rosy maple moth, is woolly and cream colored with pink wings and a white band on the forewing (Fig. 7). All species consume the entire leaf with the exception of the largest veins (Fig. 8).

Life Cycle: Fully formed adult moths overwinter in cocoons formed in the soil or leaf litter. Adults emerge in early summer (usually June or July). Within a month after emerging, females will lay several clusters of a few dozen to a few hundred eggs on the underside of leaves on suitable host trees (Fig. 9). Larvae hatch and feed together in groups throughout the summer and into early fall; they usually feed on and defoliate one branch at a time. During outbreaks, entire trees may be defoliated and caterpillars may crawl to neighboring trees to feed. At the end of September, fully mature larvae drop to the ground to pupate in the soil or leaf litter. Usually, only one generation occurs per year in North Carolina, but two generations have been known to occur. Natural predators such as birds and rodents, and parasitic insects such as wasps, limit populations. Outbreaks tend to only last a couple of years before subsiding.

Importance: Low. Severe defoliation occasionally occurs, but because defoliation occurs late in the growing season, the impact on tree health is minimal. Even trees that are defoliated in several consecutive years show little growth loss or adverse affects. The aesthetics of landscape trees can be negatively impacted.

Management: Control is not necessary. Trees will produce new leaves the following year and outbreaks usually subside after a few years. Defoliation of landscape trees may be a concern to homeowners for aesthetic reasons, and insecticides and biological control agents are commercially available for small to medium sized trees. Chemical treatments are most effective against early instars. Caterpillars can be handpicked from small trees.

Timeline: Emergence of adults from cocoons occurs in early summer; larvae first appear in June or July. Feeding proceeds throughout the summer and into the fall. Defoliation becomes prominent in late summer and early fall.

Range: Statewide.

Fig. 1 Orangestriped oakworm larvae

Fig. 2 Spiny oakworm larvae

Fig. 3 Greenstriped mapleworm larvae

Fig. 4 Pinkstriped oakworm larvae

Fig. 5 Pinkstriped oakworm moth

Fig. 6 Spiny oakworm moth

Fig. 7 Rosy maple moth

Fig. 8 Feeding caterpillars

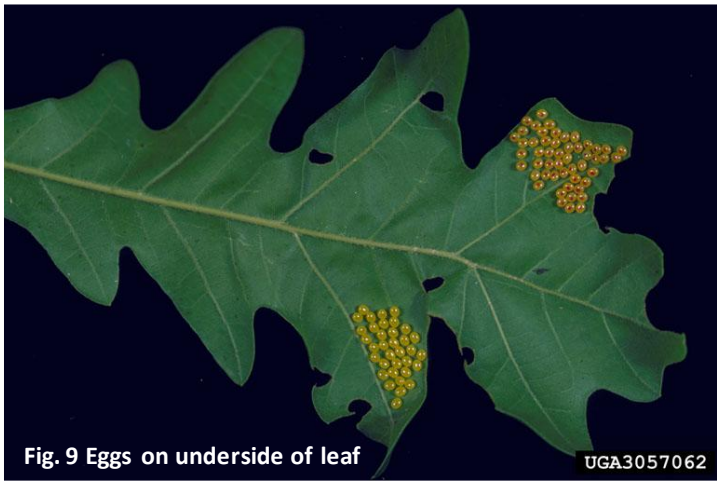

Fig. 9 Eggs on underside of leaf

Pine Colaspis Beetle

Overview: Pine colaspis beetles are not a serious forest pest, but the feeding activity of adult beetles causes needles to turn brown. Large populations of the beetle can result in a dramatic browning of entire trees, especially in young plantation settings, but little if any serious damage results. The beetles feed at night and are rarely observed; damage caused by this pest is frequently confused with Pales weevil, sawfly infestations, or needle cast disease.

Causal Agent: Pine colaspis beetle (*Colaspis pini*)

Hosts: Southern pines; especially slash pine, but also loblolly and longleaf pine. Occasionally baldcypress and ornamental spruces are attacked.

Symptoms / Signs: Adult beetles are approximately ¼ inch long, rusty brown to brownish-yellow with metallic green highlights (Fig. 1). Adult beetles feed on the edges of needles, leaving a jagged saw-like edge (Fig. 2). Entire needles are not consumed, rather needles that have been fed on turn brown, die, and fall off (Fig. 3 & 4). Occasionally, entire trees may turn brown and may have a fire-scorched appearance. By late summer, brown needles fall off the tree and even heavily infested trees appear green and healthy again.

Life Cycle: There is one generation per year in North Carolina. Eggs are laid on herbaceous plants in the understory during the summer. Larvae feed on the roots of herbaceous plants and grasses throughout the summer and fall. Larvae lie dormant in the soil through the winter and pupate in the spring. Adults emerge in early summer and begin to feed on pine for several weeks prior to laying eggs.

Importance: Low. Tree health is not seriously impacted, but the appearance of infested trees may be a concern to landowners and forest managers. Heavy infestations are most common in young plantation settings.

Management: Control measures are not necessary in forest or plantation settings. On landscape trees and ornamentals, chemical control options are commercially available to prevent unsightly damage.

Timeline: Damage is most noticeable in early to mid-summer following emergence of adult beetles.

Range: Statewide.

Fig. 1 Pine colaspis beetle adult

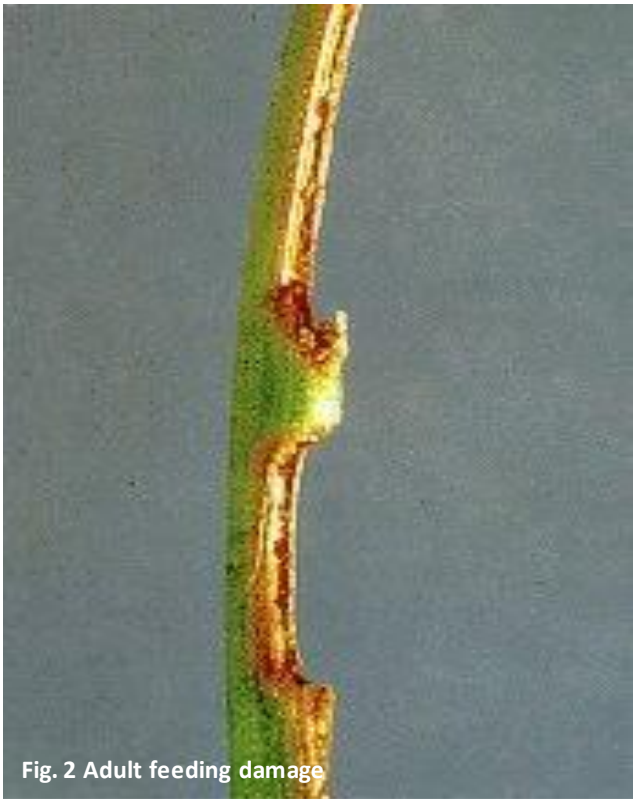

Fig. 2 Adult feeding damage

Fig. 3 Adult feeding damage

Fig. 4 Browning of attacked needles

Fig. 5 Needle browning

Bagworm

Overview: Bagworms are a very common and potentially serious pest of evergreen ornamentals in North Carolina. Heavy infestations on preferred hosts such as juniper and arborvitae can result in complete defoliation, branch dieback, or tree mortality. Bagworms, named for the bag-like sac formed around feeding larvae, are actually the larval stage of a small moth. However, female bagworms never become a moth in the typical sense: they are wingless, legless, lack antennae and mouthparts, and spend their entire lives inside of their larval bag.

Causal Agent: Bagworm (*Thyridopteryx ephameraeformis*)

Hosts: Ornamental conifers; especially junipers, arborvitae, and baldcypress. Occasionally minor infestations can be found on southern pines, maple, oak, dogwood, and willow.

Symptoms / Signs: Larvae (Fig. 3) construct an elongated silk bag interwoven with twigs and foliage within which they feed and pupate (Fig. 1). The bag is enlarged as the larvae grows, and may eventually become 2 ½ inches long. Larvae feed only on the epidermal cells of foliage; therefore the foliage remains on the tree, but will turn brown and die. Heavily infested branches or trees may turn completely brown, may have a fire-scorched appearance, and will be covered in hundreds of bags hanging from twigs by mid-summer (Fig. 2). Females never leave their bag; adult males are small black moths with clear wings and a one inch wingspan (Fig. 4).

Life Cycle: There is one generation per year in North Carolina. Bagworms overwinter as eggs inside of the female's bag. Each female produces 500-1000 eggs in a single mass which hatch in mid to late spring. Larvae begin to feed and construct their bag immediately. They may feed for several months before pupating within their bag which is suspended from a twig on their host. In the fall, male moths emerge and fly off in search of females which produce an attractive pheromone. After mating, females lay eggs within their bag and die. Male moths only live for a few days. Spread of this insect can only be accomplished by movement of the larvae, which can crawl short distances in search of suitable hosts when their original host tree is defoliated. Because dispersal is limited to short distances and so many eggs are produced by each female, populations in a single tree may grow rapidly and infestations are often very heavy. Populations are somewhat cyclical and are reduced by cold winter temperatures and large parasite/predator populations.

Importance: Moderate. Infestations are often severe and result in branch dieback or tree mortality. Some tree species can survive occasional defoliation, but tree health is severely impacted. Fortunately, this pest is easy to control if infestations are detected prior to severe defoliation.

Management: Practical control can be achieved on small to medium size trees by picking off the larvae during the growing season, or by removing the bags of females harboring eggs during the winter. Removed bags should be destroyed. Insecticides are available and effective against actively feeding larvae.

Timeline: Damage is most noticeable in early to mid-summer following emergence of larvae.

Range: Statewide.

Fig. 1 Bagworm larva during pupation

Fig. 2 Heavily infested conifer

Fig. 3 Bagworm larva removed from bag

Fig. 4 Adult male bagworm

Cankerworm

Overview: There are two species of cankerworms in North Carolina: the spring cankerworm and the fall cankerworm. Although both species are similar in behavior and appearance, their names indicate the time of year adult moths emerge and when eggs are laid. Cankerworm larvae are important defoliators of many hardwood tree species. Complete defoliation commonly occurs during severe infestations, resulting in growth loss, decline, or even mortality. These insects are also considered to be a serious nuisance because of the impact they have on the appearance of landscape trees, their tendency to drop or dangle from trees on a silken strand, and the accumulation of frass below infested trees. Cankerworms are just a few species of insects commonly referred to as inchworms, loopers, or spanworms whose larvae move by arching their body dramatically to bring their hind legs up to meet their front legs.

Causal Agent: Spring cankerworm (*Paleacrita vernata*) and fall cankerworm (*Alsophila pometaria*)

Hosts: A wide range of hardwoods; primarily ash, maple, oak, elm, hickory, beech, linden, and apple.

Symptoms / Signs: Fully grown larvae can be more than an inch long, vary in color from light green to black, and have narrow white or yellow stripes on their sides. Spring cankerworms have only two pairs of prolegs at the end of their abdomen (Fig. 2) while fall cankerworms have three pairs and a broad dark stripe down their back (Fig. 1 & 3). Color is highly variable. The larvae crawl in the typical style of an inchworm by moving their rear prolegs up to their front legs on the thorax while arching their back. Younger instars create small holes in the foliage during feeding (Fig. 7); later instars consume the entire leaf with the exception of the midrib (Fig. 8). Female adult moths are wingless and drab gray to brown (Fig. 6). Adult males are light gray or tan with a 1½ inch wingspan (Fig. 4). Small oval-shaped eggs are laid in bark crevices (spring cankerworm) or barrel-shaped eggs are laid in flat clusters that may completely surround small branches (fall cankerworms).

Life Cycle: Spring cankerworms emerge in early spring, mate, and lay eggs. Fall cankerworms in contrast, emerge in the late fall to mate and lay eggs. The eggs of both species hatch at the time of budbreak of host species. Larvae feed on new and expanding leaves for 6 to 8 weeks, then drop to the ground and burrow into the soil or leaf litter to pupate. Because the adult females lack wings, spread of this forest pest is limited to dispersal of larvae. Early instars may drop to the ground and travel to neighboring trees, or may be carried on the wind by a single silk strand (ballooning).

Importance: Moderate. Infestations can be severe and result in complete defoliation. Healthy trees can recover from an occasional attack, but several consecutive years of defoliation can lead to growth loss, decline, or mortality. Natural predators and parasites tend to keep populations of cankerworms in check, and effectively reduce large populations.

Management: Control is usually not necessary because natural predators and parasites keep populations below unacceptable or seriously damaging levels. Sticky bands can be applied around the stem of susceptible trees to trap females when they emerge from the soil and climb trees to lay eggs (Fig. 5). Insecticides are commercially available to protect high value landscape trees.

Timeline: Spring cankerworm adults emerge and lay eggs in early spring whereas fall cankerworm adults emerge and lay eggs in late fall. Larvae of both species hatch in the spring at budbreak. Feeding ceases by early summer.

Range: Statewide.

Fig. 1 Fall cankerworm larva

Fig. 2 Spring cankerworm larva

Fig. 3 Fall cankerworm larvae

Fig. 4 Adult male fall cankerworm

Fig. 5 Sticky trap

Fig. 6 Female fall cankerworm laying eggs

Fig. 7 Defoliation by young cankerworms

Fig. 8 Defoliation by older cankerworms

Locust Leafminer

Overview: The locust leafminer is an important native pest of black locust that causes more concern than actual harm to its host. The small adult beetle feeds on and skeletonizes leaves, and the beetle larvae mine leaves from the inside. Both forms of feeding result in leaf mortality and entire hillsides of black locust may turn brown. While the damage is highly noticeable and causes great concern with those unfamiliar with this insect's annual activity, defoliation by the locust leafminer rarely causes serious injury to its host.

Causal Agent: Locust leafminer (*Odontata dorsalis*)

Hosts: Black locust. Also found rarely on apple, beech, birch, cherry, elm, oak, wisteria, and hawthorn.

Symptoms / Signs: Adult beetles are less than ¼ inch long, are flat and elongated, have a black head, orange wing covers, and a black stripe down their back (Fig. 1). Adults feed on the lower side of leaves and create small holes; continued feeding eventually leads to a skeletonized or lace-like leaf surface (Fig. 4). Eggs are laid on the lower leaf surface in shingle-like clusters of three to five individuals. Beetle larvae are pale yellow, flattened, and approximately ¼ inch long (Fig. 2). Larvae feed in the inner leaf tissues creating a mine or tunnel through the leaf (Fig. 6). The terminal portion or edges of the leaf are preferred. When mining starts, a small irregular pale blotch appears on the leaf surface (Fig. 5). As the larvae grow, the mines expand and increase in length. Leaves eventually begin to turn brown and die from mining and skeletonizing. Heavily infested trees turn brown, bronze, or gray (Fig. 3).

Life Cycle: There are two generations per year in North Carolina. Beetles overwinter in the leaf litter or other places where suitable protection can be found. They emerge at budbreak and begin to feed on new and expanding leaves. Shortly after leaf expansion, the adult beetles lay eggs on the underside of leaves. Larvae hatch and mine their way into the inner leaf tissue where they begin to feed. Early instars feed together at first within the same mine; then larvae disperse and mines expand in many directions. Feeding continues through mid-summer at which time the larvae pupate within a blister-like chamber at the end of the mine. Frequently, defoliated trees will produce a second set of leaves during the summer. If a second generation is produced and the population is large, the second set of leaves can be consumed, which severely stresses the tree.

Importance: Low. The appearance of mined and skeletonized leaves can be dramatic and worrisome. While it rarely causes serious injury, if trees produce new leaves during the summer and the second set of leaves is also consumed, trees can become stressed. Several consecutive years of severe defoliation twice a year can lead to tree decline or mortality.

Management: Control is usually not necessary; damage is usually only cosmetic. Outbreaks tend to be cyclical and natural predators and parasites tend to reduce large populations before serious damage occurs. For landscape trees, chemical controls are available.

Timeline: Adults feed in early spring while larvae feed during the summer. A second generation begins in July. By August, locust trees may appear brown or gray; symptoms may resemble early fall coloration or drought.

Range: Western North Carolina within the native range of black locust. Landscape plantings in other parts of the state may also be infested.

Fig. 1 Adult locust leafminer

Fig. 2 Locust leafminer larvae

Fig. 3 Heavily infested tree

Fig. 4 Feeding damage

Fig. 5 Mining by early instars

Fig. 6 Mining larva

Gypsy Moth

Overview: The gypsy moth is a non-native insect introduced to Massachusetts from Europe in the 1860's by a scientist interested in breeding superior caterpillars for silkworm production. Since their escape from captivity, the gypsy moth has spread west and south, and is considered to be the most important defoliator of hardwoods in the eastern U.S. On average, over one million acres of hardwoods are defoliated each year by the gypsy moth; as many as 13 million acres have been defoliated during severe outbreak years. Millions of dollars are spent each year to slow the spread of this pest. The gypsy moth is not yet considered established in North Carolina, but the population front continues to move south out of Virginia, especially in the northeastern part of the state. Isolated populations of the gypsy moth have been located and successfully eradicated or managed in North Carolina since the 1990's.

Causal Agent: European gypsy moth (*Lymantria dispar*)

Hosts: Hardwoods; especially oak, aspen, apple, sweetgum, basswood, birch, poplar, and willow. Species usually avoided include ash, yellow poplar, sycamore, butternut, black walnut, catalpa, dogwood, holly, and shrubs such as mountain laurel and rhododendron. Conifers may be attacked by later instars during severe outbreaks.

Symptoms / Signs: Newly hatched larvae are less than ¼ inch long, black, and hairy. When fully grown, larvae can be up to three inches long and hairy with five pairs of blue spots followed by six pairs of red spots running down their back (Fig. 1). Adults are 1 – 1½ inches long. Females are white and flightless; males are slightly smaller, drab brown, and fly in a zig-zag pattern (Fig. 4). Eggs are laid in tan colored masses of several hundred individuals (Fig. 2). Egg masses are usually laid on the undersides of branches, within bark crevices, or in other concealed locations. During outbreaks, large amounts of frass may accumulate below infested trees (Fig. 9).

Life Cycle: There is only one generation per year. Egg hatch in early spring coincides with budbreak of host species (Fig. 3). Larvae may begin to feed immediately, or alternatively, larvae may spin a long silken thread that can carry them on the wind to neighboring trees (ballooning). Young instars create small holes in the soft tissue between leaf veins; older larvae consume the entire leaf, feeding from the outer edge inward. Normally, larvae feed at night and descend from the canopy during the day to hide under flaps of bark or branches. During heavy infestations, larvae will feed throughout the day until the entire tree is defoliated, then they descend in search of a new host. Pupation occurs in early summer. When females emerge, they are flightless, are heavily laden with unfertilized eggs, and they release a pheromone which attracts the male moths. Hundreds of eggs are laid in masses shortly after mating. During outbreaks, females may crawl off host trees in search of a suitable hiding place to lay egg masses. Frequently, eggs are laid on objects transported by humans (e.g. vehicles, firewood, or lawn furniture) (Fig. 5), assisting in the long-distance spread of this pest. Outbreaks are common, but populations tend to be regulated by weather, predators, and disease.

Importance: High. During outbreak years, defoliation by this pest can be severe (Fig. 8). Healthy trees can survive occasional defoliation, but repeated attacks may lead to tree death or decline, especially in stressed trees.

Management: North Carolina participates in the national Slow the Spread program, which is designed to slow the south and westward spreading gypsy moth population front. Pheromone-baited traps (attractive only to male moths) are deployed state-wide to detect isolated populations of the gypsy moth that may have entered the state (Fig. 7). High numbers of moth catches in a trap may reveal the location of a new infestation. Aerial treatments with insecticides or biological controls, such as bacteria and viruses, are used to eradicate these populations (Fig. 11). Eventually however, it is expected that the gypsy moth will become established in the state. Insecticides are available to treat individual infestations (Fig. 10). Egg masses can be scraped off trees during the winter, caterpillars can be picked from trees by hand when they descend during the day (larvae will gather under a strip of burlap wrapped around the trunk) (Fig. 6), and biological controls are commercially available.

Timeline: Emergence occurs in early spring; feeding occurs through late spring or early summer. Adults are active for several weeks during the summer; eggs are laid by the end of July or early August.

Range: Not yet permanently established in North Carolina; isolated populations continue to pop up throughout the state, but are usually treated and eradicated within one year.

Fig. 1 Gypsy moth larva

Fig. 2 Egg masses

Fig. 3 Newly hatched larvae

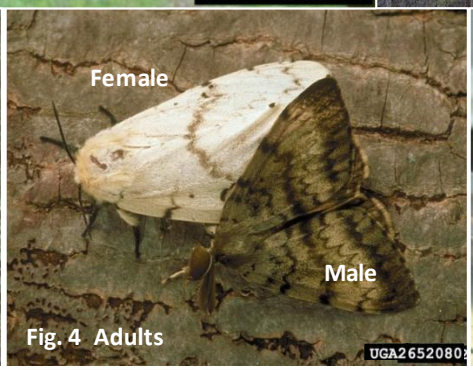

Fig. 4 Adults

Fig. 5 Females laying eggs

Fig. 6 Trapping larvae

Fig. 7 Detection trapping

Fig. 8 Defoliated hardwood stand

Fig. 9 Frass accumulation

Fig. 10 Insecticide application

Fig. 11 Aerial spraying

Japanese Beetle

Overview: The Japanese beetle is a non-native insect introduced in the northeastern U.S. in 1916. Since that time, it has continued to spread south and west and now infests most of the eastern U.S. The adult beetles feed on the foliage of dozens of tree and shrub species, especially ornamentals and landscape plantings. Defoliation can be severe and a tree's appearance can be seriously impacted. Larvae feed primarily on the roots of grasses, and can become a serious pest of turfgrass during heavy infestations.

Causal Agent: Japanese beetle (*Popillia japonica*)

Hosts: Several hundred species of hardwood trees and shrubs are hosts of adult beetles; preferred hosts include rose, crape myrtle, apple, cherry, Japanese maple, sassafras, sycamore, elm, azalea, plum, peach, pin oak, birch, beech, willow, black walnut, and viburnum. Dogwood, ash, magnolia, sweetgum, holly, yellow poplar, redbud, lilac, and conifers are avoided. Beetle larvae feed on the roots of herbaceous plants, particularly turfgrass.

Symptoms / Signs: Adult beetles skeletonize leaves giving them a lace-like appearance (Fig. 2). Heavily infested trees may appear scorched. Heavy infestations of grubs may result in circular, expanding patches of dead and dying turfgrass. Adult beetles are approximately ½ inch long, broadly oval in shape, metallic green, and have bronze wing covers (Fig. 1). Small white tufts of hair that look like white dots can be found along the edges of the beetle's body along the wing covers. When an infested branch is shaken, the beetles will play dead and drop to the ground. Beetle larvae (grubs) are white and thick bodied with six small legs emerging from just behind the head (Fig. 3). Grubs are up to one inch long and can be found within a few inches of the soil surface during the growing season or 4-8 inches below the soil line during the winter. Japanese beetle grubs are easily confused with grubs of native beetle species, not all of which are plant pests.

Life Cycle: There is one generation per year in North Carolina (Fig. 5). Adult beetles emerge from the ground in late May and early June. They immediately begin to feed on nearby plants. Males fly short distances in search of females, which produce attractive pheromones. Females occasionally stop feeding and burrow into nearby turf to lay up to a dozen eggs approximately 3 inches below the soil line. Each female will continue to feed and lay eggs throughout the summer until 40-60 eggs have been laid. By mid-summer, eggs hatch and grubs begin to feed on the roots of grass and other herbaceous plants. Grubs will feed until late fall, then they will descend deeper into the soil and lie dormant for the winter. When temperatures warm again in early spring, feeding resumes until late spring. Pupation lasts for about 2 weeks, after which adult beetles emerge from the ground.

Importance: Moderate. Japanese beetles are a serious nuisance on ornamentals and landscape plantings, and they are considered to be one of the most important pests of turfgrass. The appearance of trees and shrubs can be negatively impacted during heavy infestations, and nearby turfgrass can be killed in large patches. Because defoliation is usually minor and occurs later in the growing season, tree health is usually not seriously impacted.

Management: The Japanese beetle is notoriously difficult to control. An integrated pest management program that is based on biological, cultural, and chemical controls is the only effective option to reduce beetle numbers below an acceptable threshold; complete eradication is impossible. Surveying and population monitoring are the first step. Commercially available traps baited with pheromones can give you an idea of the adult beetle population during the growing season (Fig. 4). Pheromone baited traps catch many adult beetles, but may also lure many more beetles into the area that do not get caught. Traps should be placed away from susceptible plants. During a heavy infestation a trap can fill completely in 1-3 days. Grub populations can be assessed in late spring and late summer by removing and examining a section of sod near the edge of symptomatic turf. A heavy infestation is indicated by more than 10 grubs per square foot. Chemical controls are available and somewhat effective at protecting small to medium size plants. Biological controls such as Bt, parasitic nematodes, and milky spore disease are commercially available, but their effectiveness can vary considerably. Use resistant plants and increase the distance between turf and susceptible plants.

Timeline: Emergence of adults occurs in late spring and early summer; adults feed throughout the summer. Grubs feed throughout the summer and fall, lie dormant in the soil during the winter, and resume feeding in spring.

Range: Statewide.

Fig. 1 Japanese beetle adult

Fig. 2 Skeletonizing

Fig. 3 Japanese beetle grub

Fig. 4 Japanese beetle trap

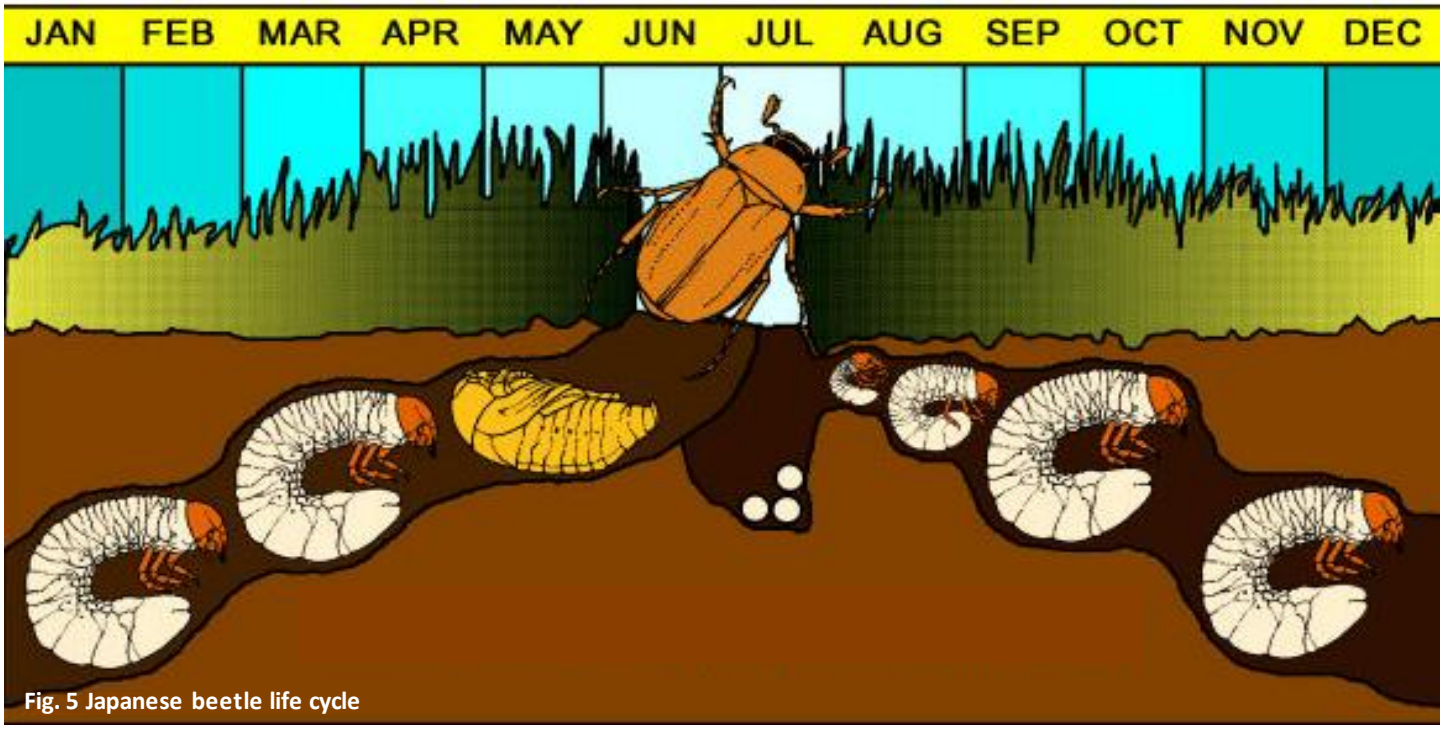

Fig. 5 Japanese beetle life cycle

Southern Pine Beetle

Overview: The southern pine beetle is the most destructive forest insect in North Carolina. Populations are cyclical; during outbreak years, southern pine beetles can attack healthy trees of all age classes and tens of thousands of acres of pine can be killed (Fig. 3). When beetle populations are low, the southern pine beetle is almost strictly a secondary pest. Because of its destructive potential, beetle activity is closely monitored by the North Carolina Forest Service. Proper forest management and control measures are necessary to prevent large outbreaks.

Causal Agent: Southern pine beetle (*Dendroctonus frontalis*)

Hosts: All southern pines are susceptible; preferred hosts include loblolly, shortleaf, Virginia, pond, and pitch pine. Eastern white pine and longleaf pine are considered to be less susceptible.

Symptoms / Signs: The first indication of an infested tree is discolored foliage. Needles will turn yellow, red, and finally brown. If trees are attacked late in the growing season, symptoms may not appear until the following spring. Resin flow out of beetle entrance holes dries on the stem forming whitish-yellow "pitch tubes" that resemble popcorn (Fig. 5). Pitch tubes may not form during drought. Beetles spread from a tree that has been successfully attacked and killed to surrounding trees forming a "beetle spot." Spots tend to spread downwind and can range from a few trees to hundreds of acres in size. Trees of all sizes can be attacked. Blue-stain fungi introduced by the beetles may give the outer sapwood a blue, purple, or blackish discoloration (Fig. 4).

Southern pine beetles are approximately 1/8 inch long, dark reddish-brown or black in color, and have a rounded or broadly pointed hind end (Fig. 1 & 2). They bore into a tree leaving a small (1/16 inch) entrance hole and form an S-shaped winding gallery in the inner bark (Fig. 7). Larval galleries branch off the adult galleries at approximately ½ inch intervals and may extend for several inches through the inner bark (Fig. 7). Larvae are 1/8 inch long, have a reddish-orange head, and a white crescent-shaped body.

Life Cycle: There are three to five overlapping generations per year in North Carolina; all life stages may overwinter. Females emerge in early spring and bore holes into the bark of a suitable host, then create S-shaped egg galleries in the inner bark and release pheromones to attract males. Healthy trees produce pitch that can expel invading beetles. However, aggregation pheromones released by adults attract large numbers of additional beetles to the tree, overcoming the tree's defenses. Eggs are laid in niches along the winding gallery and hatch within a few days. Each female can lay more than 150 eggs in her lifetime. Larvae feed on the inner bark for several weeks before pupating in the outer bark and emerging. An entire life cycle is completed in 30-40 days. Beetles tend to disperse in the fall to initiate new spots that will first appear the following spring. Dispersing beetles may fly more than 1½ miles in search of a suitable host. Trees are killed by the girdling of nutrient conducting tissues in the inner bark. Blue-stain fungi, which invade the sapwood and hasten tree death by disrupting water transport, are vectored into the tree by southern pine beetles as they create their galleries. Populations are cyclical and outbreaks occur at 10 year intervals on average. Southern pine beetles, *Ips* engraver beetles, and black turpentine beetles are frequently found attacking the same tree.

Importance: High. During outbreaks, healthy trees of all age classes can be killed. Thousands of acres and millions of board feet of timber can be lost in a single outbreak year.

Management: Prevention of outbreaks is critical and starts with proper forest management (e.g. maintaining proper stocking levels, removal of diseased trees, and planting more resistant species such as longleaf pine) and early detection and control of newly established beetle spots. Surveys are conducted bi-annually across the state to detect new beetle spots. Pheromone-baited traps are used to monitor the populations of both southern pine beetles and the predatory checkered clerid beetles (Fig. 6). Increasing ratios of southern pine beetle to clerids may indicate increased risk of an outbreak. Infested trees and a 75-100 foot buffer of green trees should be cut and removed from the stand or felled into the center of the spot to eradicate beetles and suppress outbreaks (Fig. 8 & 9). Insecticides applied to the main stem and branches are available to protect high-value landscape trees.

Timeline: Beetles are active throughout the growing season. Symptoms begin to appear in late spring.

Range: Statewide.


Fig. 1 Southern pine beetle UGA5289035


Fig. 2 Southern pine beetle UGA5289031


Fig. 3 Beetle outbreak UGA0013095


Fig. 4 Blue-stain UGA0745053


Fig. 7 SPB galleries UGA3225036


Fig. 5 Pitch tubes UGA5155029

Fig. 6 Checkered clerid UGA5289065


Fig. 8 Beetle spot before control UGA0010130


Fig. 9 Beetle spot after “cut and leave” UGA0010129

Ips Engraver Beetles

Overview: *Ips* engraver beetles are secondary forest insects that attack trees that have been stressed by predisposing factors such as fire, drought, storm damage, lightning strikes, or poor stand conditions. Occasionally, they can attack and kill small groups of healthy trees when the conditions are suitable. However, outbreaks of these beetles tend to dissipate when environmental stresses are relieved. Beetle larvae feed on the inner bark and girdle the tree's nutrient conducting tissue. There are three species of *Ips* engraver beetles in North Carolina; a single species may attack alone or along with other *Ips* species, southern pine beetles, and/or black turpentine beetles.

Causal Agent: *Ips* engraver beetles: small southern pine engraver beetle (*Ips avulsus*), five-spined engraver beetle (*Ips grandicollis*), and six-spined engraver beetle (*Ips calligraphus*).

Hosts: All southern pine species are susceptible.

Symptoms / Signs: The first indication of an infested tree is discolored foliage. Needles will turn yellow, red, and finally brown (Fig. 6). If trees are attacked late in the growing season, symptoms may not appear until the following spring. Resin flow out of beetle entrance holes dries on the stem forming whitish-yellow or amber "pitch tubes" that resemble popcorn (Fig. 5). Pitch tubes may not form during drought. Beetles spread from a tree that has been successfully attacked and killed to surrounding trees forming a "beetle spot." Mortality in *Ips* beetle spots tends to be more scattered than in a southern pine beetle spot and is usually limited to only a few trees. Blue-stain fungi introduced by the beetles may give the outer sapwood a blue, purple, or blackish discoloration (Fig. 4).

Ips engraver beetles are reddish-brown to black in color and between 1/10 to 1/4 inch long with *I. calligraphus* being the largest and *I. avulsus* being the smallest (Fig. 1). Their hind end is not rounded like the southern pine beetle. Instead, their wing covers are notched at their ends to form a scoop (used to clear frass and sawdust from galleries), giving the beetles the appearance that their posterior has been chopped off. The scoops are also lined by small spines, the number of which gives the beetles their common names (Fig. 3). They bore into a tree leaving small entrance holes, and form vertically oriented galleries in the inner bark that branch occasionally giving them an I, Y, X, or H shaped appearance (Fig. 2). Dozens of larval galleries branch off the adult gallery and fan out for several inches through the inner bark. Larvae are the same size as adults when full grown, have a reddish-orange head, and a white body.

Life Cycle: There are four to five overlapping generations per year in North Carolina; all life stages may overwinter. Females emerge in early spring and bore holes into the bark of a suitable stressed host, construct egg galleries in the inner bark, and lay eggs which hatch within a few days. Larvae feed on the inner bark for several weeks before pupating in the outer bark and emerging. An entire life cycle is completed in 20-40 days. Trees are killed by the girdling of nutrient conducting tissues in the inner bark, but the beetles also carry blue-stain fungi which invade the sapwood and disrupt water transport, further weakening the tree and accelerating its death. The three species of *Ips* engraver beetles tend to target specific regions of the tree. The small southern pine engraver usually attacks small branches and terminals in the upper crown, the five-spined engraver attacks in the mid-crown, and the six-spined engraver usually attacks the largest branches and main stem in the lower 1/3 of the tree. All age classes are susceptible to attack. One or more species of *Ips* engraver beetles, southern pine beetles, and black turpentine beetles are frequently found attacking the same tree.

Importance: Moderate. Significant mortality can occur when conditions are suitable. *Ips*-related stress or mortality can also enable the build-up of other bark beetle populations such as the southern pine beetle.

Management: Prevention of outbreaks starts with proper forest management. Scattered mortality usually does not warrant control measures. Infestations usually subside after drought when normal rainfall returns. During larger infestations, infested trees should be cut and removed from the stand to eradicate beetles and prevent additional spread; *Ips* populations can build up in logging debris or felled trees. Insecticides applied to the main stem and branches are available to protect high-value landscape trees.

Timeline: Beetles are active throughout the growing season. Symptoms begin to appear in late spring.

Range: Statewide.

Fig. 1 *Ips* engraver beetles

Fig. 2 *Ips* galleries

Fig. 3 Posterior of *Ips* beetle

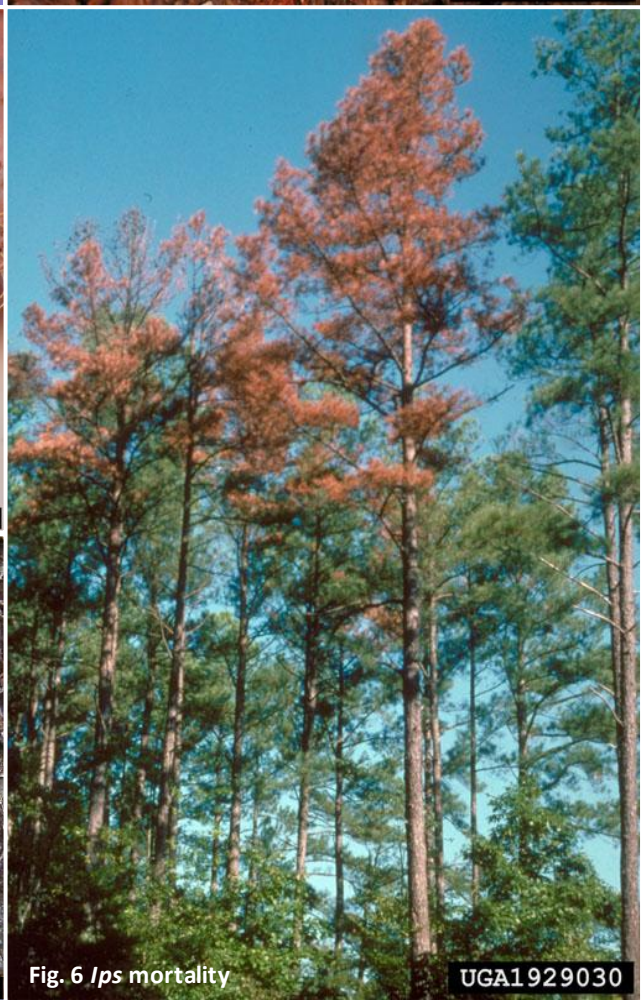

Fig. 6 *Ips* mortality

Fig. 4 Blue-stain

Fig. 5 Pitch tube

Black Turpentine Beetle

Overview: The black turpentine beetle is primarily a secondary forest pest that usually only attacks trees stressed by predisposing factors. Beetle activity tends to be highest in overstocked stands, or in trees recently wounded by logging activity, fire, or storm damage. Attacks generally occur in the lower 15 feet of the main stem; when infestations are light only localized patches of inner bark are killed and the tree will survive. Mortality can occur when galleries completely girdle the stem. Occasionally populations can reach high enough levels to kill trees that appear to be healthy, but rapidly expanding and destructive outbreaks similar to the southern pine beetle or even *Ips* engraver beetles do not occur. Infested trees are commonly attacked by other bark beetles.

Causal Agent: Black turpentine beetle (*Dendroctonus terebrans*)

Hosts: All southern pine species are susceptible.

Symptoms / Signs: The first indication of an infested tree is discolored foliage. Needles will turn yellow, red, and finally brown. If trees are attacked late in the growing season, symptoms may not appear until the following spring. Resin flow out of beetle entrance holes dries on the stem forming whitish-yellow or amber "pitch tubes" that resemble popcorn (Fig. 5 & 6). Pitch tubes may not form during drought. Attacks usually occur in the lower 15 ft of the main stem. Black turpentine beetles usually do not carry blue-stain fungi like the other pine bark beetles.

Black turpentine beetles are brown to black in color, 3/8 inch long (over twice the length of southern pine beetles which are similar in appearance) (Fig. 1 & 2), and have a rounded posterior (as opposed to the "chopped off" rear end of the *Ips* engraver beetles) (Fig. 3). Adult beetles create winding galleries that are more than 1/8 inch wide and often filled with sticky reddish-brown sawdust (Fig. 7). Larvae are nearly as long as adults when fully grown, have a reddish-brown head, and a white crescent-shaped body (Fig. 4). Because eggs are laid in clusters within the adult gallery, larval galleries tend to originate close together and fan out over time.

Life Cycle: There are two to three overlapping generations per year in North Carolina; all life stages may overwinter. Females emerge in early spring and bore holes into the bark of a suitable stressed host, construct egg galleries in the inner bark, and lay eggs which hatch within two weeks. Males and other females are attracted to the trees by pheromones and volatile compounds released from wounds. Larvae feed on the inner bark for several months before pupating in the outer bark and emerging. An entire life cycle is completed in 2½ to 4 months. Trees are killed by the girdling of nutrient conducting tissues in the inner bark. Younger trees are generally not attacked. One or more species of *Ips* engraver beetles, southern pine beetles, and black turpentine beetles are frequently found attacking the same tree. Black turpentine beetles are not common vectors of blue-stain fungi.

Importance: Low. Mortality can occur when conditions are suitable. Black turpentine-related stress or mortality can also enable the build-up of other bark beetle populations such as the southern pine beetle.

Management: Prevention of outbreaks starts with proper forest management. Avoid injuring trees during logging operations and drought (Fig. 8). Check residual trees frequently after logging operations for beetle activity. Remove wounded trees with significant black turpentine beetle activity to prevent population build-up. Scattered mortality usually does not warrant control measures, but because populations build slowly, infestations should be monitored for several years to ensure problematic levels of this pest do not develop. Insecticides applied to the main stem are available to protect trees that have minor wounds, in stands with significant mortality, evidence of growing beetle populations, or in high-value landscape situations. Chemical applications may be successful in saving trees if infestations are detected and treated early.

Timeline: Beetles are active throughout the growing season. Symptoms begin to appear in late spring.

Range: Statewide.

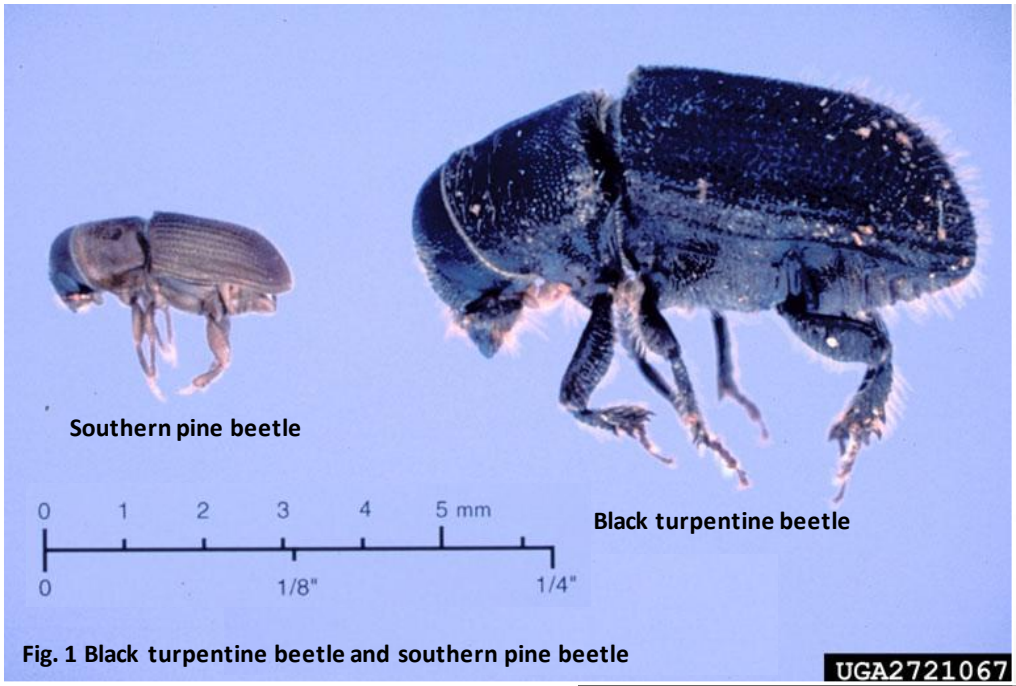

Fig. 1 Black turpentine beetle and southern pine beetle UGA2721067

Fig. 2 BTB UGA5323042

Fig. 3 Black turpentine beetle posterior UGA5155035

Fig. 4 Larvae UGA0007011

Fig. 5 Pitch tubes UGA1510079

Fig. 6 Pitch tubes UGA5004098

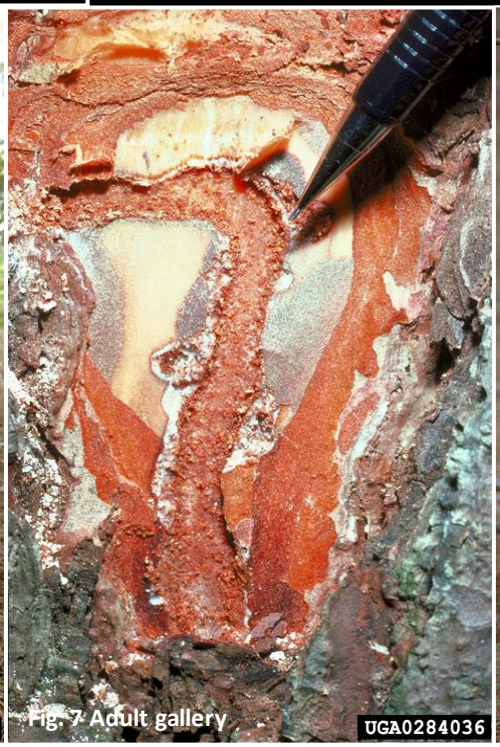

Fig. 7 Adult gallery UGA0284036

Fig. 8 Logging injury UGA1879045

Elm Bark Beetles

Overview: Before the 1930's, elm bark beetles were considered to be of little importance. But when the Dutch elm disease fungus was introduced into the U.S., these beetles quickly formed a symbiotic relationship with the deadly pathogen. There are two species of elm bark beetles: the native elm bark beetle and the now more common and dominant European elm bark beetle, which was first discovered in Boston in the early 1900's. The beetles are efficient vectors of the Dutch elm disease pathogen, carrying it up to several miles from tree to tree. In turn, the fungus creates dead and dying elms in which the beetles can breed and reproduce. The two beetle species are easily differentiated by the shape of their brood galleries. Timely removal of infested trees can limit the impact of Dutch elm disease.

Causal Agent: The native elm bark beetle (*Hylurgopinus rufipes*) and the European elm bark beetle (*Scolytus multistriatus*)

Hosts: Elm species.

Symptoms / Signs: *See Dutch elm disease* for more information.

The adult European elm bark beetle is reddish-brown and slightly glossy, approximately 1/4 inch long, with a concave posterior and a small spine projecting from the underside of the abdomen (Fig. 1). The native elm bark beetle is slightly smaller, dull brown, with a rounded rear end (Fig. 4). Larvae of the two species are nearly impossible to distinguish, but the brood galleries on the undersides of the bark are easy to differentiate. European elm bark beetles excavate a main gallery that is approximately 2 inches long and parallel with the wood grain (vertically oriented), with larval galleries extending perpendicular to the wood grain (Fig. 2). The main galleries of native elm bark beetles in contrast, are horizontally oriented and the larval galleries run with the wood grain (Fig. 3). Galleries resemble a centipede in outline.

Life Cycle: Native elm bark beetles overwinter as fully grown larvae in dead or dying trees, or as adults in the bark of large limbs or the main stem of living elms. Adults emerge in spring and tunnel into the bark of freshly dead or dying elms to lay their eggs. European elm bark beetles in contrast, overwinter as immature larvae and pupate in the spring before emerging. Adults fly around for several weeks and feed on the tender bark in branch crotches (Fig. 5 & 6) before laying eggs in an unhealthy elm. Feeding activity of both beetle species is primarily responsible for transmitting Dutch elm disease. Larvae feed for several weeks before pupating at the end of their gallery and emerging. Emergence of adult beetles may leave thousands of tiny "shot holes" in the stem and branches of dead or dying elms. In North Carolina, 2-3 generations may occur annually.

Importance: High. Although the vast majority of American elms have already been eliminated by Dutch elm disease, many beautiful trees have survived and remain susceptible to attack. New cultivars of American elms resistant to Dutch elm disease may still harbor these beetles, posing a threat to non-resistant individuals.

Management: Removal of diseased, dead, dying, and/or beetle-infested trees is critical to protect other trees in the surrounding area (Fig. 7). If caught early, individual diseased or beetle-infested branches can be removed and destroyed. Wood from removed trees should be destroyed, or securely sealed in plastic for a minimum of one year to ensure all disease transmitting beetles are trapped and killed. The bark should be removed from elm firewood to eliminate breeding habitat and should not be transported to other areas. Insecticides to prevent infestation or kill beetles before they can emerge are commercially available for high-value trees, but their effectiveness is questionable.

Timeline: Beetles emerge in spring, feeding occurs throughout the growing season with several overlapping generations.

Range: Statewide.

Fig. 1 European elm bark beetle


Fig. 2 European elm bark beetle gallery
UGA5252021


Fig. 3 Native elm bark beetle gallery


Fig. 4 Native elm bark beetle
UGA5156018


Fig. 5 Feeding beetle


Fig. 6 Feeding damage
UGA5029007


Fig. 7 Dying elm
UGA1400153

Hickory Bark Beetle

Overview: The hickory bark beetle is considered to be the most important pest of hickory in the U.S. Adult beetles feed on small twigs and the bases of leaf petioles; larvae feed on the inner bark of the main stem. Defoliation by adults is usually noticed first, but the most serious damage is caused by the galleries formed in the inner bark which girdles the tree's nutrient conducting tissue. Hickory bark beetles usually only attack stressed or unhealthy trees. Vigorous trees are seldom attacked except when large beetle populations are produced from nearby brood material. Heavy infestations usually kill a tree; light infestations may only girdle branches or a portion of the trunk causing dieback. Girdling of the inner bark is often rapid and severe, resulting in serious injury or death before symptoms are noticed. These beetles are thought to be contributors to a hickory decline disease complex.

Causal Agent: Hickory bark beetle (*Scolytus quadrispinosus*)

Hosts: Hickory species. Butternut and pecan are also susceptible; black walnut is attacked rarely.

Symptoms / Signs: The earliest symptoms of attack are usually red discoloration and/or wilting of leaves, premature leaf drop, crown thinning, and broken twigs that are not completely severed but rather hang from the tree. As symptoms progress, larger twigs and limbs begin to die, and terminal growth may appear stunted and/or tufted. Trees may be killed; dieback usually starts in the top of the tree and spreads downward (Fig. 5).

Adults are less than ¼ inch long, short, stout, and dark brown or black (Fig. 1). The underside of the posterior is concave with small spines (Fig. 4). Larvae are slightly longer when fully grown, with a reddish-orange head and white crescent-shaped body. Short egg galleries formed by the adult usually run parallel to the wood grain (vertically oriented) with dozens of larval galleries fanning out giving the appearance of a centipede etched in the outer sapwood and inner bark (Fig. 2). Fine boring dust may accumulate on bark flaps and at the base of heavily infested trees, and many 1/8 inch round exit holes may be visible on the bark (Fig. 4).

Life Cycle: Nearly-mature larvae overwinter and resume feeding for a short time before pupating in the spring. Adults emerge in late spring or early summer and fly into the upper crown to feed on the soft bark in the crotches of small twigs and at the base of leaf petioles. Adults may also tunnel into and feed on the soft tissues of young shoots. After feeding for 1-2 weeks, the adults seek out weakened host trees and bore into the main stem to create a short egg gallery in which 20-60 eggs are laid. Eggs hatch in 10-12 days and larvae feed on the inner bark for several weeks before pupating in the outer bark. There are two generations of the hickory bark beetle annually in North Carolina.

Importance: Moderate. Individual trees that become infested may be killed. Outbreaks are rare, but occasionally outbreaks have occurred during which thousands of trees have been killed.

Management: Good cultural practices such as thinning, pruning, fertilization, and irrigation are important for promoting and maintaining good tree vigor. Removal of diseased, dead, dying, and/or beetle infested trees is critical to protect other trees in the surrounding area. Bark should be removed from felled trees to eliminate breeding habitat. Bark should also be removed from firewood to eliminate breeding habitat and infested firewood should not be transported to other areas. Insecticides to prevent infestations are effective if an attack is suspected and caught early.

Timeline: Beetles emerge in late spring or early summer. Adults feed throughout the summer, while larvae feed in the summer and into the fall. Symptoms usually become evident in late summer or early fall.

Range: Statewide.

Fig. 1 Hickory bark beetle

Fig. 2 Hickory bark beetle galleries

Fig. 3 Hickory bark beetle posterior

Fig. 4 Exit holes

Fig. 5 Declining hickory

Pine Sawyer Beetles

Overview: Pine sawyers are destructive wood boring beetles whose larvae feed on green or freshly cut pine logs, dead trees, or occasionally dying trees. In addition to wood rotting and wood staining fungi introduced by the beetles, galleries degrade the value of lumber considerably; if the larvae penetrate deep into the sapwood, the value of lumber may be reduced by up to 35 percent. Adult beetles feed on the needles and soft bark of young twigs. These insects make the salvage of dead or dying pines and the storage of cut logs problematic.

Causal Agent: Southern pine sawyer (*Monochamus titillator*) and whitespotted pine sawyer (*Monochamus scutellatus*)

Hosts: The southern pine sawyer can attack all southern pine species. The whitespotted pine sawyer prefers eastern white pine, but will also feed on fir and spruce.

Symptoms / Signs: Removal of bark from infested trees may reveal the winding feeding galleries of larvae in the inner bark; as the larvae mature, the galleries become wider and deeper and will score both the bark and sapwood (Fig. 3). Galleries may be packed with wood shavings; wood shavings and frass may also be expelled through holes in the bark (Fig. 7). Sawdust and frass may accumulate on the ground beneath infested trees and logs. Galleries in the inner bark will end at a wide elliptical chamber where larvae tunnel into the sapwood. Exit holes are round and may exceed 1/4 inch in diameter (Fig. 4).

Adult southern pine sawyers are 1 to 1¼ inches long, mottled gray-brown-green, and have very long antennae that may be over 3 inches in length (Fig. 1). Larvae are white and legless, may be up to 3 inches long when fully grown, have large black mandibles, and pronounced segmentation/ribbing along the length of their bodies (Fig. 2).

Whitespotted pine sawyers are shiny black, slightly smaller (3/4-1 inches long), and have a distinct white spot at the junction of the wing covers (Fig. 6). Males have very long antennae (approximately 2 inches long), while females have antennae about as long as their bodies. Females may also be mottled with faint irregular white blotches on their bodies and faint white banding on their antennae (Fig. 5). Larvae are up to 2 inches long, whitish in color with an amber-brown head, distinctly segmented, and have a pair of dark mandibles.

Life Cycle: Adult beetles lay their eggs in etched out egg niches in the inner bark from June through September. Adults will not lay their eggs on trees lacking bark. Eggs hatch in about 2 weeks, and larvae begin to tunnel through and feed in the inner bark. Larvae overwinter in a dormant state in galleries formed deeper in the wood. Feeding resumes with warmer temperatures in the spring. When larvae reach a sufficient size, they bore into and feed deeper in the sapwood. Beetle larvae may penetrate six or more inches beneath the bark before excavating towards the surface again to pupate. After pupation, adult beetles chew through the wood to reach the surface, leaving a round exit hole in the bark. Adults feed on needles and tender bark on the underside of small twigs. In North Carolina, there are up to three generations of the southern pine sawyer, but only one generation of the whitespotted pine sawyer.

Importance: Moderate. Although not a serious threat to forest health, sawyer beetles can degrade the value of logs and lumber. Boring by larvae may introduce decay fungi and wood stain fungi into the wood causing further degradation.

Management: Rapid harvesting and utilization of dead trees, dying trees, or fresh cut logs will reduce infestations and the severity of wood degradation. If immediate utilization is not possible, logs can be debarked, immersed in water, or sprayed with an appropriate insecticide. Stacking logs in large piles in shady areas can greatly reduce the number of attacks because the beetles are sun loving. Logs can be stacked on site between September and June with little risk of attack.

Timeline: Adults emerge in late spring or early summer and egg-laying occurs throughout the summer. Larvae feed throughout the growing season, but lie dormant in the sapwood during the winter months.

Range: Statewide.

Fig. 2 Southern pine sawyer larva

Fig. 1 Southern pine sawyer

Fig. 3 Pine sawyer galleries

Fig. 4 Emerging adult

Fig. 5 Whitespotted pine sawyer

Fig. 6 Whitespotted pine sawyers

Fig. 7 Sawdust accumulation

Ambrosia Beetles

Overview: Ambrosia beetles are very small insects that do not feed on trees; rather they create vast networks of tunnels or galleries in wood to "farm" ambrosia fungi upon which both adults and larvae feed. Ambrosia beetles typically attack recently dead, dying, or severely stressed trees. They also attack green logs and unseasoned lumber. The activity of ambrosia beetles can result in considerable degradation of lumber. There are thousands of species of ambrosia beetles worldwide, but with few exceptions, they are an indicator of dead or dying trees rather than a serious threat to tree health.

Causal Agent: Ambrosia beetles: Order Coleoptera, Family Curculionidae, Subfamilies Scolytinae and Platypodinae.

Hosts: Most conifer and hardwood species can be attacked by ambrosia beetles; most ambrosia beetles are host species specific.

Symptoms / Signs: Accumulation of very fine sawdust around the base of a tree and in bark crevices will be the first and most obvious indicator of the presence of ambrosia beetles (Fig. 3). In older infestations, piles of sawdust can become quite large. Because sawdust expelled by ambrosia beetles is often mixed with excrement, toothpick-like strands of sawdust may stick several inches out of entrance holes to galleries (if it has not rained or been windy in recent days) (Fig. 4). Small pin-hole sized round entrance and exit holes will riddle the bark of a heavily infested tree. Removal of bark and examination of sapwood will reveal the galleries formed by larvae and adults; tunnels will be darkly stained with ambrosia fungi (Fig. 6).

There are thousands of species of ambrosia beetles worldwide. Most are less than 1/4 inch long, light brown, reddish brown, dark brown, or black. Some are slightly hairy while others are hairless and shiny. Most ambrosia beetles are elongated, and some have small spines that protrude from their posterior end (Fig. 1).

Life Cycle: Adult ambrosia beetles carry spores of their symbiotic ambrosia fungi in special pouches within their mouth to start new fungi "gardens." Adults are attracted to stressed, dying, or recently killed trees. When a suitable host is located, adults bore into the sapwood and begin to lay eggs (Fig. 5). When eggs hatch, larvae begin to tunnel parallel to the wood grain (Fig. 8). The wood is not consumed by the adults or larvae; rather the excavated sawdust is pushed out of the tree to keep tunnels clear. Fungal spores are released from the mouth of adults; fungi quickly geminate and begin to invade and feed on the surrounding sapwood. Nutrients gathered and spores produced by the fungi are concentrated on the surface of gallery walls. Larvae and adult beetles feed on the nutrient-rich spores and fungal mycelia. Because the fungi require adequate moisture in the wood to grow, beetles do not attack trees that have dried much beyond 40 percent wood moisture content. There may be three or more overlapping generations of ambrosia beetles per year.

Importance: Low. Although not a serious threat to forest health, ambrosia beetles can degrade the value and strength of logs and lumber (Fig. 7). Interestingly, the darkly stained galleries and networks of fine tunnels formed by ambrosia beetles are prized by many woodworkers for their uniqueness (Fig. 2).

Management: Rapid harvesting and utilization of dead and dying trees, fresh cut logs, and lumber will reduce infestations and the severity of wood degradation. Living trees infested by ambrosia beetles will likely not survive, and should be removed if they present a hazard. Be aware that ambrosia beetles can attack isolated branches and wounds; these infestations are not a threat to tree health. Control is not recommended in forest or landscape situations because the beetles will not attack even moderately healthy trees.

Timeline: Beetles will be active throughout the growing season.

Range: Statewide.

Fig. 1 Examples of ambrosia beetles

Fig. 2 Infested wood

Fig. 3 Sawdust accumulation

Fig. 4 Frass toothpicks

Fig. 5 Eggs and larvae in gallery

Fig. 6. Stained gallery entrances

Fig. 7 Galleries in cross-section

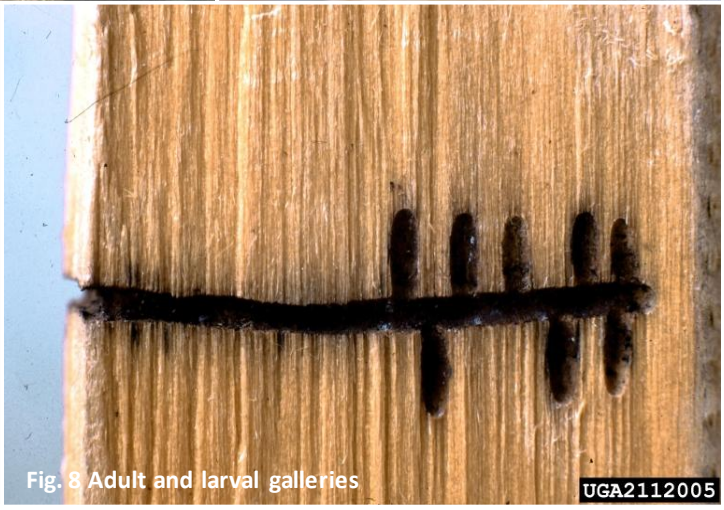

Fig. 8 Adult and larval galleries

Asian Longhorned Beetle

Overview: The Asian longhorned beetle is a serious threat to many hardwood species. First introduced in solid wood packing material from Asia in the mid-1990's, this non-native invasive insect has since been discovered in Illinois, New York, New Jersey, Massachusetts, and Ohio. Populations have been relatively contained and eradication efforts have been moderately successful in limiting its spread, but the Asian longhorned beetle has yet to be completely eradicated from the U.S. This insect has the potential to cause more damage than Dutch elm disease, chestnut blight, and the gypsy moth combined. Suspected infestations of the Asian long-horned beetle should be reported immediately to NCFS Forest Health staff.

Causal Agent: Asian longhorned beetle (*Anoplophora glabripennis*)

Hosts: Complete host range unknown, but dozens of hardwood species are known to be susceptible. Preferred hosts include maple, willow, horsechestnut, buckeye, elm, birch, sycamore, hackberry, ash, and aspen. Also known to be susceptible are apple, mulberry, cherry, plum, pear, oak, and black locust.

Symptoms / Signs: Detection of new infestations is difficult because newly infested trees exhibit few, if any, external symptoms. Egg laying sites are round, dime-sized depressions that may be visible on bark (Fig. 6). Round, pencil-sized exit holes left by emerging adult beetles may be seen on the branches or trunk (Fig. 4). Oozing frothy or foamy sap may be seen exuding from exit holes; frass and coarse sawdust accumulate at the base of heavily infested trees and in bark crevices (Fig. 5). External bark cracking may be observed surrounding galleries in the inner bark. Removal of bark from infested trees may reveal the winding, coarse frass-filled larval galleries that etch the outer sapwood and inner bark. Galleries penetrate into the sapwood and heartwood as larvae mature. As larvae continue to feed and populations increase, wilting foliage, premature leaf drop, crown thinning, and branch dieback will occur (Fig. 7). When infestations are severe, bark will become separated from the sapwood (Fig. 8). Trees can be killed several years after the initial infestation.

The Asian longhorned beetle is about 1 to 1½ inches long, jet black (with possible bluish tinge), shiny, and has up to 20 distinct white spots. Antennae are very long with black and white bands. Males are slightly smaller than females; female antennae are only about as long as their body (Fig. 1). Larvae may exceed 2 inches in length when fully grown, are white to cream colored, are distinctly segmented, and have a dark set of large distinct mandibles (Fig. 2). The thorax of larvae has a brown shield on the back.

Life Cycle: Asian longhorned beetles can fly up to 400 yards in search of a host tree. The females usually lay their eggs in the same tree from which they emerged as adults, migrating only when the population density becomes too high. During the summer months, the adult female chews 35 to 90 individual depressions into the host tree's bark and lays an egg in each. Eggs hatch in 10-15 days and the larvae tunnel into the tree's inner bark to feed for several weeks. The larvae tunnel deeper in the tree's sapwood and heartwood where they mature and pupate (Fig. 3). Pupae become adults inside the tree during the winter months. The full-grown adult beetles bore out of the tree the following spring or summer leaving a 3/8 inch round exit hole; emergence occurs as early as May and as late as October or November. Adults feed on leaves, twigs, and on tender bark in branch crotches for several weeks before mating and laying eggs. There is one generation per year in the northern United States.

Importance: High. Dozens of hardwood species are threatened. The economic and ecological impact of widespread infestations is unknown, but is expected to be catastrophic.

Management: Avoid interstate movement of firewood which can introduce the Asian longhorned beetle to new areas and accelerate its spread. Quarantines are in effect in and around currently infested areas which prevent movement of wood, logs, and living trees out of the area. Dead or dying infested trees should be removed immediately and destroyed. Systemic insecticides can be used to protect trees from attack or eradicate beetles from lightly infested trees.

Timeline: Beetles are active throughout the growing season.

Range: Northeastern United States. Not currently found in North Carolina. Potential impact statewide.

Fig. 1 Asian longhorned beetle UGA5023075

Fig. 2 Larva UGA1398107

Fig. 3 Galleries in cross-section UGA3225082

Fig. 4 Exit holes UGA5017010

Fig. 5 Frass 5392759

Fig. 6 Egg site UGA5016096

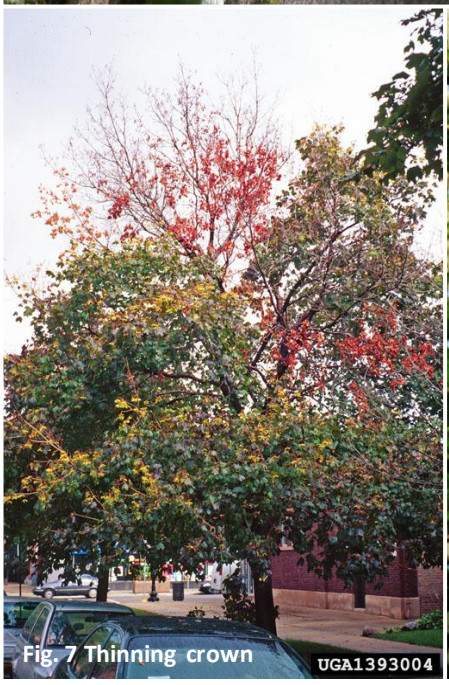

Fig. 7 Thinning crown UGA1393004

Fig. 8 Girdled tree UGA1393006

Emerald Ash Borer

Overview: The emerald ash borer is a non-native invasive forest pest that was first discovered in Michigan in 2002; it probably arrived in the U.S. in solid wood packing material from Asia. The larvae feed on the inner bark of ash trees and disrupt their ability to transport water and nutrients. Trees decline and die over a period of several years. Tens of millions of ash trees have been killed since its introduction, and the emerald ash borer threatens billions of others across the U.S. and Canada. The beetle can only spread a few miles per year naturally; however, movement of this pest in firewood has accelerated dispersal across much of the northeastern U.S. If emerald ash borer is suspected, it should be reported to NCFS Forest Health Staff immediately.

Causal Agent: Emerald ash borer (*Agrilus planipennis*)

Hosts: All ash species are highly susceptible.

Symptoms / Signs: Detection of new infestations is difficult because newly infested trees exhibit few, if any, external symptoms. Increased woodpecker activity may be the first sign that a tree is infested. D-shaped exit holes left by emerging adult beetles may be seen on branches or the trunk. Bark may split vertically adjacent to larval feeding galleries (Fig. 10). Epicormic sprouts may form on the trunk or large branches (Fig. 9). Removal of bark from infested trees may reveal the winding, frass-filled larval galleries that etch the outer sapwood and inner bark (Fig. 4&5). Discolored sapwood may result from opportunistic fungi around galleries. As larvae continue to feed and populations increase, wilting foliage, premature leaf drop, crown thinning, and branch dieback will occur (Fig. 8). Many trees will lose between 30 and 50 percent of their canopy within a few years of the initial infestation, and die within 3-4 years. Although stressed trees are initially more attractive than healthy trees, when populations are sufficient, all ash trees greater than 1½ inches in diameter will be attacked.

Adult beetles are slender and 1/4 to 1/2 inch long (Fig. 1&2). Males are generally smaller than females. Adults are usually bronze, golden, or reddish green overall, however, their metallic emerald green wing covers give them an overall green appearance when they are at rest. The top of the abdomen is metallic purple-red and can be seen when the wings are spread (Fig. 3); this characteristic distinguishes the emerald ash borer from all other insects that are otherwise similar in appearance. The prothorax, the segment just behind the head, is slightly wider than the head and the same width as the base of the wing covers. Larvae when fully grown are 1¼ inches long, white to cream-colored, have distinctly bell-shaped body segments, and are flattened in appearance (Fig. 6). They have a brown head that is retracted into the prothorax so that only the mouthparts are visible. The abdomen has 10 segments, and the last segment has a pair of small, brown, pincer-like appendages.

Life Cycle: Research suggests there would be one generation per year in North Carolina. Adult beetles begin to emerge in spring; activity peaks between mid June and early July, and continues through August. Adult beetles only live for three weeks on average. They are most active during the day, particularly when it is warm and sunny, and feed on ash foliage leaving small, irregularly shaped holes along the leaf margins. Adults feed for several weeks before mating and each female can lay more than 100 eggs during her short lifespan. Eggs are deposited individually in bark crevices or under bark flaps on the trunk or branches. Eggs hatch in 7 to 10 days and the new larvae chew through the bark and into the inner bark where they feed for several weeks. As the larvae grow, their galleries become progressively wider and etch the outer sapwood. Feeding is completed in autumn, and fully grown larvae overwinter in shallow chambers in the sapwood. Pupation begins in late April or May; adults emerge several weeks later through D-shaped exit holes that are about 1/8 inch diameter (Fig. 7).

Importance: High. The survival of all native ash species in North America is threatened by this pest.

Management: Avoid interstate movement of firewood which can introduce the emerald ash borer to new areas and accelerate its spread. Dead or dying infested trees should be removed immediately and destroyed. Systemic insecticides can be used to protect trees from attack or eradicate beetles from lightly infested trees. Insecticide treatments are costly and require reapplication every 1-2 years.

Timeline: Beetles will be active throughout the growing season.

Range: Northeastern and Midwest U.S.; has not been found in North Carolina. Potential statewide impact.


Fig. 1 Emerald ash borer UGA9000019


Fig. 2 Emerald ash borer 5369161


Fig. 3 Emerald ash borer UGA2100048


Fig. 4 Galleries UGA5147090


Fig. 5 Galleries 5382317


Fig. 6 Larva UGA5016056


Fig. 7 D-shaped exit holes UGA5016052


Fig. 8 Thinning crown UGA5038047


Fig. 9 Epicormic sprouting UGA5022037


Fig. 10 Bark splitting UGA1241005

Sirex Woodwasp

Overview: The Sirex woodwasp is a non-native invasive forest pest introduced from Europe, Asia, and Northern Africa. Although only recently introduced to the northeastern U.S. and not currently causing widespread mortality, there is serious reason for concern. The Sirex woodwasp has spread to South America, South Africa, New Zealand, and Australia where it causes more than 80 percent mortality in stands planted with North American pine species (including several species of southern pine). Spread of this wasp into the southern U.S. could have disastrous consequences. The adult wasp injects a pathogenic fungus and toxic mucus during oviposition that kills the tree. Wasp larvae bore through the wood and feed on the fungus. Because the larvae bore deep into the sapwood, the Sirex woodwasp is often transported in solid wood packing material and it is the most common exotic species of woodwasp found at ports of entry. Suspected infestations of the Sirex woodwasp should be reported immediately to NCFS Forest Health staff.

Causal Agent: Sirex woodwasp, also known as the European woodwasp (*Sirex noctilio*)

Hosts: Complete host range is unknown, but all southern pine species are potentially susceptible. Infestations have been confirmed in loblolly, slash, and shortleaf pines in other countries.

Symptoms / Signs: Trees usually wilt and die within 3-6 months of the initial attack. Foliage of infested trees initially wilts, hangs straight down, and changes color from green to yellow to red and brown (Fig. 3). Resin beads may form at and drip from egg laying sites, which are most common on the mid-stem (Fig. 5). Discolored sapwood that has been killed by a toxic mucus and wood rotting fungus may be visible beneath the bark around oviposition sites.

Adult wasps are approximately 1 to 1½ inches long, have a cylindrical body, and black antennae. Females have a metallic blue or black head and body with orange legs, (Fig. 1) and a long spike-like projection at the end of the abdomen. Males have a metallic blue head and thorax, the abdomen is orange with black at the base and tail end, and the hind legs are black (Fig. 2). Larvae are creamy-white cylindrical grubs over an inch long with a dark spine at the end of the abdomen (Fig. 7). Larval galleries are winding or serpentine, are approximately 3/8 inches wide, and are usually tightly packed with reddish-gold sticky frass (Fig. 6). Round exit holes (1/8 – 3/8 inches wide) may riddle the main stem on heavily infested trees (Fig. 4). Because there are many native species of woodwasps (horntails) that are similar in appearance, suspected Sirex woodwasps should be submitted to Forest Health staff for identification.

Life Cycle: There are dozens of species of horntails in the U.S., but they only attack dead or dying trees. Sirex woodwasps, while they prefer stressed and suppressed trees, are able to overcome the defenses of even healthy pines when populations are high. Adults emerge from July through September with peak emergence in August. Females are attracted to stressed trees. They drill their ovipositors into the outer sapwood and inject a symbiotic fungus (*Amylostereum areolatum*), a toxic mucus, and up to 450 eggs. The fungus and mucus act together to kill the tree and create a suitable environment for larval development. Unfertilized eggs develop into males, while fertilized eggs produce females. The larval stage lasts approximately 10 months, during which they feed on the fungus as they tunnel through the wood. Mature larvae pupate close to the bark surface. Adults emerge about 3 weeks later.

Importance: High. The Sirex woodwasp could have devastating consequences on the pine forests of the South.

Management: There is currently a quarantine against transport of untreated wood (packing material, firewood, untreated lumber, mulch, Christmas trees, etc.) and living pines from states known to have Sirex infestations. Preventing the introduction of this pest into North Carolina is critical because few control options are available. The Sirex woodwasp has been successfully managed using a parasitic nematode that infects sirex woodwasp larvae and ultimately sterilizes the adult females. These infected females emerge and lay infertile eggs that are filled with nematodes, which sustain and spread the nematode population. The nematodes effectively regulate the woodwasp population below damaging levels.

Timeline: Adults emerge in the summer and early fall; feeding by larvae occurs year-round.

Range: Northeastern U.S. (Fig. 8); has not been found in North Carolina. Potential statewide impact.


Fig. 1 Sirex woodwasp female 5369885


Fig. 2 Sirex woodwasp male UGA1414001


Fig. 3 Wilting UGA1393018

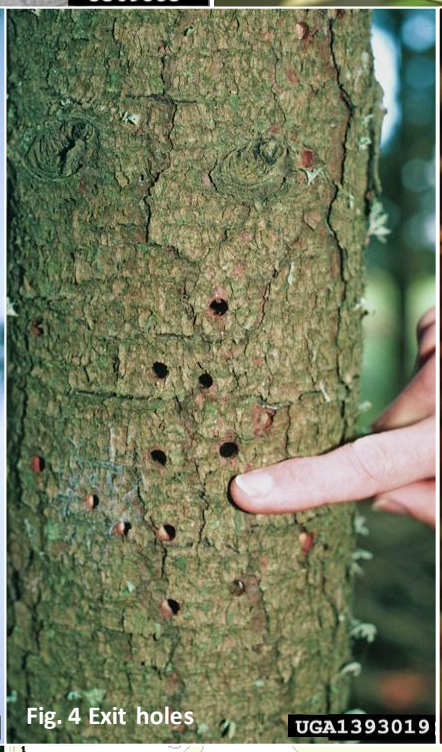
Fig. 4 Exit holes UGA1393019


Fig. 5 Resin UGA1393029


Fig. 6 Larval galleries UGA1349004


Fig. 7 Larva UGA1393017

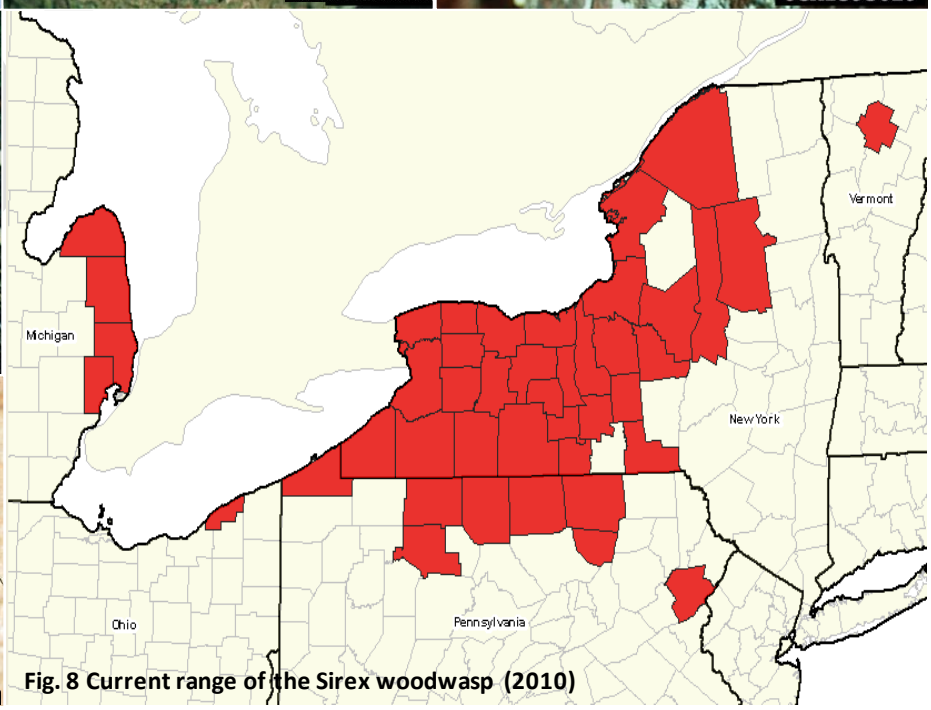

Fig. 8 Current range of the Sirex woodwasp (2010)

Pales Weevil

Overview: The Pales weevil is the most important and destructive forest pest of pine seedlings; during outbreaks, mortality in new plantings often exceeds 50 percent. The weevil has become a serious problem because of the silvicultural methods commonly utilized for pine management: mainly, the practice of planting seedlings in recently cutover stands of pine. Weevil larvae feed in fresh logging slash, dead root systems, and even dead standing trees. Adult weevils feed on the tender bark of young seedlings upon emerging from logging slash. Therefore, new plantings in cutovers are often placed in close proximity to high populations of weevils and severe infestations result. Plantings can be timed to avoid attack, and insecticides are commonly applied in seedling nurseries before shipment of seedlings into the field.

Causal Agent: Pales weevil (*Hylobius pales*)

Hosts: All southern pine species are susceptible.

Symptoms / Signs: Adult weevils prefer to feed on the lower stem of seedlings near the soil line. Feeding sites are small, irregular patches where the bark has been nibbled off and may darken over time. Resin may dry and crystallize on the wound giving the stem a sugar-coated appearance (Fig. 2). If the seedling is girdled, foliage will rapidly turn from green to yellow to red to brown. Needles may be shed as the seedling dries out. During heavy infestations, bark can be stripped from large portions of the stem or even the entire seedling.

The Pales weevil is approximately 1/4 inch long, reddish-brown, and has a long trunk-like snout. Small patches of yellowish-white hairs speckle the wing covers (Fig. 1). The adults feed at night and hide in leaf litter or below the soil line during the day (Fig. 3), so the presence of this pest is usually confirmed by feeding damage rather than direct observation of the weevil itself. Larvae are found in logging slash, root systems of cut trees, and recently killed trees. They are nearly 1/2 inch long when fully grown, creamy-white in color, and have a reddish-orange head. Larval galleries are several inches long and wind through the inner bark (Fig. 4). Pupation chambers and surrounding galleries will be packed with frass and coarse sawdust.

Life Cycle: Adult weevils overwinter in the soil, although they may be active during the winter months when temperatures rise above 50º F. In spring, adults emerge from the soil and are attracted to fresh cut stumps and logging debris, where they mate and lay eggs. Females burrow into the soil and nibble small egg niches in the roots, stumps, and buried logging debris; several eggs are laid in each niche. Larvae hatch in 1-2 weeks and feed on the inner bark for several months. Before pupation, larvae create a pupal chamber stuffed with frass and coarse sawdust. If eggs are laid before July, adults will emerge in late summer or early fall and feed on the tender bark of seedlings or twigs on larger trees. If eggs are laid after July, larvae will overwinter in their galleries and emerge as adults the following spring. There is only one generation per year.

Importance: Moderate. Large infestations can be destructive to new plantings, but insecticide-treated seedlings and proper forest management can effectively reduce the risk.

Management: Seedlings treated with an insecticide before planting are protected from heavy attacks, although minor feeding damage can be expected because the weevils must ingest the insecticide to be killed. If stands are harvested after the end of June, planting should be delayed for one entire growing season; adult weevils will emerge the spring after harvesting, and if seedlings have been planted, they may be attacked. In stands harvested before July, adult weevils will emerge from logging debris in the fall and disperse in search of seedlings.

Timeline: Weevils are active throughout the growing season and even during winter months when temperatures occasionally warm. Adult weevils generally prefer to lay eggs in logging debris that is less than one year old. Adults will emerge in the same growing season if eggs are laid prior to July. Adults will emerge the following spring if eggs are laid after June.

Range: Statewide.

Fig. 1 Pales weevil

Fig. 2 Girdled seedling

Fig. 3 Feeding adults

Fig. 4 Larval alleries in cut stump

Nantucket Pine Tip Moth

Overview: Nantucket pine tip moth larvae bore into and kill the growing shoots of southern pines. While trees are rarely killed even by heavy infestations, economic losses can result from growth loss and deformed main stems. Tip moth outbreaks are most common and severe in pine plantations less than five years old. Wide spaced plantings are preferred, but as crowns close and trees increase in height, attacks become rare. This insect also attacks female flowers and developing cones, so it can be a serious concern in seed orchards.

Causal Agent: Nantucket pine tip moth (*Rhyacionia frustrana*)

Hosts: Southern pines; longleaf, slash, and eastern white pine are considered to be resistant but may be attacked when populations are high.

Symptoms / Signs: Attacks are generally limited to trees less than 5 years old; trees taller than 12 feet are rarely attacked. Needles on infested shoots will yellow and turn brown (Fig. 4); shoots will die and curl over (Fig. 2). Severity of symptoms is dependent on the progress of larvae through the shoot. Symptoms may be limited to only a few inches at the end of shoots, or may extend for a foot or more. Terminal shoots and rapidly growing main laterals are preferred. When terminal shoots are killed, adjacent laterals will compete for dominance giving rise to deformed trees with multiple stems or leaders (Fig. 6).

Breaking open killed shoots will reveal a hollow feeding gallery running down the center of the shoot. When fully grown, larvae are almost 1/2 inch long, light brown to orange-red, and worm-like (Fig. 3). Younger larvae are paler in color and have black heads. Moths have a 1 inch wing span, a gray head and body, and wings that are reddish-orange or copper in color (Fig. 1).

Life Cycle: The moth overwinters as a pupa within the killed shoot. Emergence occurs in late winter or early spring; moths mate and lay flattened eggs at the base of needles or in bud scales. Young larvae may feed on needles and the surface of young succulent shoot growth, but then proceed to the shoot tip and begin to mine through buds or stem tissue. Pupation occurs at the bottom of the mined shoot (Fig. 5). There are 3-5 generations per year in North Carolina.

Importance: Moderate. Serious injury to trees is rare, even during heavy infestations. Trees can experience growth reduction and may be deformed by loss of terminal shoots.

Management: Insecticides are available but usually unnecessary unless infestations are unusually severe. Young trees will fully recover; growth loss and deformity is usually minimal. Chemical applications may be necessary to protect high value seed trees, landscape trees, and ornamentals. Chemical applications must be timed properly to target each generation of moths.

Timeline: Adults emerge in late winter or early spring. Larvae feed throughout the growing season.

Range: Statewide.


Fig. 1 Nantucket pine tip moth adult
UGA0485016


Fig. 2 Damaged shoot
UGA0795067a


Fig. 3 Larva
UGA0485019


Fig. 4 Attacked sapling
UGA1470066


Fig. 5 Pupa
UGA1236040


Fig. 6 Deformed growth
UGA1247118

Twig Pruners and Girdlers

Overview: Twig girdlers and twig pruners are a general term for wood boring beetles whose larvae tunnel through twigs of many hardwood species. As a result, twigs become almost completely severed and may eventually break and fall off. Although this activity rarely kills trees, it can significantly slow growth and alter tree form. Loss of terminal shoots can lead to sprouting and competition for dominance by lateral shoots leading to multi-stemmed trees lacking a main leader. Twig pruner larvae sever the twig from the inside, whereas twig girdler adults sever the twig from the outside at the time of egg laying.

Causal Agent: Several beetle species including the twig pruner (*Anelaphus villosus*) and the twig girdler (*Oncideres cingulata*)

Hosts: Hardwoods. The twig pruner prefers oak, chestnut, hickory, pecan, maple, flowering fruit trees, redbud, sweetgum, sassafras, persimmon, and elm. The twig girdler attacks elm, oak, redbud, apple, hickory, pecan, persimmon, aspen, locust, and dogwood.

Symptoms / Signs: Abundant small branches and twigs laying on the ground below susceptible host trees late in the growing season are an indicator of twig pruner or girdler activity. If the twigs are more or less clean cut, it is most likely the twig pruner; if the twigs have a broken central core then twig girdlers may be responsible. Twigs 1/4 to 2 inches in diameter are normally attacked. Heavily infested trees may have many attached branches with wilting/browning foliage giving the tree a drought-stricken appearance.

Twig pruner larvae may be found within broken or fallen twigs; they are a creamy-white colored round-headed borer with long yellow hairs primarily on the thorax. Adults are 1 to 1½ inches long, elongated, with brown bodies, gray speckles, and long antennae (Fig. 6). Larvae leave distinct concentric circular cuts from the inside of the twig, leaving only bark to hold the branch in place; eventually the bark gives way and the twig falls to the ground. Fully grown twig girdler larvae are creamy white, are less than an inch long, and are found in fallen twigs throughout the winter, spring, and summer. Adults emerge in the fall and are drab gray longhorned beetles less than 1 inch in length (Fig. 2).

Life Cycle: Adult twig pruners emerge in spring and lay eggs in small bark niches at the base of leaf petioles. Larvae hatch and immediately bore into the center of the twig; then they tunnel down the twig towards the base. The twig will remain alive and often asymptomatic until the fall when larvae begins to move into the sapwood by making expanding circular cuts towards the bark. Only the bark holds the twig together (Fig. 5). Before the twig breaks off, the larvae backs up into the end of the twig and plugs the hole with frass and sawdust. The larvae feed in fallen twigs throughout the fall and overwinter as pupae. The adult emerges from the hollowed out branch in the spring. There is one generation per year.

Twig girdler adults are active in late summer and early fall. Females lay eggs in small slits in the bark of terminal twigs or lateral twigs; up to a dozen eggs may be laid in each twig. Females then chew a thin continuous notch around the twig below the eggs to girdle it (Fig. 2). The twigs die shortly thereafter and fall to the ground (Fig 4). Eggs hatch before the onset of winter, but larvae do not begin to feed until spring when they tunnel into the cut end of the twig and feed on the sapwood throughout the summer. They create small holes in the bark to expel frass (Fig. 3). Larvae pupate and emerge as adults in September. There is one generation per year.

Importance: Low. However twig girdler/pruner activity can slow growth, and more importantly, disfigure young trees considerably. In forested situations, activity can be expected but will usually be below acceptable thresholds. Damage can be severe to landscape trees and ornamentals.

Management: Broken twigs can be gathered and destroyed in the fall to prevent girdler/pruner activity the following year.

Timeline: Adult girdlers emerge in the fall; young larvae are dormant during the winter and feed throughout the following growing season. Adult pruners emerge in the spring; larvae feed through the growing season and overwinter as pupae. Twigs will begin to die and fall off in the fall.

Range: Statewide.

Fig. 1 Twig girdler

Fig. 2 Girdler

Fig. 3 Twig girdler larva

Fig. 4 Girdled twigs

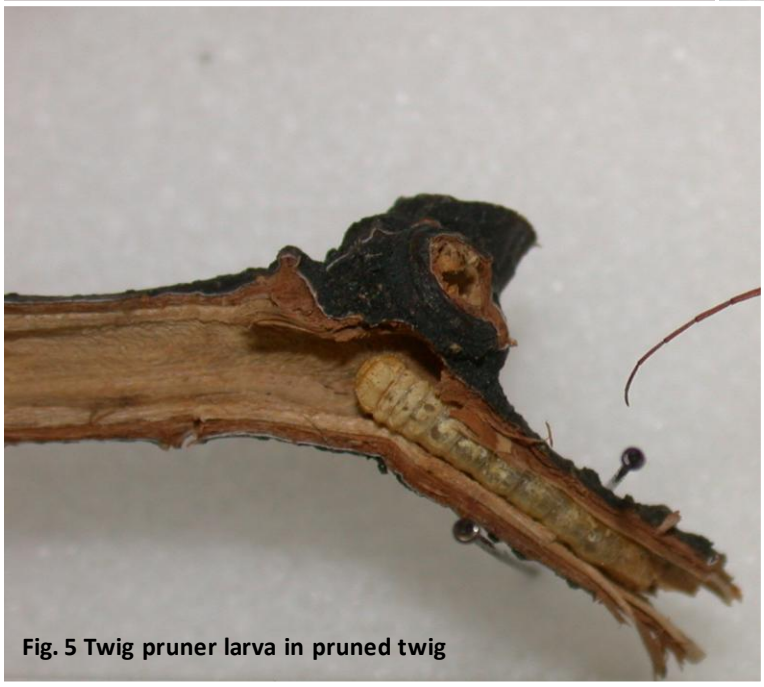

Fig. 5 Twig pruner larva in pruned twig

Fig. 6 Twig pruner